Federal Aviation Administration

N A R P

2010 National Aviation Research Plan

February 2010

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

2010 NARP
February 2010

The *National Aviation Research Plan* (NARP) is a report of the Federal Aviation Administration to the United States Congress pursuant to 49 United Sates Code 44501(c). The NARP, related appendices, and the *R&D Annual Review* may be found online at www.faa.gov/go/narp.

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Executive Summary

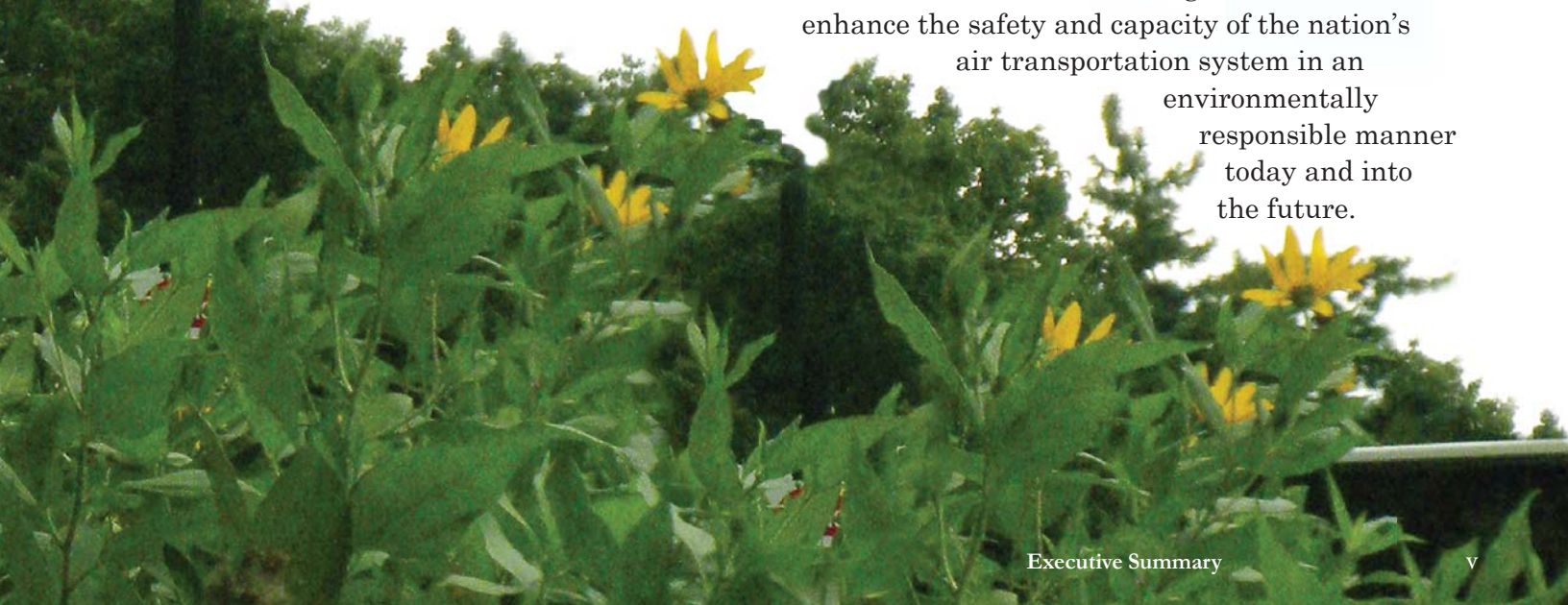
The benefits derived from a highly mobile citizenry and rapid cargo transport dictate that America's air transportation system remains the best in the world. Being the best requires the constant introduction of new technologies and procedures, innovative policies, and advanced management practices into the aviation system as well as sustained investments in advanced research and technology development. The *National Aviation Research Plan* (NARP) is the Federal Aviation Administration's (FAA's) performance-based plan to ensure that its research and development (R&D) investments are well managed, deliver results, and are sufficient to address national priorities.

To do this, the NARP uses ten crosscutting R&D goals to bridge the near-term *FAA 2009-2013 Flight Plan* performance goals and objectives, the mid-term (2012-2018) *FAA's Next Generation Air Transportation System* (NextGen) *Implementation Plan* domains and solution sets, and the far-term (2015-2025) goals and capabilities identified in the Joint Planning and Development Office (JPDO) *NextGen Integrated Work Plan Executive Summary, Version FY12*, (IWP) for the year 2025. This approach enables FAA to address the current challenges of operating the safest, most efficient air transportation system in the world while conducting the research needed to transform it into NextGen in the mid- and far-term. The ten R&D goals also help FAA focus its R&D on the biggest challenges facing the air transportation system, identify gaps in research, leverage R&D across the Agency, and measure progress toward achieving R&D targets for each goal. The targets are aggressive and challenge researchers to innovate, take risks, and seek non-traditional solutions.

This year, as we celebrate 25 years of the NARP, it is appropriate to reflect on what has been done and what is yet to do. There still remain significant challenges requiring R&D to support the nation's air transportation system today and in the future.

The 2010 NARP presents an established research plan that highlights the results of the research and describes how FAA R&D programs are progressing toward achieving the R&D targets through 2016. This year's NARP maintains continuity with the previous R&D goals and the milestones supporting those goals. It shows that in fiscal year 2011 FAA plans to invest a total of $366,046,000 in R&D. This investment spans the four FAA appropriations: $190,000,000 in Research, Engineering, and Development (R,E&D); $133,664,000 in Facilities and Equipment (F&E); $42,217,000 in the Airport Improvement Program (AIP); and $165,000 in Operations (Ops). The R&D portfolio is composed of 42 programs that address the research needs of 5 FAA lines of business: the Air Traffic Organization, Aviation Safety, Airports, the Aviation Policy, Planning and Environment Office, and Commercial Space Transportation. The 2010 NARP highlights 183 key milestones that show the importance of R&D to the goals of the Agency. Of those milestones, 76 support the implementation of NextGen.

The 2010 NARP describes how FAA continues to be a good steward of the public's investments in aviation R&D while delivering results that will enhance the safety and capacity of the nation's air transportation system in an environmentally responsible manner today and into the future.



Preface

Title 49 of the U.S. Code section 44501(c) requires the Administrator of the Federal Aviation Administration (FAA) to submit the *National Aviation Research Plan* (NARP) to Congress annually with the President's Budget. The Plan includes both applied research and development as defined by the Office of Management and Budget (OMB) Circular A-11* and involves research activities funded in four appropriations accounts: Research, Engineering and Development; Facilities and Equipment; Airport Improvement Program; and Operations.

The issuance of the 2010 NARP marks the 25th anniversary of this publication. Twenty-five years ago, in October 1985, the FAA published the first research and development plan for the Agency titled *The Federal Aviation Administration Plan for Research, Engineering, and Development*. Then FAA Administrator, Donald D. Engen, wrote in the cover letter "This research, engineering, and development (RE&D) plan has been developed by the Federal Aviation Administration to meet the challenges that face the National Airspace System (NAS) through the year 2010."

Now it is 2010, and the FAA faces many new challenges moving into the Next Generation Air Transportation System (NextGen). However, at the macro level, many research drivers, such as weather and human factors, remain the same as they were in 1985. Air traffic control (ATC) modernization was a high priority, then under the banner of NAS Modernization, and now as ATC transformation under the banner of NextGen. And of course, aviation safety has been and will always be the major focus for the FAA, in our research programs and in our operations.

What is different in 2010 is the level of technology available to address the current challenges, the technology that will become available based on today's research and development (R&D) efforts, and the fast pace at which that technology changes. One of the current challenges is how to safely and efficiently take advantage of rapid changes in technology, such as advanced software and digital systems, both in the aircraft and in air traffic operations.

Twenty-five years ago noise impact issues were at the forefront of aviation environmental research. Today, although noise impact issues remain a major research focus, climate change and the need for a sustainable and secure energy supply have also become key drivers of aviation environmental and energy research.

The 2010 NARP describes the FAA's research portfolio that will address today's needs while laying the foundation to address the needs of NextGen. The plan will highlight selected examples describing research done in 1985 and what is ongoing today.

Chapter 1 provides an overview of the national aviation system mission, vision, and goals that help FAA define its R&D needs. It has been

* OMB Circular A-11, "Preparation, Submission and Execution of the Budget," August 7, 2009, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

updated to reflect changes in NextGen planning and reflects the importance of the near- and mid-term implementation in the NextGen Implementation Plan (NGIP) and FAA Enterprise Architecture (EA) as well as the far-term goals in the JPDO *Next Generation Air Transportation System Integrated Plan*.

Chapter 2 includes a master schedule and a high-level plan for each of the ten FAA R&D goals. It integrates the R&D programs with FAA's R&D goals and details how those programs will achieve the R&D targets. It explains how the R&D targets will be validated and what milestones are required to achieve each target. The chapter includes a summary of the progress in fiscal year 2009 for each R&D goal.

Chapter 3 describes how FAA NextGen R&D programs map to the domains and solution sets in the NGIP and the operational improvements in the IWP. FAA NextGen R&D programs and budget are the relevant subset of information presented in Chapter 2.

Chapter 4 provides business information on the R&D sponsors, programs, budget, partnerships, and evaluation. It presents the programs and the budget organized according to the President's budget submission for fiscal year 2011.

Appendix A provides the detailed program descriptions for each R&D program, including intended outcomes, outputs, programmatic structure, partnerships, accomplishments, and a five-year program plan.

Appendix B provides detailed information on FAA partnerships with government, academic, and industry organizations. It lists information for fiscal year 2009, including active agreements with other government agencies, cooperative R&D agreements, patents, and grants. This appendix supports the partnership section in Chapter 4.

Appendix C provides the recommendations of the Research, Engineering, and Development Advisory Committee (REDAC) listed according to the reports produced by the committee in fiscal year 2009. The FAA response to each recommendation is included. This appendix supports the evaluation section in Chapter 4.

Appendix D is a new appendix that provides a summary of all changes to the milestones in Chapter 2, with explanations for the changes. The appendix is aligned with the ten R&D goals in Chapter 2 to provide the reader complete transparency and maintain continuity with previous editions of the NARP.

Appendix E provides a list of acronyms and abbreviations used in the 2010 NARP and its appendices.

All appendices are included in a separate volume from the main body of the 2010 NARP.

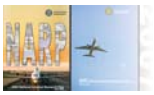
A companion document to the 2010 NARP, the *R&D Annual Review*, describes the accomplishments of the R&D programs in the fiscal year 2009. It aligns the accomplishments with the ten R&D goals presented in Chapter 2 of the NARP and the programs described in Appendix A.

Chapter One

National Aviation System

Aviation is a vital resource for the United States because of its strategic, economic, and social importance. The aviation industry provides opportunities for business, jobs, economic development, law enforcement, emergency response, personal travel, and recreation. It attracts investment to local communities and opens new domestic and international markets and supply chains.

To maximize these opportunities, the United States must maintain and improve upon an aviation system that is responsive to its rapidly changing and expanding transportation needs while ensuring the highest level of safety. Increased mobility, higher productivity, and greater efficiency are possible through the introduction of new technologies and procedures, innovative policies, and advanced management practices. Collaborative, needs-driven research and development (R&D) is central to this process. R&D enables the United States to be a world leader in its ability to move people and goods by air safely, securely, quickly, affordably, efficiently, and in an environmentally sound manner.



Mission

The Federal Aviation Administration (FAA) mission is to provide the safest, most efficient aerospace system in the world. The nation's air transportation system provides a service: it moves anyone and anything (e.g., people, goods, aerospace vehicles) through the atmosphere between points on the earth's surface and between the Earth and space. It does this for a wide range of users (e.g., passengers, shippers, general aviation) and purposes (e.g., business and personal travel, law enforcement, defense, emergency response, surveillance, research).

The system is global, operates day and night, in peacetime and wartime, and in all but the most severe weather conditions. It consists of three major elements: aerospace vehicles (e.g., commercial, military, and unmanned aircraft, general aviation, space launch and re-entry vehicles, rotorcraft, gliders, hot air balloons); infrastructure (e.g., airports and airfields, air traffic management systems, space launch and re-entry sites); and people (e.g., aircrews, air traffic controllers, system technicians, ground personnel). Because the role and interactions of all of these elements determine the nature and performance of the system, it is important to consider all elements simultaneously in designing, developing, and operating the system.

The air transportation system is designed, developed, maintained, and operated through the efforts of various federal, state, and local government organizations; industry; labor unions; academia; and other domestic and international organizations. The public also plays a key role by paying taxes and fees that are ultimately used by the government to regulate the aviation industry; develop, maintain, and operate the air traffic management system; and provide airport security and other public aviation services.

In November 2003, the Secretary of Transportation set forth a vision to transform the nation's air transportation system into one that is substantially more capable of ensuring America maintains its leadership in global aviation. That vision, created by the U.S. Departments of Defense (DoD), Transportation (DOT), Homeland Security (DHS), and Commerce (DOC); the FAA; the National Aeronautics and Space Administration (NASA); and the President's Office of Science and Technology Policy (OSTP), is "A transformed aviation system that allows all communities to participate in the global marketplace, provides services tailored to individual customer needs, and accommodates seamless civil and military operations."*

To realize this vision, the air transportation system must accommodate an increasing number and variety of aerospace vehicles (e.g., unmanned aircraft systems, very light jets), a broader range of air and space operations (e.g., point-to-point, space launch and re-entry), and a variety of business models (e.g., air taxis, regional jets). It will do this across all airspace, at all airports, space launch and re-entry sites, and in all weather conditions, while simultaneously improving system performance and ensuring safety and security.

To achieve this vision, the Secretary of Transportation established a set of far-term national goals to transform the current aviation system by 2025 into a next generation air transportation system (NextGen) that will contribute substantially to continued economic prosperity, national security, and a higher standard of living for all Americans in the 21st century. These national goals are:

- Enhancing economic growth and creating jobs
- Expanding system flexibility and delivering capacity to accommodate future demand
- Tailoring services to customer needs
- Integrating capabilities to ensure our national defense
- Promoting aviation safety and environmental stewardship
- Retaining U.S. leadership and economic competitiveness in global aviation

* Letter to the President from Secretary of Transportation Norman Y. Mineta, "America at the Forefront of Aviation: Enhancing Economic Growth," November 25, 2003.

FAA Plans

The FAA uses complimentary planning documents, each developed and used for different purposes, to manage elements of its business. The scope of each document differs, as do their respective timescales for planning and action development. The FAA ensures compatibility and consistency between these documents. Figure 1.1 illustrates the relationship between the respective planning documents. The target and intent of the plans that are relevant to the FAA's R&D programs are described after Figure 1.1.

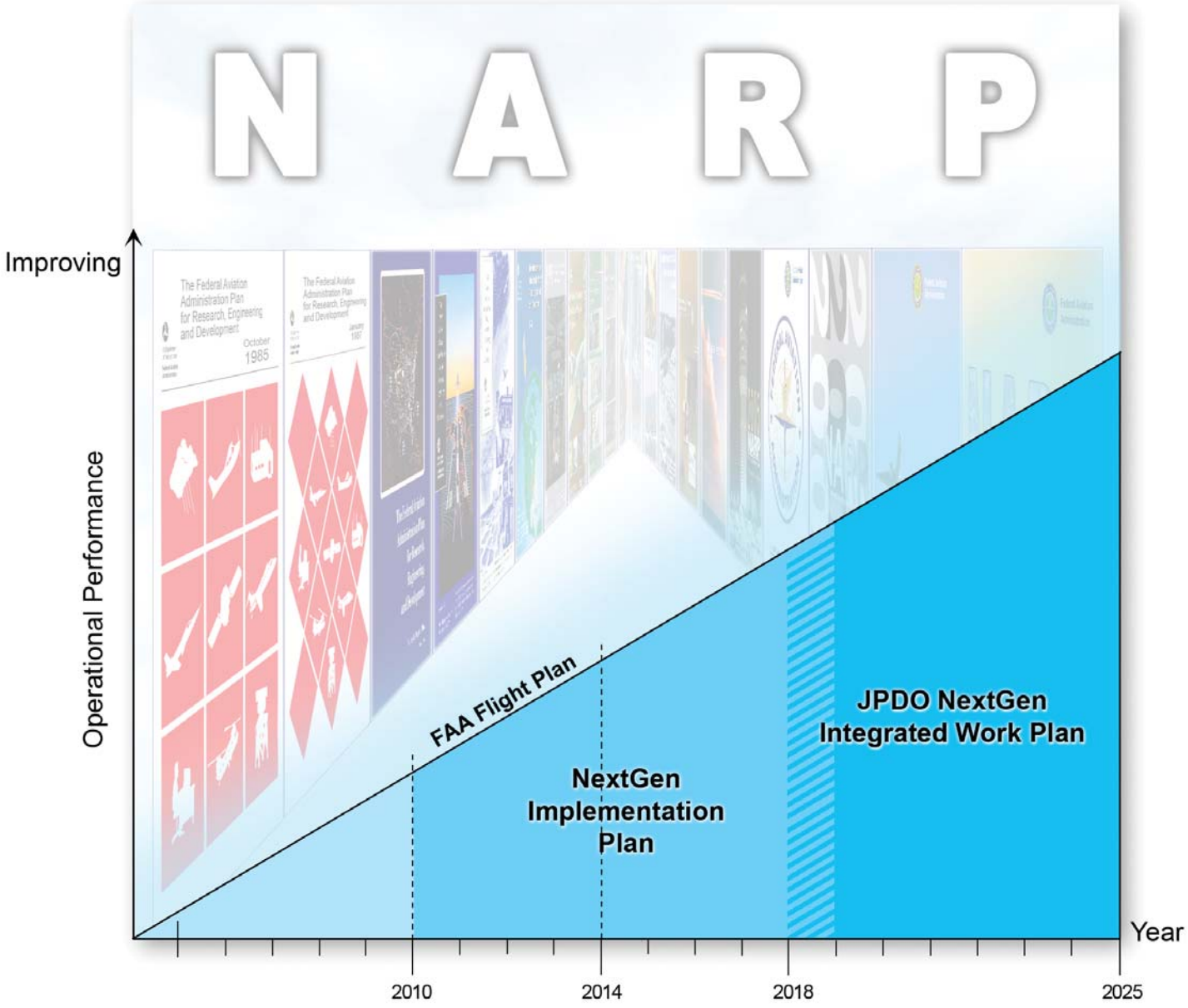


Figure 1.1: FAA Integrated Planning

Joint Planning and Development Office Plans

In 2003, Congress created the Joint Planning and Development Office (JPDO)* to coordinate interagency planning related to NextGen. In addition, the office supports the Office of the Secretary of Transportation and its Senior Policy Committee, which is chaired by the Secretary of Transportation, and includes representatives from the DoD, DOT, DHS, DOC, FAA, NASA, and OSTP. Working with industry and academia, the JPDO established the following set of initial far-term system goals and objectives for NextGen**:

- Retain U.S. leadership in global aviation
  - Retain our role as the world leader in aviation
  - Reduce costs for air transportation
  - Enable services tailored to traveler and shipper needs
  - Encourage performance-based, harmonized global standards for U.S. products and services to keep new and existing markets open
- Expand capacity
  - Satisfy future growth in demand and operational diversity
  - Reduce transit time and increase predictability (domestic curb-to-curb transit time cut by 30 percent)
  - Minimize the impact of weather and other disruptions (95 percent on time)
- Ensure safety
  - Maintain aviation's record as the safest mode of transportation
  - Improve the level of safety of the U.S. air transportation system
  - Increase the safety of worldwide air transportation
- Protect the environment
  - Reduce noise, emissions, and fuel consumption
  - Balance aviation's environmental impact with other societal objectives
- Ensure our national defense
  - Provide for the common defense, while minimizing civilian constraints
  - Coordinate a national response to threats
  - Ensure global access to civilian airspace
- Secure the nation
  - Mitigate new and varied threats
  - Ensure security efficiently serves demand
  - Tailor strategies to threats, balancing costs, and privacy issues
  - Ensure traveler and shipper confidence in system security

* Vision 100 – Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003.

** Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan* (http://www.jpdo.gov/library/NGATS_v1_1204r.pdf).

Based on these goals and objectives, the JPDO has compiled, developed, and maintains a comprehensive suite of planning information to foster communication, understanding, and consensus among the NextGen stakeholder community. The planning information takes into account the research, development, and implementation plans, commitments, and contributions of private industry and Federal partner agencies, as well as potential future solutions needed to reach NextGen. This collection of information is captured in JPDO-developed outputs: the NextGen Concept of Operations (ConOps), Enterprise Architecture (EA), and Integrated Work Plan (IWP). As unconstrained planning documents, these outputs describe what the potential NextGen end-state could be, how it could operate, and when NextGen capabilities and potential improvements might be introduced. The JPDO periodically updates the outputs based on input and feedback from the aviation community, including the Federal government, industry, and the public.

The most recent update to the IWP is summarized in the Fiscal Year 2012 Version of the NextGen IWP, released September 30, 2009. The *NextGen Integrated Work Plan Executive Summary, Version FY12*, highlights the fundamental changes made since the release of Version 1.0 in September 2008 and the efforts undertaken by the JPDO to validate and enhance the maturity of the IWP.

FAA's NextGen Implementation Plan

FAA's Next Generation Air Transportation System (NextGen) *Implementation Plan* (NGIP) outlines the Agency's path to deliver mid-term (2010-2018) NextGen capabilities and their associated benefits. The NGIP defines proposed system changes, guides these changes into use, and includes all FAA NextGen-related initiatives.

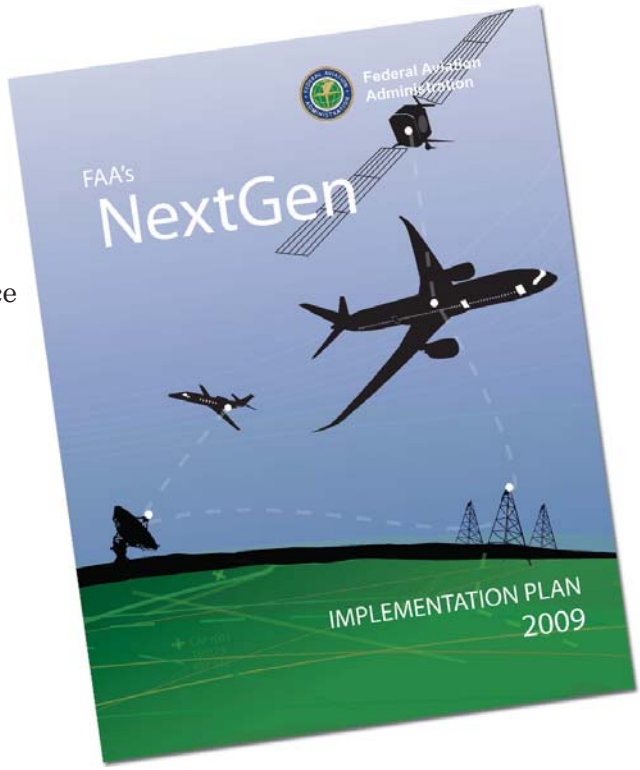
The NGIP provides a structured framework for FAA to plan, execute, and implement NextGen. It is centered on improvements in three domains: Air Traffic Operations; Airport Development; and Aircraft and Operator Requirements. The NGIP is the single entry point for new initiatives from all FAA lines of business and focuses their efforts to achieve NextGen in a fully coordinated, integrated, and transparent manner. When projects reach sufficient technological and operational maturity, the NGIP will ensure their implementation into the National Airspace System (NAS). The Air Traffic Operations domain focuses on seven solution sets targeted to address capacity, efficiency, safety, and security of air transportation operations. These are:

- Initiate Trajectory-Based Operations
- Increase Arrivals/Departures at High Density Airports
- Increase Flexibility in the Terminal Environment
- Improve Collaborative Air Traffic Management
- Reduce Weather Impact
- Increase Safety, Security, and Environmental Performance
- Transform Facilities

Each of these solution sets represents a portfolio of transformational capabilities and research requirements for the mid term. Each capability integrates activities from multiple programs in FAA and in other agencies.

The Airport Development domain focuses on upgrading airport infrastructure to provide greater capacity and reduce delays in the most congested metropolitan airports.

The Aircraft and Operator Requirements domain focuses on the performance requirements that aircraft and operators must meet to participate in NextGen. By aligning the aircraft and operator-related expectations of FAA's near-term commitments along with the mid-term capabilities described in the solutions sets, the Agency can better ensure that required safety and standardization activities are completed in a timely manner. This domain provides sufficient detail on aircraft capabilities to enable manufacturers and operators to identify related avionics investments and plan a logical migration for their aircraft.



FAA Enterprise Architecture

The FAA Enterprise Architecture (EA) provides the overall architecture for the Agency. It has three parts:

- The NAS Enterprise Architecture (NASEA) contains the systems and operational changes for the command and control of the NAS including mission support systems, design, management, and procedures.
- The NAS Regulatory EA contains systems and operational changes for the regulation of the NAS, including policy definition, procedure certification, environment regulation, and safety management.
- The Non-NAS EA contains information technology investments and operational changes for Agency business processes, including administrative, strategic, and financial planning.

The NASEA is the set of of technical roadmaps describing how the current NAS will transition to NextGen. It provides the mid-term target architecture for 2018 and the transition strategy to achieve that architecture. It also provides the operational and technical framework for all FAA plans, including the NGIP, the *Flight Plan*, the *Capital Investment Plan*, and the *National Aviation Research Plan* (NARP). FAA and JPDO have aligned FAA EA planning with the JPDO NextGen EA and IWP, and continue to maintain the alignment as FAA and JPDO plans are updated.

FAA Flight Plan

The *FAA 2009-2013 Flight Plan* describes the Agency's overall near-term performance goals and objectives.* Since FAA has the day-to-day responsibility to promote the safe and efficient operation of the current aviation system, many Agency priorities (including research) are driven by *Flight Plan* goals and objectives. These are:

- Increased Safety – Achieve the lowest possible accident rate and constantly improve safety.
  - Reduce commercial air carrier fatalities
  - Reduce general aviation fatalities
  - Reduce the risk of runway incursions
  - Ensure the safety of commercial space launches
  - Enhance the safety of FAA's air traffic systems
  - Implement a Safety Management System (SMS) for FAA
- Greater Capacity – Work with local governments and airspace users to provide increased capacity in the United States airspace system that reduces congestion and meets projected demand in an environmentally sound manner.
  - Increase capacity to meet projected demand and reduce congestion
  - Increase reliability and on-time performance of scheduled carriers
  - Address environmental issues associated with capacity enhancements

* Federal Aviation Administration, *FAA 2009-2013 Flight Plan*, October 2008 (http://www.faa.gov/about/plans_reports/media/flight_plan_2009-2013.pdf).

- International Leadership – Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner.
  - Promote improved safety and regulatory oversight in cooperation with bilateral, regional, and multilateral aviation partners
  - Promote seamless operations around the globe in cooperation with bilateral, regional, and multilateral aviation partners
- Organizational Excellence – Ensure the success of FAA's mission through stronger leadership, a better-trained and safer workforce, enhanced cost-control measures, and improved decision making based on reliable data.
  - Implement human resources management practices to attract and retain a highly skilled, diverse workforce and provide employees a safe, positive work environment
  - Make the organization more effective with stronger leadership, a results-oriented, high-performance workforce, and a culture of accountability
  - Improve financial management while delivering quality customer service
  - Make decisions based on reliable data to improve overall performance and customer satisfaction
  - Enhance our ability to respond to crises rapidly and effectively, including security-related threats and natural disasters

Capital Investment Plan

The FAA *National Airspace System Capital Investment Plan for Fiscal Years 2011–2015* describes the NAS modernization projects and lists the activities FAA intends to complete during that period.** It contains projects that modernize existing systems and projects that begin the transformation to NextGen, including R&D activities. It also contains the NASEA roadmaps that show the timetable for introduction of new technology to achieve the planned NextGen capabilities and capacity increases.

National Aviation Research Plan

The NARP is FAA's integrated, performance-based R&D plan that supports FAA's near-, mid-, and far-term needs for the NAS. Previously, NARP priorities were driven primarily by the near-term operational needs of the aviation system as defined in the *Flight Plan*, with a large share of its R&D program focused on specific, near-term safety and capacity issues. The current NARP simultaneously addresses the critical, near-term requirements of the system while supporting the mid-term and far-term needs of NextGen. See Figure 1.1.

** Federal Aviation Administration *National Airspace Systems Capital Investment Plan for Fiscal Years 2011-2015*, Feb. 2010 (http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/operations/sysengsaf/cip/)

FAA Research and Development

FAA uses R&D to support policy and planning; regulation, certification, and standards development; and modernization of the NAS. As such, it conducts applied research and development as defined by the Office of Management and Budget Circular A-11. Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Development is defined as systematic application of knowledge or understanding directed toward production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.*

Mission

The FAA R&D mission is to "Conduct, coordinate, and support domestic and international R&D of aviation-related products and services that will ensure a safe, efficient, and environmentally sound global air transportation system." It supports a range of research activities from materials and human factors to the development of new products, services, and procedures.

Organizational Values

FAA has defined five R&D organizational values that will enable it to better manage its programs and achieve its far-term R&D vision: "To provide the best air transportation system through the conduct of world-class, cutting edge research, engineering and development." The Agency R&D portfolio has adopted the following values:

- Goal driven – Achieve the mission. FAA uses R&D as a primary enabler to accomplish its goals and objectives.
- World class – Be the best. FAA delivers world-class R&D results that are high quality, relevant, and improve the performance of the aviation system.
- Collaborative – Work together. FAA partners with other government agencies, industry, and academia to capitalize on national R&D capabilities to transform the air transportation system.
- Innovative – Turn ideas into reality. FAA empowers, inspires, and encourages its people to invent new aviation capabilities. It creates new ways of doing business to accelerate the introduction of R&D results into new and better aviation products and services.
- Customer focused – Deliver results. FAA R&D programs deliver quality products and services to the customer quickly and affordably.

By aggressively espousing these values, FAA will generate the maximum benefit from limited R&D resources to help achieve the national vision of a transformed aviation system.

* OMB Circular A-11, "Preparation, Submission and Execution of the Budget," August 7, 2009, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

Goals

The FAA R&D portfolio supports both the day-to-day operations of the national aerospace system and the development of NextGen. Hence, far-term focus on NextGen will have to be balanced with the research needed to address the day-to-day safety and capacity issues of the national aerospace system. To achieve balance between the near, mid, and far term, FAA has defined ten crosscutting R&D goals to focus and integrate its programs. As shown in Table 1.1, the R&D goals are aligned with the near-term *Flight Plan* goals, the mid-term NGIP domains and solution sets, and the far-term goals identified in the JPDO *Integrated Plan*.

These R&D goals are meant to challenge researchers to think far term and achieve future breakthroughs. The R&D portfolio can help transform the system by aiming for ideal performance rather than by focusing on incremental improvements to current capabilities that may not achieve NextGen. The FAA R&D goals are:

- **R&D Goal 1 - Fast, Flexible, and Efficient** – a system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs
- **R&D Goal 2 - Clean and Quiet** – a reduction of significant aerospace environmental impacts in absolute terms
- **R&D Goal 3 - High Quality Teams and Individuals** – the best qualified and trained workforce in the world
- **R&D Goal 4 - Human-Centered Design** – aerospace systems that adapt to, compensate for, and augment the performance of the human
- **R&D Goal 5 - Human Protection** – a reduction in fatalities, injuries, and adverse health impacts due to aerospace operations
- **R&D Goal 6 - Safe Aerospace Vehicles** – a reduction in accidents and incidents due to aerospace vehicle design, structure, and subsystems
- **R&D Goal 7 - Separation Assurance** – a reduction in accidents and incidents due to aerospace vehicle operations in the air and on the ground
- **R&D Goal 8 - Situational Awareness** – common, accurate, and real-time information on aerospace operations, events, crises, obstacles, and weather
- **R&D Goal 9 - System Knowledge** – a thorough understanding of how the aerospace system operates, the impact of change on system performance and risk, and how the system impacts the nation
- **R&D Goal 10 - World Leadership** – a globally recognized leader in aerospace technology, systems, and operations

In December 2006, the President of the United States established the first National Aeronautics Research and Development Policy with the goal of advancing the U.S. technological leadership in aeronautics R&D. In accordance with the policy, in December 2007, the National Plan for Aeronautics R&D and Related Infrastructure defined the highest priority aeronautics R&D goals and objectives for the nation. These goals and objectives are intended to provide high-level guidance for foundational, advanced aircraft system, and air transportation system R&D through 2020. The FAA's aviation research and development programs align with the National Plan in all areas with a focus on the near-term objectives while laying the foundation for the mid- and far-term objectives.

In December 2008, the Technical Appendix was released to provide additional technical content on the aeronautics R&D goals and objectives, and a preliminary assessment of current relevant federal aeronautics R&D activities to identify areas of opportunity for potential increased emphasis. Areas of opportunity for potential increased emphasis that have been identified are now able to be assessed by the appropriate executive departments and agencies, as well as by the larger aeronautics community through ongoing outreach by the Aeronautics Science and Technology Subcommittee of the Committee on Technology to the National Science and Technology Council.

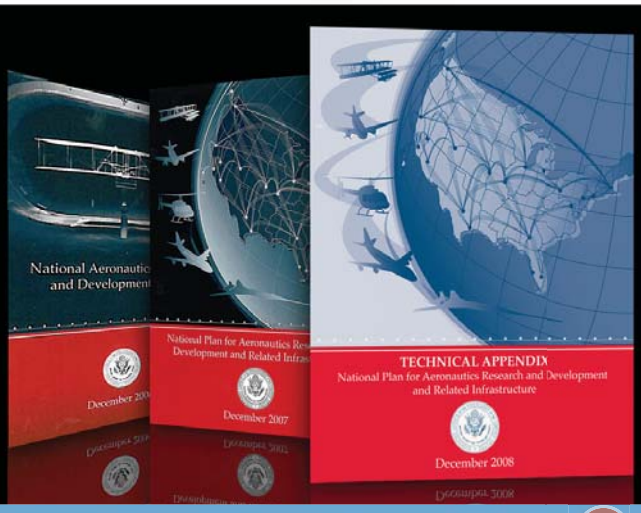
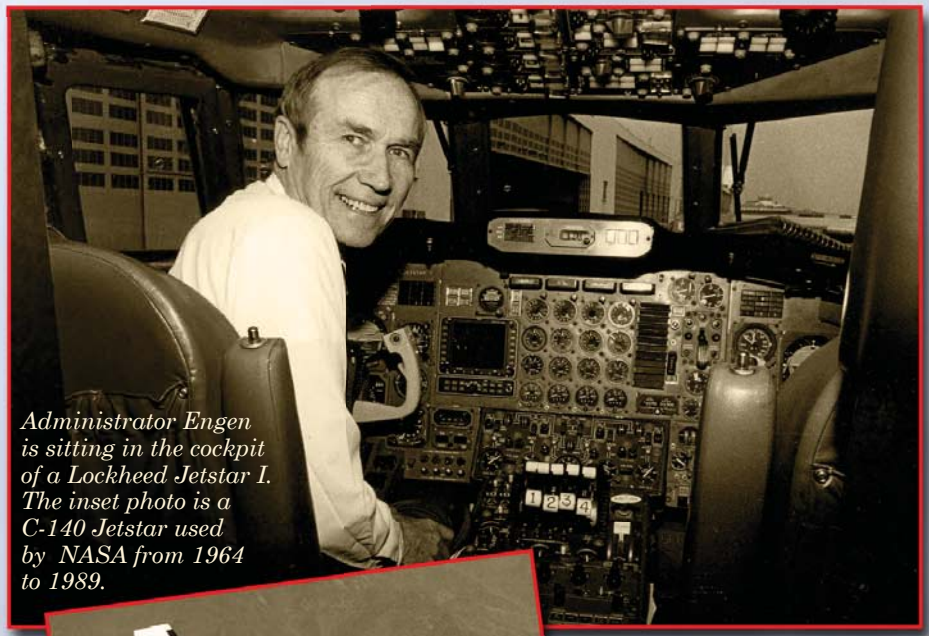


Table 1.1: Alignment of Goals

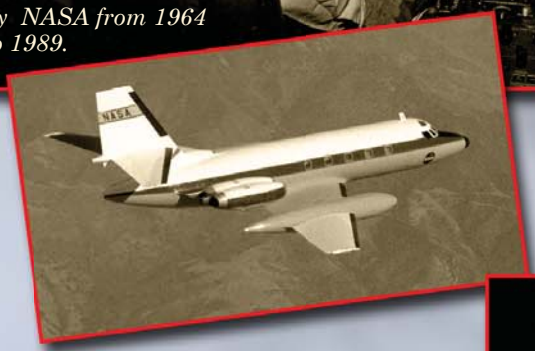
Flight Plan Goals	FAA R&D Goals	*FAA's NextGen Implementation Plan* Domains and Solution Sets	JPDO *Integrated Plan* Goals
◆Greater Capacity	1-Fast, Flexible, and Efficient	◆Airport Development Domain ◆Air Traffic Operations Domain • Initiate Trajectory-Based Operations • Reduce Weather Impact • Increase Flexibility in the Terminal Environment • Increase Arrivals/Departures at High Density Airports • Improve Collaborative Air Traffic Management • Transform Facilities	◆Expand Capacity
	2-Clean and Quiet	◆Air Traffic Operations Domain • Increase Safety, Security, and Environmental Performance ◆Aircraft and Operator Requirements Domain	◆Protect the Environment
◆Increased Safety	4-Human-Centered Design 5-Human Protection 6-Safe Aerospace Vehicles 7-Separation Assurance 8-Situational Awareness 9-System Knowledge		◆Ensure Safety
—	—		◆Secure the Nation ◆Ensure our National Defense
◆International Leadership	10-World Leadership	—	◆Retain U.S. Leadership in Global Aviation
◆Organizational Excellence	3-High Quality Teams and Individuals	—	

Table 1.1 shows the primary relationship among the *Flight Plan* goals, FAA R&D goals, the NGIP domains and solution sets, and the JPDO far-term goals identified for NextGen. Each FAA R&D goal is aligned with its primary *Flight Plan* goal, recognizing that there may be other relationships. For example, R&D Goal 3 - High Quality Teams and Individuals is aligned with the Organizational Excellence goal; however, it also supports the Increased Safety and Greater Capacity goals. Similarly, R&D Goal 9 - System Knowledge and R&D Goal 7 - Situational Awareness also align with the Greater Capacity goal, in addition to the Increased Safety goal.

The FAA's first research and development plan, *The Federal Aviation Administration Plan for Research, Engineering and Development*, was published in October 1985. Then Administrator, Donald D. Engen, recognizing the importance of research in preparing for the future of aviation, wrote,



Administrator Engen is sitting in the cockpit of a Lockheed Jetstar I. The inset photo is a C-140 Jetstar used by NASA from 1964 to 1989.



"This research engineering and development (R,E&D) plan has been developed by the FAA to meet the challenges that face the national airspace system (NAS) through 2010. . . . The next several decades of flight will present many challenges and opportunities for improvement. It is essential that the aviation community maintain a comprehensive and far-ranging program to capitalize on our collective talents and opportunities for advances in the efficiency and safety of our air transportation system."

Twenty-five years later, the FAA continues to capitalize on challenges and opportunities to meet aviation needs in the 21st century. Administrator Randy Babbitt says,

"Admiral Engen was right. The only way we'll be able to handle what's coming down the road is if we plan for it. The 25th Anniversary *National Aviation Research Plan* is a roadmap that helps make sure we're pointed in the right direction. We're facing challenges and changes that not too many people would have forecast 25 years ago, including human factors, fuel prices, greenhouse emissions and passenger totals stretching toward a billion. With all of these in one hand – and an unyielding need to keep increasing the margin of safety in the other – staying on track remains a formidable task. I'm confident that we can get where we need to go. I'm confident that this Plan will make sure that we do."

Administrator Babbitt is sitting in the cockpit of the Virgin Galactic's WhiteKnightTwo Virgin MotherShip Eve. The inset photo is the same aircraft in flight.

Chapter Two

Research and Development Goals

The Federal Aviation Administration (FAA) research and development (R&D) plan is built around the ten R&D goals defined in the previous chapter. The master schedule and R&D goals help to align, plan, and evaluate R&D activities to support the near-term needs of the FAA *Flight Plan* and the *Capital Investment Plan*, the mid-term needs of *FAA's NextGen Implementation Plan* (NGIP), and the far-term needs described in the interagency JPDO *Integrated Plan*. This chapter describes how the R&D programs achieve the R&D targets for each R&D goal by identifying key milestones (or outputs) and summarizing progress made in the current year for each R&D goal.

Each R&D goal has an R&D target. The R&D goals, with each target, were derived by first comparing the performance targets in the near-term *Flight Plan* to the objectives of the far-term JPDO *Integrated Plan* to develop notional targets for 2025. These notional targets were first derived in the 2007 NARP. The targets for capacity, from the 2004 JPDO *Integrated Plan*, provide the connection between the two plans and define the targets for safety and organizational excellence. The targets for safety are needed to reduce the fatality rate considering capacity increases. The specific metrics are defined in Chapter 2, under R&D Goal 9 - System Knowledge, in the section on Safety Evaluation. The targets for organizational excellence are those needed to provide increased capacity without incurring a commensurate increase in cost.

The notional targets for 2025 were then used to develop the R&D goals and mid-term R&D targets. Achieving the R&D targets will demonstrate that it is possible to meet the notional targets by 2025. The R&D targets focus on the mid term to allow time to implement new regulations, standards, technologies, systems, and procedures by 2025.

For each R&D goal, there is also a description of the methods (e.g., modeling, simulation, physical demonstration, initial standards) that will be used to validate the target. This is followed by some of the milestones required to achieve the target. These milestones are grouped in major areas for each R&D goal. Completion of these milestones will also be used to measure progress toward achieving the target. The program or programs responsible for completing each milestone are identified with each milestone. Appendix D, new this year, describes all changes to the milestones in each R&D goal and provides a rationale for the change. Additional research activities in each program are described in Appendix A. In all cases, the demonstration milestones require multiple programs to work together for the final demonstration. Some milestones reflect existing efforts that are generally focused on near-term results, while others are new requirements that support mid- and far-term objectives. This dual-time-frame approach helps FAA balance its R&D programs so that it addresses near-term needs while making progress toward the mid-term and far-term goals.

Finally, for each R&D goal, there is a funding summary by fiscal year (FY) and a list of the progress made during the past year.

Figure 2.1 illustrates how the R&D targets integrate and focus FAA R&D programs through the R&D milestones to achieve the notional targets for 2025 while bridging the near-term goals of the *Flight Plan* with the mid-term goals of the NGIP and the far-term goals of the JPDO *Integrated Plan*.

Table 2.1 shows which R&D programs directly support which R&D goals with milestones listed in the NARP. The intent is to identify clear responsibilities so that each program focuses on a specific, limited number of R&D goals.

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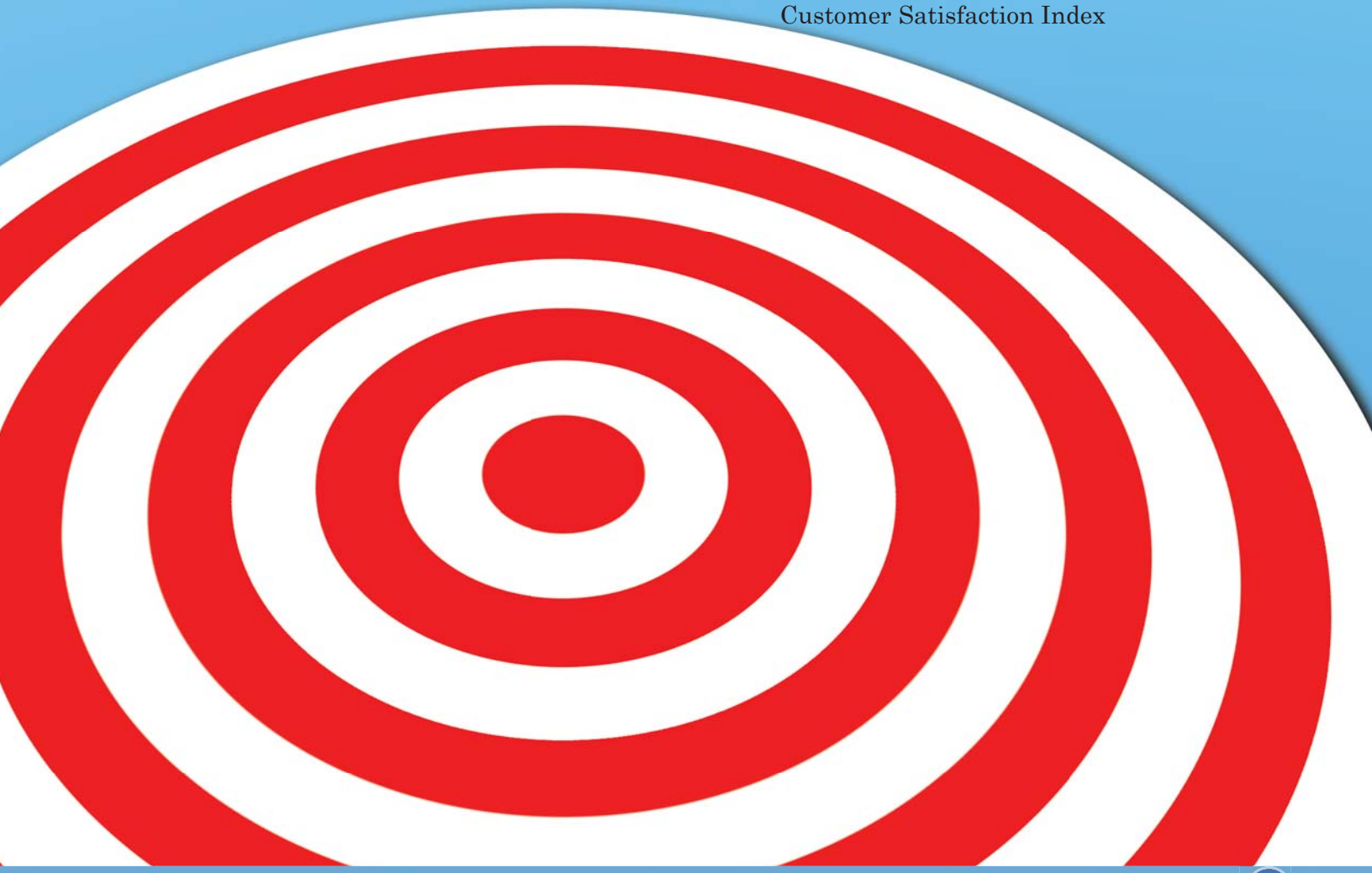
Notional Targets for 2025 (Based on 2004 levels)

- Increased Safety
  - Reduce commercial air carrier fatalities
  - Reduce GA fatalities
  - No commercial space launch fatalities or injuries
  - Reduce the rate of runway incursions
  - Reduce the rate of operational errors
  - Manage and mitigate risk

- Greater Capacity
  - Increase average daily airport capacity to up to three-times
  - Increase on-time arrival rate to 95 percent
  - Reduce gate-to-gate transit time by 30 percent
  - Reduce the number of people exposed to noise
  - Improve aviation fuel efficiency
- International Leadership
  - Reduce time and cost to market for products and services (e.g., procedures, regulations, standards, technologies)
  - Increase the use of U.S. aviation-related products and services
- Organizational Excellence
  - Increase controller efficiency to support notional capacity targets
  - Reduce costs and improve productivity
  - Increase Employee Attitude Survey scores
  - Increase Agency scores on the American Customer Satisfaction Index



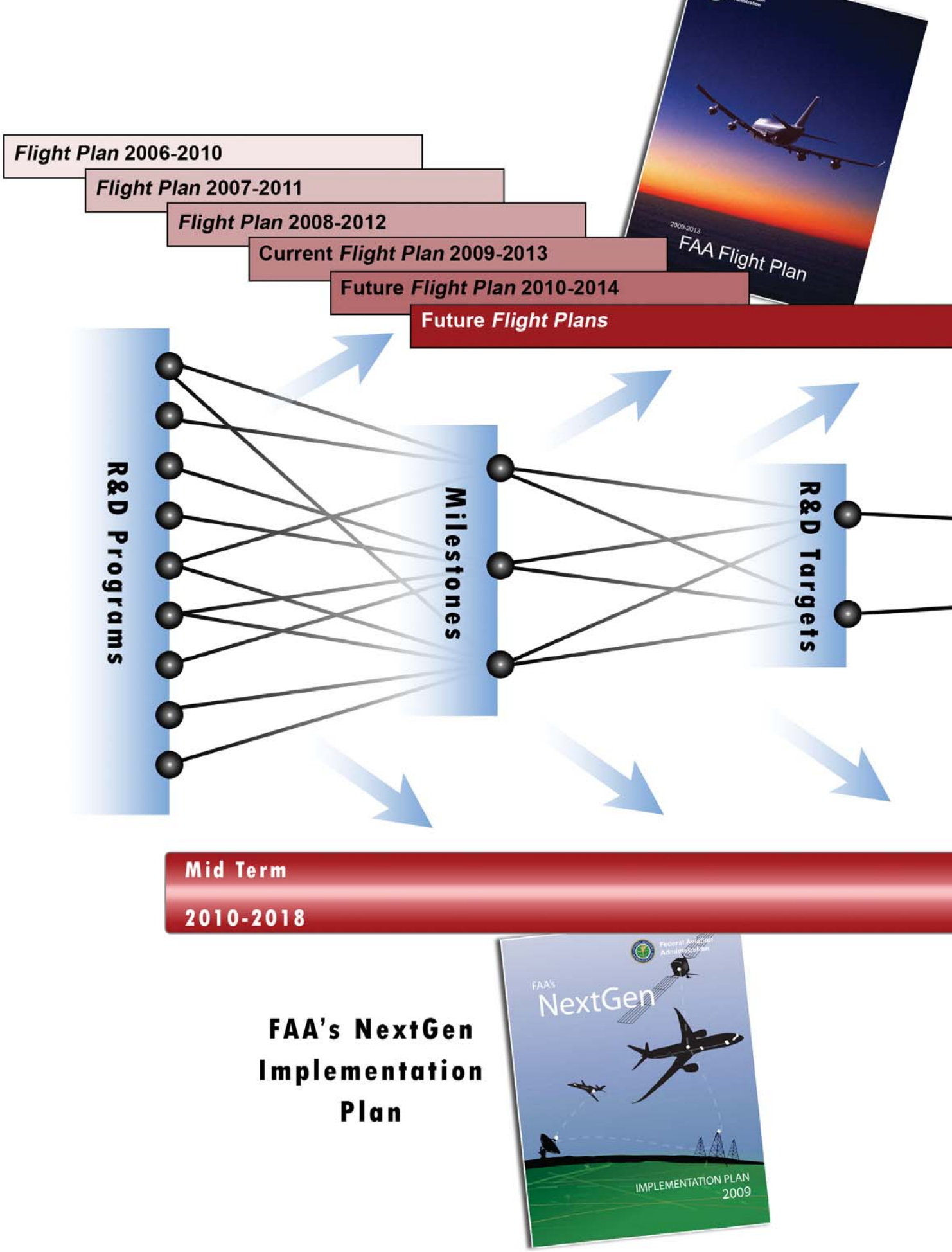


Figure 2.1: Path to Achieving Notional Targets

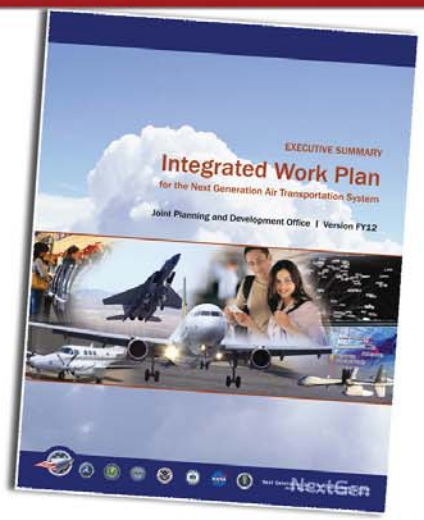
Future *Flight Plans*

Notional Targets

2025 Desired Capabilities

Far Term

2018-2025



JPDO Integrated Work Plan

Table 2.1: Map of R&D Programs in 2011 to R&D Goals

R&D Programs		R&D Goals									
		Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goal 9	Goal 10
		Fast, Flexible and Efficient	Clean and Quiet	High Quality Teams and Individuals	Human-Centered Design	Human Protection	Safe Aerospace Vehicles	Separation Assurance	Situational Awareness	System Knowledge	World Leadership
Advanced Materials/Structural Safety	A11.c					Coordinate	X				
Aeromedical Research	A11.j					X				Coordinate	
Air Traffic Control/Technical Operations Human Factors	A11.i			X	Coordinate			Coordinate	Coordinate		
Aircraft Catastrophic Failure Prevention Research	A11.f						X				
Airport Cooperative Research - Capacity	-	X			X					X	
Airport Cooperative Research - Environment	-		X								Coordinate
Airport Cooperative Research - Safety	-					X			Coordinate	X	
Airport Technology Research - Capacity	-	X									
Airport Technology Research - Safety	-					X			X		
Airspace Management Program	1A01E									X	
Atmospheric Hazards - Aircraft Icing/Digital System Safety	A11.d					X	X				
Center for Advanced Aviation System Development (CAASD)	4A09A	X		X			X		X	X	
Commercial Space Transportation Safety	-						X			X	
Continued Airworthiness	A11.e						X			X	
Environment and Energy	A13.a		X								Coordinate
Fire Research and Safety	A11.a					X	X				Coordinate
Flightdeck/Maintenance/System Integration Human Factors	A11.g			Coordinate	X			Coordinate	Coordinate		
Joint Planning and Development Office (JPDO)	A12.a	X	Coordinate	Coordinate	Coordinate			Coordinate	Coordinate	X	
NAS Weather Requirements	1A01D								X		
NextGen - Air Ground Integration Human Factors	A12.c				X						
NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	1A08A			X	Coordinate						Coordinate
NextGen - Alternative Fuels for General Aviation	A11.m						X				
NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	1A08D		X								
NextGen - New Air Traffic Management Requirement	1A08B	X									
NextGen - Operational Assessments	1A08F		Coordinate							X	
NextGen - Operations Concept Validation - Validation Modeling	1A08C									X	
NextGen - Self-Separation Human Factors	A12.d							X			Coordinate
NextGen - Staffed NextGen Towers	1A08H								X		
NextGen - System Safety Management Transformation	1A08G									X	Coordinate
NextGen - Wake Turbulence	A12.b	X									
NextGen - Wake Turbulence - Re-categorization	1A08E	X			Coordinate			Coordinate			Coordinate
NextGen - Weather Technology in the Cockpit	A12.e				Coordinate				X		Coordinate
NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	A13.b		X								Coordinate
Operations Concept Validation	1A01C	Coordinate								X	
Propulsion and Fuel Systems	A11.b						X				
Runway Incursion Reduction	1A01A								X		
System Capacity, Planning and Improvement	1A01B									X	
System Planning and Resource Management	A14.a										X
System Safety Management	A11.h				Coordinate					X	
Unmanned Aircraft Systems Research	A11.l						X			X	
Weather Program	A11.k	X			Coordinate	X			X		
William J. Hughes Technical Center Laboratory Facility	A14.b				X						

R&D Goal 1
Fast, Flexible, and Efficient

A system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs

R&D target

By 2016, demonstrate that the system will have the flexibility to handle growth in demand up to three times current levels* and demonstrate that gate-to-gate transit time can be reduced by up to 30 percent.

Method of validation**

The approach includes developing and demonstrating NextGen capabilities according to the NGIP and continuing ongoing efforts related to increasing airport capacity and reducing costs. Validation of the R&D target will include a combination of modeling, analysis, full scale testing, and initial standards development. The capacity evaluation (under R&D Goal 9 - System Knowledge) supports the interim assessment of progress and validation of this target.

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* The year 2004 is used as a baseline for consistency with the Vision 100 – Century of Aviation Reauthorization Act (P.L. 108-176) and the *Next Generation Air Transportation System Integrated Plan* submitted to Congress as required in that legislation.

** In this goal, demonstrate means to show that the methods and metrics developed are valid and that, with the system improvements planned, it is possible to handle a significant increase in system capacity, where three-times is used as an upper limit (not a prediction) and is purposely aggressive, as R&D goals should be stretch goals.

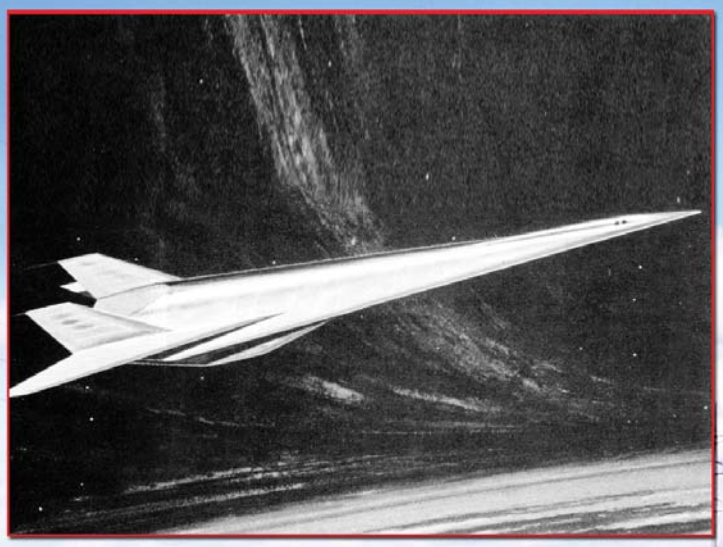
Then and Now 25th Anniversary 1985 - 2010

From Super Fast to Super Big and Super Small

The 1985 FAA Plan anticipated supersonic and hypersonic transport aircraft operating in the NAS at altitudes of 70,000 to 100,000 feet, respectively. The Plan set forth two initiatives to support the introduction of these vehicles into the NAS, development of appropriate standards for airports and aircraft certification guidance.

How surprised would the authors of the 1985 Plan be to see where technology developments have steered the 2010 research activities of the FAA.

For a number of reasons, both economical and environmental, the needs of the industry diverted from developing aircraft with supersonic speeds to aircraft with super size (and lots of passengers) and unmanned vehicles (with no passengers).



The 1985 R,E&D plan used this image to symbolize future advanced-technology aircraft.

Milestones

Aviation weather

— **Reduce weather-related delays to increase on-time arrival rate and reduce transit time. (Weather Program)**

2010: Develop 0-6 hour advanced storm prediction algorithm.

2010: Transition Rapid Refresh Weather Forecast Model for implementation at National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction.

2011: Demonstrate 0-6 hour advanced storm prediction algorithm.

2013: Transition 0-6 hour advanced storm prediction algorithm for implementation.

2013: Transition in-flight icing Alaska forecast and analysis capability for implementation.

Separation standards

— **Reduce separation with procedures only.**

2008: Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions. (Wake Turbulence) [COMPLETED]

2013: Modify procedures as requested to allow use of closely spaced parallel runways for arrival operations during non-visual conditions. (NextGen - Wake Turbulence)

— **Develop new performance-based separation standards.**

2009: Develop and simulate separation procedures that vary according to aircraft capability and pilot training. (NextGen Demonstrations and Infrastructure Development) [COMPLETED, see third bullet under Progress in FY 2009]

2013: Determine how best to incorporate the leader/follower based wake separation standards into the en-route and terminal automation platforms. (NextGen - Wake Turbulence - Re-categorization)

The Airbus A-380 at the 2009 AirVenture in Oshkosh, WI.

UAS with 10.2 foot wing span.

An airplane the size of the Airbus 380 would have challenged the imagination of research planners in 1985. Yet in 2010, the FAA is developing the standards for airports to handle these enormous transport aircraft based in large part on taxiway deviation studies at Anchorage, San Francisco, and JFK airports. At the same time FAA pavement research has developed and validated design standards that will ensure long-life pavements.

At the other end of the size spectrum, industry is pressuring the FAA to expedite certification and operational procedures that allow the introduction of unmanned aircraft systems (UAS) into the NAS. These UAS range in size from Global Hawks and Predators used by the military, to micro-size aircraft measured in inches for commercial use, and every size in between. Current research focuses primarily on establishing a regulatory framework that incorporates the principles of the FAA Safety Management System.

Handheld micro-aircraft are ready for civil applications.

NextGen demonstrations

Develop and demonstrate NextGen technologies and concepts.

— **Demonstrate super-density operations. (NextGen Demonstrations and Infrastructure Development*)**

2009: Demonstrate the addition of convective weather (current and forecast) into Traffic Management Advisor (TMA) routing to increase throughput and efficiency for large, super density airports. [COMPLETED, see first bullet under Progress in FY 2009]

— **Demonstrate trajectory-based operations. (NextGen Demonstrations and Infrastructure Development)**

2008: Demonstrate improved trajectory-based operations in mixed-equipage, oceanic airspace with actual aircraft and procedures. [COMPLETED]

2009: Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication. [COMPLETED, see second bullet under Progress in FY 2009]

Airport capacity

— **Increase airport capacity while reducing costs.**

2008: Increase airport capacity. (Airport Cooperative Research - Capacity) [COMPLETED]

2011: Develop guidebook to assist airport planners with airfield and airspace capacity evaluation. (Airport Cooperative Research - Capacity)

2012: Develop new standards and guidelines for runway pavement design. (Airports Technology Research - Capacity)

Wake turbulence

— **Demonstrate wake turbulence avoidance technologies and procedures.**

2010: Determine pilot and air navigation service provider (ANSP) situational aircraft separation display concepts required for implementation of the NextGen Trajectory-Based Operation (TBO) and High Density concepts. (NextGen - Wake Turbulence)

2011: Refine the boundaries of the current six weight categories for the National Airspace System (NAS) fleet mix and define automation requirements to support those modifications. (NextGen - Wake Turbulence - Re-categorization)

2011: Determine optimal set of aircraft flight characteristics and weather parameters for use in setting wake separation minimums. (NextGen - Wake Turbulence - Re-categorization)

2012: Determine the NAS infrastructure requirements (ground and aircraft) for implementing the NextGen TBO and High Density concepts within the constraints of aircraft-generated wake vortices and aircraft collision risk. (NextGen - Wake Turbulence)

2016: Develop the algorithms that will be used in the ANSP and flight deck automation systems for setting dynamic wake separation minimum for each pair of aircraft. (NextGen - Wake Turbulence - Re-categorization)

* The NextGen Demonstrations and Infrastructure Development program is no longer considered R&D after FY 2009.

Funding Requirements - R&D Goal 1

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
—	Airport Cooperative Research - Capacity	AIP	5,000	1,650	1,650	1,650	1,650	1,650	33% of total program
—	Airports Technology Research - Capacity	AIP	10,596	12,930	12,930	12,930	12,930	12,930	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	13,409	13,196	13,212	13,523	13,834	18,968	56% of R&D program in FY 2010
A12.a	Joint Planning and Development Office	R,E&D	10,085	10,004	10,094	10,194	10,248	10,305	70% of total program
1A08B	NextGen - New ATM Requirements	F&E	13,200	23,000	31,200	32,000	50,100	51,900	100% of total program
A12.b	NextGen - Wake Turbulence	R,E&D	10,631	10,685	10,742	10,799	10,800	10,801	100% of total program
1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	2,000	3,000	3,000	3,000	3,000	3,000	100% of total program
1A01C	Operations Concept Validation	F&E	0	0	0	0	0	0	coordination only
1A01I	Wake Turbulence Research	F&E	1,000	0	0	0	0	0	combined with 1A08E after FY 2010
A11.k	Weather Program	R,E&D	1,679	1,651	1,638	1,623	1,595	1,566	10% of total program
		Total ($000)	67,600	76,116	84,466	85,720	104,157	111,121	

Progress in FY 2009: Fast, Flexible, and Efficient

- **Traffic Management Advisor Weather Demonstration:** Demonstrated the integration of weather forecasts into decision support tools by incorporating weather predictions into the TMA system. This laboratory proof-of-concept demonstration at Embry-Riddle Aeronautical University, conducted in November 2008, showed incorporation of a predictive weather product into the TMA using a System-Wide Information Management-like interface. This will enhance TMA and support traffic flow during periods of convective weather. (NextGen Demonstrations and Infrastructure Development)

- **Heavy Aircraft Dependent Paired Instrument Approaches:** Defined a NextGen-era wake turbulence mitigation procedure concept that allows Boeing 757 and heavier aircraft to be the leader in dependent paired instrument approaches to an airport's closely spaced parallel runways (CSPR). Use of the procedure will require many airports to collect additional, highly accurate information concerning the crosswinds that are encountered, or may be encountered, along the approaches to their CSPR. This enhanced procedure allows the air traffic controller to have more flexibility in assigning arriving aircraft to the airport's CSPR approaches during instrument flight rule (IFR) operations. (NextGen - Wake Turbulence and NextGen Demonstrations and Infrastructure Development)

- **Dependent Paired Instrument Approaches To Closely Spaced Parallel Runways:** Approved procedure for dependent paired instrument approaches for use at airports having CSPR. When weather conditions require the use of IFR operations, the dependent paired instrument approach procedure allows the airports to continue to use their CSPR landing configuration. Formerly, because of wake turbulence concerns, they had to revert to using only one of their CSPR for landing operations. The procedure allows 10 to 15 more landings per hour than the airports' single runway landing configuration. (NextGen - Wake Turbulence)

- **Flight Management Systems 4D Trajectories Downlink for TBO:** Collected and analyzed data from operational flights in the NAS to help identify parameters of importance for TBO. The four-dimensional trajectory (4DT) data was down-linked from a Boeing 737NG aircraft equipped with GE Aviation Flight Management Systems (FMS) avionics. In describing TBO, the NextGen Concept of Operations mentions key end state transformations that include the exchange of 4DT data between capable aircraft and the ANSP. Most current generation FMSs generate 4DT information on board the aircraft to provide the basis for autoflight systems to execute a route from takeoff to touchdown. Some of these systems installed on various aircraft operating in the NAS can also communicate the 4DT data to the airline operations center using existing ground networks. However, the utility of this 4DT information in helping meet the operational requirements as envisioned by the NextGen concept for TBO has only recently begun to be assessed. In 2009, to explore more fully the NextGen concept of TBO, Continental Airlines and Center for Advanced Aviation System Development (CAASD) researchers worked together to gain operational experience in the use of down-linked 4DT data among air traffic specialists and airline operations personnel. (CAASD)

- **Probabilistic Forecasts:** Completed concept development of methods that will enable customized 1-3 hour probabilistic forecasts, targeted initially for the OEP 35 Airports. This capability will use current observations and past history to produce hourly forecasts in five minutes. This approach will enable timely forecasts and will be combined with modeling techniques to extend the forecasts to 12 hours. This capability will provide a valuable tool for identifying hazardous ceiling and visibility conditions that impact traffic capacity at the airports' terminals. (Weather Program)

- **Updated Wake Turbulence Mitigation Separation Standards:** Developed a revised set of separation standards and associated safety and benefit studies with EUROCONTROL to better address the changing air carrier fleet mix operating at airports. Current wake turbulence mitigation separation standards used by air traffic control (ATC) have not changed in last 20+ years both in the United States and throughout the world, while the types of aircraft and the relative number of each type of aircraft has changed. In FY 2008, an analysis by the FAA and EUROCONTROL indicated that more runway operational capacity could be safely achieved by revising the ATC wake turbulence mitigation separation standards. After further analysis and coordination, these revised standards will be submitted to the International Civil Aviation Organization (ICAO) for approval and adoption. (NextGen - Wake Turbulence - Re-categorization)

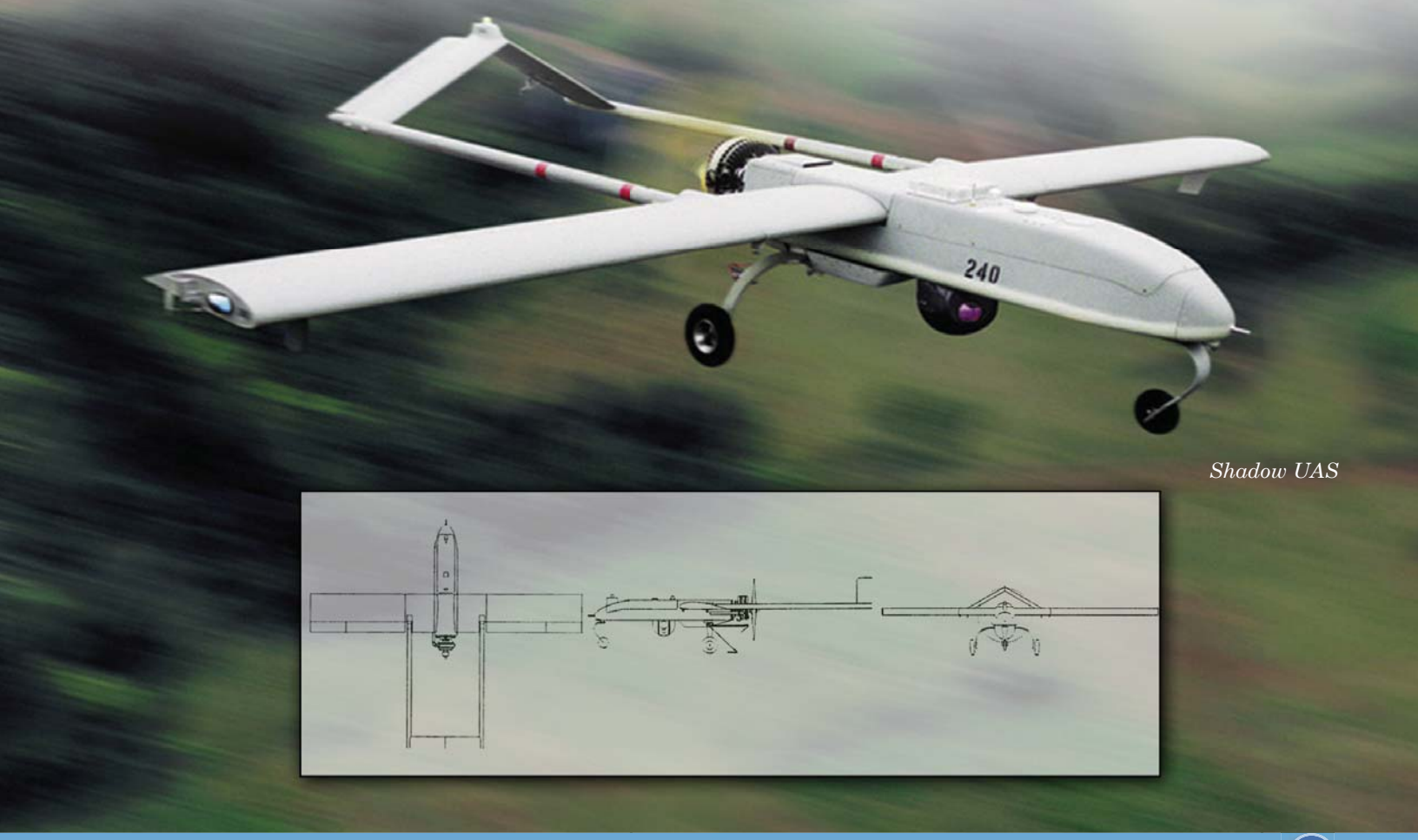
- **Oceanic Collaborative Trajectory Optimization Demonstration:** Initiated demonstrations of collaborative trajectory optimization in the oceanic environment. FAA and European partners used an optimization process with assistance from automated profile optimization and deconfliction tools as a step toward an automated process for oceanic, four-dimensional trajectory-based operations. These five-month long demonstrations measured the benefits of collaborative air traffic management (ATM) with a more dynamic and proactive application of the FAA's Ocean 21 automation, which allows the aircraft to fly as close as possible to the user preferred trajectories. (NextGen Demonstrations and Infrastructure Development)

- **Advanced Weather Radar Techniques:** Enhanced the national 3D radar mosaic algorithms to incorporate the super-resolution radar data available from all NOAA WSR-88D radars. The resolution of the national 3D radar mosaic and derivative products was increased from an update rate of 5 minutes to 2.5 minutes. This increased update rate facilitates more timely depiction of storms, their structure, and their movement, which will enable users to plan more effective and safer routes of flight that will avoid hazardous convective areas. Additionally, 31 Canadian radars were integrated into the national 3D radar mosaic to produce seamless radar information along the U.S. and Canadian border. This will support coverage for U.S. flights into Canada as well as domestic U.S. flights that fly into Canada because of hazardous weather over the Great Lakes. (Weather Program)

- **Unmanned Aircraft System Demonstration:** Conducted a UAS demonstration project flight that collected data to verify and calibrate the Shadow UAS six-degree-of-freedom model. This flight of a Shadow UAS was performed at Redstone Arsenal, Huntsville, AL. A flight test team from AAI Corporation operated the UAS as an activity under a Cooperative Research and Development Agreement (CRDA) with FAA. Data from the demonstration will be integrated with the FAA's NAS models for follow-on laboratory simulations. The primary objectives of the evaluations and demonstrations are to provide data to support the evaluation and integration of UAS operations in the NAS. (NextGen Demonstrations and Infrastructure Development)

- **Multiple Precise Routes:** Developed concept for using an aircraft's navigation capabilities to follow one of multiple precise routes to an airport's CSPR. The concept is being developed as a candidate airport wake turbulence mitigation approach design for NextGen-era increased CSPR airport operations. In FY 2010, the terminal area CSPR approach design will be evaluated for feasibility in terms of air traffic controller tasks, air crew tasks and required controller and pilot decision aids. (NextGen - Wake Turbulence)

- **Turbulence Forecast Capability Prototypes:** Developed prototypes of clear-air and mountain-wave turbulence forecast capability for all altitudes from the surface to 45,000 feet. The prototypes are model-based and have turbulence nowcast capability that ingests *in-situ* eddy dissipation rate data, pilot reports, and the NEXRAD Turbulence Detection Algorithm mosaic output. Both the turbulence forecast, updated hourly out to 12 hours, and the turbulence nowcast, updated every 15 minutes, will allow users to plan more effective and safer routes of flight that will avoid hazardous turbulence areas. These capabilities are planned for inclusion as part of the NextGen Initial Operational Capability. (Weather Program)



Shadow UAS

A reduction of significant aerospace environmental impacts in absolute terms

R&D target

By 2016, demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (to enable up to a three-times capacity increase*) in a cost-effective way and reduce uncertainties in particulate matter and climate impacts to levels that enable appropriate action.

Method of validation

The approach has five parts: measure current levels in the system, determine the target levels of noise and emissions, build models to assess and predict the impact of change, develop reduction techniques and assess their cost-benefits, and develop environmental management systems for the NAS. Validation of the R&D target will include modeling, physical demonstrations, prototypes, full-scale tests, and software beta tests. The environmental evaluation milestones under R&D Goal 9 - System Knowledge also support the interim assessment of progress and validation of this target.

* In this goal, demonstrate means to show that the models and metrics developed are valid and that, with the system improvements planned, it is possible to reduce aviation noise and emission impacts even with a significant increase in system capacity, where three-times is used as an upper limit (not a prediction) and is purposely aggressive, as R&D goals should be stretch goals.

Then and Now 25th Anniversary 1985 - 2010

From Noise Complaints to Global Environmental Challenges

Aviation environmental and energy (E&E) issues have evolved dramatically over the last 25 years. The 1985 Plan envisioned a future that included supersonic, hypersonic, and transatmospheric flights. There was no warning that environmental concerns would become a constraint on the growth of aviation. Although the role of aircraft emissions on the earth's ozone layer was a concern, noise was the primary environmental topic of interest, and the climate impacts of aviation emissions were not even on the radar screen. With noise near airports as the primary driver, most E&E research focused on simpler noise certification procedures for aircraft, improved compatibility criteria for land use near airports, and methods to better quantify the reaction of airport neighbors to aviation noise.

The Concorde Super Sonic Transport was so loud that in 1977 the FAA issued a Notice of Proposed Rulemaking on Noise and Sonic Boom Requirements.

Milestones

Threshold levels

— Determine acceptable levels of noise and emissions.

2010: Develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions. (Environment and Energy and Airport Cooperative Research - Environment)

2011: Develop a new metric to quantify the environmental impacts of new aircraft types. (Environment and Energy)

2011: Complete tests and data collection to determine if the right metrics are being used to assess the impact of aircraft noise. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2011: Determine how aviation-generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate. (Environment and Energy, NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics, and Airport Cooperative Research - Environment)

2011: Investigate feasibility of new standards for aircraft noise and emissions certification. (Environment and Energy)

Today, noise is still an issue but climate impacts pose the most pressing challenge. Likewise, aviation fuel efficiency is still a concern but the need for sustainable and secure jet fuel supplies is now a key component of the E&E portfolio. What is also new today is that aviation E&E issues are no longer addressed in isolation. Optimally balanced solutions are being analyzed and designed after careful consideration of associated interdependencies, tradeoffs, and associated costs and benefits. The E&E research portfolio includes a basket of solutions including advanced aircraft technologies, sustainable alternative fuels, efficient operational procedures, market options, and policy and regulatory measures that are implemented and controlled via an environmental management system (EMS).

First flight of the Boeing 787 Dreamliner on December 15, 2009

The Boeing 787 Dreamliner is expected to have a significant cumulative noise margin below Stage 4 Aircraft Noise Standards and is expected to use 20% less fuel than comparable aircraft. The Dreamliner is so fuel-efficient, for example, it can travel from San Francisco to New York carrying 275 passengers with comparable fuel economy to a 2010 Honda Accord traveling the same distance with 3 passengers.

Baseline measurement

— **Measure current levels of aviation related noise and emissions.**

2009: Develop methodologies to quantify and assess the impact of Particulate Matter and Hazardous Air Pollutants. (Environment and Energy, Airport Cooperative Research - Environment) [COMPLETED, see the first bullet under Progress in FY 2009]

2011: Establish the relationship between aviation engine exhaust and the gases and particulate matter that are deposited in the atmosphere. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2012: Expand noise data collection to very light jets, and supersonic aircraft. (Environment and Energy)

2013: Obtain direct measurements of hazardous air pollutants and particulate matter data to update modeling tools. (Environment and Energy)

Prediction

— **Develop models to predict the impact and benefits of changes.**

2008: Develop and distribute the first generation of integrated noise and emission prediction and modeling tools, including an environmental cost module. (Environment and Energy) [COMPLETED]

2010: Develop a preliminary planning version of an Aviation Environmental Design Tool (AEDT) that will allow integrated assessment of noise and emissions impact at the local and global levels. (Environment and Energy)

2010: Assess the impacts of aviation on regional air quality, including the effects of nitrogen oxide (NO_x) emissions from aircraft climb and cruise. (Environment and Energy)

2011: Assess the level of certainty of aviation's impact on climate change, with special emphasis on the effects of contrails. (Environment and Energy)

2011: Complete development of first-generation ground plume model for aircraft engine exhaust. (Environment and Energy)

2011: Enhance regional analysis capability in aviation environmental analysis tools. (NextGen - Operational Assessments)

2013: Update environmental assessments models to incorporate new noise metrics. (Environment and Energy)

2014: Complete development and field a fully validated suite of tools, including the AEDT and the Aviation Environmental Portfolio Management Tool (APMT). (Environment and Energy and Airport Cooperative Research - Environment)

2014: Assess NAS-wide benefits of environmental mitigation solutions comprised of new technologies, alternative fuels, advanced operational procedures, market measures, and options for policy and noise/emissions standards. (NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction)

Reduction techniques

— **Develop noise and emission reduction methods.**

2008: Enable implementation of a new continuous-descent approach noise abatement and fuel burn (emissions) reduction procedure at low-traffic airports during nighttime operations and optimize aircraft routing to reduce fuel usage. (Environment and Energy) [COMPLETED]

2010: Develop algorithms to optimize ground and airspace operations by leveraging communication, navigation, and surveillance technology in the short- to medium-term to optimize aircraft sequencing and timing on the surface and in the terminal area. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2010: Complete detailed feasibility study, including economic feasibility, measure environmental impacts, and demonstrate drop-in potential for alternative fuels. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2011: Complete detailed feasibility study, including economic and environmental impacts and an assessment of potential of renewable alternative fuels for gas turbine engines. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2013: Demonstrate optimized airport and terminal area operations that reduce or mitigate aviation impacts on noise, air quality, or water quality in the vicinity of the airport. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction and Airport Cooperative Research - Environment)

2013: Identify and pursue the development of engine and airframe technologies that will be the most effective at producing environmental benefits. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

2013: Complete significant demonstration of "drop-in" alternative turbine engine fuels. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2013: Establish engine design sensitivities by measuring particles emitted from combustor engine systems. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2013: Demonstrate airframe and engine technologies to reduce noise and emissions. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2014: Demonstrate optimized en route operations that enhance fuel efficiency and reduce emissions. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

2014: Complete assessment of renewable alternative turbine engine fuels. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2015: Complete transition plans for renewable alternative fuels. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2015: Assess environmental benefits of first round of Continuous Lower Energy, Emissions and Noise (CLEEN) airframe and engine technologies through integrated flight demonstration. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

Environmental Management

— **Develop environmental management systems for the NAS**

2013: Evaluate, refine, and apply Environmental Management System (EMS) decision support tools to aviation system. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

2015: Refine and update approaches for EMS performance tracking. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

Funding requirements - R&D Goal 2

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
—	Airport Cooperative Research - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000	100% of total program
A13.a	Environment and Energy	R,E&D	15,522	15,374	15,335	15,287	15,131	14,969	100% of total program
A12.a	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	26,509	20,600	20,691	20,778	20,752	20,726	100% of total program
1A08D	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	F&E	7,000	15,000	18,000	18,000	18,000	18,000	100% of total program
1A08F	NextGen - Operational Assessments	F&E	0	0	0	0	0	0	coordination only
		Total ($000)	54,031	55,974	59,026	59,065	58,883	58,695	

Progress in FY 2009: Clean and Quiet

- **Guidance for Quantifying Speciated Organic Gas Emissions from Airport Sources:** Published a guidance document to develop emissions inventory of airport level emissions of hazardous air pollutants. In addition, the FAA published a companion document to quantify speciated organic gas emissions from aircraft engines. Both documents are intended to provide a standard approach that an airport community could use for consistent inventory, analysis, and reporting of airport emissions. (Environment and Energy)

- **High-Level Tool for Prioritization of Optimized Profile Descent Implementation Sites:** Completed a data-driven methodology for the prioritization and planning of Optimized Profile Descent (OPD, also referred to as Continuous Descent Arrival or CDA) implementation sites NAS-wide. The tool ranks sites in accordance with overall benefits of OPDs, where OPDs would be simplest to implement, and where resources are available to support immediate planning and implementation of OPDs. (Environment and Energy)

- **Commercial Aviation Alternative Fuel Initiative:** Conducted three demonstration flights using a bio-jet fuel that advanced the acceptance and understanding of alternative aviation fuels. Commercial Aviation Alternative Fuel Initiative (CAAFI) played a key leadership role in the introduction of alternative aviation fuels with the issuance of a new specification for synthetic aviation fuel in September 2009. The new specification, ASTM International D7566, will allow the use of semi-synthetic aviation fuel in commercial airliners. (Environment and Energy)

- **Aircraft Noise Research Roadmap:** Developed a comprehensive research roadmap to address four critical research areas needed to advance the state of knowledge and practice on aircraft noise impacts: noise effects on health and welfare; noise impacts in National Parks and wilderness; NextGen noise modeling and unconventional aircraft; and the societal cost of aircraft noise. The research roadmap efforts in each of the four areas are at different levels of maturity. FAA will closely track progress against the research roadmap to prepare for any policy adjustments that may be warranted by new knowledge gained from the research. (Environment and Energy)

- **Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories:** Completed a study to provide airport operators with clear and cohesive guidance information and established uniform methodology to develop a source-specific inventory of airport greenhouse gas (GHG) emissions. There are increasing concerns about GHG emissions in the U.S. Several states and municipalities are taking legislative actions and implementing controls. At present there is no specific guidance or generally applied practice for computing airport-level GHG emission inventories. (Airport Cooperative Research - Environment)

- **Aviation Climate Change Research Initiative:** Developed high-level research priority recommendations for implementation in FY 2010. The FAA worked closely with other federal agencies to develop a solicitation of research proposals from national and international scientific communities. Key elements of this solicitation include simulations and assessment of regional and global aviation climate impacts for current flight activities and future projections under changing climate conditions, assessment of simplified aviation climate impacts models, and development of contrail prediction capabilities in numerical weather forecast models being used for aviation navigation purposes. A panel of interagency climate program managers and experts has been assembled and is presently reviewing the proposals. The panel will provide recommendations for selection of proposals on a competitive merit basis. (Environment and Energy)

- **Alternative Aviation Fuel Experiment:** Characterized aircraft engine emissions during combustion of a range of blended natural gas and coal-based Fischer-Tropsch (FT) alternative fuels. Researchers at Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), an FAA/NASA/Transport Canada-sponsored Center of Excellence, participated in this Alternative Aviation Fuel Experiment (AAFEX) project. Preliminary analyses indicate that combustion of FT fuels yields lower emissions of particulate matter, hydrocarbons, and sulfur oxides as compared to conventional jet fuels. Equally important, they provide energy security and sustainability. (Environment and Energy)

- **Managing Runoff From Aircraft and Airfield Deicing and Anti-Icing Operations:** Developed planning guidelines incorporating an array of best management practices for the practical, cost-effective control of runoff from aircraft and airfield deicing and anti-icing operations. These guidelines will assist airports of all sizes and operational levels in designing (or re-designing) site-specific solutions. These guidelines will also serve as tools for airports to promote the use of sustainable, efficient management systems that reduce the potential presence of aircraft deicing and anti-icing fluid (ADAF) in storm water runoff. (Airport Cooperative Research - Environment)

High Quality Teams and Individuals

The best qualified and trained workforce in the world

R&D target

By 2016, demonstrate improvement in air navigation service provider (ANSP) efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operations, procedures, and information.

Method of validation

The approach includes continued, incremental pursuit of efficiency gains in the en route phase of flight and pursuit of new knowledge and results that produce efficiency gains in terminal and tower operational phases. Automation and new capabilities that are added through implementation of operational improvements are believed to provide incremental efficiency benefits, and there are likely interactions among these capabilities; however, the specific benefits that accrue will need to be verified through human performance modeling and human-in-the-loop testing. The program will examine the roles of controllers and maintainers at increased capacity levels and how those roles are best supported by allocation of functions between human operators and automation to enhance safety and minimize the potential for human error while increasing efficiency. This goal contributes to the integrated demonstration under R&D Goal 4 - Human-Centered Design.

Then and Now 25th Anniversary 1985 - 2010

FAA's Flying Laboratories

Just like today, many aviation research challenges in 1985 could be investigated only with specially instrumented and reconfigurable airborne laboratories. Back then, the FAA research fleet included a Boeing 727, two Convair 580 turboprops, and a Sikorsky S-76 helicopter. Wake turbulence research was a high priority program and remains so today. The photo on the left shows the S-76 helicopter trailing smoke plumes that provide visible evidence of wake characteristics after test aircraft passage. These flying laboratories were essential components of research studies into Traffic Alert and Collision Avoidance System (TCAS), Microwave Landing Systems, and the effect of lightning strikes on avionics. Yes, FAA pilots regularly flew their aircraft into thunderstorms intent on being hit by lightning! Today, the FAA's Flight Program Airborne Laboratories has traded in the Boeing 727 for a Bombardier Global 5000. The Sikorsky S-76 helicopter and both Convair 580s, now with glass cockpits, remain in service. These flying laboratories support a laundry list of NextGen communication, navigation, and surveillance programs including Path Arrival Management, Global Position Sattelite, WAAS/LAAS, and ADS-B (Automatic Dependent Surveillance – Broadcast). These aircraft also support airport safety programs like runway incursion reduction, surface traction, heliport lighting, and painting and marking of airport surfaces. The background photo shows FAA's flying laboratory N47 testing the Runway Status Lights during a simulated runway incursion at LAX. And just like in 1985, the most important part of these flying laboratories today is the team of pilots, engineers, scientists, and mechanics who plan the operation, configure the laboratory, and fly the aircraft time and time again to meet the mission.

Milestones

Selection criteria

— **Ensure ANSPs have the aptitude and capability required to manage air traffic in the future system. (Air Traffic Control/Technical Operations Human Factors)**

2012: Apply program-generated human factors knowledge to improve aviation system personnel selection and training.

2015: Develop selection procedures to transform the workforce into a new generation of service providers that can manage traffic flows in a highly automated system.

Demonstrate improvements in ANSP efficiency

— **Demonstrate improvements in ANSP efficiency achieved by implementation of NextGen ground automation capabilities and aircraft equipage, use of data communications, and implementation of new decision support tools and automation. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))**

2010: Define anticipated controller workload reductions due to implementation of data communications.

2010: Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area.

2013: Analyze controller roles in a strategic air traffic environment for en route and terminal domains for the impact on personnel selection and training.

2013: Demonstrate collaborative air traffic management efficiencies enabled by common situation awareness between flight operators and ANSP.

2013: Demonstrate increased ANSP efficiencies through new procedures that allow ANSP personnel to manage and introduce routing, airspace, and traffic mix changes in the four-dimensional (position plus time), dynamic air traffic environment.

2016: Perform an analysis of controller roles in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur.

*Increase to 130 percent**

— **Demonstrate 130 percent controller efficiency. (Air Traffic Control/ Technical Operations Human Factors)**

2007: Demonstrate how to reduce verbal communication workload between the pilot and controller for en route operations. [COMPLETED]

2007: Identify the performance limitations of the controller in the terminal and tower environments. [COMPLETED]

2008: Demonstrate efficiency improvements when controllers receive information on aircraft equipage, performance capabilities, and applicable procedures in a mixed equipage environment. [COMPLETED]

2008: Conduct initial simulation to determine what weather information is required by en route and tower controllers to improve efficiency. [COMPLETED]

* The year 2004 was chosen as a baseline for consistency with the Vision 100 – Century of Aviation Reauthorization Act (P.L. 108-176) and the *Next Generation Air Transportation System Integrated Plan* submitted to Congress as required in that legislation.

Funding requirements - R&D Goal 3

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.i	Air Traffic Control/ Technical Operations Human Factors	R,E&D	10,302	10,475	10,633	10,799	10,934	11,073	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	4,310	4,242	4,247	4,347	4,447	6,097	18% of R&D program in FY 2010
A11.g	Flightdeck/Maintenance/ System Integration Human Factors	R,E&D	0	0	0	0	0	0	coordination only
A12.a	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
1A08A	NextGen - ATC/Technical Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	10,000	10,000	10,000	10,000	10,000	10,000	100% of total program
		Total ($000)	24,612	24,717	24,880	25,146	25,381	27,170	

Progress in FY 2009: High Quality Teams and Individuals

- **Strategic Job Analysis Database:** Assessed the probable impact of NextGen concepts of operation, procedures, and technologies on the profile of innate abilities and other personal characteristics (aptitudes) required to enter the air traffic controller station (ATCS) occupation. The primary focus in FY 2009 was on the design and construction of two prototypes of the Job Analysis Information Database (JAIdB). The first prototype was constructed for the tower cab controller job using Task Architect Pro (v2.0), a commercial hierarchical task analysis application. While the work of a tower cab controller was represented in Task Architect reasonably well, the ability requirements could not be addressed explicitly, and it was not possible to link sub-activities to abilities, as required in selection-oriented job

task analysis (JTA) practice and case law. The second prototype was built in Microsoft Access 2003. This prototype provided a means for mapping sub-activities and tasks defined in two previous ATCS job analyses to sub-activities and tasks defined in a third job analysis. The prototype provided an explicit linkage between sub-activities and abilities required for successful performance. It also demonstrated the feasibility of linking to other JTA data sources. However, as an Access application, the prototype JAIdB is not network aware and thus, cannot support multiple users. It also does not support multiple instances representing the job-by-ability relationships at different times (e.g., now, mid- and far-term). Finally, a market survey of commercial-off-the-shelf (COTS) job analysis applications was also conducted over the summer of 2009. No viable COTS JTA application was identified through the market survey. (Air Traffic Control/Technical Operations Human Factors)

- **New Practical Color Vision Tests for ATCS Applicants:** Developed a construct-based job-sample test to assess an applicant's ability to discriminate the colors deployed for critical tasks in current air traffic displays and transitioned it from research to operations. The Air Traffic Control Color Vision Test (ATCOV) was modified to more realistically represent targets currently deployed on critical air traffic displays. Also, the ATCOV was modified to better comply with the 1978 Uniform Guidelines on Employee Selection Procedures. It was concluded that the operational version of ATCOV is a true job-sample test, making use of display formats and color values deployed for critical functions on critical displays as defined by a review of published task analyses of ATCS duties. The Operational ATCOV was deployed to nine Regional Flight Surgeon Offices and/or Medical Field Offices in August and September of 2009, allowing clearance of some ATCS candidates who failed clinical color vision screening. (Air Traffic Control/ Technical Operations Human Factors)

- **Proactive Audit Approach to Support Safety Management Systems in Airline Maintenance and Ramp Operations:** Developed maintenance and ramp Line Operations Safety Audit (LOSA) forms and assisted with the creation of training materials for the forms. LOSA aims to identify precursors to maintenance or ramp events during normal activity. These proactive approaches, as opposed to post accident and event investigation, are aligned with the principles of risk management and Safety Management Systems (SMS). For any organization, SMS has the potential to evaluate its vulnerability to error (including those of its systems, processes, and personnel), ascertain the validity and reliability of its information, and consequently assess its internal control. The research team tested the forms and training materials with the assistance of industry personnel. Preliminary findings showed that ongoing maintenance LOSA observations raise safety awareness in the workforce and LOSA observers believed the process made them better mechanics. Additionally, researchers discovered several areas of improvement that the airlines should address in their normal operations to continuously improve safety and efficiency. (Air Traffic Control/Technical Operations Human Factors)

- **Guidelines for an Aircraft Maintenance Aviation Safety Action Program:** Developed and issued *A Practical Guide to Maintenance Aviation Safety Action Program (ASAP)* in response to an industry-wide desire for a simple and practical source of information regarding the assessment, development, and operation of ASAPs across many areas of the aviation maintenance community. Aviation Safety Action Programs (ASAPs) are a non-punitive error-reporting program intended to encourage reporting of errors made by employee groups so that systemic solutions can be developed and error-inducing conditions can be minimized. In aviation maintenance, safety is dependent on reliability of the maintenance personnel and hardware. ASAPs acknowledge the complexity of these human-machine dynamics and human relationships and provide a means to address errors that impact the overall safety of aviation maintenance. Over the past several years, the number of ASAPs has increased significantly (currently 199 for maintenance, pilot, cabin, dispatch, and others). (Air Traffic Control/Technical Operations Human Factors)

Human-Centered Design

Aerospace systems that adapt to, compensate for, and augment the performance of the human

R&D target

By 2016, demonstrate that operations (e.g., day and night, all weather), procedures, and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft.

Method of validation

The approach includes identifying roles and responsibilities, defining human and system performance requirements, applying error management strategies, and conducting an integrated demonstration across multiple goal areas. Validation of the R&D target will include simulations and demonstrations to confirm the requirements and methodologies for human performance and error management. The final demonstration will integrate weather-in-the-cockpit technologies, self-separation procedures, air traffic controller productivity tools, and network-enabled collaborative decision-making to increase capacity, reduce delays, and promote safety.

Then and Now 25th Anniversary 1985 - 2010

From Cockpit Resource Management to Human System Integration

From the flight deck to the air traffic controller workstation, many of today's human factors challenges, such as crew performance, human error management, training, and display design and integration, are similar to the challenges faced in 1985. However, a greater amount of increasingly complex operational information is now available to both pilots and controllers. These advances underscore the importance of human factors research in ensuring systems and their operators function as specified.

In 1985, cockpit resource management (CRM) research focused on better communication between captains and first officers. Supported by FAA research, this practice matured to include the cabin crew. Now the total operational environment is considered, with a focus on threat and error management. This approach was adopted worldwide and integrated into all segments of air carrier training. In 1985, display design and integration focused primarily on flight displays that were located on an aircraft's instrument panel. Now, research is focused on integrating information from displays such as electronic flight bags (EFBs), enhanced and synthetic vision, and heads-up displays.

Milestones

Roles and responsibilities

— **Define the changes in roles and responsibilities, between pilots and controllers and between humans and automation, required to implement NextGen.**

2011: Document ramp operational and safety techniques and how airport operators implement pavement maintenance programs. (Airport Cooperative Research - Capacity)

2011: Develop initial mid-term analysis describing the relationship between human pilots and controllers with associated automated systems. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration)

2012: Complete initial research to evaluate and recommend procedures for negotiations and shared decision-making between pilots and controllers. (NextGen - Air Ground Integration Human Factors, NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

2016: Complete research to enable safe and effective changes to controller roles and responsibilities for NextGen procedures. (NextGen - Air Ground Integration Human Factors, NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

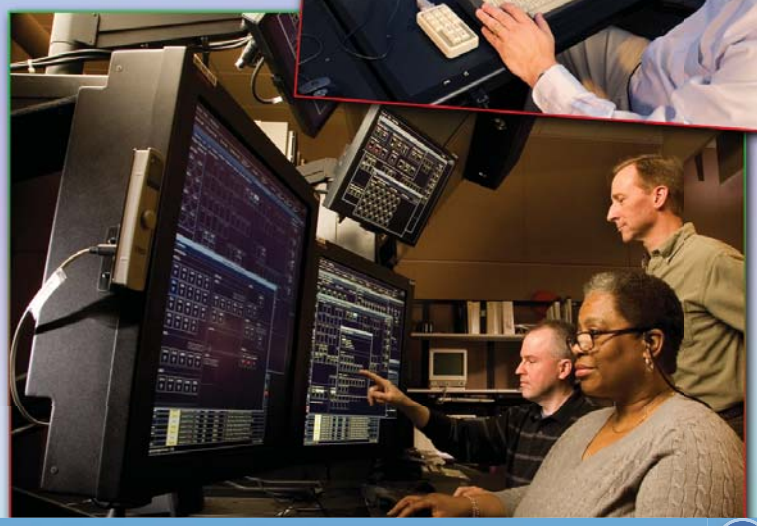
Integrated demonstrations

— **Conduct incremental and full-mission demonstrations to increase the likelihood of successful implementation of research results. (NextGen - Air Ground Integration Human Factors, NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration), William J. Hughes Technical Center Laboratory Facility)**

2017: Functional demonstration – demonstrate integrated pilot and controller functional capabilities.

After the air traffic controller strike in 1981, there was an influx of air traffic control new-hires, which drove the need for new forms of controller aptitude and occupational knowledge testing. Human factors research activities successfully culminated in the Air Traffic Selection and Training (AT-SAT) test. Now, 25 years later, the FAA is once again in a surge of hiring air traffic controllers in association with the cycle of increased retirements.

NextGen places the focus of human factors efforts on automation and decision support tools. The 2010 human factors research portfolio makes extensive use of high fidelity simulation capabilities such as sophisticated eye tracker technologies and automated data collection to develop and test future concepts. In addition, human factors research in 2010 and beyond addresses the challenges of personnel selection, training, human error, workstation design, and the changing roles and responsibilities that are aligned in NextGen using a Human System Integration approach.



(previous page) top – FAA radar training facility; bottom – Controller using monochromatic display circa 1985

(this page) top – Eye-tracking technology for measuring scanning patterns; bottom – En route modernization automation monitor and control consoles

Human system integration

— **Define human and system performance requirements for design and operation of aircraft and air traffic management systems.**

2010: Initiate research to identify equipment categories for legacy flight deck avionics to support human factors evaluations of use of these systems in NextGen flight procedures. (NextGen - Air Ground Integration Human Factors)

2012: Initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations. (NextGen - Air Ground Integration Human Factors)

2012: Develop human factors guidance for Automatic Dependent Surveillance – Broadcast (ADS-B) enabled Cockpit Display of Traffic Information (CDTI) certification and operational approval. (Flightdeck/Maintenance/System Integration Human Factors)

2012: Provide human factors guidance for the design of instrument procedures. (Flightdeck/Maintenance/System Integration Human Factors)

2013: Complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures. (NextGen - Air Ground Integration Human Factors)

2016: Complete research to assess procedures, training, display, and alerting requirements to support development and evaluation of planned and unplanned transitions between NextGen and legacy airspace procedures. (NextGen - Air Ground Integration Human Factors)

Error management

— **Develop and apply error management strategies, mitigate risk factors, and reduce automation-related errors. (NextGen - Air Ground Integration Human Factors, NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))**

2012: Complete research to develop methods to mitigate mode errors in use of NextGen equipment.

2014: Develop initial guidance on training methods to support detection and correction of human errors in near- to mid-term NextGen procedures.

2016: Complete research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment.

Funding requirements - R&D Goal 4

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.i	Air Traffic Control/ Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	coordination only
—	Airport Cooperative Research - Capacity	AIP	0	1,700	1,700	1,700	1,700	1,700	34% of total program
A11.g	Flightdeck/Maintenance/ System Integration Human Factors	R,E&D	7,128	7,174	7,253	7,336	7,390	7,446	100% of total program
A12.a	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	5,688	10,614	10,656	10,692	10,670	10,648	100% of total program
1A08A	NextGen - ATC/Technical Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	0	0	0	0	0	0	coordination only
1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	0	0	0	0	0	0	coordination only
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	0	0	0	0	0	coordination only
A11.h	System Safety Management	R,E&D	0	0	0	0	0	0	coordination only
A11.k	Weather Program	R,E&D	0	0	0	0	0	0	coordination only
A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	4,588	3,717	3,785	3,857	3,920	3,986	100% of total program
		Total ($000)	17,404	23,205	23,394	23,585	23,680	23,780	

Progress in FY 2009: Human-Centered Design

- **Dynamic Comprehension - Time on Position and Mental Fatigue:** Determined the amount of time necessary to develop dynamic comprehension of the traffic situation following a position transfer. The purpose of the study was to provide an empirical basis for establishing minimum and maximum times on position for en route controllers. Controllers commonly state that it takes time to develop a feel for the traffic once they assume position control. The results of this study suggest that the feel that controllers are referring to may be associated with calibrating their mental clock with the time it takes to execute their plan. Controllers may have a plan when they assume position control, but may be underestimating the amount of time it will take to execute that plan. Results suggest that it takes between 5-10 seconds per aircraft for controllers to adapt to the traffic demands of their sector once they assume position control. This range serves as an initial basis for estimating the minimum amount of time a controller should be on position before being relieved. (ATC/ Technical Operations Human Factors)

- **Weather in the Cockpit Baselining and Assessment:** Assembled information on present, near-term, and anticipated weather information requirements for air transport flight decks, general aviation (GA) cockpits, and airline operations centers (AOC). Adverse weather is both a challenge for safe flight operations and a significant limiting factor for airspace capacity. Predicting and avoiding adverse weather requires a great deal of attention from air transport pilots and airline operation centers. As cockpit and air traffic weather information systems and products enter the NAS, they should facilitate both near-term and future operations and provide, at a minimum, the same access to information that participants now have with the expectation that a wider breadth of information should become available to all users in the future. Civil Aerospace Medical Institute (CAMI) personnel evaluated the procedures, products, priorities, and communication methods used in AOCs. Dispatchers from the airlines gave very similar ratings of priorities across most of the weather factors. While there were small differences between the airlines, they all consulted several information sources to develop a weather picture relevant to their flights. Larger airline operations develop products of their own, usually based on data delivered from a commercial weather information source. The only differences of note were that dispatchers from the larger long-haul airlines gave somewhat higher priorities to some of the wind factors. (Flightdeck/Maintenance/System Integration Human Factors)

- **Automatic Dependent Surveillance – Broadcast:** Conducted a research study that explored the intuitiveness, ease of learning, and ease of remembering different proposed traffic symbols. This task supports FAA understanding of human factors issues related to the use of Cockpit Displays of Traffic Information (CDTI) based on ADS-B. The goal was to determine whether there are some general principles that should be followed for the design of traffic symbols. Results of the study were considered by Federal Advisory Committee RTCA Special Committee-186, which is developing standards for these traffic displays, (Flightdeck/Maintenance/System Integration Human Factors)

- **Electronic Flight Bags:** Completed a study on human factors issues related to the implementation and integration of electronic flight bags (EFBs) into normal flight operations. The goal of the EFB research into these electronic display systems is to support the FAA in the development of EFB-related policies and guidance. The results showed that the majority of EFB-related safety events concerned use of charting applications, but in the updated report the emphasis shifts toward the use of performance calculations applications. Research results were presented at a conference and will be published and shared through EFB human factors workshops. (Flightdeck/Maintenance/System Integration Human Factors)

- **Data Communications, Human-in-the Loop Simulation and Part Tasks:** Completed en route human-in-the-loop (HITL) simulations to support the development of human-machine interface requirements for the Data Communications (Data Comm) system. This activity investigated the effect of traffic complexity on cognitive workload and provided new requirements for terminal and flight deck as well as updating requirements for the en route interface. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

- **Surface Moving Maps:** Conducted an operational evaluation to examine the impact of a Surface Moving Map with ownship position on a Class 2 or Class 3 EFB. This project supports the development of guidelines and approval criteria for surface moving maps depicting ownship position, regardless of whether they are installed or portable. Several advanced functions are being considered, including display of surface traffic and indications or alerts of potential runway incursions. Additional guidance is needed to establish minimum standards and best practices, as they are critical to support flight deck implementation and integration. The Volpe Center, which provided human factors support in this project, completed and published a formal survey of the surface moving map industry to understand current and proposed capabilities. (Flight Deck/Maintenance/System Integration Human Factors)

- **Future En Route Workstation III Simulation:** Investigated Future En Route Workstation (FEWS) III simulation concepts based on NextGen plans to increase airspace capacity. The concepts included increased use of Area Navigation (RNAV) routes and the delegation of self-spacing to the flight deck. Researchers also included an aircraft grouping procedure to enable two or more aircraft to be controlled as a single unit, similar to the way controllers manage military aircraft in formation flight. Aircraft conducting these procedures may require less controller intervention than aircraft requiring conventional control, thus enabling an increased number of aircraft to be handled. This simulation evaluated the benefits and feasibility of the concepts using a baseline system and the FEWS system that provided additional task support features. Results indicate that participants managed more aircraft, reported lower workload, and held aircraft less when using the FEWS system. They also managed more traffic when aircraft were adhering to RNAV routes that had both lateral and vertical conformance constraints. The participants reacted positively to the self-spacing concept, but did not find the grouping concept useful. These results indicate that FEWS and the use of full RNAVs allow controllers to safely and effectively manage a much larger volume of aircraft in a sector. (ATC/Technical Operations Human Factors)

- **Future Terminal Workstation-1:** Evaluated the Future Terminal Workstation-1 (FTWS-1) in a HITL simulation in which controllers participated in scenarios that reflect future traffic volumes, equipage levels, and workstation designs. The project was designed to develop an FTWS-1 prototype workstation for terminal approach control to support many NextGen components. Benefits were reported from the use of advanced arrival routes with conformance monitoring. However, researchers observed interdependencies between some of the independently developed tools and also that the participants continued to use a vector mindset rather than use a TBO. Initial data analysis for the FTWS-1 simulation is complete and technical reports for the simulation will be delivered in FY 2010. (ATC/Technical Operations Human Factors)

- **Front Line Manager Best Practices:** Identified best practices of Terminal Radar Approach Control (TRACON) front line managers (FLMs) for promoting safety and preventing reportable errors throughout the NAS. This is the third study to look at FLM best practices. Previous studies looked at the subject in the en route and tower environments. Air traffic FLMs play an important role in meeting Flight Plan objectives for a safer workplace by facilitating prevention of reportable errors and runway incursions and providing necessary leadership to manage both controller performance and resources. Research focused on reviewing existing research data and performing an operational error analysis based on various contributing factors such as weather, training tasks, and implementation of new equipment and procedures. All of the facilities chosen for this phase had a history of low error rates and the participating FLMs had been identified as high performers in those facilities. The studies' interview results and information analyses produced an integrated set of FLM best practices encompassing the en route, tower, and TRACON environments. These were used to develop a comprehensive set for the FLM Best Practices Quick Reference Guide to be distributed to all ATC FLMs within FAA in FY 2010. (ATC/Technical Operations Human Factors)

Human Protection

A reduction in fatalities, injuries, and adverse health impacts due to aerospace operations

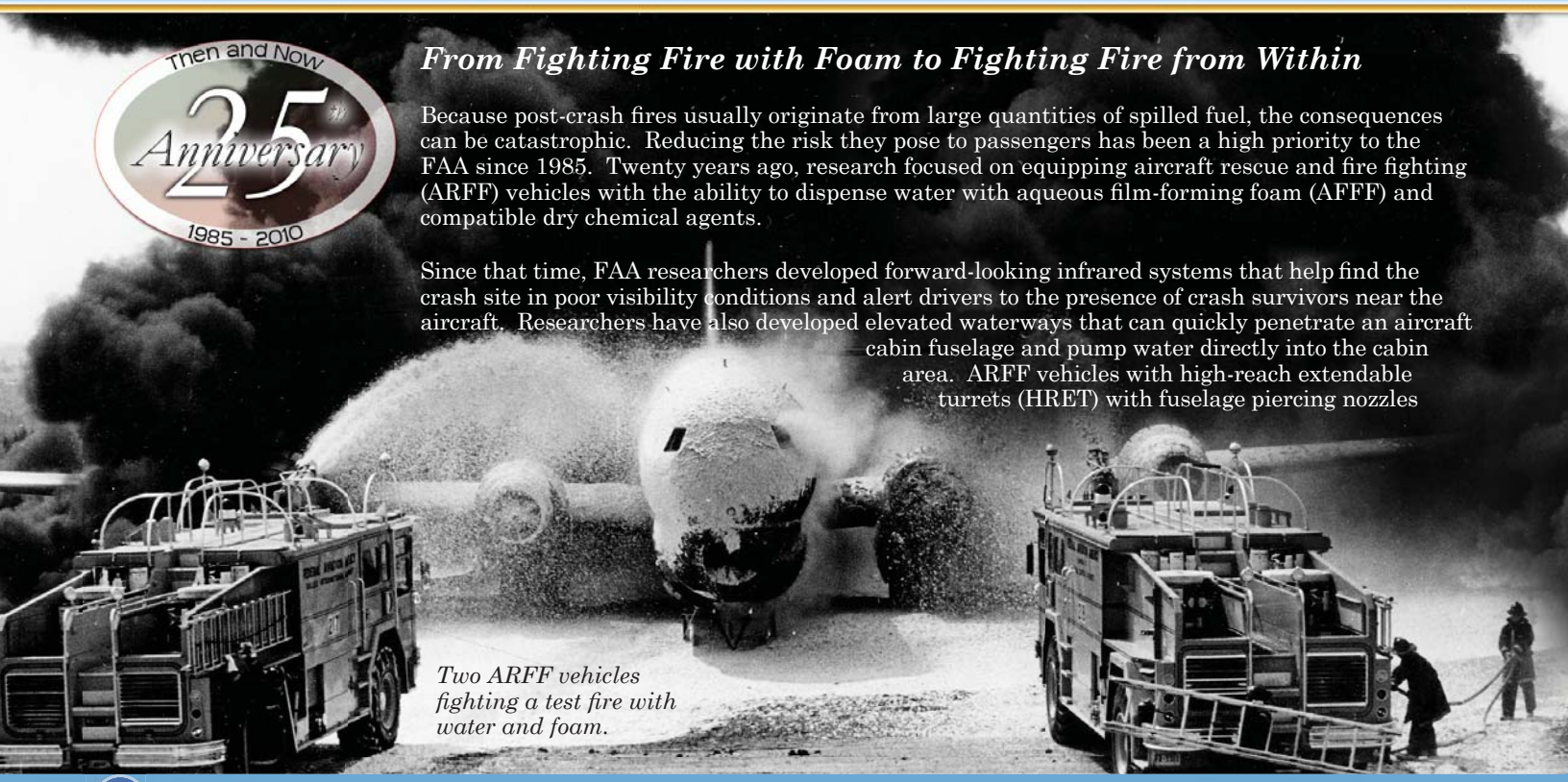
R&D target

By 2015, demonstrate a two-thirds reduction in the rate of aerospace-related fatalities and significant injuries.*

Method of validation

The approach includes preventing injuries during regular operations and protecting people in the event of a crash. Validation of the supporting milestones will include demonstrations, analysis, modeling, simulations, full-scale testing, and initial standards. Validation of the R&D target will include analysis of U.S. accident data. Results from R&D Goal 6 - Safe Aerospace Vehicles will contribute to the interim and final measurements of the reduction. The safety evaluation (under R&D Goal 9 - System Knowledge) will support the interim assessment of progress and validation of the R&D target. The demonstration will show that the R&D is sufficient to meet the targeted operational improvement.

* The year 2004 was chosen as a baseline for consistency with the Vision 100 – Century of Aviation Reauthorization Act (P.L. 108-176) and the *Next Generation Air Transportation System Integrated Plan* submitted to Congress as required in that legislation.



From Fighting Fire with Foam to Fighting Fire from Within

Because post-crash fires usually originate from large quantities of spilled fuel, the consequences can be catastrophic. Reducing the risk they pose to passengers has been a high priority to the FAA since 1985. Twenty years ago, research focused on equipping aircraft rescue and fire fighting (ARFF) vehicles with the ability to dispense water with aqueous film-forming foam (AFFF) and compatible dry chemical agents.

Since that time, FAA researchers developed forward-looking infrared systems that help find the crash site in poor visibility conditions and alert drivers to the presence of crash survivors near the aircraft. Researchers have also developed elevated waterways that can quickly penetrate an aircraft cabin fuselage and pump water directly into the cabin area. ARFF vehicles with high-reach extendable turrets (HRET) with fuselage piercing nozzles

Two ARFF vehicles fighting a test fire with water and foam.

Milestones

Safe evacuation

— **Prevent injuries or fatalities during evacuations.**

2012: Define composite fuselage fire safety design criteria. (Fire Research and Safety)

2012: Develop aircraft rescue and fire-fighting procedures and equipment standards to address double-decked large aircraft. (Airport Technology Research - Safety)

2012: Validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability. (Aeromedical Research)

Hazardous weather

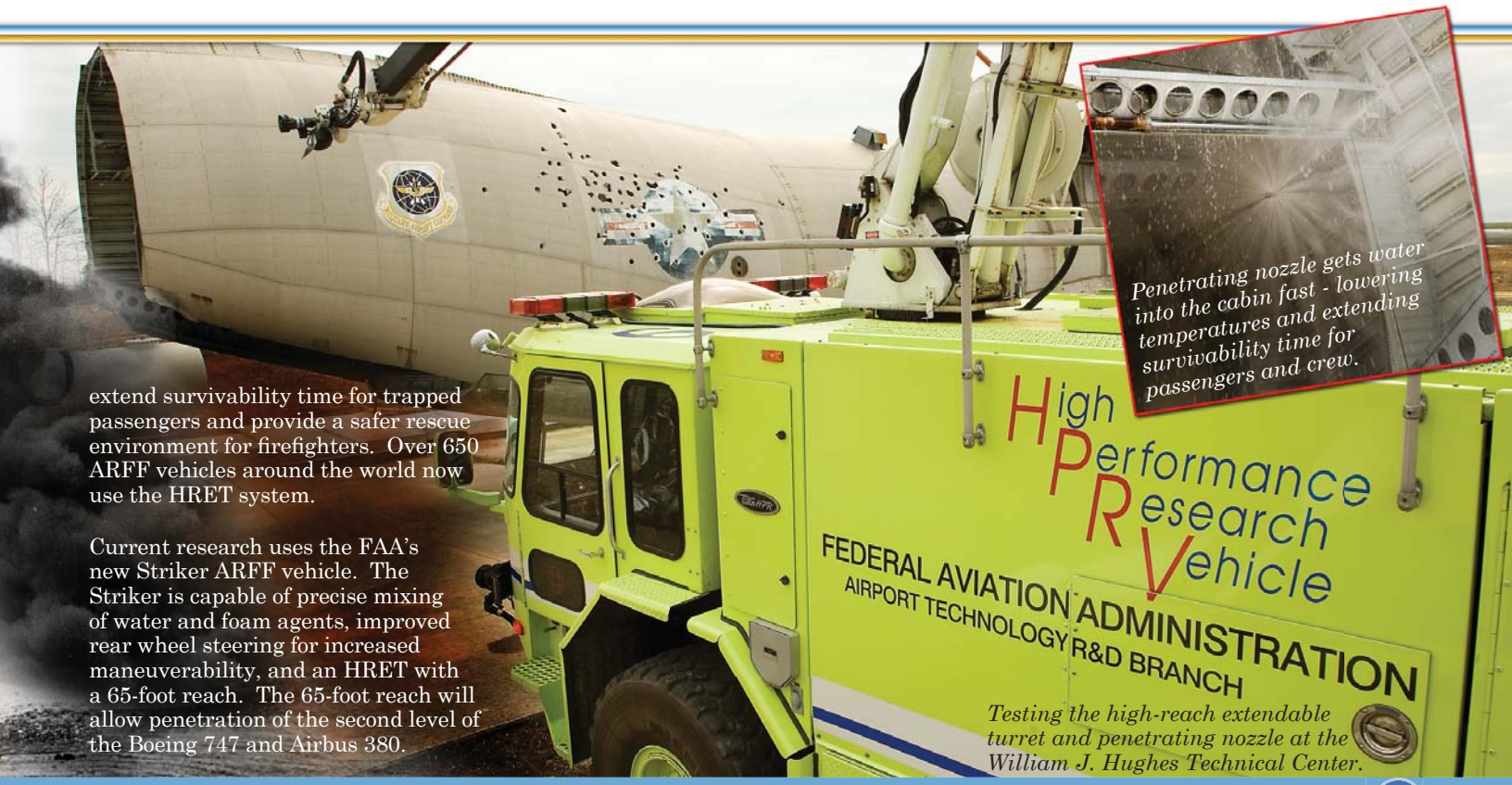
— **Prevent injuries and fatalities due to hazardous weather.**

2014: Develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments. (Atmospheric Hazards - Aircraft Icing/Digital System Safety)

Occupant restraint

— **Improve occupant restraint systems to reduce injuries and fatalities.**

2012: Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain. (Aeromedical Research, Advanced Materials/Structural Safety)



Penetrating nozzle gets water into the cabin fast - lowering temperatures and extending survivability time for passengers and crew.

extend survivability time for trapped passengers and provide a safer rescue environment for firefighters. Over 650 ARFF vehicles around the world now use the HRET system.

Current research uses the FAA's new Striker ARFF vehicle. The Striker is capable of precise mixing of water and foam agents, improved rear wheel steering for increased maneuverability, and an HRET with a 65-foot reach. The 65-foot reach will allow penetration of the second level of the Boeing 747 and Airbus 380.

Testing the high-reach extendable turret and penetrating nozzle at the William J. Hughes Technical Center.

Human aeromedical safety and health risk management

— **Identify and manage human aeromedical safety and health risks.**

2011: Assess role of airports and airlines in the spread of vector-borne diseases. (Airport Cooperative Research - Safety)

2015: Incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control. (Aeromedical Research)

2015: Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks. (Aeromedical Research)

2015: Develop a methodology to compile, classify, and assess aviation-related injuries, the mechanisms that resulted in these injuries, and their relationship to: autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic testing: Aerospace Accident Injury and Autopsy Data System. (Aeromedical Research)

2015: Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors. (Aeromedical Research)

Cabin air quality

— **Reduce health risk to aircrew and passengers due to cabin environmental threats. (Aeromedical Research)**

2010: Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants.

2010: Validate computational models of chemical air contaminants, such as volatile organic compounds (VOCs), to evaluate health and safety impacts on passengers and crew.

2011: Apply and validate advanced air sensing technology for VOCs in the aircraft cabin environment.

2011: Develop bleed air contamination models of engine compressors and high temperature air system for effects on the health and safety of passengers and crew.

2012: Accomplish experimental projects in support of regulations, certification, and operations for existing Aviation Rulemaking Committees by providing data and guidance for new or revised regulation of airliner cabin environment standards.

2012: Develop and validate chemical kinetic models for bleed air systems for health and safety effects on passengers and crew.

Commercial space

— **Identify the requirements for safe commercial space transportation operations. (Commercial Space Transportation Safety)**

2008: Conduct a study to provide a basic understanding of what is necessary in an Informed Consent form for commercial space flight participants. [COMPLETED]

Turbulence

— **Prevent injuries and fatalities due to turbulence. (Weather Program)**

2012: Transition turbulence forecast capability for all flight levels for implementation.

2012: Transition mountain-wave turbulence forecast capability for implementation.

2013: Transition convectively-induced turbulence forecast capability for implementation.

2016: Transition global turbulence forecast capability for implementation.

Airports

— **Prevent injuries and fatalities due to aircraft overrun. (Airport Technology Research - Safety)**

2011: Complete evaluation of new airport runway pavement groove shape to reduce risk of overrun due to hydroplaning.

Funding requirements - R&D Goal 5

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.c	Advanced Materials/ Structural Safety	R,E&D	0	0	0	0	0	0	coordination only
A11.j	Aeromedical Research	R,E&D	10,378	11,217	11,390	11,570	11,718	11,870	100% of total program
—	Airport Cooperative Research - Safety	AIP	3,000	2,500	2,500	2,500	2,500	2,500	50% of total program
—	Airports Technology Research - Safety	AIP	4,157	5,000	5,000	5,000	5,000	5,000	35% of total program
A11.d	Atmospheric Hazards - Aircraft Icing/Digital System Safety	R,E&D	1,345	1,991	2,003	2,015	2,017	2,019	30% of total program
A11.a	Fire Research and Safety	R,E&D	6,551	6,074	6,174	6,279	6,367	6,459	84% of total program
A11.k	Weather Program	R,E&D	1,511	1,485	1,474	1,461	1,436	1,410	9% of total program
		Total ($000)	26,941	28,267	28,541	28,825	29,038	29,258	

Progress in FY 2009: Human Protection

- **Aerospace Accident Injury and Autopsy Data System Progress:** Enhanced the Aerospace Accident Injury and Autopsy Data System (AAIADS) program to provide an early operational benefit to support accident investigation. The medical research team coordinated with accident investigators to develop detailed information regarding the accident and to assist the investigators in evaluating any medical factors that could have contributed to the accident. During the development of AAIADS, researchers determined that the data would provide investigators in the field and in FAA offices with medical certification information and autopsy and toxicological findings relative to fatal and high profile accidents. The autopsy program was tasked to identify accident victims, ensure that an autopsy was performed, and provide autopsy information to investigators. The autopsy team provided information to the medical research team, allowing the research physicians to combine the pilot's medical certification history, findings from the autopsy, and results from toxicological testing to establish a complete picture of the pilot's health. While still in the development phase, the AAIADS program was able to support accident investigation and form the basis for future research. (Aeromedical Research)

- **Safe Evacuation:** Completed the first phase of mathematical evacuation model development and validation with a final report to be published in 2010. This project created a versatile mathematical method that could simulate evacuation from all airliner models with various seating, door, and cabin designs. The computational aircraft evacuation model uses features such as the shortest distance to exits, speed of an evacuation cue line, gaps in the evacuation cue line, evacuee behavior, and flow rate at exits. (Aeromedical Research)

- **Centrifuge-Based Simulators in Pilot Training:** Completed a congressionally-directed assessment of a centrifuge-based simulator to evaluate its effectiveness in training pilots to recover from an upset or unusual attitude situation. The physiological concept of the centrifuge-based simulator was that the acceleration forces applied by the centrifuge would replicate the acceleration forces felt by the pilot in an actual upset condition and would assist in recovery to normal flight. The research program compared the use of the centrifuge-based full cockpit simulator with a computer-based desktop simulator. Pilots trained with one of the two methods and then were flown as passengers through unusual attitudes in a Super Decathlon acrobatic aircraft. Their ability to correctly return the aircraft to normal flight was subjectively and objectively measured. Both training methods similarly improved the pilots' ability to recover indicating that ground-based training can improve in-flight upset recovery. The study's findings are available in two reports: *An Experiment to Evaluate Transfer of Upset-Recovery Training Conducted Using Two Different Flight Simulation Devices*, (DOT/FAA/AM-09/17) and *An Experiment to Evaluate Transfer of Low-Cost Simulator-Based Upset-Recovery Training*, (DOT/FAA/AM-09/5). (Aeromedical Research)

- **Aircraft Laser Illumination Awareness for the Aviation Community:** Prepared and released an informational training video, "Aircraft Laser Illumination Awareness for the Aviation Community." In response to the growing trend of unauthorized aircraft laser illuminations, the FAA and the U.S. Air Force jointly produced this video to serve as a tool to educate and inform the aviation community of the dangers associated with these unauthorized laser incidents. It presents a brief history of cockpit laser events and discusses the potential hazards of laser exposure. The video also demonstrates strategies that flight crew members can adopt to safely manage and report a laser illumination. All cockpit illuminations depicted in the video were filmed in the Boeing 737-800 full flight simulator equipped with a dual-laser delivery system as part of HITL pilot laser illumination flight tests at the FAA's Flight Operations Simulations Laboratory. The training video supports ongoing efforts within the aviation community to address the risks associated with laser illuminations. This approach continues to highlight recommended best practices, procedures, and other rulemaking processes associated with laser safety. (System Safety Management)

- **47 Years of Aerospace Toxicology Research:** Developed a comprehensive reference source for topics related to aerospace toxicology. The article addresses agricultural aviation (aerial application), aviation combustion toxicology, postmortem aviation forensic toxicology, cabin air contamination, and references for the period of 1960–2007. The report entitled *Aerospace Toxicology, An Overview*, (DOT/FAA/AM-09/8) can be found online: http://www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200908.pdf. (Aeromedical Research)

- **Cannabinoids in Fatal Aviation Accidents:** Determined the effect of an increase in the delta-9-tetrahydrocannabinol (THC) content of commonly available cannabis on the impairment of pilots involved in aviation accidents. The National Institute on Drug Abuse and the Office of National Drug Control Policy reported a 1.5-fold increase in THC content of seized cannabis from 1997-2001 to 2002-2006. FAA research found a 2.7-fold increase in the mean blood THC concentration of specimens from aviation fatalities for the same time periods. Further, it was found that approximately 46 percent of the blood samples positive for THC from 2002-2006 had concentrations of THC greater than the impairing concentration of THC, whereas only 25 percent exceeded that concentration between 1997 and 2001. The results are described in the report *Increased Cannabinoids Concentrations Found in Specimens from Fatal Aviation Accidents Between 1997 and 2006*, (DOT/FAA/AM-09/12). (Aeromedical Research)

- **Detection and Prevention of Carbon Monoxide Exposure in GA Aircraft:** Identified protocols to quickly alert GA pilots to the presence of excessive carbon monoxide (CO) in the cabin and evaluated inspection methods and maintenance practices to safeguard against CO generation. Exposure to CO, which is formed by the incomplete combustion of carbon-containing materials such as aviation fuels, is associated with headache, dizziness, fatigue, and at elevated doses, death. Exhaust system failures in GA aircraft can result in CO exposure. This research focused on the detection and prevention of CO exposure in GA aircraft. The research culminated with a specification for optimal detector type and installation locations in the GA cockpit to detect CO exposure. In addition, it defined best practices for inspection and maintenance of GA aircraft exhaust systems to prevent CO leakage. (System Safety Management)

Safe Aerospace Vehicles

A reduction in accidents and incidents due to aerospace vehicle design, structure, or subsystems

R&D target

By 2015, demonstrate damage and fault tolerant vehicles and systems.

Method of validation

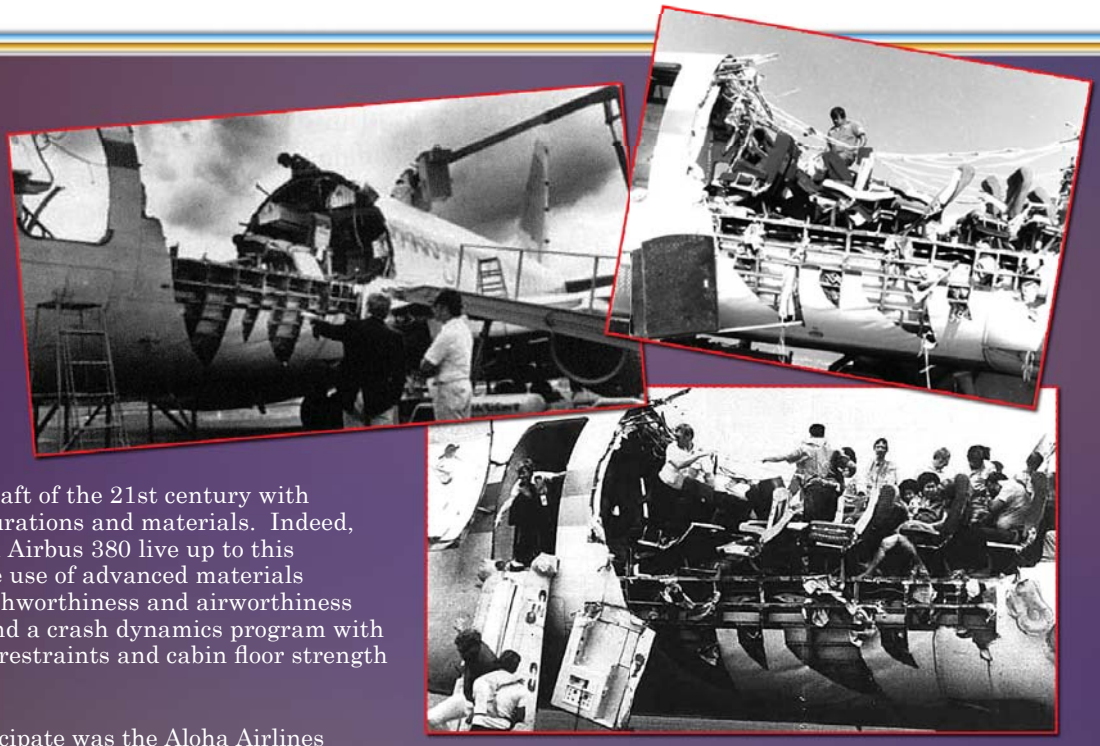
The approach includes preventing accidents due to engine failures, structural failures, and system failures; developing a fireproof cabin; integrating unmanned aircraft and commercial space vehicles into the NAS; and addressing safety problems specific to GA aircraft. Validation of the R&D target will include analysis, modeling, flight simulation, physical demonstration, prototypes, and initial standards. The results from this goal will contribute to the R&D target to demonstrate a two-thirds reduction in fatalities and significant injuries under R&D Goal 5 - Human Protection.

Then and Now 25th Anniversary 1985 - 2010

The Science of Aging Gracefully - From Metals to Composites

The 1985 Plan anticipated aircraft of the 21st century with very different structural configurations and materials. Indeed, aircraft like the Boeing 787 and Airbus 380 live up to this expectation and make extensive use of advanced materials and fabrication processes. Crashworthiness and airworthiness research in 1985 centered around a crash dynamics program with an emphasis on passenger seat restraints and cabin floor strength in survivable impact scenarios.

What the 1985 Plan did not anticipate was the Aloha Airlines accident in 1988 where widespread fatigue damage led to an in-flight loss of a 18-foot section of fuselage and the death of one flight attendant. Almost immediately, the FAA research program refocused on the continued airworthiness aspects of aging aircraft with emphasis on inspection and maintenance.



Pictured above are photos from the Aloha accident.

Milestones

Structures

— **Prevent accidents due to structural failures or fire.**

2010: Develop certification methods for damage tolerance and fatigue of composite airframes. (Advanced Materials/Structural Safety)

2011: Provide comprehensive guidance on lithium battery fire safety. (Fire Research and Safety)

2011: Apply damage-detection technologies for inspecting remote and inaccessible areas of in-service aircraft with metal structures. (Continued Airworthiness)

2012: Define criteria for use of embedded sensors in fault-tolerant structures. (Advanced Materials/ Structural Safety)

Unmanned aircraft

— **Integrate unmanned aircraft systems (UAS) into the civil airspace. (Unmanned Aircraft Systems Research)**

2012: Determine performance characteristics and operational requirements for UAS detect, sense, and avoid (DSA) technologies.

2012: Analyze data on the safety implications of system performance impediments to UAS command, control, and communication (C3) in different classes of airspaces and operational environments.

2013: Develop and conduct system-level proof-of-concept regulatory-based causal factor framework by applying Safety Management System (SMS) principles to support integration of UAS civil/ commercial operations in the NAS.

2015: Conduct field evaluation of DSA technology; C3 technologies; and flight termination procedures.

FASTER facility at the William J. Hughes Technical Center.

Final preparations on a bonded repair before the November 10, 2009 residual strength test.

In 2010, the goal of the Continued Airworthiness Program is to understand and develop methods to counter the effects of age and usage on the airworthiness of an aircraft over its lifetime, including potential effects of modifications and repairs. Towards this goal, FAA established the Full-Scale Aircraft Structural Test Evaluation and Research (FASTER) facility, a state-of-the-art core capability developed to perform structural testing of legacy and next generation fuselage structure. The facility has been effectively used to leverage resources through partnerships with other government agencies, industry and academia, including NASA, Boeing, and Drexel University.

On November 10, 2009, a residual strength test was conducted to characterize the damage-tolerance of a bonded repair to a B727 fuselage panel containing a large two-bay crack with the central frame and tear strap severed. Test results revealed that a properly designed and installed bonded repair can effectively contain large damage under severe loads in excess of ultimate load requirements.

Commercial space

— **Identify the requirements for safe commercial space transportation vehicles. (Commercial Space Transportation Safety)**

2010: Conduct a study to provide information on the capability, limitations, and considerations for GPS implementation in space launch and reentry environments, such as Space and Air Traffic Control, which will be used to help determine requirements for GPS usage and future technologies.

2010: Conduct a study to identify means of preventing hazards (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically hydrogen peroxide, H_2O_2, and nitrous oxide, N_2O) used in propulsion systems in commercial space applications

2010: Conduct a study to provide guidance to AST and industry on the use of operational limitations and inspection requirements for suborbital reusable launch vehicles (RLVs) comprised of composite materials. The results of this study will help to develop effective rules for operations and maintenance for use of composite materials, as they apply to commercial space transportation.

2010: Conduct a study to examine the operational environment, determine the number of sensors needed, define the data recovery process, and provide black box survivability criteria for use in developing requirements for a black box system to be used in commercial space transportation systems (expendable launch vehicles and RLVs).

2010: Conduct an assessment on the outputs from two specialized, independent system safety analyses conducted by separate parties to determine the optimal system safety method. The assessment will include the strengths and weaknesses, the hazard analysis depth, the hazard identification thoroughness, and the projected resource utilization.

General aviation

— **Reduce GA accidents.**

2012: Complete development of methods and data for damage tolerance analysis of rotorcraft structure. (Continued Airworthiness)

2013: Develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems for usage credits. (Continued Airworthiness)

2015: Evaluate and characterize all candidate replacement formulations for 100LL. (NextGen – Alternative Fuels for General Aviation)

Systems

— **Prevent accidents due to system failures.**

- ***Avionics***

2013: Evaluate development and integration techniques that will produce software for complex highly integrated systems that must comply with airworthiness requirements. (Atmospheric Hazards - Aircraft Icing/Digital System Safety)

- ***Flight controls***

2011: Complete the study in usage, design, and training issues for rudder control systems in transport aircraft. (Continued Airworthiness)

Engines

— **Prevent engine failures.**

- ***In-flight icing***

  2013: Develop methods for the airworthiness testing of engines in simulated high ice water content environments. (Atmospheric Hazards - Aircraft Icing/Digital System Safety)

- ***Engine and component structures***

  2010: Complete development of damage-tolerant design methods as the basis for propeller structural design and assess impacts on propeller weight. (Continued Airworthiness)

  2012: Complete a certification tool* that will predict the risk of failure of rotor disks containing material and manufacturing anomalies. (Propulsion and Fuel Systems)

- ***Uncontained engine failures***

  2013: Develop and verify a generalized damage and failure model with regularization for aluminum and titanium materials impacted during engine failure events. (Aircraft Catastrophic Failure Prevention Research)

* Design Assessment of Reliability With INspection (DARWIN)

Funding requirements - R&D Goal 6

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.c	Advanced Materials/ Structural Safety	R,E&D	4,935	2,566	2,596	2,628	2,650	2,672	100% of total program
A11.e	Continued Airworthiness	R,E&D	10,506	10,369	10,422	10,475	10,473	10,470	96% of total program
A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,545	1,165	1,171	1,177	1,177	1,176	100% of total program
A11.d	Atmospheric Hazards - Aircraft Icing/Digital System Safety	R,E&D	3,137	4,645	4,673	4,701	4,705	4,711	70% of total program
4A09A	Center for Advanced Aviation System Development	F&E	718	707	708	724	741	1,016	3% of R&D program in FY 2010
—	Commercial Space Transportation Safety	Ops	73	83	83	83	83	83	50% of total program
A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	0	2,000	2,004	2,007	1,999	1,990	100% of total program
A11.a	Fire Research and Safety	R,E&D	1,248	1,157	1,176	1,196	1,213	1,230	16% of total program
A11.b	Propulsion and Fuel Systems	R,E&D	3,105	2,332	2,357	2,383	2,399	2,416	100% of total program
A11.l	Unmanned Aircraft Systems Research	R,E&D	2,912	3,103	3,116	3,129	3,125	3,121	84% of total program
		Total ($000)	28,179	28,126	28,305	28,502	28,564	28,884	

- **Propulsion Malfunction – Information Based Displays:** Demonstrated an information-based engine-lubrication display developed from the results of a pilot survey on the use of cockpit propulsion indicators. FAA has an ongoing multi-year effort to study propulsion malfunctions that precipitate inappropriate crew response accidents and incidents. This effort is in response to research recommendations from a 1998 Aerospace Industries Association (AIA) report. The current research directly supports the AIA Propulsion Indications Task Team that is working to develop recommendations for future changes in 14 CFR 25.1305. The research also provided input for the propulsion section of the recently published Advisory Circular (AC) 25-11. Phase 3 of this program was completed in 2009. (Propulsion and Fuel Systems)

- **Turbine Engine Rotor-burst Mitigation:** Developed an analysis process to minimize the threat from uncontained turbine engine failures with Naval Air Warfare Center China Lake. Mitigation of hazard from uncontained turbine engine failures during the design layout of aircraft systems is required for all turbine-powered aircraft in their respective parts of Title 14 CFR XX.903. Uncontained engine failure events release high-energy fragments that can impact and disable critical systems and reduce the airworthiness of the vehicle. When multiple systems are disabled, the potential for an accident increases. System redundancy and separation and thoughtful component location in the design of an aircraft can make a significant improvement in the ability to survive one of these high-energy events. (Aircraft Catastrophic Failure Prevention)

- **14 CFR Part 135 Certificate Holder Functional Model:** Developed the 14 CFR Part 135 Certificate Holder Functional Model that identifies the functions that should be performed by Part 135 certificate holders and the interactions among those functions. The Part 135 certificate holder functional model will serve as the foundation for FAA research efforts to support a system safety approach to aviation safety oversight. The model also provides an important communications bridge between FAA and the aviation industry. (System Safety Management)

- **Uncontained Engine Debris Damage Model Version 3.1:** Developed the Uncontained Engine Debris Damage Assessment Model (UEDDAM) code version 3.1 for use by the FAA Transport Aircraft Directorate. The UEDDAM, developed using parts of existing military threat analysis tools, is designed to support the airframe certification process and has tailored output that matches the certification package requirements identified in AC20-128. Version 3.1 includes improvements in items identified from industry comments to improve usability and accuracy. The Visualizer was upgraded to give a more user-friendly view of the aircraft model being analyzed. In addition, a conversion for PATRAN, a finite element pre- and post-processor, was developed in which a PATRAN model can be converted for incorporation into the UEDDAM code without building a new compatible model. This greatly reduces modeling set up time. In 2010, the final major revision to UEDDAM to complete the upgrade to be compatible with the latest military improvements will be performed. (Aircraft Catastrophic Failure Prevention)

- **Engine Containment Analysis:** Continued to develop a new LS-DYNA explicit finite element model called MAT224 by completing material testing for aluminum 2024. LS-DYNA is an advanced, general-purpose multiphysics simulation software package that can be used for modeling engine fragment impact on aircraft. MAT224 supports a goal to have a publicly available analysis tool with standardized generic models, user guides, training, software quality control process, and validated material models. This will allow FAA engineers to validate the proprietary tools, streamline the certification process, and help mitigate fatalities and injuries when engine failures occur. Significant progress has been made on the MAT224 model, and it has already been adopted by one car manufacturer to improve crash analysis. A mesh regularization routine has been added which will greatly enhance the accuracy of the model for complex mesh geometries during failure. Also in FY 2009, material tests were started on titanium 6-4, the next material to be characterized under the FAA-NASA material characterization effort. (Aircraft Catastrophic Failure Prevention)

- **Aircraft Icing:** Completed a study of the characteristics and aerodynamic effects of runback ice shapes on thermally protected wings. The study was a joint effort with the University of Illinois at Urbana-Champaign (UIUC), NASA Glenn Research Center (GRC), the Office National d'Etudes et de Recherches Aerospatiales (ONERA), and Cessna Aircraft Company. Previously, public domain data on the aerodynamic effects of runback ice shapes on thermally protected wings was limited. A thermally-protected wing model was tested in a range of conditions in the NASA GRC Icing Research Tunnel (IRT). Ice shapes were documented with photographs, tracings, molds, and castings. Based on the castings, simulated ice shapes were developed for testing on a full-scale wing in the ONERA F1 aerodynamic wind tunnel, and for parametric subscale studies in a UIUC aerodynamic tunnel. Ice shapes in supercooled large droplet (SLD) conditions are sometimes large span-wise ridges that form aft of the ice-protected area of the wing, with a dramatic adverse effect on wing aerodynamics. The runback shapes from the IRT in this study were also span-wise ridges, but were of shorter height, covered a larger surface length, and had a more streamlined geometry than the SLD ice ridges. Consequently, the flow field and aerodynamic effects were generally not as adverse as for span-wise SLD ridges, although still significant. The data and information from this study established a more extensive basis for guidance addressing runback ice shapes on thermally protected wings in the aircraft certification process. (Atmospheric Hazards/ Digital System Safety)

- **UAS Concept of Regulatory-Based Causal Factor Framework:** Developed a concept for a regulatory-based causal factor framework that applies Safety Management System (SMS) principles to UAS. SMS provides a process that compensates for uncertainties due to a lack of experience and actual operational data required to perform safety risk analysis. It uses the existing regulations, which provide the minimum safety standards, as a measure to assess whether all potential risk areas, using the traditional event-driven approach, are adequately addressed. (Unmanned Aircraft Systems Research)

Separation Assurance

A reduction in accidents and incidents due to aerospace vehicle operations in the air and on the ground

R&D target

By 2016, develop initial standards and procedures for self-separation.

Method of validation

The approach includes conducting research and development to support the standards, procedures, training, and policy required to implement the NextGen operational improvements leading to self-separation. This goal does not develop technology but prepares for the operational use of the technology. Validation of the R&D target will include demonstrating that the research and development is sufficient for the initial policy and standards that are required to certify technology, procedures, and training needed to implement self-separation.

Then and Now 25th Anniversary 1985 - 2010

The Study of Swirling Air: Past and Present

Aircraft wake vortices, the swirls of air behind the aircraft, are an unavoidable consequence of an aircraft's generation of lift. These wake vortices require large separation distances between landing aircraft to ensure safety. Minimizing separation distances, without compromising safety, has been the objective of wake turbulence research since the 1970s. From the 1970s to the 1990s, wake physics was studied in wind tunnels and wake turbulence separation standards research relied heavily on flight test data. Wake turbulence data collections were frequently done using dedicated research aircraft, smoke generators and photography (as shown on the left) for qualitative description of the wake flow field. Data collection only occurred in good weather when the aircraft was close enough to the airport that the researcher could verify which aircraft was generating the wake vortices.

Since 2000, the pulsed Light Detection and Ranging (LIDAR) sensor system (shown on the next page) automatically tracks and measures the parameters of an aircraft's wake near the airport and several miles from the airport. The pulsed LIDAR sensor system is designed to operate 24 hours a day, 7 days a week without on-site staffing. These pulsed LIDAR systems measure and record wake turbulence tracks generated by aircraft during the airport's normal operational day.

Reduced separation

— **Support procedures, equipage, training, and design to enable reduced separation. (NextGen - Self-Separation Human Factors)**

2011: Complete initial research to evaluate the impact and potential risks associated with use of the Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.

2014: Complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings.

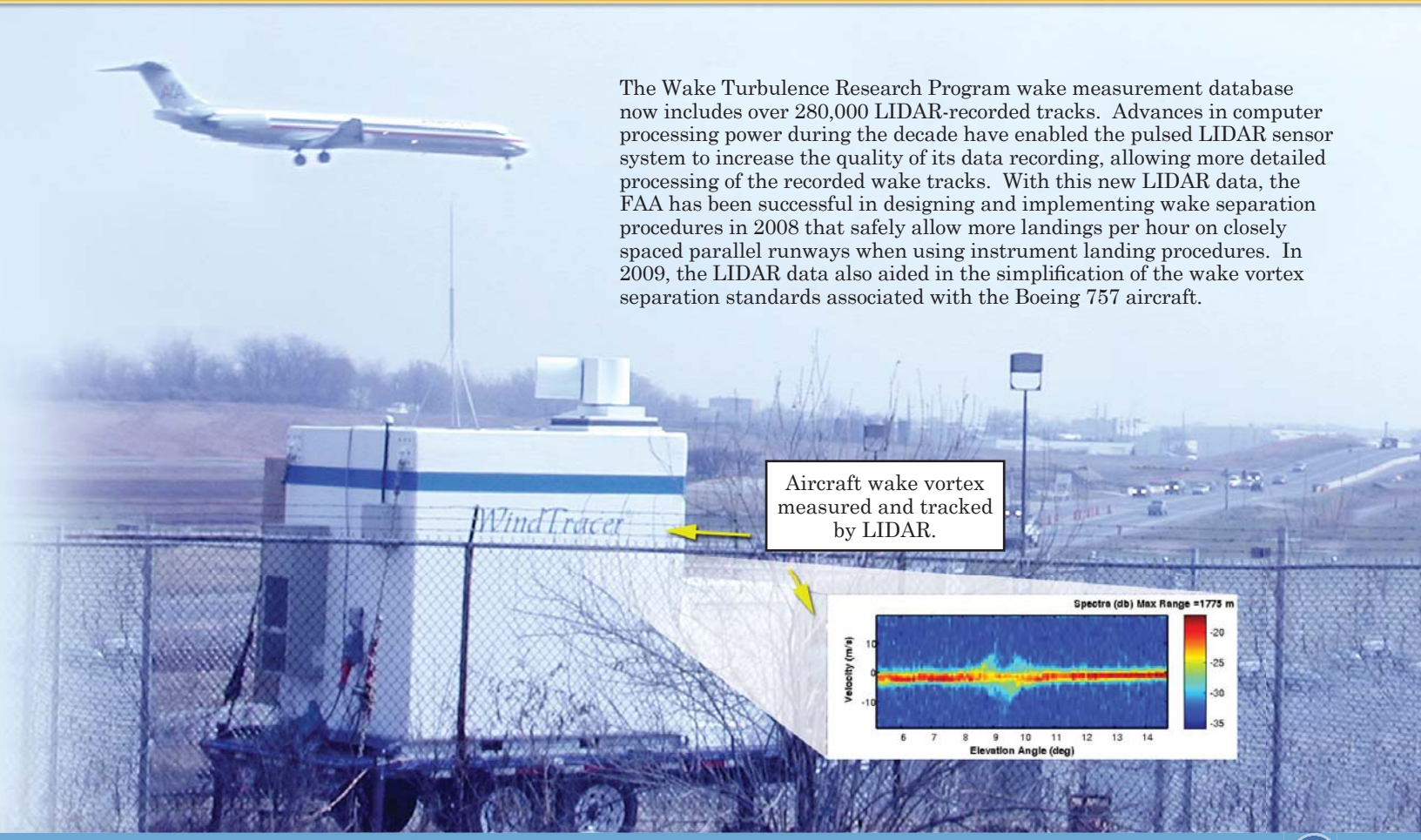
2015: Complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment.

Delegated separation

— **Support procedures, equipage, training, and cockpit design to enable delegated separation. (NextGen - Self-Separation Human Factors)**

2011: Complete initial research to evaluate and recommend procedures, equipage, and training to safely conduct oceanic and en route pair-wise delegated separation.

2015: Enable reduced and delegated separation in oceanic airspace and high-density en route corridors.



The Wake Turbulence Research Program wake measurement database now includes over 280,000 LIDAR-recorded tracks. Advances in computer processing power during the decade have enabled the pulsed LIDAR sensor system to increase the quality of its data recording, allowing more detailed processing of the recorded wake tracks. With this new LIDAR data, the FAA has been successful in designing and implementing wake separation procedures in 2008 that safely allow more landings per hour on closely spaced parallel runways when using instrument landing procedures. In 2009, the LIDAR data also aided in the simplification of the wake vortex separation standards associated with the Boeing 757 aircraft.

Surface/runway operations awareness

— **Support procedures, equipage, training, and design to enable enhanced aircraft spacing for surface movements. (NextGen - Self-Separation Human Factors)**

2012: Complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.

2014: Evaluate and recommend minimum display standards and operational procedures for use of Cockpit Display of Traffic Information (CDTI) to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff, departure, and arrival phases of flight.

2016: Complete research to enable enhanced aircraft spacing for surface movements in low-visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures.

Funding requirements - Goal 7

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.i	Air Traffic Control/ Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	coordination only
A12.a	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
A12.d	NextGen - Self-Separation Human Factors	R,E&D	8,247	9,971	10,009	10,043	10,022	10,000	100% of total program
1A08E	NextGen - Wake Turbulence Re-categorization	F&E	0	0	0	0	0	0	coordination only
		Total ($000)	8,247	9,971	10,009	10,043	10,022	10,000	

Progress in FY 2009: Separation Assurance

- **Multi-Purpose Cockpit Display of Traffic Information:** Developed a prototype multi-purpose CDTI. NextGen will use the CDTI, Automatic Dependent Surveillance-Broadcast (ADS-B), and other new technologies and procedures to enable delegation of some traditional ATC tasks to the cockpit. To take advantage of these advances, aircraft must first be appropriately equipped and no single design supports the broad array of envisioned applications. The prototype development process included both the necessary algorithmic processing and the user interface that allowed CAASD researchers to conclude that the multi-purpose CDTI is feasible. The usability of the prototype was evaluated in a human-in-the lab experiment with favorable results. Additionally, the prototype was used in an evaluation of an ADS-B-based delegated separation application with favorable results. (CAASD)

R&D Goal 8
Situational Awareness

Common, accurate, and real-time information of aerospace operations, events, crises, obstacles, and weather

R&D target

By 2015, demonstrate common, real-time awareness of ongoing air operations, events, crises, and weather at all types of airports by pilots and controllers.

Method of validation

The approach includes supporting development of standards and procedures for weather-in-the-cockpit to provide the flight crew awareness of weather conditions and forecasts; demonstrating wake turbulence procedures and technologies to support self-separation; and improving situational awareness at airports. Validation of the R&D target will include pilot-in-the-loop simulations, modeling, tests, physical demonstrations, and development of initial standards and procedures.

Then and Now 25th Anniversary 1985 - 2010

Dealing With Bad Weather – From Reporting to Predicting

Bad weather events cause the same problems today that they did in 1985. Despite remarkable improvements in weather sensors and services, predicting system (NAS) capacity and planning routes free of adverse weather conditions are still a challenge. Weather research in 1985 focused on wind shear detection using Doppler Weather Radar, hazardous weather warnings, cloud layer heights, and accurate location of gust fronts and storm activity.

1985: DIFAX machines printed out paper charts containing meteorological data that was usually taped to a wall for analysis and forecasting.

Airports

— **Ensure safe airport operations.**

2010: Develop system enhancements for runway status lights. (Runway Incursion Reduction)

2010: Develop advisory material to install new visual guidance systems. (Airport Technology Research - Safety)

2011: Develop performance standards for avian radar use on airports. (Airport Technology Research - Safety)

2012: Develop guidance material for airport planning to ensure consistency from the operator's perspective from airport to airport. (Airport Technology Research - Safety)

Weather situational awareness

— **Develop common situational awareness for weather.**

- ***Weather information improvements (Weather Program)***

2010: Develop CONUS ceiling, visibility, and flight category forecast capability.

2012: Demonstrate 1-3 hour CONUS ceiling, visibility, and flight category forecast capability.

2013: Transition in-flight icing Alaska forecast for implementation.

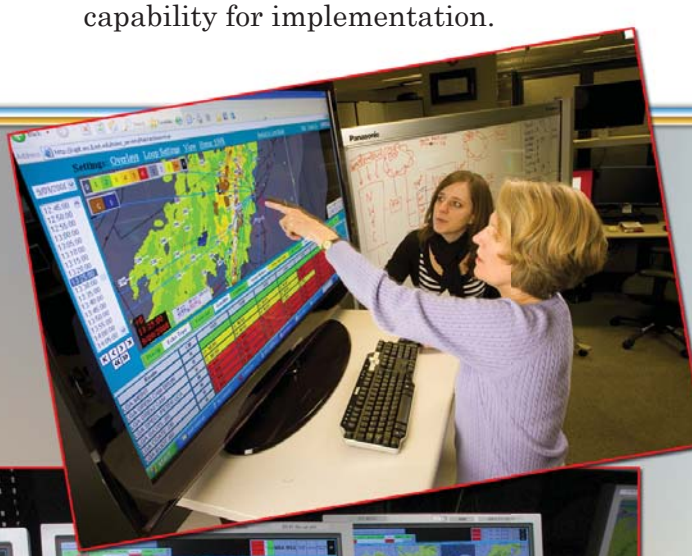
2014: Demonstrate 1-12 hour CONUS ceiling, visibility, and flight category forecast capability.

2016: Transition 1-12 hour CONUS ceiling, visibility, and flight category forecast capability for implementation.

Today, FAA weather research activities include much better forecast capabilities for use by air traffic, dispatchers, and pilots; integration of ground, airborne, and satellite weather observations in real time; and the development of policy, standards, and guidance needed to safely implement weather technologies in the cockpit to provide shared situational awareness and shared responsibilities.

For example, in 2009, the FAA conducted a laboratory proof-of-concept demonstration incorporating weather predictions into the TMA systems, an automated decision-making support tool. With TMA, controllers were able to plan rerouting of traffic around the forecasted weather. The demonstration also allowed flight management information to stay visible in TMA.

The images on the right show FAA weather researchers at the William J. Hughes Technical Center analyzing graphical information from the Route Availability Planning Tool (RAPT) and the Integrated Terminal Weather System (ITWS). Both RAPT and ITWS have predictive weather capabilities.



FAA researchers at the William J. Hughes Technical Center.

— **Weather Technology in the Cockpit (WTIC)* (NextGen - Weather Technology in the Cockpit)**

2010: Develop NextGen mid-term concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit.

2010: Assess bandwidth demand of graphical icing products (Current Icing Product and Forecast Icing Product) and graphical turbulence products (Graphical Turbulence Guidance) for potential delivery via existing and planned FAA data link services.

2011: Identify, validate, and document datalink system attributes that may affect use of weather in the cockpit.

2012: Simulate and evaluate available cockpit weather technologies.

2013: Develop prototype weather modules for flight deck.

2014: Simulate, test, and evaluate cockpit use of weather decision support tools, including probabilistic forecasts.

2014: Simulate, test, and evaluate fully-integrated cockpit use of NextGen operational concepts, including WTIC.

2015: Demonstrate the integration of navigation information and flight information, including weather information, into cockpit decision-making and shared situational awareness among pilots, dispatchers, and air traffic controllers supported by NextGen air and ground capabilities.

* WTIC enables pilots and aircrews to engage in shared situational awareness and shared responsibilities with controllers, dispatchers, Flight Service Station specialists, and others, pertaining to safe and efficient preflight, en route, and post-flight aviation safety decisions involving weather.

Commercial space

— **Develop situational awareness for commercial space transportation. (Commercial Space Transportation Safety)**

2009: Review integrated operations of reusable launch vehicles (RLVs) from spaceports, joint use airport and spaceports, as well as the airspace surrounding those facilities and provide recommendations on how to safely integrate and conduct routine RLV operations. [COMPLETED, see first bullet under Progress in FY 2009]

2009: Conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of radar wind profiler to obtain winds to greater altitudes than currently available. [COMPLETED, see second bullet under Progress in FY 2009]

2009: Conduct a study to determine the need to develop a temporal wind database to support the launch of wind-weighted, unguided, suborbital rockets launched from nonfederal launch sites. [COMPLETED, see third bullet under Progress in FY 2009]

Funding requirements - R&D Goal 8

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
—	Airports Cooperative Research - Safety	AIP	2,000	0	0	0	0	0	coordination only beginning in FY 2011
—	Airports Technology Research - Safety	AIP	7,719	9,287	9,287	9,287	9,287	9,287	65% of total program
A11.i	Air Traffic Control/ Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	coordination only
4A09A	Center for Advanced Aviation System Development	F&E	1,676	1,650	1,652	1,690	1,729	2,371	7% of R&D program in FY 2010
A11.g	Flightdeck/Maintenance/ System Integration Human Factors	R,E&D	0	0	0	0	0	0	coordination only
A12.a	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	3,300	3,400	3,400	100% of total program
1A08H	NextGen - Staffed NextGen Towers	F&E	0	6,000	0	0	0	0	100% of total program
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	9,570	9,312	9,360	9,407	9,406	9,404	100% of total program
1A01A	Runway Incursion Reduction	F&E	11,000	5,000	3,000	3,000	3,000	3,000	100% of total program
A11.k	Weather Program	R,E&D	13,599	13,369	13,265	13,149	12,921	12,686	81% of total program
		Total ($000)	46,564	45,617	37,563	39,833	39,743	40,148	

Progress in FY 2009: Situational Awareness

- **Commercial Space Operations: Airspace, Airport, and Spaceport Considerations:** Completed a case study entitled *A Case Study on Routine Space Vehicle Operations in the NAS for NextGen*. The top-level conclusion of the study is that the flights believed to be critical will have minimal impact on NAS operations. The case study was developed to depict typical operations in the 2025 timeframe with an assumed flight rate of two flights a week. The goal of the study was to uncover any unique requirements that must be considered in the development of NextGen so that this type of commercial space tourism would have minimal impact on the NAS as it develops. Several issues that were believed to be critical prior to this study were found to present minimal impact to the NAS. Furthermore, export of this type of operation to other geographic areas could be easily integrated into the NAS in other areas, especially those with lower traffic density than the northern Florida area west of Jacksonville used in the study. Because of the unique nature of these kinds of flights, individual evaluations of other proposed sites would be necessary, but there were no systematic issues that would prevent export of this type of operation to other locations. (Commercial Space Transportation Safety)

- **High Altitude Wind Prediction and Measurement Technology Assessment:** Reviewed the principles and the operational characteristics of balloon and radar-based techniques for measuring upper air winds in support of launches and recoveries. Each technique has advantages and disadvantages. The most effective approach to meeting upper air wind requirements may involve a mixed set of instruments, each with different strengths. The best mix for generating high-quality wind profiles may consist of a Doppler Radar Wind Profiler in combination with balloons. The former gives more timely observations in a fixed volume, while the latter provide higher resolution. (Commercial Space Transportation Safety)

- **Temporal Winds Database for Launch Sites:** Conducted a study to evaluate the impact of temporal winds on unguided suborbital rockets. This study had two objectives: first, to determine if a suitable temporal wind database exists at three inland launch sites of interest and, second, to determine how much temporal winds can change the planned impact point of an unguided suborbital rocket, whether it is a suborbital to 30,000 feet or 360,000 feet. The change in planned trajectories was related to the monthly wind variation. Data was collected from existing temporal wind data from these stations and stations located at the Eastern Test Range and assessed a low altitude and high altitude unguided suborbital launch vehicle to determine the relationship between the temporal winds and the monthly winds. (Commercial Space Transportation Safety)

- **ATM Implications of UAS Operations in Controlled Airspace:** Completed analysis of HITL simulation to begin to quantify ATC-related human factors issues associated with UAS in Class A airspace. Demand for access to the NAS by UAS is increasing. However, UAS have several unique operational characteristics that could have an impact on air traffic management (ATM). The CAASD evaluation compared controller performance and workload ratings while varying the ratio of UAS to manned aircraft within the participant's sector. The results showed that workload increased as the ratio of UAS to manned aircraft increased. The controllers indicated that the increased workload was due primarily to the UAS not being Reduced Vertical Separation Minima compliant as well as UAS performance differences. The participants also indicated that they preferred to give control instructions to the manned aircraft, but the results showed that on average the participants issued more commands to the UAS than manned aircraft, which may have contributed to their increased workload ratings. (CAASD)

R&D Goal 9
System Knowledge

A thorough understanding of how the aerospace system operates, the impact of change on system performance and risk, and how the system impacts the nation

R&D target

By 2016, understand economic (including implementation) and operational impact of system alternatives.

Method of validation

The approach includes developing the information analysis and sharing system to support FAA and NextGen safety initiatives; generating guidelines to help stakeholders develop their own safety management systems; and modeling activities to help measure progress toward achieving safety, capacity, efficiency, and environmental goals. Validation of the R&D target will include analysis, modeling, prototypes, and demonstrations using safety, capacity, efficiency, and environmental metrics. The evaluation efforts under this goal support the interim assessment of progress and validation of the R&D targets under the following: R&D Goal 1 - Fast, Flexible, and Efficient, R&D Goal 2 - Clean and Quiet, and R&D Goal 5 - Human Protection.

Then and Now 25th Anniversary 1985 - 2010

From Blood Tests to Genetic Markers

In 1985, aviation medicine research focused on the biomedical and human behavioral aspects of the evolving National Airspace System (NAS). This included aerospace medical certification, education, occupational health, and the performance of the human element in the civil aviation system. Of particular concern were the changing roles of pilots and controllers as increasing levels of automation were introduced. Most of these research efforts were conducted at CAMI in Oklahoma City, Oklahoma.

CAMI was, and continues to be, home to state-of-the-art laboratories for toxicological research. From an initial focus on safety concerns and exposure to pesticides for crop-duster pilots, CAMI quickly demonstrated a world-renowned capability in blood and tissue analysis in fatal accident investigations including precision toxicology tests for alcohol and a myriad of drugs. Blood tests done by CAMI researchers have also helped determine whether aircraft occupants died from carbon monoxide poisoning from an exhaust leak or whether they inhaled fumes from an in-flight fire prior to an airplane crash.

Inhalation toxicity testing (above); On-site accident research team (right).

Today, the Functional Genomics Research Team at CAMI uses advanced technologies to determine which gene expression changes (or expression marker changes) are due to aerospace medical factors such as the effects of fatigue, hypoxia, medications, and alcohol. The expression markers discovered will be used to develop biochemical tests that will enhance accident prevention and investigation strategies. Gene expression research at CAMI keeps the FAA at the forefront of scientific discovery in aerospace medicine and safety.

Milestones

Capacity and efficiency evaluation

— **Develop methods, metrics, and models to demonstrate that the modernized system can handle anticipated increases in capacity.***

2008: Demonstrate capacity increase to 130% of baseline levels.** (Operations Concept Validation; System Capacity, Planning and Improvement) [COMPLETED]

2011: Demonstrate capacity and efficiency increase up to 166% of baseline levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

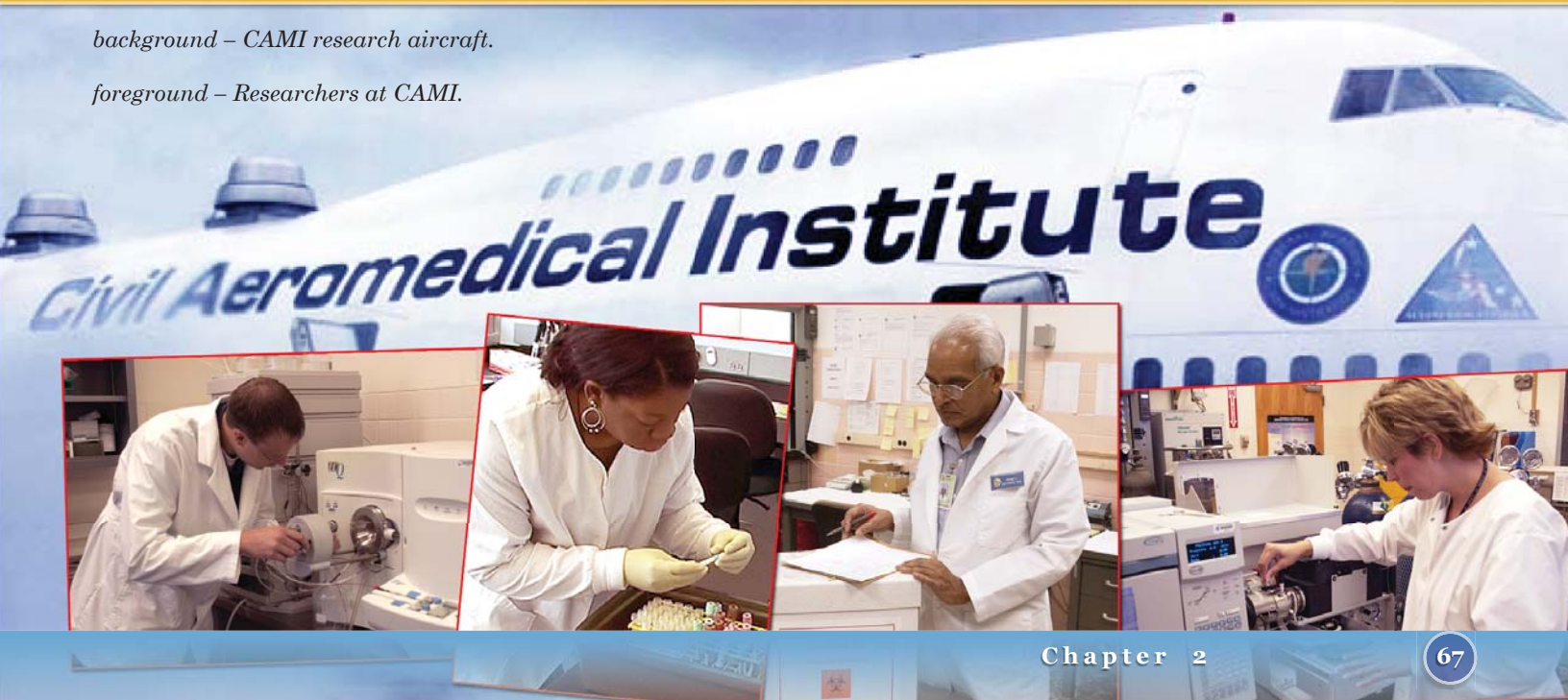
2011: Develop a guidebook for airport operators and air cargo industry stakeholders that provides tools and techniques for measuring economic impacts of air cargo activities at the national, regional, and local level. (Airport Cooperative Research - Capacity)

2013: Demonstrate capacity and efficiency increase up to 230% of baseline levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

2016: Demonstrate capacity and efficiency increase up to 300% of baseline levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

* This supports demonstration of the R&D target under R&D Goal 1 - Fast, Flexible, and Efficient.

** The year 2004 was chosen as a baseline for consistency with the Vision 100 – Century of Aviation Reauthorization Act (P.L. 108-176) and the *Next Generation Air Transportation System Integrated Plan* submitted to Congress as required in that legislation.



background – CAMI research aircraft.

foreground – Researchers at CAMI.

Information analysis and sharing

— **Develop an information management system to serve as the foundation for the analysis of data trends and the identification of potential safety hazards before accidents occur. (NextGen - System Safety Management Transformation)**

2009: Evaluate current information protection and assurance models and evaluate potential conflicts with privacy and consumer advocacy groups. [COMPLETED, see first bullet under Progress in FY 2009]

2012: Validate the Net Enabled Operations (NEO) Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders.

2013: Complete the Aviation Safety Information Analysis and Sharing (ASIAS) pre-implementation activities, including concept definition, with other JPDO member agencies, participants, and stakeholders.

— **Develop a system to increase safety of commercial operations. (System Safety Management)**

2011: Develop automated tools to monitor databases for potential safety issues.

2012: Demonstrate a working prototype of network-based integration of information extracted from diverse, distributed sources.

Environmental assessment

— **Develop methods, metrics, and models to demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms to enable the air traffic system to handle growth in demand up to three times current levels.* (NextGen - Operational Assessments)**

2009: Develop and implement NAS-wide regional environmental analysis capability within AEDT. [COMPLETED, See second bullet under Progress in FY 2009]**

2010: Implement weather effects in AEDT environmental analyses.

2012: Develop and implement NAS-wide cost-benefit environmental analysis capability with APMT.

2013: Explore options to integrate environmental assessment capability with NextGen NAS models.

2016: Employ AEDT and APMT for NAS-wide environmental analyses.

* This supports demonstration of the R&D target under R&D Goal 2 - Clean and Quiet as it relates to the R&D target under R&D Goal 1 - Fast, Flexible, and Efficient.

** This 2009 milestone was funded by NextGen - Environment and Energy - Validation Modeling; starting in FY 2010, the remaining milestones will be funded by NextGen - Operational Assessments.

Safety management system

— **Produce guidelines for developing processes and technologies to implement a safety management system.**

2011: Complete study of risk-based fleet management for small-airplane continued operational safety. (Continued Airworthiness)

2011: Develop proof of concept for NextGen including a prototype to implement on a trial basis with selected participants that involve a cross-section of air service providers. (NextGen - System Safety Management Transformation)

2011: Develop and validate a software tool to quantify risk and support engineering decision-making related to runway safety area requirements. (Airport Cooperative Research - Safety)

2012: Develop risk management concepts, models, and tools for unmanned aircraft systems. (Unmanned Aircraft Systems Research)

2012: Develop risk management concepts, models, and tools for transport category airplanes. (System Safety Management)

2014: Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across NextGen. (NextGen - System Safety Management Transformation)

Safety evaluation[†]

— **Develop methods and metrics to measure progress in reducing the rate of fatalities and significant injuries by two-thirds.**[‡] **(System Safety Management)**

2010: Demonstrate a one-third reduction in the rate of fatalities and injuries.

2012: Demonstrate a one-half reduction in the rate of fatalities and injuries.

2015: Demonstrate a two-thirds reduction in the rate of fatalities and injuries.[§]

Commercial space

— **Develop understanding of commercial space transportation system operations. (Commercial Space Transportation Safety)**

2010: Conduct a study with current information related to the state of the commercial suborbital transportation industry with a focus on market demand, safety, operability, and international coordination.

2010: Conduct a study to evaluate the adequacy of current rules and polices related to commercial space transportation, implement new rules, policy, and advisory materials, and identify barriers to industry caused by unnecessary or conflicting regulations.

[†] For these milestones, demonstrate means to show that the methods and metrics developed are valid and that, with the system improvements planned, it is possible to reduce the rate of fatalities and injuries by the stated amounts.

[‡] This supports demonstration of the R&D target under R&D Goal 5 - Human Protection.

[§] These milestones have set targets that are purposely more aggressive than those in the *Flight Plan*, as R&D goals should be stretch goals.

Funding requirements - R&D Goal 9

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
A11.j	Aeromedical Research	R,E&D	0	0	0	0	0	0	coordination only
—	Airport Cooperative Research - Capacity	AIP	0	1,650	1,650	1,650	1,650	1,650	33% of total program
—	Airport Cooperative Research - Safety	AIP	0	2,500	2,500	2,500	2,500	2,500	50% of total program
1A01E	Airspace Management Program	F&E	3,000	1,000	5,000	5,000	5,000	5,000	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	3,831	3,770	3,775	3,864	3,953	5,420	16% of R&D program in FY 2010
—	Commercial Space Transportation Safety	Ops	73	83	83	83	83	83	50% of total program
A11.e	Continued Airworthiness	R,E&D	438	432	434	436	436	436	4% of total program
A12.a	Joint Planning and Development Office	R,E&D	4,322	4,288	4,326	4,369	4,392	4,417	30% of total program
1A08F	NextGen - Operational Assessments	F&E	7,500	10,000	10,000	10,000	10,000	10,000	100% of total program
1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	10,000	10,000	10,000	10,000	10,000	10,000	100% of total program
1A08G	NextGen - System Safety Management Transformation	F&E	16,300	18,000	18,000	18,000	18,000	18,000	100% of total program
1A01C	Operations Concept Validation	F&E	8,000	4,000	8,000	6,000	6,000	6,000	100% of total program
1A01B	System Capacity, Planning and Improvement	F&E	4,100	4,100	6,500	6,500	6,500	6,500	100% of total program
A11.h	System Safety Management	R,E&D	12,698	11,907	11,913	11,915	11,841	11,765	100% of total program
A11.l.	Unmanned Aircraft Systems Research	R,E&D	555	591	594	596	595	594	16% of total program
		Total ($000)	71,223	72,320	82,774	80,913	80,950	82,364	

Progress in FY 2009: System Knowledge

- **Information Protection Assurance Models:** Completed the evaluation of current information protection and assurance models to be used in ASIAS and evaluated potential conflicts that might occur with privacy and consumer advocacy groups due to the use of flight-specific operational data. The results of the evaluations were used to develop the Military Flight Operations Quality Assurance ASIAS prototype plan that will add Department of Defense (DoD) data to ASIAS and give DoD control over their own data and information. (NextGen - System Safety Management Transformation)

- **Aviation Environmental Design Tool:** Completed an alpha version of the AEDT for seamless integration with NASA's Airspace Conflict Evaluation Simulator (ACES) and FAA's airspace and airport simulation tool (SIMMOD). The AEDT was provided to investigators in support of NASA's funded research for next generation aircraft technologies. Additionally, the AEDT environmental analysis capability was integrated with the FAA's Terminal Area Route Generation, Evaluation and Traffic Simulation. This integration will allow design for new navigational procedures while considering noise, fuel burn, and emissions. AEDT's improved modeling capability was used at several major U.S. airports for environmental analysis of CDA and Tailored Arrivals. AEDT, being uniquely positioned for interdependency analyses, also provided impacts on ICAO/CAEP NO_x Stringency analyses on noise and fuel burn. (NextGen - Environment and Energy - Validation Modeling)

- **Multi-Sector Planner:** Conducted high fidelity simulations of the Multi-Sector Planner (MSP) concept to assess roles, responsibilities, and coordination requirements between ATM positions and to determine tool and display requirements for this proposed new position that would use NextGen communications, navigation, and automation improvements to create efficient trajectory-based solutions to fine-tune traffic management initiatives to increase efficiency and reduce delays. Concept development experiments simulated en route area supervisory and radar control positions, and traffic management coordinator and MSP positions over two en route centers. Simulation results will be available in FY 2010. (Operations Concept Validation)

- **NextGen Implementation Modeling and Performance:** Developed a process to characterize the benefit mechanisms associated with NextGen Operational Improvements (OIs). The benefit mechanisms and their relationships to one another were captured in Benefit Mechanism Influence Diagrams developed by CAASD researchers. As the FAA continues NextGen implementation, it is essential that the modeling, simulation, and performance assessment tools and methodologies continue to provide insight into the evolution of the NAS. The diagrams served as a framework to communicate benefit details to other stakeholders and to facilitate the quantification of each mechanism. CAASD researchers also developed a capability to build 36 days of base year and corresponding future year demand schedules with more realistic itineraries and reasonable turnaround times between flights in future years. An analysis of NextGen OI-related factors found that changes in key parameters such as individual airport capacity or sector capacity of as little as 10 to 20 percent resulted in significant shifts in NAS-wide delay depending upon the location and connectivity of the location where the adjustment was made. (CAASD)

- **Traffic Collision Avoidance System Resolution Advisories:** Completed a research study into techniques and unique approaches that will lead to new safety enhancements, tools, processes, and capabilities for identifying and assessing risks associated with TCAS Resolution Advisories. Results will be used to guide focused investigations at key airports, identify common threads and contributing factors, categorize rates by degree of risk, and so forth. (System Safety Management)

- **Secure Internet-Based Data Portal:** Developed a secure internet-based data portal that provides a mechanism to share ASIAS data and selected results with ASIAS participants. The portal will also provide access to a limited number of canned queries of selected databases. (System Safety Management)

- **UAS Flight Termination and Emergency Recovery Systems Survey:** Conducted a technology survey and regulatory gap analysis of UAS Flight Termination and Emergency Recovery systems while operating in the NAS. FAA researchers presented technical papers at international conferences including Association for Unmanned Vehicle Systems International (AUVSI)'s Unmanned Systems North America 2009 Conference and SAE International AeroTech 2009 Congress and Exhibition. The FAA sponsored research presentation, titled: "A Technology Survey and Regulatory Gap Analysis of Emergency Recovery and Flight Termination for UAS" presented in the Airspace Standard session, won the AUVSI 2009 Pathfinder Chapter Best Paper Award. A final technical report is near completion. (Unmanned Aircraft Systems Research)

- **Processes for Conducting Directed Studies and Airline Benchmark Studies:** Developed detailed processes that define procedures used for conducting directed studies, safety metric studies, and associated tracking and airline benchmark studies. Includes summarized experience from recent analytical results on ASIAS in terms of problem definition, interaction with stakeholders (ASIAS Executive Board, Commercial Aviation Safety Team, and Joint Implementation and Data Analysis Team), proper use of industry subject matter experts, and safety metric standards. (System Safety Management)

- **Safety Issues Studied:** Conducted and summarized analytical studies on the status of work on safety metrics and benchmarks trends over time. Safety topics included aircraft loss of control, controlled flight into terrain, and approach and landing issues. (System Safety Management)

- **NextGen Towers:** Conducted a HITL Talk-Aloud analysis at the Ronald Reagan Washington National Airport training simulator. The HITL Talk-Aloud analysis examined the out-the-window information that controllers visually acquire while providing air traffic services. The HITL Talk-Aloud will be used to validate the findings from a cognitive walkthrough and drive the functional and physical architecture for NextGen Towers. (NextGen - Operations Concept Validation - Validation Modeling)

R&D Goal 10
World Leadership

A globally recognized leader in aerospace technology, systems, and operations

R&D target

By 2016, demonstrate the value of working with international partners to leverage research programs and studies in order to improve safety and promote seamless operations worldwide.

Method of validation

The approach includes managing research collaborations to increase value and leveraging research under the existing R&D programs to increase value. Validation of the R&D target will include developing agreements, reviewing past and current research collaboration, and conducting analyses. The research results listed under the subheading of Products are outputs of the other nine goals in this plan. The purpose of this goal is to help plan the use of these products in international partnering activities to produce the highest value. The method of validation for the individual research results is provided under the respective goal for each product.

Milestones

Management

— **Manage ongoing research. (System Planning and Resource Management)**

2008: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2008-2013 FAA R&D plan. [COMPLETED]

2009: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2009-2014 FAA R&D plan. [COMPLETED, see the two bullets under Progress in FY 2009]

2010: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2010-2015 FAA R&D plan.

— **Leverage international research collaboration. (System Planning and Resource Management)**

2010: Determine criteria for assessing the benefits of the international research collaboration.

2011: Develop a strategic mapping for international research collaboration.

2011: Identify a process to measure quality, timeliness, and value of international research collaboration.

2016: Determine final value of international research collaboration.

Products

— Leverage research results.*

2008: Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions. (Wake Turbulence) [COMPLETED]

2010: Develop a preliminary planning version of an Aviation Environmental Design Tool that quantifies and assesses interrelationships among noise and emissions at the local and global levels. (Environment and Energy)

2011: Provide comprehensive guidance on lithium battery fire safety. (Fire Research and Safety)

2011: Determine how aviation-generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate. (Environment and Energy, NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics, and Airport Cooperative Research - Environment)

2012: Validate the NEO-Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders. (NextGen - System Safety Management Transformation))

2014: Deploy the Aviation Environmental Portfolio Management Tool that will provide the cost/benefit methodology needed to harmonize national aviation policy and environmental policy. (Environment and Energy)

2015: Enable reduced and delegated separation in oceanic airspace and high density en route corridors. (NextGen - Self-Separation Human Factors)

2015: Demonstrate the integration of navigation information and flight information, including weather information, into cockpit decision-making and shared situational awareness amongst pilots, dispatchers, and air traffic controllers supported by NextGen air and ground capabilities. (NextGen - Weather Technology in the Cockpit)

2016: Demonstrate significant improvements in air traffic controller efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operation, procedures, and information. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

* These milestones were selected from the other nine goals to show international collaboration.

Funding requirements - R&D Goal 10

The funding levels listed for years 2012 to 2015 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

			2010	2011	2012	2013	2014	2015	Notes
—	Airport Cooperative Research - Environment	AIP	0	0	0	0	0	0	coordination only
A13.a	Environment and Energy	R,E&D	0	0	0	0	0	0	coordination only
A11.a	Fire Research and Safety	R,E&D	0	0	0	0	0	0	coordination only
1A08A	NextGen - ATC/Tech Ops Human Factors - (Controller Efficiency and Air Ground Integration)	F&E	0	0	0	0	0	0	coordination only
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	0	0	0	0	0	coordination only
A12.d	NextGen - Self-Separation Human Factors	R,E&D	0	0	0	0	0	0	coordination only
1A08G	NextGen - System Safety Management Transformation	F&E	0	0	0	0	0	0	coordination only
1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	0	0	0	0	0	0	coordination only
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	0	0	0	0	0	coordination only
A14.a	System Planning and Resource Management	R,E&D	1,766	1,733	1,717	1,700	1,668	1,634	100% total program
		Total ($000)	1,766	1,733	1,717	1,700	1,668	1,634	

Progress in FY 2009: World Leadership

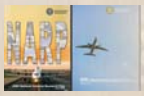
- **Research, Engineering, and Development Portfolio Management:** Provided guidance on the FAA FY 2011 R&D portfolio on October 2008. The R&D Executive Board (REB) developed the proposed FY 2011 R&D portfolio between November 2008 and February 2009. The five REDAC subcommittees reviewed the portfolio in February 2009, and the REDAC provided its final review of the FY 2011 R&D portfolio to the FAA on March 2009. ATO Executive Council approved the FY 2011 R,E&D budget on May 2009, and the Joint Resources Council approved it on June 2009. The FAA FY 2011 R,E&D budget was submitted to the Office of the Secretary of Transportation on July 2009, and to Office of Management and Budget on September 2009. (System Planning and Resource Management)

- **2009 National Aviation Research Plan:** Submitted to Congress in June 2009. (System Planning and Resource Management)

Chapter Three

Alignment with NextGen

The R&D portfolio supports a range of mid- to far-term NextGen needs. There are four sections to this chapter. The first section provides definitions of NGIP domains and solution sets. The second section describes the NextGen portfolio management process. The third section describes how FAA NextGen R&D programs align with the Operational Improvements (OIs) identified in the NGIP. The fourth section presents FAA NextGen R&D program budget.



NextGen Domains and Solution Sets

This section defines the domains and solution sets of the NGIP. There are three domains: Air Traffic Operations; Aircraft and Operator Requirements; and Airport Development. Under the Air Traffic Operations domain, there are seven solution sets. The descriptions of the domains and solution sets were provided by the NextGen Integration and Implementation (I&I) Office.

Air Traffic Operations Domain

This domain focuses on implementing transformational capabilities to improve the U.S. air traffic management system, which encompasses operational rules, regulations, and procedures as well as the infrastructure network of U.S. airspace; air navigation facilities, equipment, and services; airports or landing areas; aeronautical charts, information, and services; technical information; and manpower and material. The seven solution sets under the Air Traffic Operations domain are as follows.

Initiate Trajectory-Based Operations

Trajectory-based operations (TBO) represents a shift from clearance-based to trajectory-based control. Aircraft will fly negotiated trajectories and air traffic control moves to trajectory management. The traditional responsibilities and practices of pilots/controllers will evolve due to the increase in automation, support, and integration inherent in management by trajectory. This solution set focuses primarily on en route cruise operations, although the effects of the trajectory-based operations will be felt in all phases of flight.

Currently, controllers using radar screens and limited computer decision support visualize trajectories to make cognitive judgments on how to maintain static separation standards between aircraft. With an increasing diversity of aircraft characteristics, using a single separation standard for all aircraft encounters is becoming increasingly inefficient, and it limits capacity. The current automation tools provide support for the controllers in managing separation. Performance-based services are a basic principle of NextGen. Performance-based assumes that separation standards might vary according to aircraft capabilities and pilot training. The automation tools will be updated to support the performance-based diversity of aircraft to increase controller efficiently and be able to support an increase in capacity.

Increase Arrivals/Departures at High Density Airports

The Increase Arrivals/Departures at High Density Airports solution set involves airports (and the airspaces that access those airports) in which:

- Demand for runway capacity is high
- There are multiple runways with both airspace and taxiing interactions, or
- There are close-proximity airports with the potential for airspace or approach interference

The above-defined airports require all the capabilities of the flexible terminals and airspace plus integrated tactical and strategic flow capabilities. They may require higher performance navigation and communications capabilities for air traffic and the aircraft to support these additional operational requirements.

Increase Flexibility in the Terminal Environment

The Increase Flexibility in the Terminal Environment solution set covers the terminal and airport operations ability to meet the need of both high-density terminals and other airports. Flexible terminal solutions focus on improvements to the management of separation at all airports. Such capabilities will improve safety, efficiency and maintain capacity in reduced visibility high-density terminal operations. Flexible terminal solutions will also improve trajectory management and advanced separation procedures employed when demand warrants. At airports where traffic demand is lower, and at high-density airports during times of low demand, operations requiring lesser aircraft capability are conducted, allowing access to a wider range of operators while retaining the throughput and efficiency advantages of high-density operations. Both trajectory and non trajectory-based operations may be conducted within flexible terminal operations.

Improve Collaborative Air Traffic Management

The Improve Collaborative Air Traffic Management (CATM) solution set covers strategic and tactical flow management, including interactions with operators to mitigate situations when the desired use of capacity can not be accommodated. The

CATM solution set includes flow programs and collaboration on procedures that will shift demand to alternate resources (e.g. routings, altitudes, and times). CATM also includes the foundational information elements for managing National Airspace System (NAS) flights. These elements include development and management of aeronautical information, management of airspace reservation, and management of flight information from pre-flight to post-analysis.

Reduce Weather Impact

The Reduce Weather Impact solution set allows users and controllers to plan operations based on the predicted impact of weather, rather than attempting to mitigate the effects of weather once the weather has changed. Integrated weather observations and forecasts will lead to better decision making.

Increase Safety, Security, and Environmental Performance

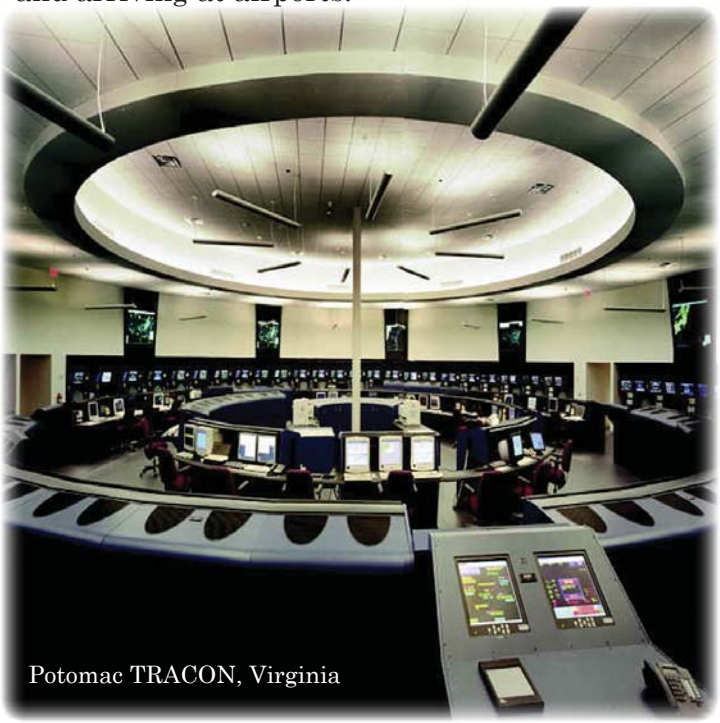
Increase Safety, Security, and Environmental Performance: Inherent in all evolving aspects of National Airspace System (NAS) operations and protocol are the three areas of safety, security, and the environment. Projected FAA investments in these three areas include:

- Safety Management System (SMS)
- Airspace and information security (Note: Since information security is already included in the baseline of each NAS program, only airspace security capabilities are discussed in this solution set.)
- Environmental Management System (EMS) and specific operational demonstrations

All NAS programs will continue to follow NAS institutional processes and protocol in safety, information security, and environment. As technology and best practices in the NAS-installed baseline advance, these three areas will be upgraded accordingly.

Transform Facilities

The ATO maintains and operates thousands of staffed and unstaffed operational facilities that the FAA must regularly upgrade and modernize. The largest facilities are the 21 en route centers, which house hundreds of employees and equipment to control aircraft flying in the en route airspace. The other operational facilities with significant staffing are the more than 500 towers and 167 Terminal Radar Approach Control (TRACON) facilities that control traffic departing and arriving at airports.



Potomac TRACON, Virginia

The FAA is evaluating the design and configuration of future NextGen facilities to support the planned NextGen improvements in service and the potential changes in airspace controlled by these facilities. It is important that these new facilities are sized correctly so the full benefits of the NextGen architecture can be realized. The potential benefits include accommodating NextGen capabilities such as Integrated Arrival and Departure Services, High Altitude Generic En Route Services, Flexible Airspace Management, Staffed NextGen Towers, and integrated business continuity services.

Aircraft and Operator Requirements Domain

This domain identified the gaps between current avionics capabilities and NextGen operational requirements to help the FAA focus future research and development and prioritize the development of new standards and criteria. The avionics requirements include communications, navigation, and surveillance capabilities and refined weather equipment and displays.

In 2008, the FAA developed the framework for a NextGen equipage strategy, which describes the process to evaluate potential avionics requirements. The 2009 NGIP laid out a set of governing principles that the FAA believes are critical to achieve accelerated, wide-spread aircraft avionics equipage to enable NextGen capabilities. These principles provide focus toward an integrated strategy, centered on the installation of three core avionics capabilities for the midterm: Area Navigation (RNAV) and Required Navigation Performance, Automatic Dependent Surveillance-Broadcast (ADS-B), and Data Communications (Data Comm).

Airport Development Domain

This domain focuses on adding new airport surface infrastructure at the OEP 35 airports and in the 15 major U.S. metropolitan areas likely to experience the greatest congestion over the next two decades. The NGIP efforts will provide for significant capacity increases, including new runways, runway extensions, and end-around taxiways; planning and environmental assessments; and growth in metropolitan areas.

NextGen Portfolio Management Process

To enhance FAA performance and management control, the FAA NextGen I&I Office manages each NextGen investment. That office ensures effective and efficient application, planning, programming, budgeting, and execution of the FAA NextGen portfolio, including the NextGen R&D programs. The NextGen I&I Office is responsible for consolidated tracking and reporting of financial and program information on all NextGen initiatives and manages the NextGen portfolio across all FAA lines of business using resource planning documents and automated financial management tools. The NextGen I&I Office is also responsible for all NextGen-related decision-making processes and accountability across the Agency.

FAA NextGen Research Requirements

FAA NextGen R&D programs are a subset of the FAA R&D portfolio that supports some of the goals, targets, and milestones listed in Chapter 2. Table 3.1 presents the links of the NextGen R&D programs to the mid- and far-term OIs in the NGIP solution set timelines. These NGIP OIs are identical to the OIs displayed in the NASEA's service roadmaps. A NextGen R&D program may support more than one NGIP OI.

Table 3.1: Mapping of FAA NextGen R&D Programs to FAA's NextGen Implementation Plan for the Air Traffic Operations Domain

Solutions Sets		Air Traffic Operations Domain	FAA NextGen R&D Budget Lines													
	OI#	Operational Improvements/Capabilities	NextGen - New Air Traffic Management Requirements (1A08B)	NextGen - Air Ground Integration Human Factors (A12.c)	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) (1A08A)	NextGen - Alternative Fuels for General Aviation (A11.m)	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08D)	NextGen - Operational Assessments (1A08F)	NextGen - Operational Concept Validation - Validation Modeling (1A08C)	NextGen - Self-Separation Human Factors (A12.d)	NextGen - Staffed NextGen Towers (1A08H)	NextGen - System Safety Management Transformation (1A08G)	NextGen - Weather Technology in the Cockpit (A12.e)	NextGen - Wake Turbulence (A12.b)	NextGen - Wake Turbulence - Re-categorization (1A08E)	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b)
Trajectory Based Operations	101103	Provide Interactive Flight Planning from Anywhere														
	102108	Oceanic In-trail Climb and Descent						X							X	
	102114	Initial Conflict Resolution Advisories														
	102117	Reduced Horizontal Separation Standards - 3 mi.							X	X				X	X	
	102118	Delegated Responsibility for Separation		X	X				X	X				X		
	102122	Use Aircraft-provided Intent Data to Improve Conflict Resolution								X						
	102136	NextGen Oceanic Procedures		X	X			X	X	X				X		
	102137	Automation Support for Mixed Environments						X	X						X	
	104102	Flexible Entry Times for Oceanic Tracks														
	104105	Expanded Conflict Resolution via Data Communications		X	X											
	104120	Point-in-Space Metering						X								
	104121	Tactical Trajectory Management	X	X	X											
	108206	Flexible Airspace Management			X											
	108209	Increase Capacity and Efficiency using RNAV and RNP	X					X								
High Density Arrivals/Departures	102139	Use Aircraft-provided Intent Data to Improve Flow and Conflict Resolution						X		X						
	102143	Delegated Responsibility for Horizontal Separation						X								
	102141	Improved Operations to Closely-Spaced Parallel Runways	X					X	X					X	X	
	102142	Wake Vortex Incorporated into Flow						X	X				X	X	X	
	104117	Optimize Runway Assignments			X			X								
	104122	Integrated Arrival/Departure Airspace Management			X			X								
	104123	Time Based Metering using RNAV and RNP Route Assignments						X	X							
	104206	Full Surface Traffic Management with Conformance Monitoring		X	X			X		X						
	104208	Use Data Messaging to Provide Flow and Taxi Assignments		X	X			X								
	104209	Initial Surface Traffic Management						X								
Flexible Terminal Environment	102138	ADS-B Services to Secondary Airports														
	102140	WTMD: Wind Based Wake Procedures						X								
	102144	Wake Turbulence Mitigation for Arrivlas: CSPRs						X								
	102145	Wake Turbulence Mitigation for Arrivlas: Single Runway						X								
	102406	Provide Full Surface Situation Information	X													
	102409	Provide Situation to Pilots, Service Providers and Vehicle Operators for All-Weather Operations														
	104124	Use Optimized Profile Descents						X							X	
	104207	Enhanced Surface Traffic Operations														
	103207	Improved Runway Safety Situational Awareness for Controllers		X	X			X								
	103208	Improved Runway Safety Situational Awareness for Pilots		X	X			X								
	107107	GBAS Precision Approaches						X								
	107202	Low Visibility Surface Operations		X			X	X	X							
	107117	Low Visibility/Ceiling Approach Operations		X			X	X	X							
	107118	Low Visibility/Ceiling Landing Operations		X			X	X	X							
	107115	Low Visibility/Ceiling Takeoff Operations		X			X	X	X							
	107116	Low Visibility/Ceiling Departure Operations		X			X	X	X							
	107119	Expanded Low Visibility Operations using Lower RVR Minima		X			X	X	X							

Air Traffic Operations Domain

Solutions Sets	OI#	Operational Improvements/Capabilities	NextGen - New Air Traffic Management Requirements (1A08B)	NextGen - Air Ground Integration Human Factors (A12.c)	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) (1A08A)	NextGen - Alternative Fuels for General Aviation (A11.m)	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08D)	NextGen - Operational Assessments (1A08F)	NextGen - Operational Concept Validation - Validation Modeling (1A08C)	NextGen - Self-Separation Human Factors (A12.d)	NextGen - Staffed NextGen Towers (1A08H)	NextGen - System Safety Management Transformation (1A08G)	NextGen - Weather Technology in the Cockpit (A12.e)	NextGen - Wake Turbulence (A12.b)	NextGen - Wake Turbulence - Re-categorization (1A08E)	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b)
			FAA NextGen R&D Budget Lines													
Collaborative Air Traffic Management	101102	Provide Full Flight Plan Constraint Evaluation with Feedback														
	103305	On-Demand NAS Information											X			
	105207	Full Collaborative Decision Making		X	X					X						
	105302	Continuous Flight Day Evaluation	X													
	108207	Manage Airspace to Flow														
	108212	Improved Management of Airspace for Special Use														
	105208	Traffic Management Initiatives with Flight Specific Trajectories														
Reduce Weather Impact	103116	Initial Improved Weather Information from Non-Ground Based Sensors														
	103117	Automatic Hazardous Weather Alert Notification											X			
	103119	Initial Integration of Weather Information into NAS Automation and Decision Making											X			
	103120	Near-real Time Dissemination of Weather Information to all Ground and Air Users.											X			
	103121	Full Operational Weather Capability											X			
Security, Safety, and Environment	*SAFETY*															
	106202	Enhanced Emergency Alerting										X				
	109303	ASIAS-Information Sharing and Emergent Trend Detection						X				X				
	109304	Enhanced Aviation Safety Information Analysis and Sharing										X				
	109305	Improved Safety for NextGen Evolution						X				X				
	109306	Increased International Cooperation for Aviation Safety														
	109307	Improved Air Safety Across Air Tansportation System Boundaries						X				X				
	109308	Enhanced (Automated) Aviation Safety Information Sharing and Analysis Scope and Effectiveness						X				X				
	ENVIRONMENT															
	--	Establish Metrics and Formulate Policy						X								X
	--	Integrated Models Assess Trade-offs between Environment and Capacity					X									
	--	NextGen Operational Initiatives Implemented that Reduce Environmental Impacts					X	X								
	--	National EMS Supports Integrated Environmental Performance					X									X
	--	Explore Environmental Control Algorithms for Operational Procedures					X	X								
	--	Establish the Impacts of New Aircraft Technologies and Alternative Fuels				X	X	X								
	SECURITY															
	109302	Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk-Based Assessment														
Transform Facilities	105104	NAS-wide Sector Demand Prediction and Resource Planning														
	109402	Remotely Staffed Tower Services									X					

-- Does not have OI#, not in NASEA

X Supporting NextGen R&D Activities

Mid-term OI/Capability

Far-term OI/Capability

FAA NextGen R&D program five-year budget plan by line item and appropriation is summarized in Tables 3.2 and 3.3. Figures are shown in the thousands of dollars.

Table 3.2: NextGen R&D Funding Levels in F&E*

R&D NextGen Programs in F&E		2010	2011	2012	2013	2014	2015	R&D Goal
1A08A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency and Air Ground Integration)	10,000	10,000	10,000	10,000	10,000	10,000	3
1A08B	NextGen - New ATM Requirements	13,200	23,000	31,200	32,000	50,100	51,900	1
1A08C	NextGen - Operations Concept Validation - Validation Modeling	10,000	10,000	10,000	10,000	10,000	10,000	9
1A08D	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	7,000	15,000	18,000	18,000	18,000	18,000	2
1A08E	NextGen - Wake Turbulence - Re-categorization	2,000	3,000	3,000	3,000	3,000	3,000	1
1A08F	NextGen - Operational Assessments	7,500	10,000	10,000	10,000	10,000	10,000	9
1A08G	NextGen - System Safety Management Transformation	16,300	18,000	18,000	18,000	18,000	18,000	9
1A08H	NextGen - Staffed NextGen Towers	0	6,000	0	0	0	0	9
—	NextGen - Initial Operation Test & Evaluation	100	0	0	0	0	0	9
	Total ($000)	66,100	95,000	100,200	101,000	119,100	131,496	

Key:
- R&D Goal 1 - Fast, Flexible, and Efficient
- R&D Goal 2 - Clean and Quiet
- R&D Goal 3 - High Quality Teams and Individuals
- R&D Goal 4 - Human-Centered Design
- R&D Goal 9 - System Knowledge

Table 3.3: NextGen R&D Funding Levels in R,E&D*

R&D NextGen Programs in R,E&D		2010	2011	2012	2013	2014	2015	R&D Goal
A11.m	NextGen - Alternative Fuels for General Aviation	0	2,000	2,004	2,007	1,999	1,990	6
A12.a	Joint Planning and Development Office	14,407	14,292	14,420	14,563	14,640	14,722	10
A12.b	NextGen - Wake Turbulence	7,605	10,685	10,742	10,799	10,800	10,801	1
A12.c	NextGen - Air Ground Integration Human Factors	5,688	10,614	10,656	10,692	10,670	10,648	4
A12.d	NextGen - Self-Separation Human Factors	8,247	9,971	10,009	10,043	10,022	10,000	7
A12.e	NextGen - Weather Technology in the Cockpit	9,570	9,312	9,360	9,407	9,406	9,404	8
A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	26,509	20,600	20,691	20,778	20,752	20,726	2
	Total ($000)	**72,026**	**77,474**	**77,882**	**78,289**	**78,289**	**78,291**	

Key:
- R&D Goal 1 - Fast, Flexible, and Efficient
- R&D Goal 2 - Clean and Quiet
- R&D Goal 4 - Human-Centered Design
- R&D Goal 7 - Separation Assurance
- R&D Goal 8 - Situational Awareness
- R&D Goal 10 - World Leadership

* The total R&D program is summarized in Tables 4.1 through 4.4 of Chapter 4 in this Plan. The funding levels listed for fiscal years 2012 through 2015 are estimates and subject to change.

Chapter Four

Research Management

This chapter summarizes the Federal Aviation Administration (FAA) research and development (R&D) portfolio according to its FY 2011 budget submission. The chapter explains what FAA is doing (programs), how much it is spending (budget), how it performs its programs (partnerships), and how well it executes its programs (evaluation).

Sponsors

FAA R&D program supports regulation, certification, and standards development; modernization of the national airspace system (NAS); and policy and planning. To support FAA goals, R&D addresses the specific needs of sponsoring organizations, including Aviation Safety; the Air Traffic Organization; Airports; Commercial Space Transportation; and Aviation Policy, Planning and Environment. The Office of Research and Technology Development under NextGen and Operations Planning in the Air Traffic Organization manages the FAA research portfolio for the Agency.

Programs

The R&D programs are funded in four appropriation accounts: Research, Engineering and Development (R,E&D); Facilities and Equipment (F&E); the Airport Improvement Program (AIP); and Operations (Ops). In general, the R,E&D account funds R&D programs that improve the NAS by increasing its safety, security, productivity, capacity, and environmental compatibility to meet the expected air traffic demands of the future.* R&D programs funded under the F&E account include R&D concept development and demonstration prior to an FAA investment decision. The AIP account generally funds airport improvement grants, including those emphasizing capacity development, and safety and security needs; and funds grants for aircraft noise compatibility planning and programs and low emissions airport equipment.** It also funds administrative and technical support costs to support airport programs. The commercial space transportation program's R&D expenses are funded under the Ops account.

The programs in the FY 2011 R&D budget request are listed by appropriation in the following sections. Appendix A provides detailed information for each program, including intended outcomes, outputs, programmatic structure, partnerships, and a five-year program plan.

* FAA Order 2500.8B, *Funding Criteria for Operations, Facilities and Equipment (F&E), and Research, Engineering and Development (R,E&D) Accounts*, dated October 1, 2006.

** FAA Budget Estimates FY 2007 submitted for use by The Committees on Appropriations, Section 3D. – Grants-In-Aid for Airports, page 3; and Vision 100 – Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003.

Research, Engineering and Development (R,E&D) Appropriation

Fire Research and Safety (A11.a):

The program develops technologies, procedures, and test methods that can prevent accidents caused by fires and fuel tank explosions and improve survivability during a post-crash fire. Near-term activities include improvements in fire test methods and materials performance criteria, fire detection and suppression systems, fuel tank explosion protection, and hazardous materials fire safety. Far-term research focuses on the enabling technology for ultra-fire-resistant interior materials.

Propulsion and Fuel Systems (A11.b):

The program develops and validates technologies, tools, methodologies, and materials to enhance the airworthiness, reliability, and performance of civil turbine and piston engines, propellers, and fuel management systems.

Advanced Materials/Structural Safety (A11.c):

The program ensures the safety of civil aircraft constructed of advanced composite materials by developing analytical and testing methods to understand how design, load, and damage can affect composite structures and by developing maintenance and repair methods. The program also increases the ability of passengers to survive aviation accidents by improving the crash characteristics of aircraft structures through modeling and testing crash events, and verification of analytical crash prediction methodologies.

Atmospheric Hazards-Aircraft Icing/ Digital System Safety (A11.d):

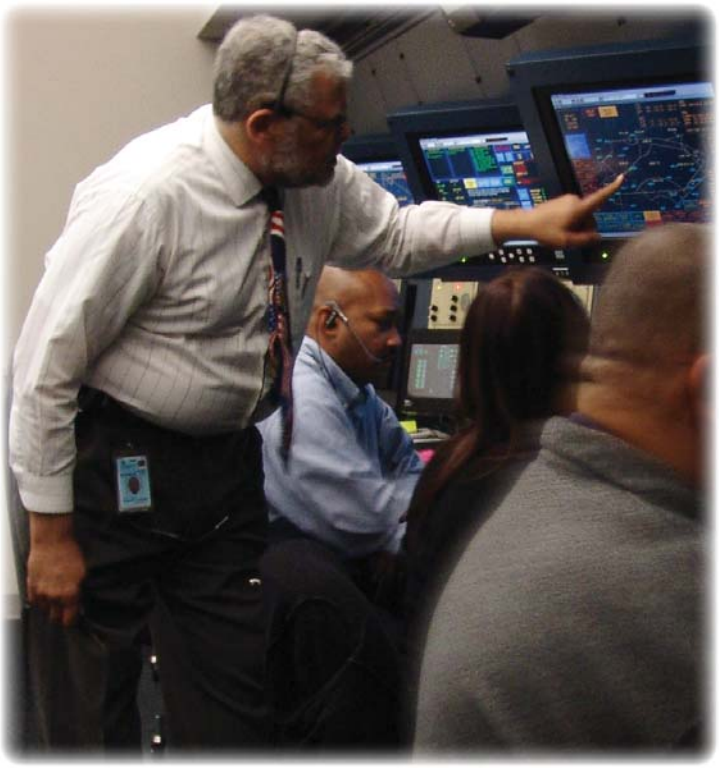
The program develops technologies and methods to detect or prevent frozen contamination and predicts anti-icing fluid failure and ensures safe operations in atmospheric icing conditions. It improves aircraft safety by ensuring the safe operation of advanced, flight-critical digital (software-based and programmable logic-based) airborne systems technology. It also assesses how this technology may be safely employed in flight-essential and flight-critical systems such as fly-by-wire, augmented manual flight controls, navigation and communication equipment, and autopilots.

Continued Airworthiness (A11.e):

The program develops technologies, technical information, procedures, and practices to help ensure the continued airworthiness of aircraft structures, engines, and systems. It assesses the causes and consequences of fatigue damage of aging aircraft; ensures the continued safe operation of aircraft electrical, mechanical, and flight control systems; detects and quantifies damage through nondestructive inspection techniques; updates and validates airworthiness standards; develops and validates guidance for health monitoring systems; and establishes damage-tolerant design and maintenance criteria.

Aircraft Catastrophic Failure Prevention Research (A11.f):

The program develops technologies and methods to assess risk and prevent the occurrence of potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems. It also uses historic accident data to investigate turbine engine un-containment events and propulsion malfunctions.



Flightdeck/Maintenance/System Integration Human Factors (A11.g):

The program provides the human factors research for guidelines, handbooks, Advisory Circulars (ACs), rules, and regulations that ensure safe and efficient aircraft operations. It improves task performance and training for aircrew, inspectors, and maintenance technicians; develops and applies error management strategies to flight and maintenance operations; and ensures that human factors are considered in certifying new aircraft and in designing and modifying equipment.

System Safety Management (A11.h):

The program monitors and analyzes aviation system operations and safety risks and develops risk management methodologies, prototype tools, technical information, procedures, and practices to improve aviation safety. It develops an infrastructure that enables the free sharing of de-identified, aggregate safety information from various government and industry sources in a protected, aggregated manner. It also conducts research to evaluate proposed new technologies and procedures that will improve safety by making relevant information available to the pilot during terminal operations.

Air Traffic Control/Technical Operations Human Factors (A11.i):

The program identifies and analyzes trends in air traffic operational errors and technical operations incidents and develops and implements strategies to mitigate errors and incidents. It manages human error hazards, their consequences, and recovery methods in early stages of system design or procedural development and assesses concepts and technology to modernize workstations and improve controller performance.

Aeromedical Research (A11.j):

The program identifies pilot, flight attendant, and passenger medical conditions that indicate an inability to meet flight demands, both in the absence and in the presence of emergency flight conditions. It also defines cabin air quality and analyzes requirements for occupant protection and aircraft decontamination.

Weather Program (A11.k):

The program develops new and enhanced algorithms to improve weather information required for integration with decision-support tools to reduce the impact of adverse weather in the nation's aviation system. The improved weather information enhances capacity and increases safety by supporting better operational planning by air traffic management (ATM), dispatchers, and pilots.

Unmanned Aircraft Systems Research (A11.l):

The program ensures safe integration of unmanned aircraft systems (UAS) into the nation's aviation system. It also provides information to support certification procedures, airworthiness standards, operational requirements, maintenance procedures, and safety oversight activities for UAS civil applications and operations.

NextGen – Alternative Fuels for General Aviation (A11.m):

The program addresses the use of alternative and renewable fuels for GA to lessen aviation environmental impacts (air and water quality). The program develops data and methodologies to support certification of alternative aviation fuels for GA aircraft.

Joint Planning and Development Office (A12.a):

The program plans and designs the next generation air transportation system by coordinating goals, priorities, and implementation requirements within the federal government and with the U.S. aviation community.

NextGen - Wake Turbulence (A12.b):

The program provides a better understanding of the wake turbulence generated by aircraft, develops mechanisms to reduce wake turbulence separation to enhance capacity safely, and develops requirements to implement these mechanisms.

NextGen - Air Ground Integration Human Factors (A12.c):

The program addresses flight deck and air traffic service provider integration for NextGen operational capabilities with a focus on those human factors issues that primarily affect the pilot side of the air-ground integration challenge (i.e., the challenge of ensuring that the right information is provided to pilots, at the right time, to make the right decisions, and to allow pilots to successfully collaborate with air navigation service provider (ANSP) personnel to operate in the NAS safely and efficiently). Through the use of modeling, simulation, and demonstration, the program assesses interoperability of tools, develops design guidance, determines training requirements, and verifies procedures for ensuring effective and efficient human system integration in transitions of NextGen capabilities.

NextGen - Self-Separation Human Factors (A12.d):

The program addresses human performance and coordination requirements for pilots and ANSPs through development of the initial standards and procedures that will lead to an operational capability for separation assurance. It assesses the human factors risks and requirements associated with self-separation policies, procedures, and maneuvers, including interim operational capabilities for reduced and delegated separation and high-density airport traffic operations in reduced visibility using advanced flight deck technologies. Research results will provide the technical information and data needed to support the development of standards, procedures, and training by the Flight Standards service to implement enhanced spacing and separation operations.

NextGen - Weather Technology in the Cockpit (A12.e):

The program enables the integration of cockpit, ground, and communication technologies, practices, and procedures to provide pilots with shared and relevant weather information to enhance common situational awareness. It will do this by aiding development of airborne decision-support tools to exploit the common weather picture, exchange weather information automatically with surrounding aircraft and ground systems, and facilitate the integration of weather information into the cockpit to support NextGen capabilities. The program develops policies and standards on hardware and software requirements, including guidelines and procedures for testing, evaluating, and qualifying weather systems for certification and operation on aircraft. It also addresses the human factors issues in developing policies, standards, and guidance, including training, procedures, and error management.

Environment and Energy (A13.a):

The program provides fundamental knowledge, and develops and validates methodologies, models, metrics, and tools. This program characterizes aircraft noise and emissions and their environmental impacts and provides guidance on their mitigation. It analyzes and balances the interrelationships between noise and emissions, considers local to global impacts, and determines economic consequences. The program also reduces scientific uncertainties related to aviation environmental issues to support decision making.

NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b):

The program develops solutions to mitigate aviation environmental impacts in absolute terms and increase fuel efficiency. It matures aircraft technologies through the Continuous Lower Energy, Emissions and Noise (CLEEN) program to reduce noise and emissions at the source level. It assesses, demonstrates, and supports qualification of alternative aviation fuels that reduce emissions that impact air quality and climate change. Availability of alternative aviation fuels also increases energy security. The program also supports research to determine the appropriate goals and metrics to manage NextGen aviation environmental impacts that are needed to support Environmental Management Systems (EMSs).

System Planning and Resource Management (A14.a):

The program manages the R&D programs to meet customer needs, to increase program efficiency, and to reduce management and operating costs. It works to increase customer and stakeholder involvement in FAA programs and foster acceptance of U.S. standards and technology to meet global aviation needs.

William J. Hughes Technical Center Laboratory Facility (A14.b):

The program provides well-equipped, routinely available facilities to emulate and evaluate field conditions; performs human-in-the-loop simulations; measures human performance; evaluates human factors issues; and provides research aircraft that are specially instrumented and re-configurable.

William J. Hughes Technical Center

Runway Incursion Reduction (1A01A):

The program minimizes the chance of injury, death, damage, or loss of property caused by runway accidents or incidents. It selects and evaluates technologies, validates technical performance and operational suitability, and develops a business case to support program implementation. It improves pilot situational awareness with airport visual aids such as runway status lights, final approach runway occupancy signals, and other enhanced airport lighting technologies.

System Capacity, Planning and Improvement (1A01B):

The program delivers products and services to alleviate traffic congestion, system delays, and operational inefficiencies in the aviation system through the development of new runways, new technologies, and modified operational procedures. It also develops performance metrics; implements performance measurement tools; and collects, processes, and analyzes data to measure and report performance on a routine basis.

Operations Concept Validation (1A01C):

The program conducts modeling and simulation to validate new ATO operational concepts for the next generation of decision support systems for pilots and air traffic controllers. It validates performance requirements and identifies research criteria at the system and subsystem level. It also assesses safety, identifies risk, and takes actions necessary to reduce risk.

NAS Weather Requirements (1A01D):

The program analyzes mission needs and establishes weather requirements for the NAS to increase operational efficiency and safety during weather events. It aligns requirements, priorities, programs, and resources and develops metrics to measure and understand the impact of weather on the system. It also evaluates weather-related services and technologies for the NAS.

Airspace Management Program (1A01E):

The program investigates and demonstrates new airspace concepts and procedures to increase national aviation system capacity. It focuses on the nation's major metropolitan areas to shorten flight distances, to provide more fuel-efficient routes, and to reduce arrival and departure delays

NextGen – Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) (1A08A):

The program addresses human system integration and human performance issues related to improving controller efficiency to yield greater traffic throughput without a commensurate increase in the number of ANSP. It examines how ANSP personnel can achieve higher efficiency levels through the integration of automation, decision support tools, workstation displays, and procedures. It also addresses the air traffic service provider perspective and works together with the flight deck human factors program to address the air-ground integration required to transition from the current system to NextGen. It addresses changes in responsibilities and liabilities and examines new types of human error modes to manage safety risk.

NextGen - New Air Traffic Management Requirements (1A08B):

The program supports new procedures and technologies to increase efficiency in the national airspace system and to provide three times current capacity levels. It develops data communication requirements and standards, conflict resolution methods, procedures, and technologies to reduce aircraft separation, enhance surface management technologies, and develop procedures for low visibility conditions and decision support tools for air and ground operations.

NextGen - Operations Concept Validation - Validation Modeling (1A08C):

The program develops methods, metrics, and models to demonstrate that the system can handle growth in demand up to three-times current levels at higher efficiency levels than today. It measures the improvements planned by NextGen under the seven solution sets and determines whether or not these improvements will provide the targeted levels of capacity and efficiency.

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction (1A08D):

The program supports development and implementation of the NextGen Environmental Management System (EMS). The EMS will dynamically manage NextGen environmental impacts and help to define and identify optimum mitigation actions and their benefits. The program also evaluates the benefits of aviation environmental mitigation options and identifies ways to integrate them into the NAS infrastructure and demonstrate any NAS adaptation required to realize their full benefits. These options include new CLEEN aircraft technologies, alternative fuels, environmental and energy-efficient operational policies and procedures, environmental standards, and market-based measures.

NextGen - Wake Turbulence - Re-categorization (1A08E):

The program develops enhanced methods to define wake turbulence separation between aircraft. Wake characterization models will be developed to include various aircraft design parameters for defining wake vortices. Enhanced wake turbulence separation standards and procedures will be evaluated through field measurements, analyses, and human-in-the-loop simulations.

NextGen - Operational Assessments (1A08F):

The program researches and develops system-wide assessment of NAS performance, safety, and environmental impacts. The transition to NextGen requires the conduct of operational assessments to ensure that safety, environmental, and system performance considerations are addressed throughout the integration and implementation of NextGen.

NextGen - System Safety Management Transformation (1A08G):

The program develops a safety information analysis and sharing environment for NextGen to serve as the foundation for trend analysis and the identification and mitigation of potential safety hazards before incidents occur. It also produces guidelines for developing processes and technologies to implement a safety management system across NextGen.

NextGen - Staffed NextGen Towers (1A08H):

The program will enable ANSP personnel to provide surface and tower services by other-than-direct visual observation. The program outlines a roadmap for the research and engineering activities needed to develop and evaluate the Staffed NextGen Towers (SNT) concept, verify its operational feasibility, and generate technical performance requirements for providing air traffic services through SNT.

Center for Advanced Aviation System Development (CAASD) (4A09A):

The program identifies and tests new technologies for application to air traffic management, navigation, communication, separation assurance, surveillance, and system safety; and conducts R&D and high-level system engineering to meet FAA's far-term requirements.

Airport Improvement Program (AIP) Appropriation

Airport Cooperative Research - Capacity:

The program conducts research to provide better airport planning and design. Future aviation demand will rely on the ability of airports to accommodate increased aircraft operations, larger aircraft, and more efficient passenger throughput. This program will prepare for those future needs while simultaneously solving current and near-term airport capacity issues.

Airport Cooperative Research - Environment:

The program examines the impact an airport has on the surrounding environment and advances the science and technology for creating an environmentally friendly airport system. Projects include the study of airport-specific aviation noise and emissions and their environmental impacts, developing strategies and guidance for green airports via reduction in noise and emissions, infrastructure, and benefits of alternative aviation fuels at airport facilities, deicing management, and advanced noise and emissions databases.

Airport Cooperative Research - Safety:

The program conducts research to prevent and mitigate potential injuries and accidents within the airport operational environment. A fundamental element of this program is to produce results that provide protection of aircraft passengers and airport personnel through improved safety training, airport design, and advanced technology implementation.

Airport Technology Research - Capacity:

The program provides better airport planning and designs and improves runway pavement design, construction, and maintenance. It ensures new pavement standards will be ready to support safe international operation of next-generation heavy aircraft and makes pavement design standards available to users worldwide.

Airport Technology Research - Safety:

The program increases airport safety by conducting research to improve airport lighting and marking, reduce wildlife hazards near airport runways, improve airport fire and rescue capability, and reduce surface accidents.

Operations (Ops) Appropriation

Commercial Space Transportation Safety:

The program examines safety considerations for commercial space transportation, including those that involve crew and spaceflight participants' health and safety, spacecraft vehicle safety, launch and re-entry risks, public safety, and personal property risk.

This section provides four tables that present the FAA R&D budget by appropriation, program sponsor, R&D category, and performance goal. It presents the FAA R&D request for the President's Budget for FY 2011. The funding levels listed for FYs 2012 to 2015 are estimates and subject to change.

Appropriation Account – Table 4.1 shows the FAA R&D budget planned for FY 2011, including the five-year plan through FY 2015, grouped by appropriation account. The previous section described the programs in each of the four appropriation types. The F&E budget in Table 4.1 includes three main line items: Advanced Technology Development and Prototyping (ATD&P), 1A01; NextGen System Development, 1A08; and the Center for Advanced Aviation System Development (CAASD), 4A09A. ATD&P and NextGen Systems Development have several programs under them. Both the F&E and the Ops appropriations have programs that are not R&D; however, only R&D programs are shown.

Sponsoring Organization – Table 4.2 shows the FAA R&D budget planned for FY 2011, including the five-year plan through FY 2015, grouped by sponsoring organization. Sponsoring organizations are: Aviation Safety; Air Traffic Organization; Airports; Commercial Space Transportation; and Aviation Policy, Planning, and Environment.

R&D Category – FAA research includes both applied research and development as defined by the Office of Management and Budget (OMB) Circular A-11.* Table 4.3 shows the FAA R&D program according to these categories with the percent of applied research and development for FY 2011 through 2015.

Performance Goal – Table 4.4 shows the FAA R&D budget by the performance goals defined in Exhibit II of the FAA budget request for FY 2011. The R&D programs apply to three performance goals – safety, reduce congestion, and environmental stewardship. Programs may support more than one goal; however, each program is listed only once under its primary goal for budget purposes. The table provides information on contract costs, personnel costs, and other in-house costs planned for FY 2011.

* OMB Circular A-11, "Preparation, Submission and Execution of the Budget," August 7, 2009, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

Table 4.1: Planned R&D Budget by Appropriation Account

Project Number	FY 2011 Budget Line Item	Program	Appropriation Account	2010 Enacted ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	2014 Planned ($000)	2015 Planned ($000) /1
Research, Engineering and Development (R,E&D)									
061-110	A11.a	Fire Research and Safety	R,E&D	7,799	7,231	7,350	7,475	7,580	7,689
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	3,105	2,332	2,357	2,383	2,399	2,416
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	4,935	2,566	2,596	2,628	2,650	2,672
064-110/111	A11.d	Atmospheric Hazards-Aircraft Icing/Digital System Safety	R,E&D	4,482	6,635	6,675	6,715	6,722	6,730
065-110	A11.e	Continued Airworthiness	R,E&D	10,944	10,801	10,856	10,911	10,909	10,906
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,545	1,165	1,171	1,177	1,177	1,176
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,128	7,174	7,253	7,336	7,390	7,446
060-110	A11.h	System Safety Management	R,E&D	12,698	11,907	11,913	11,915	11,841	11,765
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,302	10,475	10,633	10,799	10,934	11,073
086-110	A11.j	Aeromedical Research	R,E&D	10,378	11,217	11,390	11,570	11,718	11,870
041-110	A11.k	Weather Program	R,E&D	16,789	16,505	16,377	16,233	15,952	15,662
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,467	3,694	3,710	3,725	3,720	3,715
	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	0	2,000	2,004	2,007	1,999	1,990
027-110	A12.a	Joint Planning and Development Office	R,E&D	14,407	14,292	14,420	14,563	14,640	14,722
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,631	10,685	10,742	10,799	10,800	10,801
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	5,688	10,614	10,656	10,692	10,670	10,648
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	8,247	9,971	10,009	10,043	10,022	10,000
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	9,570	9,312	9,360	9,407	9,406	9,404
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,522	15,374	15,335	15,287	15,131	14,969
111-150	A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	26,509	20,600	20,691	20,778	20,752	20,726
011-130	A14.a	System Planning and Resource Management	R,E&D	1,766	1,733	1,717	1,700	1,668	1,634
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	4,588	3,717	3,785	3,857	3,920	3,986
			TOTAL R,E&D	**190,500**	**190,000**	**191,000**	**192,000**	**192,000**	**192,000**
Facilities & Equipment (F&E)									
S09.02-00	1A01A	Runway Incursion Reduction	F&E	11,000	5,000	3,000	3,000	3,000	3,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	4,100	4,100	6,500	6,500	6,500	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	8,000	4,000	8,000	6,000	6,000	6,000
M08.27-01	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	3,300	3,400	3,400
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	1,000	5,000	5,000	5,000	5,000
M08.36-01	1A01I	Wake Turbulence Research	F&E	1,000	0	0	0	0	0
			Subtotal Line 1A01	28,100	15,100	23,500	23,800	23,900	23,900 /2
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G6M.02-01	1A08D	NextGen - Environment & Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	7,000	15,000	18,000	18,000	18,000	18,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	13,200	23,000	31,200	32,000	50,100	51,900
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	18,000	18,000	18,000	18,000	18,000
G6M.02-02	1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	2,000	3,000	3,000	3,000	3,000	3,000
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	7,500	10,000	10,000	10,000	10,000	10,000
G3M.04-01	1A08H	NextGen - Staffed NextGen Towers	F&E	0	6,000	0	0	0	0
M25.00-00		NextGen - Initial Operation Test & Evaluation	F&E	100	0	0	0	0	0 /3
			Subtotal Line 1A08	66,100	95,000	100,200	101,000	119,100	120,900
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	23,944	23,564	23,594	24,148	24,703	33,872 /4
			TOTAL F&E	**118,144**	**133,664**	**147,294**	**148,948**	**167,703**	**178,672**
Airport Improvement Program (AIP)									
--	--	Airports Technology Research - Capacity	AIP	10,596	12,930	12,930	12,930	12,930	12,930
--	--	Airports Technology Research - Safety	AIP	11,876	14,287	14,287	14,287	14,287	14,287
--	--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
			TOTAL AIP	**37,472**	**42,217**	**42,217**	**42,217**	**42,217**	**42,217**
Operations									
--	--	Commercial Space Transportation Safety	Ops	145	165	165	165	165	165
			TOTAL Ops	**145**	**165**	**165**	**165**	**165**	**165**
			GRAND TOTAL	**$346,261**	**$366,046**	**$380,676**	**$383,330**	**$402,085**	**$413,054**

Notes:

/1 The funding levels listed for years 2012 to 2015 are estimates and subject to change.

/2 The amount shown for ATD&P reflects only R&D activities: it does not include acquisition, operational testing, or other non-R&D activities.

/3 There is no FY 2011 budget narrative for NextGen - Initial Operation Test & Evaluation in Appendix A.

/4 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 29.2 percent in FY 2010.

Table 4.2: Planned R&D Budget by Sponsoring Organization

Project Number	FY 2011 Budget Line Item	Program	Appropriation Account	2010 Enacted ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	2014 Planned ($000)	2015 Planned ($000) /1
Aviation Safety (AVS)									
061-110	A11.a	Fire Research and Safety	R,E&D	7,799	7,231	7,350	7,475	7,580	7,689
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	3,105	2,332	2,357	2,383	2,399	2,416
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	4,935	2,566	2,596	2,628	2,650	2,672
064-110/111	A11.d	Atmospheric Hazards-Aircraft Icing/Digital System Safety	R,E&D	4,482	6,635	6,675	6,715	6,722	6,730
065-110	A11.e	Continued Airworthiness	R,E&D	10,944	10,801	10,856	10,911	10,909	10,906
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,545	1,165	1,171	1,177	1,177	1,176
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,128	7,174	7,253	7,336	7,390	7,446
060-110	A11.h	System Safety Management	R,E&D	12,698	11,907	11,913	11,915	11,841	11,765
086-110	A11.j	Aeromedical Research	R,E&D	10,378	11,217	11,390	11,570	11,718	11,870
041-110	A11.k	Weather Program	R,E&D	16,789	16,505	16,377	16,233	15,952	15,662
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,467	3,694	3,710	3,725	3,720	3,715
	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	0	2,000	2,004	2,007	1,999	1,990
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	5,688	10,614	10,656	10,692	10,670	10,648
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	8,247	9,971	10,009	10,043	10,022	10,000
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	9,570	9,312	9,360	9,407	9,406	9,404
		Subtotal	**R,E&D**	106,775	113,124	113,677	114,217	114,155	114,089
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	18,000	18,000	18,000	18,000	18,000
		***Aviation Safety* Total**		**123,075**	**131,124**	**131,677**	**132,217**	**132,155**	**132,089**
Air Traffic Organization (ATO)									
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,302	10,475	10,633	10,799	10,934	11,073
027-110	A12.a	Joint Planning and Development Office	R,E&D	14,407	14,292	14,420	14,563	14,640	14,722
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,631	10,685	10,742	10,799	10,800	10,801
011-130	A14.a	System Planning and Resource Management	R,E&D	1,766	1,733	1,717	1,700	1,668	1,634
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	4,588	3,717	3,785	3,857	3,920	3,986
		Subtotal	**R,E&D**	41,694	40,902	41,297	41,718	41,962	42,216
S09.02-00	1A01A	Runway Incursion Reduction	F&E	11,000	5,000	3,000	3,000	3,000	3,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	4,100	4,100	6,500	6,500	6,500	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	8,000	4,000	8,000	6,000	6,000	6,000
M08.27-01	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	3,300	3,400	3,400
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	1,000	5,000	5,000	5,000	5,000
M08.36-01	1A01I	Wake Turbulence Research	F&E	1,000	0	0	0	0	0
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	13,200	23,000	31,200	32,000	50,100	51,900
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G6M.02-02	1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	2,000	3,000	3,000	3,000	3,000	3,000
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	7,500	10,000	10,000	10,000	10,000	10,000 /2
M25.00-00		NextGen - Initial Operation Test & Evaluation	F&E	100	0	0	0	0	0 /3
G3M.04-01	1A08H	NextGen - Staffed NextGen Towers	F&E	0	6,000	0	0	0	0
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	23,944	23,564	23,594	24,148	24,703	33,872 /4
		Subtotal	**F&E**	94,844	100,664	111,294	112,948	131,703	142,672
		***Air Traffic Organization* Total**		**136,538**	**141,566**	**152,591**	**154,666**	**173,665**	**184,888**
Airports (ARP)									
--	--	Airports Technology Research - Capacity	AIP	10,596	12,930	12,930	12,930	12,930	12,930
--	--	Airports Technology Research - Safety	AIP	11,876	14,287	14,287	14,287	14,287	14,287
--	--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
		***Airports* Total**		**37,472**	**42,217**	**42,217**	**42,217**	**42,217**	**42,217**
Aviation Policy, Planning and Environment (AEP)									
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,522	15,374	15,335	15,287	15,131	14,969
G1M.02-01	A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	26,509	20,600	20,691	20,778	20,752	20,726
		Subtotal	**R,E&D**	42,031	35,974	36,026	36,065	35,883	35,695
G6M.02-01	1A08D	NextGen - Environment & Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	7,000	15,000	18,000	18,000	18,000	18,000
		Subtotal	**F&E**	7,000	15,000	18,000	18,000	18,000	18,000
		***Aviation Policy, Planning and Environment* Total**		**49,031**	**50,974**	**54,026**	**54,065**	**53,883**	**53,695**
Commercial Space Transportation (AST)									
--	--	Commercial Space Transportation Safety	Ops	145	165	165	165	165	165
		***Commercial Space Transportation* Total**		**145**	**165**	**165**	**165**	**165**	**165**
		TOTAL		**$346,261**	**$366,046**	**$380,676**	**$383,330**	**$402,085**	**$413,054**

Notes:

/1 The funding levels listed for years 2012 to 2015 are estimates and subject to change.

/2 NextGen - Operational Assessments jointly sponsored by AVS, ATO, and AEP.

/3 There is no FY 2011 budget narrative for NextGen - Initial Operation Test & Evaluation in Appendix A.

/4 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 29.2 percent in FY 2010.

Table 4.3: Planned R&D Budget by Research Category

Project Number	FY 2011 Budget Line Item	Program	Appropriation Account	2010 Enacted ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	2014 Planned ($000)	2015 Planned ($000) /1
Applied Research									
061-110	A11.a	Fire Research and Safety	R,E&D	7,799	7,231	7,350	7,475	7,580	7,689
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	3,105	2,332	2,357	2,383	2,399	2,416
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	4,935	2,566	2,596	2,628	2,650	2,672
064-110/111	A11.d	Atmospheric Hazards-Aircraft Icing/Digital System Safety	R,E&D	4,482	6,635	6,675	6,715	6,722	6,730
065-110	A11.e	Continued Airworthiness	R,E&D	10,944	10,801	10,856	10,911	10,909	10,906
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,545	1,165	1,171	1,177	1,177	1,176
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,128	7,174	7,253	7,336	7,390	7,446
060-110	A11.h	System Safety Management	R,E&D	12,698	11,907	11,913	11,915	11,841	11,765
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,302	10,475	10,633	10,799	10,934	11,073
086-110	A11.j	Aeromedical Research	R,E&D	10,378	11,217	11,390	11,570	11,718	11,870
041-110	A11.k	Weather Program	R,E&D	16,789	16,505	16,377	16,233	15,952	15,662
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,467	3,694	3,710	3,725	3,720	3,715
	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	0	2,000	2,004	2,007	1,999	1,990
027-110	A12.a	Joint Planning and Development Office	R,E&D	14,407	14,292	14,420	14,563	14,640	14,722
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,631	10,685	10,742	10,799	10,800	10,801
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	5,688	10,614	10,656	10,692	10,670	10,648
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	8,247	9,971	10,009	10,043	10,022	10,000
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	9,570	9,312	9,360	9,407	9,406	9,404
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,522	15,374	15,335	15,287	15,131	14,969
111-150	A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	26,509	20,600	20,691	20,778	20,752	20,726
011-130	A14.a	System Planning and Resource Management	R,E&D	1,766	1,733	1,717	1,700	1,668	1,634
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	4,588	3,717	3,785	3,857	3,920	3,986
		Subtotal	**R,E&D**	190,500	190,000	191,000	192,000	192,000	192,000
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	23,944	23,564	23,594	24,148	24,703	33,872 /2
		Subtotal	**F&E**	23,944	23,564	23,594	24,148	24,703	33,872
--	--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
		Subtotal	**AIP**	15,000	15,000	15,000	15,000	15,000	15,000
--	--	Commercial Space Transportation Safety	Ops	73	83	83	83	83	83 /3
		Subtotal	**Ops**	73	83	83	83	83	83
		Applied Research		**229,517**	**228,647**	**229,676**	**231,231**	**231,786**	**240,955**
		Percent Applied Research		**66.3%**	**62.5%**	**60.3%**	**60.3%**	**57.6%**	**58.3%**
Development									
S09.02-00	1A01A	Runway Incursion Reduction	F&E	11,000	5,000	3,000	3,000	3,000	3,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	4,100	4,100	6,500	6,500	6,500	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	8,000	4,000	8,000	6,000	6,000	6,000
M08.27-01	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	3,300	3,400	3,400
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	1,000	5,000	5,000	5,000	5,000
M08.36-01	1A01I	Wake Turbulence Research	F&E	1,000	0	0	0	0	0
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G6M.02-01	1A08D	NextGen - Environment & Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	7,000	15,000	18,000	18,000	18,000	18,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	13,200	23,000	31,200	32,000	50,100	51,900
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	10,000	10,000	10,000	10,000	10,000	10,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	18,000	18,000	18,000	18,000	18,000
G6M.02-02	1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	2,000	3,000	3,000	3,000	3,000	3,000
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	7,500	10,000	10,000	10,000	10,000	10,000
G3M.04-01	1A08H	NextGen - Staffed NextGen Towers		0	6,000	0	0	0	0
M25.00-00	-	NextGen - Initial Operation Test & Evaluation	F&E	100	0	0	0	0	0 /4
		Subtotal	**F&E**	94,200	110,100	123,700	124,800	143,000	144,800
--	--	Airports Technology Research - Capacity	AIP	10,596	12,930	12,930	12,930	12,930	12,930
--	--	Airports Technology Research - Safety	AIP	11,876	14,287	14,287	14,287	14,287	14,287
		Subtotal	**AIP**	22,472	27,217	27,217	27,217	27,217	27,217
--	--	Commercial Space Transportation Safety	Ops	73	83	83	83	83	83 /3
		Subtotal	**Ops**	73	83	83	83	83	83
		Development		**116,745**	**137,400**	**151,000**	**152,100**	**170,300**	**172,100**
		Percent Development		**33.7%**	**37.5%**	**39.7%**	**39.7%**	**42.4%**	**41.7%**
		TOTAL		**$346,261**	**$366,046**	**$380,676**	**$383,330**	**$402,085**	**$413,054**

Notes:

/1 The funding levels listed for years 2012 to 2015 are estimates and subject to change.

/2 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 29.2 percent in FY 2010.

/3 The Commercial Space Transportation Program is 50 percent applied research and 50 percent development.

/4 There is no FY 2011 budget narrative for NextGen - Initial Operation Test & Evaluation in Appendix A.

Table 4.4: Planned R&D Budget by Performance Goal (Budget Exhibit II)

Project Number	FY 2011 Budget Line Item	Program	Appropriation Account	FY 2011 Contract Costs ($000)	FY 2011 Personnel Costs ($000)	FY 2011 Other In-house Costs ($000)	FY 2011 Total Planned ($000) /1
1. SAFETY							
a. Reduce the Commercial Air Carrier Fatality Rate							
061-110	A11.a	Fire Research and Safety	R,E&D	2,750	4,118	363	7,231
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	1,200	1,047	85	2,332
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	1,250	1,218	98	2,566
064-110/111	A11.d	Atmospheric Hazards-Aircraft Icing/Digital System Safety	R,E&D	4,119	2,308	208	6,635
065-110	A11.e	Continued Airworthiness	R,E&D	6,949	3,517	335	10,801
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	750	384	31	1,165
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	3,623	3,309	242	7,174
060-110	A11.h	System Safety Management	R,E&D	8,926	2,652	329	11,907
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	4,302	5,800	373	10,475
086-110	A11.j	Aeromedical Research	R,E&D	4,547	6,389	281	11,217
041-110	A11.k	Weather Program	R,E&D	15,547	712	246	16,505
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	2,450	1,135	109	3,694
011-130	A14.a	System Planning and Resource Management	R,E&D	826	16	11	853 /2
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	617	1,171	44	1,832 /2
	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	2,000	0	0	2,000
		Subtotal	**R,E&D**	59,855	33,776	2,755	96,387 /3
S09.02-00	1A01A	Runway Incursion Reduction	F&E	5,000	0	0	5,000
		Subtotal	**F&E**	5,000	0	0	5,000
--	--	Airports Technology Research - Safety	AIP	12,146	1,741	0	13,887 /4
--	--	Airport Cooperative Research - Safety	AIP	3,750	1,250	0	5,000
		Subtotal	**AIP**	15,896	2,991	0	18,887
		Reduce the Commercial Air Carrier Fatality Rate		**80,751**	**36,767**	**2,755**	**120,274**
b. Reduce the Number of General Aviation Fatal Accidents							
--	--	Airports Technology Research - Safety	AIP	400	0	0	400 /4
		Reduce the Number of General Aviation Fatal Accidents		**400**	**0**	**0**	**400**
c. Maintain Zero Commercial Space Transportation Accidents							
--	--	Commercial Space Transportation Safety	Ops	134	31	0	165
		Maintain Zero Commercial Space Transportation Accidents		**134**	**31**	**0**	**165**
		TOTAL SAFETY		**81,285**	**36,798**	**2,755**	**120,839**
2. REDUCE CONGESTION							
a. Increase NAS On-Time Arrival Rate at the 35 OEP Airports							
027-110	A12.a	Joint Planning and Development Office	R,E&D	10,819	3,152	321	14,292
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	9,517	800	368	10,685
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	10,035	416	164	10,614
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	9,440	388	143	9,971
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	8,369	764	179	9,312
011-130	A14.a	System Planning and Resource Management	R,E&D	524	10	7	541 /2
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	391	742	28	1,161 /2
		Subtotal	**R,E&D**	49,095	6,272	1,210	56,576 /3
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	4,100	0	0	4,100
M08.29-00	1A01C	Operations Concept Validation	F&E	4,000	0	0	4,000
M08.27-01	1A01D	NAS Weather Requirements	F&E	1,000	0	0	1,000
M08.28-04	1A01E	Airspace Management Program	F&E	1,000	0	0	1,000
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency and Air Ground Integration)	F&E	10,000	0	0	10,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	23,000	0	0	23,000
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	10,000	0	0	10,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	18,000	0	0	18,000
G6M.02-02	1A08E	NextGen - Wake Turbulence - Re-categorization	F&E	3,000	0	0	3,000
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	10,000	0	0	10,000
G3M.04-01	1A08H	NextGen - Staffed NextGen Towers	F&E	6,000	0	0	6,000
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	23,564	0	0	23,564 /5
		Subtotal	**F&E**	113,664	0	0	113,664
--	--	Airports Technology Research - Capacity	AIP	11,190	1,740	0	12,930
--	--	Airport Cooperative Research - Capacity	AIP	3,750	1,250	0	5,000
		Subtotal	**AIP**	14,940	2,990	0	17,930
		TOTAL REDUCE CONGESTION		**177,699**	**9,262**	**1,210**	**188,171**
4. ENVIRONMENTAL STEWARDSHIP							
a. Reduce Exposure to Significant Aircraft Noise							
091-110/111/116	A13.a	Environment and Energy	R,E&D	12,615	2,111	648	15,374
111-150	A13.b	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	19,043	1,150	407	20,600
011-130	A14.a	System Planning and Resource Management	R,E&D	327	6	4	338 /2
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	244	463	17	725 /2
		Subtotal	**R,E&D**	32,229	3,731	1,077	37,037 /3
G6M.02-01	1A08D	NextGen - Environment & Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	15,000	0	0	15,000
		Subtotal	**F&E**	15,000	0	0	15,000
--	--	Airport Cooperative Research - Environment	AIP	3,750	1,250	0	5,000
		TOTAL ENVIRONMENTAL STEWARDSHIP		**50,979**	**4,981**	**1,077**	**57,037**
		GRAND TOTAL		**309,964**	**51,041**	**5,042**	**366,046**

Notes:

/1 Many R&D programs apply to more than one goal area; however, for budgeting purposes most programs are included in only one goal area.

/2 System Planning and Resource Management and William J. Hughes Technical Center Laboratory Facility are considered Mission Support for the R,E&D program and are pro-rated across the three goals areas as follows: Safety at 49.3 percent; Reduce Congestion at 31.2 percent; and Environmental Stewardship at 19.5 percent.

/3 Personnel for R,E&D measured in full-time equivalents is as follows: 244 for Safety; 42 for Reduce Congestion; and 25 for Environmental Stewardship.

/4 The Airport Technology Research - Safety program total budget request is divided between reducing the commercial air carrier fatality rate ($13,887K) and reducing the number of general aviation fatal accidents ($400K).

/5 The budget request amount shown for CAASD is only the R&D program portion of the total CAASD line item amount (29.2 percent of the total CAASD line item).

Partnerships and Other Research Mechanisms

FAA enhances and expands its R&D capabilities by working with other government, industry, and academic organizations using a variety of mechanisms, such as partnerships, grants, and contracts. These research mechanisms help leverage critical national capabilities to ensure FAA attains its R&D goals.

Federal Government

Other federal departments and agencies conduct aviation-related R&D that directly or indirectly supports FAA goals and objectives. To leverage this R&D, FAA uses formal agreements, such as memoranda of understanding/agreement (MOU/MOA); cooperative efforts, such as interagency research transition teams; and technical coordination, such as on-site personnel at field offices at other federal research laboratories and centers. The establishment of the multi-agency Joint Planning and Development Office (JPDO) shows how government can leverage the R&D capabilities of multiple agencies to transform the nation's air transportation system.

Joint Planning and Development Office

The JPDO provides government-wide planning and coordination for NextGen. The JPDO members include: the Departments of Defense, Transportation, Homeland Security, and Commerce; FAA; NASA; and the Office of Science and Technology Policy. Its mission is to plan federal aviation R&D and focus it on the far-term needs of the nation's air transportation system. Having developed the foundational NextGen documents, the JPDO is now focusing on the far-term NextGen vision to ensure FAA alignment with partner government agencies and other stakeholders that contribute to the NextGen effort. For more information, see http://www.jpdo.gov.

Memoranda of Understanding/ Agreement

Joint research activities are performed via Memoranda of Understanding/Agreement (MOUs/MOAs) that set forth areas for cooperative endeavor. An MOU is a high-level agreement describing a broad area of research that fosters cooperation between departments or agencies and develops a basis for establishing joint research activities. An MOA is an agreement describing a specific area of research and is used to implement a broader MOU. An MOA includes interagency agreements (IAs) that are written agreements between FAA and other agencies in which FAA agrees to receive from, or exchange supplies or services with, the other agency. Appendix B lists current FAA MOUs, MOAs, and IAs.

FAA Field Offices

FAA has field offices at the NASA Ames and Langley Research Centers to foster and provide technical coordination of research that contributes to modernization efforts and safety enhancements of the air transportation system. The first field office opened in 1971 at NASA Ames Research Center, located in Moffett Field, California. The second office opened in 1978 at NASA Langley Research Center in Hampton, Virginia. Both offices report to the Office of Research and Technology Development in the NextGen and Operations Planning Service Unit at FAA headquarters.

Global Earth Observation System of Systems

The Global Earth Observation System of Systems (GEOSS) provides an umbrella for 15 federal departments and agencies and several White House offices to work collaboratively to address a wide range of environmental issues, including those pertaining to aviation. These include enhanced weather observation, modeling, and forecasting; and air and water quality monitoring, modeling, and emissions. Under GEOSS, FAA works with the Environmental Protection Agency to address air quality and emissions issues facing aviation. For more information, see http://www.epa.gov/geoss.

The Climate Change Science Program

Thirteen federal departments and agencies participate in the U.S. Climate Change Science Program to coordinate scientific research across a wide range of related climate and global change issues. The research addresses the Earth's environmental and human systems, which are undergoing changes caused by a variety of natural and human-induced causes. The *U.S. Climate Change Science Program Strategic Plan** provides the research areas and questions the program addresses. FAA supports this program by identifying the impact of aviation on the climate due to cruise altitude emissions in the upper troposphere and lower stratosphere. For more information, see http://www.climatescience.gov.

* *Strategic Plan for the U.S. Climate Change Science Program*, report by the Climate Change Science Program and the Subcommittee on Climate Change Research, July 2003 (http://www.climatescience.gov).

Industry

FAA technology transfer activities meet the objectives of the Stevenson-Wydler Technology Innovation Act of 1980, the Bayh-Dole Act of 1980, the Federal Technology Transfer Act of 1986, the Technology Transfer Commercialization Act of 2000, Executive Order 12591 - Facilitating Access to Science and Technology, and Executive Order 12618 - Uniform Treatment of Federally Funded Inventions. The purpose is to transfer knowledge, intellectual property, facilities, equipment, or other capabilities developed by federal laboratories or agencies to the private sector. FAA does this through the following mechanisms:

Cooperative Research and Development Agreements

A Cooperative Research and Development Agreement (CRDA) is collaborative in nature and allows FAA to share facilities, equipment, services, intellectual property, personnel, and other resources with private industry, academia, or state and local government agencies. Appendix B provides a list of the Agency's active FY 2009 CRDAs. For more information on using CRDAs, see www.faa.gov/go/ttp.

Contracts and Cooperative Agreements

FAA awards contracts and cooperative agreements to conduct applied research studies and to develop, prototype, demonstrate, and test new hardware and software. FAA also awards contracts to small businesses in compliance with the terms of the Small Business Innovation Research Program.

Intellectual Property and Patents

As part of its commitment to assist industry through technology transfer, FAA encourages the commercialization of its R&D products or results, known as intellectual property. Among the most transferred intellectual properties are inventions that may be protected by patents. Appendix B provides a list of current patents.

Academia

FAA has an extensive program to foster research and innovative aviation solutions through the nation's colleges and universities. By doing so, it not only leverages the nation's significant investment in basic and applied research but also helps to build the next generation of aerospace engineers, managers, and operators. FAA efforts include the following mechanisms:

Joint University Program

This cooperative research partnership among three universities (Ohio University, Massachusetts Institute of Technology, and Princeton University) conducts scientific and engineering research on technical disciplines that contribute to civil aviation, including air traffic control theory, human factors, satellite navigation and communications, aircraft flight dynamics, avionics, and meteorological hazards. FAA and NASA benefit directly from the results of the research, and, less formally, from valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical experts in industry, academia, and government. For more information, see http://u2.princeton.edu/~jup.

Aviation Research Grants

All colleges, universities, and legally incorporated non-profit research institutions qualify for research grants. At FAA, the evaluation criteria for grant proposals include the potential application of research results to FAA's far-term goals for civil aviation technology. Appendix B provides a summary of grants issued in FY 2009. For more information, see http://www.tc.faa.gov/logistics/grants.

Air Transportation Centers of Excellence

FAA currently has five Air Transportation Centers of Excellence (COEs) through cooperative agreements with academic institutions to assist in mission-critical research and technology that focus on the areas of advanced materials, airliner cabin environment and intermodal research, airport technology, general aviation, and noise and emissions mitigation. A new COE for Commercial Space Transportation is under consideration for 2010. Through these multi-year, collaborative, cost-sharing partnerships, government and university-industry teams leverage their resources to advance the technological future of the nation's aviation community. Appendix B provides a summary of COE activities. For more information, see http://www.coe.faa.gov.

Aerospace Vehicle Systems Institute

The Aerospace Vehicle Systems Institute is a cooperative industry, government, and academic venture for investigation and standardization of aerospace vehicle systems to reduce life-cycle cost and accelerate development of systems, architectures, tools, and processes. For more information, see http://avsi-tees.tamu.edu.

International

FAA uses cooperative agreements with European and North American aviation organizations to participate in air traffic management modernization programs and to leverage research activities that harmonize operations and promote a seamless air transportation system worldwide.

EUROCONTROL

The European Organization for the Safety of Air Navigation (EUROCONTROL) is a civil and military organization with the goal to develop a seamless, pan-European Air Traffic Management (ATM) system. In 1986, EUROCONTROL and FAA established the first memorandum of cooperation (MOC), which they updated in 1992 and again in 2004. The aim of the MOC and its governance structure is to broaden the scope of the cooperation between the two organizations and their respective partners in the areas of ATM research, strategic ATM analysis, technical harmonization, operational harmonization, and harmonizing safety and environment factors.

AIRE

The Atlantic Interoperability Initiative to Reduce Emissions (AIRE) was established in 2007 and provides a foundation for cooperation between the FAA and the European Commission on research to aid the environment while making air transportation more efficient. In addition to facilitating cooperation among aviation authorities, AIRE also involves industry partners, such as aircraft manufacturers, operators, and providers of aviation navigation services. In 2009, a five-month trial on oceanic routes was started with AIRE using a full range of fuel-saving and emissions-reducing tactics.

Transport Canada

In the spring of 2004, Transport Canada joined FAA and NASA as a sponsor of the PARTNER (Partnership for AiR Transportation Noise and Emissions Reduction) Center of Excellence. Transport Canada has studied and will continue to study air quality at Canadian airports to develop and implement practices that reduce air pollution from airports. Canada, as a member state of the International Civil Aviation Organization (ICAO), is working to reduce smog-forming pollutants from the aviation sector and participates in the COE partnership to advance the state of knowledge in many key areas.

ASPIRE

The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) was established February 18, 2008 as a partnership, with initial partners FAA, Airservices Australia, and Airways New Zealand; and demonstration partners SEAC Tahiti and Airports Fiji. The partnership seeks to reduce the impact of aviation on the environment in the Asia and South Pacific regions through technological innovation and best practice air traffic management.

Since its inception, the initial ASPIRE partners have produced the ASPIRE Strategic Plan, executed a series of demonstration flights, and initiated the development of shared performance metrics. The ASPIRE partnership will include demonstrations and implementation of key NextGen technologies and practices that have either demonstrated or will demonstrate environmental efficiencies, including:

- Automatic Dependent Surveillance-Contract In-Trail Procedures: separation reductions down to 10-15 nautical miles during climbs and descents to improve the availability of more efficient altitudes;

- Pre-Departure and In-Flight Oceanic Trajectory Management 4-D: procedures and automation to identify opportunities for flights to fly more efficient profiles based on real-time evaluation of airspace availability; and

- Tailored Arrivals: dynamic optimization of aircraft approach profiles, designed to reduce periods of level-off during descent and to meet the flexible needs of the air traffic system at congested airports.

For more information,
see http://www.aspire-green.com.

Evaluation

Since R&D tends to be far-term in nature, it does not lend itself to traditional return-on-investment analysis, such as net present value. The FAA conducts evaluation through formal and informal reviews by internal and external groups.

Internal Portfolio Reviews

The FAA R&D portfolio receives continuous internal review to ensure that it meets sponsor needs, is high quality, and is well managed.

Process Improvements and Quality Managgement

The FAA uses methods such as ISO 9000 and models like the Integrated Capability Maturity Model to manage quality and evaluate and improve processes.

Program Planning Teams

To ensure effective engagement with research stakeholders, the FAA Office of Research and Technology Development uses program planning teams comprised of internal sponsors and researchers to review program outcomes and outputs, prioritize and plan research efforts, and recommend research priorities and programs.

R&D Executive Board

When R&D portfolio formulation is complete, the FAA R&D Executive Board (REB) provides portfolio approval. The REB is made up of senior executives representing the major R&D sponsors of the FAA. This process helps FAA establish research priorities to meet its strategic goals and objectives.

Joint Resources Council

The Joint Resources Council (JRC) is FAA's corporate-level acquisition-decision-making body that provides strategic guidance to the R&D portfolio process and ensures that the research requirements support the FAA NAS program. The JRC reviews and approves the proposed R&D portfolio.

The NextGen Review Board and the NextGen Management Board

The NextGen Review Board provides oversight, status, prioritization, and guidance on existing and proposed NextGen initiatives. It is focused on making firm commitments to implement new operational capabilities in a coordinated, timely fashion. This assists with integration, timely rulemaking, identification of required policy changes, and understanding of funding impacts. It assesses funded NextGen R&D programs and drives budget plans. The NextGen Review Board provides recommendations to the NextGen Management Board.

The NextGen Management Board, chaired by FAA's Deputy Administrator, takes an enterprise approach to developing and executing FAA's NextGen plan. With representatives from all key Agency lines of business, the Board has the authority to force timely resolution of emerging NextGen implementation issues. The Board's focus includes: measuring the progress of deployments and of key activities that support decision-making; ensuring essential resources are available, including reprioritizing resources as necessary; issuing policies and guidance; and identifying leaders within their organizations who will be accountable for delivering system changes.

For more information on both boards, see http://www.faa.gov/about/initiatives/nextgen/.

External Portfolio Reviews

The FAA R&D portfolio receives periodic external review from advisory committees to ensure that it meets customer needs and is technically sound. FAA also seeks feedback from the National Academies and through user surveys and discussion groups. Researchers also present progress reports at public forums and science reviews, publish and present technical papers, obtain formal peer validation of science, and maintain and share lessons learned.

Research, Engineering, and Development Advisory Committee

Established in 1989, the Research, Engineering, and Development Advisory Committee (REDAC) advises the Administrator on R&D issues and assists in ensuring FAA research activities are coordinated with other government agencies and industry. REDAC considers aviation research needs in five areas: NAS operations, airport technology, aircraft safety, human factors, and environment and energy.* A maximum of 30 members can serve on the REDAC and represent corporations, universities, associations, consumers, and government agencies. For more information, see http://research.faa.gov/redac/default.aspx.

During 2009, the REDAC held two committee meetings and ten subcommittee meetings and produced two reports. Appendix C provides the recommendations from these reports and the Agency responses.

* Aviation Safety Research Act of 1988, Public Law Number 100-591, November 3, 1988, and FAA Research, Engineering and Development Authorization Act of 1990, Public Law Number 101-508, November 5, 1990.

Transportation Research Board

The National Research Council established the Transportation Research Board (TRB) in 1920 as the National Advisory Board on Highway Research. In 1974, the Board was renamed TRB to reflect its expanded services to all modes of transportation. The TRB mission is to promote innovation and progress in transportation through research. It fulfills this mission through the work of its standing committees and task forces. The TRB manages the Airport Cooperative Research Program (ACRP) for FAA with program oversight and governance provided by representatives of airport operating agencies.

The ACRP Oversight Committee announced their FY 2010 projects in August 2009. The 30 projects will examine different research areas that target near-term solutions to problems facing airport operators and industry stakeholders, such as the Airports Council International. These projects include development of airport performance metrics, low-cost practices to reduce airport carbon footprint, airport development under oil price uncertainty, and assessment of the risks of runway safety areas and existing airfield separation standards.

Commercial Space Transportation Advisory Committee

Established in 1984, the Commercial Space Transportation Advisory Committee (COMSTAC) advises the FAA Administrator and the U.S. Department of Transportation on matters relating to the U.S. commercial space transportation industry, including R&D activities. Currently, the Committee has twenty-two members. Each member is recommended by the Administrator and appointed by the Secretary of Transportation for a two-year term. Members represent commercial launch providers of expendable and reusable launch vehicles, rocket propulsion, commercial launch site operations, satellite manufacturing and operations, space policy and education, space law, insurance and finance, state government and economic development, space advocacy, and space business and technical associations. The COMSTAC provides annual recommendations for commercial space transportation R&D projects and periodically reviews FAA commercial space R&D reports and activities. For more information, see: http://www.faa.gov/about/office_org/headquarters_offices/ast/advisory_committee.

During 2009, the COMSTAC held two full committee meetings and five working group meetings. The Committee produced the 2009 Commercial Geosynchronous Orbit Launch Demand Forecast and a white paper entitled *DoD Impact on U.S. Commercial Launch Services Competitiveness*.

Credits

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Acronyms and Abbreviations

AAIADS	Aerospace Accident Injury and Autopsy Data System
AC	Advisory Circular
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance-Broadcast
AEDT	Aviation Environmental Design Tool
AIA	Aerospace Industries Association
AIP	Airport Improvement Program Appropriation
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
ANSP	Air Navigation Service Provider
APMT	Aviation Environmental Portfolio Management Tool
ARFF	Aqueous Film-Forming Foam
ASAP	Aviation Safety Action Program
ASIAS	Aviation Safety Information Analysis and Sharing
ASPIRE	Asia and South Pacific Initiative to Reduce Emissions
ATC	Air Traffic Control
ATCOV	Air Traffic Control Color Vision Test
ATCS	Air Traffic Controller Station
ATM	Air Traffic Management
AUVSI	Association of Unmanned Vehicle Systems International
C3	Command, Control, and Communication
CAASD	Center for Advanced Aviation System Development
CAMI	Civil Aerospace Medical Institute
CATM	Collaborative Air Traffic Management
CDA	Continuous Descent Arrival
CDTI	Cockpit Display of Traffic Information
CLEEN	Continuous Lower Energy, Emissions and Noise
CO	Carbon Monoxide
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
COTS	Commercial-Off-the-Shelf
CRDA	Cooperative Research and Development Agreement
CSPR	Closely Space Parallel Runways
DARWIN	Design Assessment of Reliability With INspection
Data Comm	Data Communications
DHS	U.S. Department of Homeland Security
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DSA	Detect, Sense, and Avoid
E&E	Environment and Energy
EA	Enterprise Architecture
EFB	Electronic Flight Bag
EMS	Environmental Management System
EUOCONTROL	European Organization for the Safety of Air Navigation
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FASTER	Full-Scale Aircraft Structural Test Evaluation and Research
FEWS	Future En Route Workstation
FLM	Front Line Manager
FMS	Flight Management System
FT	Fischer-Tropsch
FTWS	Future Terminal Workstation
FY	Fiscal Year
GA	General Aviation
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GPS	Global Positioning Satellites
GRC	NASA Glenn Research Center
HITL	Human-In-The-Loop
HRET	High-Reach Extendable Turret
I&I	Integration and Implementation
IA	Interagency Agreement
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
IRT	Icing Research Tunnel
ITWS	Integrated Terminal Weather System
IWP	Integrated Work Plan
JAIdB	Job Analysis Information Database
JPDO	Joint Planning and Development Office
JRC	Joint Resources Council
JTA	Job Task Analysis
LIDAR	Light Detection and Ranging
LOSA	Line Operations Safety Audit
MOA	Memorandum of Agreement
MOC	Memorandum of Cooperation
MOU	Memorandum of Understanding
MSP	Multi-Sector Planner
N_2O	Nitrous Oxide
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASEA	National Airspace System Enterprise Architecture
NEO	Net Enabled Operations
NextGen	Next Generation Air Transportation System
NGIP	FAA's NextGen Implementation Plan
NOAA	U.S. National Oceanic and Atmospheric Administration
OI	Operational Improvement
OMB	Office of Management and Budget
ONERA	Office of National d'Etudes et de Recherches Aerospatiales
OPD	Optimized Profile Descent
Ops	Operations Appropriation
OSTP	Office of Science and Technology Policy
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
R&D	Research and Development
R,E&D	Research, Engineering and Development Appropriation
RAPT	Route Availability Planning Tool

REB	Research and Development Executive Board
REDAC	Research, Engineering, and Development Advisory Committee
RLV	Reusable Launch Vehicle
RNAV	Area Navigation
SLD	Supercooled Large Droplet
SMS	Safety Management System
SNT	Staffed NextGen Towers
SSM	Safety Systems Management
TBO	Trajectory-Based Operation
TCAS	Traffic Alert and Collision Avoidance System
THC	Delta-9-Tetrahydrocannbinol
TMA	Traffic Management Advisor
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
UAS	Unmanned Aircraft System
UEDDAM	Uncontained Engine Debris Assessment Damage Model
UIUC	University of Illinois at Urbana-Champaign
VOC	Volatile Organic Compound
WTIC	Weather Technology in the Cockpit

The NARP, related appendices, and the *R&D Annual Review* may be found online at:

www.faa.gov/go/narp

2006
Research & Development
Annual Review
The Federal Aviation Administration Plan for Research, Engineering, and Development
National Aviation Research Plan 2006
1995
1996
1997
1998
2005
NARP
Critical Research for Aviation's Future

Federal Aviation Administration

2010 National Aviation Research Plan (NARP)

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February 1, 2010

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

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*Budget line item numbers are not used for these programs within the Operations (OPS) and Airport Improvement Program (AIP) appropriations.

Budget Item	Program Title	Budget Request
A11.a	**Fire Research and Safety**	**$7,231,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Fire Research and Safety Program helps achieve FAA's strategic goal of increasing aviation safety by reducing the number of accidents associated with aircraft fires and by mitigating the effects of a post-crash ground fire. The program develops technologies, procedures, test methods, and fire performance criteria that can prevent accidents caused by hidden in-flight fires and fuel tank explosions and improve survivability during a post-crash fire. Fire safety research focuses on near-term improvements in fire test methods and materials performance criteria, fire detection and suppression systems, aircraft fuel tank explosion protection, and long-range development of ultra-fire resistant cabin materials.

Agency Outputs: The FAA issues aircraft fire safety rules that govern material selection, design criteria, and operational procedures. The new test methods, reports, and journal publications produced by the Fire Research and Safety Program describe the technical basis for these regulations and offer guidance for regulatory compliance. FAA provides industry with state-of-the-art safety products and information as a result of its research. FAA research also produces new materials and government-owned patents.

Research Goals: The FAA will work to reduce the number of accidents and incidents caused by in-flight fire in both passenger-carrying and all-cargo (freighter) aircraft, to prevent fuel tank explosions, and to improve survivability during a post-crash fire. Near term research will focus on improved fire test standards for interior and structural materials, improved fuel tank inerting systems and extended inerting applications, and new or improved fire detection and extinguishment systems. Additionally, long-term research will be conducted to develop the enabling technology for a fireproof aircraft cabin constructed of ultra-fire resistant materials. The following milestones directly support the ultimate strategic goals of in-flight fire prevention, fuel tank explosion prevention and improved post-crash fire survivability:

- By FY 2011, provide comprehensive guidance for fire safety of high energy density lithium batteries in passenger carry-on items and aircraft power systems.
- By FY 2012, define composite fuselage fire safety design criteria
- By FY 2013, demonstrate the improvements in post-crash fire survivability, provided by ultra-fire resistant materials using full-scale test simulations.

Customer/Stakeholder Involvement: The Fire Research and Safety Program works with the following industry and government groups:

- Aircraft Safety Subcommittee of the FAA Research, Engineering and Development Advisory Committee – These representatives from industry, academia, and other government agencies annually review the program's research activities.
- Technical Community Representative Groups – The FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and development of alternate means of compliance for existing rules.
- Aircraft manufacturers (U.S. and foreign), airlines, foreign airworthiness authorities, chemical companies, material suppliers, and aircraft fire safety equipment manufacturers meet regularly to share information on interior material fire tests and improvement of fire detection and suppression systems.
- National Transportation Safety Board (NTSB) – The FAA works with and supports NTSB on in-flight fire incidents, on-site accident investigations, and related testing.
- Pipeline and Hazardous Materials Safety Administration (PHMSA) – The FAA works with PHMSA to cooperatively develop requirements/guidelines for the safe transport of hazardous materials (current focus on lithium batteries).

R&D Partnerships: Fire Research and Safety Program R&D partners include:

- FAA-sponsored International Systems Fire Protection Working Group – R&D involves fuel tank protection, hidden fire safety, fire/smoke detectors, halon replacement, and lithium battery fire hazards.
- FAA-sponsored International Aircraft Materials Fire Test Working Group – R&D involves development and standardization of improved material fire tests.
- Interagency working group on fire and materials – promotes technology exchange among U.S. Government agencies and prevents unwarranted duplication of work.
- Interagency agreement with the National Institute of Standards and Technology – develops fire retardant mechanisms and rapid screening tools for flammability.
- Memorandum of cooperation with the British Civil Aviation Administration – R&D involves a variety of fire safety research efforts.
- Cabin safety research technical group – cooperates in and coordinates cabin safety research conducted and/or sponsored by the international regulatory authorities.
- Arrangements with Fortune 100 companies to share development costs for new fire resistant materials.

Accomplishments: The FAA operates the world's most extensive aircraft fire test facilities. The FAA certification engineers receive training in these facilities each year and, at the request of the NTSB, program personnel participate in major fire accident and incident investigations. The Fire Research and Safety Program annually publishes over two-dozen reports and papers (available to the public on-line at http://www.fire.tc.faa.gov/reports.asp) highlighting research results that have led to major improvements in aircraft safety.

Outstanding program accomplishments include:

FY 2009:

- Developed guidance for the extinguishment of lithium battery fires in passenger carry-on items.
- Developed hazardous gas emission criteria for post-crash fire exposure of a burn-through resistant fuselage, including composite construction.
- Evaluated non-intrusive oxygen measurement technology in aircraft fuel tanks.
- Developed analytical model to predict wing fuel tank flammability.
- Developed an improved flammability test method and criteria for aircraft electrical wiring.
- Evaluated the behavior of lithium cells in aircraft battery systems subjected to fire threats.
- Evaluated the behavior of small prototype fuel cells under development for personal items when subjected to fire threats.
- Evaluated the effectiveness of graphite-oxide nanoparticles as an additive approach to non-halogen fire retardant materials.

FY 2008:

- Measured and compared the flammability of composite and aluminum wing fuel tanks under simulated flight conditions.
- Measured and compared the heat transfer from an in-flight fire in composite and aluminum fuselage constructions.
- Developed safe acute exposure limits for gaseous halocarbon extinguishing agents in ventilated aircraft
- Developed a one-dimensional thermo-kinetic burning model for combustible materials.

FY 2007:

- Developed a cabin crew training video for fighting in-flight fires.
- Characterized the flammability of epoxy-graphite structural composites.
- Developed and standardized a next generation burner for insulation burn-through resistance.
- Evaluated the flammability of non-halogen, ultra-fire resistant plastics.

FY 2006:

- Evaluated the cabin hazards caused by outgassing from a composite fuselage material subjected to a simulated post-crash fuel fire.
- Determined the fire hazards of lithium ion batteries shipped as air cargo.

- Conducted engine nacelle fire extinguishment tests to determine the suitability of a promising new environmentally friendly agent, NOVEC 1230, as a replacement for the currently used halon.

Previous Years:

- Developed and demonstrated a simple and cost effective fuel tank inerting system.
- Determined the limiting concentration of oxygen to prevent fuel tank explosions.
- Developed improved and new flammability tests for thermal acoustic insulation, measuring in-flight fire resistance and post-crash burn-through resistance, respectively.
- Developed minimum performance test standards for halon replacement agents.
- Developed and demonstrated an onboard cabin water spray system for significantly improving post-crash fire survivability.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fire Safety Improvements

- Determine the cost/benefit of freighter on-board fire detection and suppression systems.
- Evaluate adequacy of certification tests used to demonstrate freighter smoke/fire detection compliance with regulatory requirements.
- Examine the effectiveness of depressurization to control in-flight fires in freighter aircraft.
- Develop a small-scale test that measures the in-flight fire resistance of composite fuselage materials.
- Evaluate the hazards of magnesium alloy seat structure during full-scale post-crash fire tests.
- Evaluate the relative fire hazards of state-of-the-art fuel cell technology.

Fire Resistant Materials

- Develop and validate burning model for charring and laminated/composite materials.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

- Research on in-flight fire safety will continue to address all-cargo (freighter) aircraft, responding to improved freighter fire safety recommendations issued by NTSB, related to fire detection and suppression.
- Research will address the fire hazards of lithium batteries in passenger items, aircraft systems, and transported as cargo. The safe transport of lithium batteries will be emphasized, supporting a joint PHMSA/FAA plan which outlines needed research and planned rulemaking.
- FAA's unique fire test facilities will support the mandated replacement of halon extinguishing agents in aviation proposed by ICAO. Specific dates will be required for the use of halon replacement agents in handheld extinguishers, engines, and cargo compartments.
- Research related to the fire behavior of structural composites is driven by the new Boeing 787, the first large transport aircraft with a composite fuselage and wings. New test methods (e.g., in-flight fire resistance) will be standardized.
- Research will continue on the improvement of existing required flammability tests and the development of new tests for novel applications of materials that may impact future aircraft fire safety; namely, new magnesium alloy seat structure and other applications which may offer potential large weight savings.
- Research will be undertaken to examine the impact of alternative aviation fuels (e.g., biofuels) on fire safety. The initial emphasis will be on fuel tank flammability.
- Long-term, applied research will continue to develop the enabling technology for ultra-fire resistant interior materials and facilitate the transfer of that technology to the private sector through patents, reports, publications, and international standards. In addition, work will continue on the development of a numerical computer model to simulate full-scale aircraft fire tests to determine the improvement in post-crash fire survivability provided by ultra-fire resistant interior materials.

New Initiatives

No new initiatives are planned in FY 2011.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fire Safety Improvements

- Determine the feasibility of cost effective fire suppression systems in freighter aircraft.
- Evaluate the effectiveness of current and advanced fire extinguishing agents against lithium battery fires.
- Provide comprehensive guidance on lithium battery fire safety in passenger items and aircraft systems.
- Determine the effectiveness and safety of approved and developmental halon replacement agents for the extinguishment of cabin fires with hand-held extinguishers.
- Standardize the new composite flammability test method for in-flight fire resistance.
- Develop a flammability test method for seat structure (e.g., magnesium alloy), if warranted.
- Determine and compare the fuel tank flammability envelope for candidate alternative fuels and Jet A fuel.

Fire Resistant Materials

- Fabricate cabin components and assemblies of ultra-fire resistant materials (seat sets, wall/ceiling panels, carpeting) and measure component fire behavior.
- Extend the FAA thermal-kinetic burning model (ThermaKin) to two-dimensional to simulate flame spread in aircraft cabins for current and ultra-fire resistant materials.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	154,998
FY 2010 Enacted	7,799
FY 2011 Request	7,231
Out-Year Planning Levels (FY 2012-2015)	30,094
Total	200,122

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Fire Research and Safety	2,816	3,355	2,961	3,495	2,750
Personnel Costs	3,588	3,650	3,443	3,940	4,118
Other In-house Costs	234	345	246	364	363
Total	**6,638**	**7,350**	**6,650**	**7,799**	**7,231**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	6,182	6,638	7,350	6,650	7,231
Development (includes prototypes)	0	0	0	0	0
Total	**6,638**	**7,350**	**6,650**	**7,799**	**7,231**

A11.a - Fire Research and Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
061-110 Fire Research & Safety							
Fire Resistant Materials	**300**						
Demonstrate numerical burning model for composites used in AC		♦					
Extend ThermoKin burning model to 2-D for flame spread in cabins			◊				
Measure fire behavior of current and fire resistant components and assemblies			◊				
Demonstrate 3-D ThermaKin model for AC cabins using component fire data				◊			
Evaluate improvement in post-crash fire survivability provided by ultra-fire resistant materials using full-scale fire test simulations					◊		
Fire Safety Improvement	**2,450**						
Examine prototype fuel cell technology for fire safety risks		♦					
Evaluate freighter fire detection certification tests		♦					
Determine cost/benefit of freighter detection/suppression systems		♦					
Examine effectiveness of depressurization for cargo fire control		♦					
Develop in-flight fire resistance test for composite materials		♦					
Full-scale tests on magnesium seat structure		♦					
Determine the feasibility of cost/effective freighter fire suppression systems			◊				
Evaluate the effectiveness of current/advanced agents against lithium batteries			◊				
Provide comprehensive guidance on lithium battery fire safety			◊				
Determine effectiveness of halon replacement agents in hand-held extinguishers			◊				
Standardize composite in-flight fire test method			◊				
Develop a small-scale test for seat structure, if warranted			◊				
Determine fuel tank flammability envelope for alternative fuels			◊				
Define composite fuselage fire-safety design criteria				◊			
Develop a prototype fire hardened cargo container for the shipment of lithium batteries				◊			
Determine an optimal halon replacement agent for cargo compartments based on full-scale fire tests				◊			
Determine the effect of alternative fuels on postcrash cabin fire safety					◊		
Develop detection/extinguishing system to suppress hidden in-flight fires						◊	
Examine fire safety aspects of aircraft oxygen systems							◊
Personnel and Other In-House Costs	**4,481**						
Total Budget Authority	**7,231**	**7,799**	**7,231**	**7,350**	**7,475**	**7,580**	**7,689**

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

Budget Item	Program Title	Budget Request
A11.b	**Propulsion and Fuel Systems**	**$2,332,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Propulsion and Fuel Systems Program helps achieve FAA's strategic goal of increasing aviation safety by reducing the number of accidents associated with the failure of aircraft engines, components, and fuel systems. The program develops technologies, procedures, test methods, and criteria to enhance the airworthiness, reliability, and performance of civil turbine and piston engines, propellers, fuels, and fuel management systems. To improve safety, the program conducts research needed to develop tools, guidelines, and data to support improvements in turbine engine certification requirements.

Agency Outputs: The FAA issues certification standards, Advisory Circulars, and reviews the specifications and practices recommended by recognized technical societies (ASTM International, SAE International) to maintain the airworthiness of aircraft engines, fuels, and airframe fuel management systems. The agency also publishes information and sponsors technology workshops, demonstrations, and other means of training and technology transfer. The Propulsion and Fuel Systems Program provides the technical information, R&D resources, and technical oversight necessary for the agency to enhance the airworthiness, reliability, and performance of propulsion and fuel systems.

Research Goals: The main research area within the Propulsion and Fuels Program is to ensure the structural integrity and durability of critical rotating engine parts in turbine engines throughout their service life. This research is providing analytical tools to meet the requirements of Advisory Circular AC33.14-1, "Damage Tolerance for High Energy Turbine Engine Rotors", allowing aircraft turbine engine manufacturers to assess the risk of fracture and manage the life of rotor disks. Research is also being conducted to establish an improved understanding of other material factors and manufacturing anomalies that can shorten the fatigue life of rotor disks.

- By FY 2012, develop a design methodology for use by industry to prevent cold dwell fatigue in turbine engine rotor disks and define a technique to assess the risk of the current aircraft fleet for cold dwell fatigue.
- By FY 2012, develop a certification tool that will predict the risk of failure of rotor disks containing material and manufacturing anomalies.

Customer/Stakeholder Involvement: The Propulsion and Fuel Systems Program works with the following industry and government groups:

- Subcommittee on Aircraft Safety of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and development of alternate means of compliance with existing rules.
- The Aerospace Industries Association (AIA) – working subcommittees on rotor integrity and rotor manufacturing.
- The National Transportation Safety Board – Recommendations A-90-89 and A-90-90, recommend that a damage tolerance philosophy be implemented in the design and maintenance of failure critical engine parts, and A-98-28 recommends that FAA in cooperation with industry address the uncontained engine failures caused by cold dwell fatigue.

R&D Partnerships: Propulsion and Fuel Systems Program R&D partners include:

- Turbine Rotor Material Design Program - Southwest Research Institute (SwRI) has teamed with Pratt and Whitney, General Electric, Honeywell, and Rolls Royce to provide DARWIN™ (Design Assessment of Reliability With INspection), a probabilistic-based rotor life and risk management certification tool.
- The AIA working subcommittees on rotor integrity and rotor manufacturing.

Accomplishments: Outstanding program accomplishments include:

FY 2009:

- Released an enhanced version of the DARWIN™ probabilistic rotor design code with capabilities for automatic rotor modeling.
- Completed experiments to calibrate and verify analytical methods for time-dependent crack growth and thermo-mechanical fatigue crack growth.
- Test results on Swift Enterprises high-octane, bio-renewable aviation gasoline were published showing that the fuel provided slightly better detonation performance than 100LL, and slightly lower power output than 100LL and resulted in higher engine operating temperatures. Overall the performance of the fuel showed promise and justifies further research.
- Continued laboratory characterization and engine ground testing of candidate unleaded fuels to replace 100LL avgas.

FY 2008:

- Released an enhanced version of the DARWIN™ probabilistic rotor design code with capabilities for surface damage of turned surfaces and blade slots.
- Published final report on full scale engine tests of 45 fuel formulations provided by the CRC. The results were used to develop a predictive model used for testing unleaded fuel components and determined that unleaded fuels require 3 more octane numbers than leaded fuels for comparable full-scale engine detonation performance.

FY 2007:

- Completed an enhanced version of the DARWIN™ code with the following new features: new analysis mode for titanium hard alpha anomalies, probabilistic treatment of multiple anomalies, and a crack formation module.
- Completed full scale engine tests of 45 fuel formulations provided by the CRC.

FY 2006:

- Continued the enhancement of the DARWIN™ probabilistic rotor design code.
- Completed research on an experimental GA fuel provided by Exxon-Mobil under a cooperative research and development agreement; results demonstrated that amine-based additives show some promise as a replacement for 100LL.
- Completed research investigating the feasibility of using ethyl tertiary butyl ether (ETBE), an ethanol fuel blend, as a GA fuel; results showed there are significant range penalties associated with this fuel that make it an undesirable replacement for 100LL.

FY 2005:

- Completed an enhanced version of the DARWIN™ code that addresses multiple subsurface defects in turbine engine rotor disks.

Previous Years:

- Populated a rotor manufacturing induced anomaly database for use by the engine industry in sharing lessons learned in the manufacture of critical rotating engine parts to prevent future accidents caused by manufacturing defects.
- Completed an industrial demonstration of the pool power controller for the vacuum arc remelting process that will aid in producing defect-free titanium material for the manufacturer of turbine engine rotor disks.
- Completed research on the performance in a GA piston engine of 30 unleaded fuel formulations specified by the CRC Unleaded Aviation Gasoline Development Group. The research showed that none of the candidate formulations match the detonation suppression capability of 100LL.

- Demonstrated, verified, and industrialized the probabilistic rotor design and life management code known as DARWIN™ for titanium alloys that provides turbine engine manufacturers a tool to augment their safe life approach.
- Demonstrated and verified the DEFORM™ defect deformation code for analysis of titanium alloy defects during the rotor disk forging process.

- Proved that the fleet octane requirement is the single most critical parameter for development of high octane unleaded aviation gasoline and that the motor octane rating of any potential candidate must be 100 or greater.
- Defined detonation detection procedures that were adopted by the American Society for Testing and Materials as a test standard (ASTM D6424) for use on candidate unleaded replacement fuels.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Turbine Engine Research

- Released an enhanced version of the DARWIN™ probabilistic rotor design code with second generation capabilities for automatic rotor modeling.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

- Continue to advance DARWIN™, the probabilistically based turbine engine rotor design and life management code to enhance its predictive capability. This code is an FAA approved means to support a damage tolerant based certification enhancement to the current safe life design approach.
- Continue to develop advanced damage tolerance methods for turbine rotor disks through experimentation and modeling to address the effects of complex time-temperature stress histories, small crack sizes, anomalies in nickel alloys, crack geometries, and surface residual stress on fatigue crack growth life.
- Continue to develop a design methodology for use by industry to prevent cold dwell fatigue in turbine engine rotor disks and define a technique to assess the risk of the current aircraft fleet for cold dwell fatigue.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Turbine Engine Research

- Release an enhanced version of the DARWIN™ probabilistic rotor design code with capabilities for high temperature crack growth and the ability to introduce anomalies at shop visits and during service.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	101,585
FY 2010 Enacted	3,105
FY 2011 Request	2,332
Out-Year Planning Levels (FY 2012-2015)	9,555
Total	116,577

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**		**FY 2011 Request**
Contracts:						
Propulsion And Fuel Systems	2,592	2,463	2,415	1,579		1,200
Personnel Costs	1,366	1,476	1,168	1,400		1,047
Other In-house Costs	90	147	86	126		85
Total	**4,048**	**4,086**	**3,669**	**3,105**		**2,332**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**		**FY 2011 Request**
Basic	0	0	0	0		0
Applied	5,741	4,086	3,669	3,105		2,332
Development (includes prototypes)	0	0	0	0		0
Total	**4,048**	**4,086**	**3,669**	**3,105**		**2,332**

A11.b - Propulsion and Fuel Systems Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
063-110 Propulsion and Fuel Systems							
Turbine Engine Research	**1200**						
Develop a certification tool that will predict the risk of failure of rotor disks containing material and manufacturing anomalies		♦	◊	◊			
Release an enhanced version of the DARWIN™ probabilistic rotor design code with second generation capabilities for automatic rotor modeling		♦					
Release an enhanced version of the DARWIN™ probabilistic rotor design code with capabilities for high temperature crack growth and the ability to introduce anomalies at shop visits and during service.			◊				
Develop design methodology for use by industry to prevent cold dwell fatigue in turbine engine rotor disks and define a technique to assess the risk of the current aircraft fleet for cold dwell fatigue.		♦	◊	◊			
Personnel and Other In-House Costs	**1,132**						
Total Budget Authority	**2,332**	**3,105**	**2,332**	**2,357**	**2,383**	**2,399**	**2,416**

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

Budget Item	Program Title	Budget Request
A11.c	**Advanced Materials/Structural Safety**	**$2,566,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Advanced Materials/Structural Safety Program helps FAA achieve its strategic goal of increasing aviation safety by preventing accidents that would occur as a result of structural failure. The Advanced Materials/Structural Safety Program assesses the safety implications of new and present day composites, alloys, and other materials, and associated structures and fabrication techniques that can help to reduce aviation fatalities. The program also develops advanced methodologies for assessing aircraft crashworthiness.

Agency Outputs: The Advanced Materials/Structural Safety Program provides technical support for rule making and develops guidance to help the aviation industry comply with agency regulations.

Advanced Materials

The FAA establishes rules for the certification of safe and durable materials for use in aircraft construction. While the rules are the same for composite or metal structures, different behavioral characteristics of structural materials call for different means of compliance. Although Advisory Circular AC 20-107B, "Composite Aircraft Structure" has been published, advances in technologies and materials require periodic updates and expansion of the Advisory Circular. The FAA Chief Scientist and Technical Advisor disseminates current technical information developed in this program to regulatory personnel through technical reports, handbooks, guidance, and policy. The goal of this data exchange is to allow regulatory processes to keep pace with industry advances and benefit from state-of-the-art technology and design. This provides the most efficient safety and certification information to the FAA certification service and industry.

Structural Safety

The FAA revises or updates crashworthiness-related Federal Aviation Regulations to accommodate new information for overhead stowage bins, auxiliary fuel tanks and fuel systems, aircraft configurations, seat and restraint systems, and human tolerance injury criteria. The FAA through this program is developing alternative methods to streamline the certification process (i.e. certification by analysis and component tests in lieu of full-scale tests).

Research Goals: To prevent accidents associated with the airframe use of advanced materials and to improve the crashworthiness of airframes in the event of accidents, the Advanced Materials/Structural Safety research focuses on developing analytical and testing methods for standardization; understanding how design, loading, and damage can affect the remaining life and strength of composite aircraft structures; developing maintenance and repair methods that are standardized and correlated with training and repair station capabilities; enhancing occupant survivability and reducing personal injury from accidents; improving crash characteristics of aircraft structures, cabin interiors, auxiliary fuel tanks, fuel systems, and occupant seat and restraint systems; and improving the efficiency of aircraft certification through the use of better analytical modeling of crash events.

- By FY 2011, develop preliminary full-scale test and analysis protocols for repeated loads and damage threats.
- By FY 2012, assess the risks and technical issues associated with severe blunt impact (e.g., ground service vehicle collisions).
- By 2011, develop side facing aircraft seat neck injury criteria for low tension/high lateral moment upper neck loading.
- By FY 2012, establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.
- By FY 2012, quantify critical sandwich panel degradation mechanisms (e.g., disbonding, fluid ingression, freeze/thaw).
- By FY 2013, develop criteria for damage tolerance assessments of laminated composite structures.
- By FY 2012, define criteria for use of embedded sensors in fault tolerant structures.
- By FY 2013, generate methodology for demonstrating aircraft structure crashworthiness certification by analysis.

- By FY 2014, evaluate field bonded and bolted repair practices to update related guidance and training for composite aircraft structures.
- By FY 2014, evaluate the ability of models to predict off-axis and multiple terrain impacts.
- By FY 2015, evaluate existing and emerging bonded airframe technology to update guidelines and standards.

Customer/Stakeholder Involvement: The Advanced Materials/Structural Safety Program complies with or cooperates with the following legislation and industrial and government groups:

- Public Law 100-591, the Aviation Safety Research Act of 1988, and House of Representatives Report 100-894 – sets priorities to develop technologies, conduct data analysis for current aircraft, and anticipate problems related to future aircraft.
- The Aviation Rulemaking Advisory Committee (ARAC) – this FAA committee and its subcommittees help to ensure the effectiveness of the agency's rule making by identifying R&D requirements and priorities, providing guidance for the update of documents, such as the Advisory Circular (AC) AC20-107B and encouraging industry's full participation in implementing new rules.
- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and development of alternate means of compliance for existing rules.

R&D Partnerships: The Advanced Materials/Structural Safety Program benefits from a close working relationship with the Joint Center of Excellence (COE) for Advanced Materials and Structures (JAMS) lead by Wichita State University and the University of Washington. The research performed under this program is leveraged by the monetary and intellectual contributions of its partners including many major commercial aviation companies.

Advanced Materials

FAA sponsors with the cooperation of other government agencies and industry, a primary, authoritative handbook (Composite Materials Handbook 17) facilitating the statistical characterization data of current and emerging composite materials. This international reference tool is the best available data and technology source for testing and analysis, and also includes guidance on data development, design, inspection, manufacturing and product usage. On recommendations by regulatory guidance, material data contained in this handbook are acceptable for use in the certification process.

Structural Safety

The program maintains cooperative interagency agreements in the structural safety area with the U.S. Army and Navy in the analytical modeling area.

Memoranda of cooperation and exchange of personnel have been established between the program and the French, Italian, and Japanese governments in the crash testing area. The program has worked closely with Drexel University to develop dynamic crash computer modeling codes for transport airplane structures.

Accomplishments: The Advanced Materials/Structural Safety Program provides technical reports (available on-line at http//actlibrary.tc.faa.gov), handbooks, ACs, and certification guidance to FAA organizations, aircraft manufacturers, maintainers, and operators. Outstanding program accomplishments include:

FY 2009:

- Documented the technical basis for draft AC 20-107B updates through cooperative efforts with industry on bonded structures, damage tolerance, and maintenance practices (e.g., workshops in 2004 through 2008).
- Assessed the scaling affects on dynamic properties of composite materials.
- Work with Commercial Aircraft Safety Team (CAST) to determine bounds of the threats from airport service vehicle collisions as related to research on high energy blunt impact.
- Determined typical strain rates of aircraft seats during dynamic loading.
- Compared the Hybrid II anthropomorphic test dummy response to the FAA Hybrid III response for use in future certification by analysis modeling.

- Demonstrated geometric dependence of composite materials for crash response (flat specimens and curved specimens)

FY 2008:

- Developed chemical characterization tests to ensure adequate surface preparation for bonded joints.
- Developed safety criteria for damage tolerance of fiber/metal laminates and friction stir welded joints.
- Assessed the severity of control surface stiffness degradation and its effect on dynamic characteristics.
- Developed analytical method to evaluate anthropomorphic test device (ATD) model results for crash testing
- Completed research of computer modeling of aircraft water impacts to help determine revised rotorcraft water impact and ditching standards.

FY 2007:

- Evaluated analytical methods to predict residual strength of composite sandwich structures following an impact event.
- Established feasibility of embedded sensors to track damage in composite structures.
- Evaluated aging composite aircraft by a destructive evaluation and testing.
- Developed an updated ATR 42-300 model to analyze critical fuselage frame failure observed in the vertical drop test.
- Developed occupant protection criteria for side facing seats commonly used in business jets. Currently, no criteria exist.
- Evaluated the use of reticulated foam to mitigate post-crash fires using full-scale sled tests.

FY 2006:

- Developed software for analyzing bonded joints that can be used by the general aviation industry.
- Developed a web-based course on maintenance of composite airframe structures.
- Developed analytical models that predict durability of braided materials.
- Generated data on human neck injury criteria for side-facing aircraft seats that may be used to develop safety criteria for business jet with side-facing seats. Currently, no criteria exist for these seats.

Previous years:

- Developed an aircraft seat cushion replacement methodology that may have the potential to replace future requirement for full-scale sled test currently required when replacing aircraft seat cushions.
- Established common practices for bonded joints in composites structures that served as a basis for a policy memo.
- Developed data on the procurement and processing of composites that resulted in a published Advisory Circular.
- Analyzed data from ATR42-300 drop test to help establish crashworthiness criteria for commuter aircraft.
- Developed an economical data reduction method, characterizing statistically composite materials through shared databases, that is now used worldwide by the general aviation industry.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Materials

- Continued work with industry to develop consensus for a damage tolerance and fatigue certification protocol.
- Initiate work to expand developments in composite training with the initial emphasis on levels of safety awareness.
- Initiate studies for the types of threats to composite aircraft structures while at the service gate and on the flight line.
- Generate composite material dynamic properties important to crashworthiness.
- Continue work with the FAA Office of Aviation Safety (AVS) in support of AC 20-107B by providing next level of protocols, data and guidance through research initiatives.

- Initiate work with new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures.

Structural Safety

- Continue to develop analytical modeling techniques of aircraft crash conditions.
- Continue to review of the need for off axis analysis capabilities to assist in certification of structures for crashworthiness.
- Initiate discussions with EASA and other foreign regulators to evaluate modeling for rotorcraft impact on water, soft soil and hard surface.
- Develop guidelines (SAE 5765) to support the use of certification by analysis to streamline aircraft seat certification.
- Develop analytical modeling techniques to evaluate head injury criteria to support stream lining of aircraft seat certification.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

The program will continue to focus on damage tolerance and fatigue issues of composite airframes. This includes assessment of impact damage threats (e.g., in-flight hail, ground vehicle collisions). In addition it will focus on the aging of composite materials. Composite control surfaces degradation on transport airplanes will be explored and linked to aircraft safety issues. Quality control procedures will be studied for adhesive joints. Important field variables will be evaluated for bonded and bolted repairs. Researchers will also explore savings in maintenance costs, of using embedded sensors to monitor in-service damage and will investigate the long-term safety of friction stir-welded parts and fiber/metal laminates proposed for use in new aircraft. In addition, they will collect data for new materials and applications, such as ceramics and high temperatures.

Research will continue to develop analytical models of aircraft crash events. This will focus on the development of criteria and methodologies to validate analysis techniques and assess the effectiveness of the analysis to properly describe the crash event.

New Initiatives

No new initiatives are planned in FY 2011.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Materials

- Document accepted certification methodology for damage tolerance and fatigue. including full-scale test and analysis protocols for repeated loads and damage threats
- Develop training and conduct workshops to review progress in damage tolerance, adhesive joints and maintenance.

Structural Safety

- Develop analytical modeling protocols and methodologies of aircraft structures crash conditions for certification use

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	101,001
FY 2010 Enacted	4,935
FY 2011 Request	2,566
Out-Year Planning Levels (FY 2012-2015)	10,546
Total	119,048

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Advanced Materials	1,211	6,054	1,838	3,855	1,250
Structural Safety	165	0	0	0	0
Personnel Costs	1,394	945	1022	1004	1,218
Other In-house Costs	73	84	60	76	98
Total	**2,843**	**7,083**	**2,920**	**4,935**	**2,566**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	2,843	7,043	2,920	4,935	2,566
Development (includes prototypes)					
Total	**2,843**	**7,083**	**2,920**	**2,448**	**2,566**

A11.c – Advanced Materials/Structural Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
062-111 Advanced Materials Structures							
Advanced Materials	**1,250**						
Generate composite material dynamic properties important to crashworthiness.		♦	◊				
Continue to provided data to the FAA Office of Aviation Safety (AVS) in support of AC 20-107B		♦	◊				
Continued work with industry to develop consensus for a damage tolerance and fatigue certification protocol.		♦	◊				
Initiate work to expand developments in composite training with the initial emphasis on levels of safety awareness.		♦	◊	◊			
Initiate studies for the types of threats to composite aircraft structures while at the service gate and on the flight line.		♦	◊	◊	◊		
Document accepted certification methodology for damage tolerance and fatigue. including full-scale test and analysis protocols for repeated loads and damage threats		♦	◊	◊	◊		
Develop training and conduct workshops to review progress in damage tolerance, adhesive joints and maintenance.		♦	◊	◊	◊		◊
Initiate work with new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures.		♦	◊	◊	◊	◊	◊
062-110 Structural Safety							
Structural Safety	**0**						
Continue to develop analytical modeling techniques of aircraft crash conditions.		♦	◊				
Continue to review of the need for off axis analysis capabilities to assist in certification of structures for crashworthiness.		♦	◊				
Develop analytical modeling techniques to evaluate head injury criteria to support stream lining of aircraft seat certification.		♦	◊	◊			
Develop analytical modeling protocols and methodologies of aircraft structures crash conditions for certification use		♦	◊	◊	◊		
Develop guidelines (SAE 5765) to support the use of certification by analysis to streamline aircraft seat certification.		♦	◊	◊	◊		
Initiate discussions with EASA and other foreign regulators to evaluate modeling for rotorcraft impact on water, soft soil and hard surface.			◊	◊	◊	◊	
Personnel and Other In-House Costs	**1,316**						
Total Budget Authority	**2,566**	**4,935**	**2,566**	**2,596**	**2,628**	**2,650**	**2,672**

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

Budget Item	Program Title	Budget Request
A11.d	**Atmospheric Hazards - Aircraft Icing/Digital System Safety**	**$6,635,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Atmospheric Hazards/Digital System Safety Research Program supports FAA's strategic goal of increased safety by reducing the number of accidents or potential accidents associated with aircraft icing and failures to software-based digital flight controls and avionics systems in preparation for the Next Generation Air Transportation System (NextGen). The program develops and tests technologies that detect frozen contamination, predict anti-icing fluid failure, and ensure safe operations both during and after flight in atmospheric icing conditions. To improve digital system safety, researchers are proactive in ensuring the safe operation of emerging, highly complex software-based digital flight controls and avionics systems.

A major goal of the program is to reduce aviation's vulnerability to all in-flight icing hazards through the application of its research to improve certification criteria. Commercial airplanes are not yet certified to fly in icing conditions to an icing envelope that includes supercooled large droplet (SLD) icing conditions. The program's researchers have contributed to the development of technical data and advisory materials to correct this omission. A study by the Engine Harmonization Working Group indicates that over 100 in-service engine events, many resulting in power loss and at least six in multiple engine flameouts, occurred in high ice water content environments over the period 1988 to 2003. A current collaborative research effort will address this issue.

The program will develop new guidelines for testing, evaluating, and qualifying digital flight controls and avionics systems for the certification of aircraft platforms. Additionally, the program supports development of policy, guidance, technology, and training needs of the Aircraft Certification Service and Flight Standards Service that will assist and educate FAA and industry specialists in understanding digital systems safety and assessing how it may be safely employed in systems such as fly-by-wire, augmented manual flight controls, navigation and communication equipment, and autopilots.

Agency Outputs: The FAA establishes rules for the certification and operation of aircraft that encounter icing conditions as well as rules for the use of software, digital flight controls, and onboard avionics systems. The agency uses the research results to generate ACs, and various other forms of technical information detailing acceptable means for meeting requirements, to guide government and industrial certification and airworthiness specialists and inspectors.

Research Goals: To reduce the number and severity of accidents, or potential accidents, associated with icing and failures to software-based digital flight controls and avionics systems, the program develops and assesses ways to ensure that airframes and engines can safely operate in atmospheric icing conditions, and ensure the proper operation of software, electronic hardware, and digital systems.

Atmospheric Hazards

- By FY 2011, complete characterization of high ice water content atmospheric environments potentially hazardous to engines.
- By FY 2012, complete experimental work on the physics of engine icing in high ice water content environments.
- By FY 2013, develop methods for the airworthiness testing of engines in simulated high ice water content environments.
- By FY 2014, develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments.

Digital System Safety

- By FY 2011, determine potential safety, security, and certification issues of connecting aircraft systems to external systems, onboard network security and integrity.
- By FY 2011, develop new methods of evaluation for airborne electronic hardware to include semiconductor device wear out, system effects produced by microprocessors, reliability prediction, and lifecycle

maintenance, while dealing with commercial off-the-shelf (COTS) technology in complex and safety-critical systems.

- By FY 2013, evaluate development and integration techniques that will produce software for complex highly integrated systems that must comply with airworthiness requirements.
- By FY 2013, evaluate airborne electronic hardware techniques and tools for qualification, verification, and assurance to develop additional evaluation methods that may improve the certification process for airborne electronic hardware.
- By FY 2013, evaluate alternatives to existing verification and validation techniques; improved techniques will provide a way to identify system requirement errors early in the development process before implementation into the system.
- By FY 2014, determine applicability of safety engineering and reliability engineering to software development assurance standards (i.e., Software Considerations in Airborne Systems and Equipment Certification (DO-178B).

Customer/Stakeholder Involvement: The Atmospheric Hazards/Digital System Safety Research Program collaborates with a broad segment of the aviation community to improve aircraft certification, inspection, and maintenance, including:

- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the activities of the Atmospheric Hazards/Digital System Safety Research Program.
- Technical Community Representatives Groups – FAA representatives apply formal guidelines to ensure that the program's R&D projects support new rule making and the development of alternate means of compliance with existing rules.
- Ice Protection Harmonization Working Group and Engine Harmonization Working Group of the FAA Aviation Rulemaking Advisory Committee – groups that ensure the effectiveness of the agency's rule making. Members of the working group and full committee identify research requirements and priorities.
- G-12 Aircraft Ground Deicing Committee of the Society of Automotive Engineers (SAE) – this subcommittee assists in updating holdover time guidelines and establishing standards for de/anti-icing methodologies, deicing fluids, and ground ice detection.
- SAE AC-9C Aircraft Icing (In-flight) Subcommittee – this subcommittee assists in establishing guidance and standards for icing test and simulation methods.
- RTCA (formerly known as Radio Technical Commission for Aeronautics) – members of this U.S. Federal Advisory Committee and its special committees (SC) help to ensure the effectiveness of the agency's rulemaking by identifying research requirements and priorities and providing guidance for Aircraft Certification Office engineers and the update of documents, such as avionics software, and electromagnetic hazards.
- Certification Authorities Software Team (CAST) – a group of international certification software and AEH specialists who collaborate and make recommendations to regulatory authorities on the resolution of software and AEH aspects of safety.
- Research and Innovative Technology Administration (RITA) Volpe National Transportation Center – U.S. DOT organization that is leading information security research for U.S. transportation and is providing collaborative research inputs for the FAA research in aeronautical system security that supports the onboard network security goal.

R&D Partnerships: The program maintains a number of cooperative relationships:

- NASA Glenn Research Center – includes various cooperative efforts on aircraft icing activities.
- Transport Canada – based on an international agreement on research on aircraft ground deicing issues.
- Environment Canada – based on an international memorandum of cooperation for research on in-flight icing conditions.
- National Research Council of Canada - based on an international memorandum of cooperation for research on engine and airframe icing.
- Australian Bureau of Meteorology (BOM) – partner in field campaign in Darwin, Australia to obtain data in high ice water content (HIWC) environments

- Aerospace Vehicle Systems Institute (AVSI) – cooperative industry, government, and academia venture for investigation and standardization of aerospace vehicle systems to reduce life-cycle cost and accelerate development of systems, architectures, tools, and processes.

Accomplishments: Significant program accomplishments include:

Aircraft Icing

FY 2009:

- Completed the development of methods for simulation of ice pellet and some mixed conditions for determination of fluid failure and allowance times.
- Completed investigation of runback ice formation and size and velocity effects on aerodynamic impact of runback ice for thermal ice protection for simulated flight conditions.
- Continued planning for collaborative flight research to acquire atmospheric data for high ice water content environments.
- Continued experimental work on the physics of engine icing in high ice water content environments.
- Completed the development of methods for simulation of ice pellet and some mixed conditions for determination of fluid failure and allowance times.
- Initiated development of methods to test engines in simulated high ice water content environments.

FY 2008:

- Completed analysis of data from propeller icing test at McKinley Climatic Laboratory to provide data for guidance to ensure safe flight of propeller aircraft in icing conditions.
- Continued research to characterize high ice water content environments for engines to ensure their safe operation in such conditions.
- Continued experimental work on the physics of engine icing in high ice water content environments
- Developed improved methods for simulation of ice pellet, mixed, and other conditions for determination of fluid failure and holdover times.
- Continued study of aerodynamic effects of runback ice for thermal ice protection for simulated flight conditions.

FY 2007:

- Conducted propeller icing test in McKinley Climatic Chamber and processed and published data.
- Conducted testing at flight Reynolds numbers on full-scale airfoil model of simulated runback ice for a thermal ice protection system.
- Developed technical data for the use of ground ice detectors.

FY 2006:

- Developed snow generation system to test the time of effectiveness of modern de/anti-icing fluids in a controlled laboratory environment.
- Completed development of facility simulation capability for SLD icing testing to show safe operation in SLD environments in accordance with new proposed rules.
- Completed documentation and analysis of residual and inter-cycle ice for pneumatic boots at low airspeeds to provide data for guidance to ensure safe operation of pneumatic boots on low speed aircraft in icing conditions.

FY 2005:

- Investigated and documented characteristic features of runback ice for thermal ice protection systems to provide data for guidance to ensure safe operation of thermally protected aircraft in icing conditions.

- Enhanced in-flight icing simulation capability at the McKinley Climatic Laboratory suitable for testing of full scale engines and rotor blades for substantiation of safe operation of engines and helicopters in icing conditions.

Digital System Safety

FY 2009:

- Determined additional microprocessor evaluation issue that showed there is no consistent method to evaluate the safety of systems using these devices at the component or subsystem level and that a system-level analysis is required to mitigate this issue at the system level; results used to provide important inputs into a Microprocessor Selection and Evaluation Concepts Document.
- Completed the evaluation of Phase 3 onboard network security and integrity issues, which found wired and wireless access points to the networks of the aircraft control domain and airline information services domain of recently developed large transport aircraft and determined that operational maintenance security requirements will impact these two domains plus the in-flight entertainment domain. The results were fed into the Phase 4 research effort that includes work with RTCA SC-216.
- Determined that AEH tools can be qualified effectively through an electronic hardware validation all of the system requirements and an independent assessment of the tool's outputs. The results will be used for developing policy and guidance.

FY 2008:

- Determined additional microprocessor evaluation issues pertaining to risk and safety that included advancing past the stage of the use of a feature modeling approach to assure microprocessor system safety to a system-level behavioral approach; results used to provide important inputs into a Microprocessor Selection and Evaluation Concepts Document.
- Evaluated AEH tools to determine the major safety issues in the qualification process and AEH items for sufficiency of verification coverage analysis that includes development of criteria. The results will be used for developing policy and guidance.

FY 2007:

- Completed research of COTS component integration and verification for integrated modular avionics (IMA) systems on a generic aviation platform. The results are useful for FAA and industry practitioners of integrating IMA systems on aircraft, and will lead to more effective systems development and enhance the certification of digital flight controls and avionics systems. The results are published in a technical report and handbook.
- Developed and documented evaluation criteria for airworthiness of newly proposed databases that will define a suitable approach to develop and evaluate data networks for safety-critical avionics; results will provide guidance to FAA certification engineers.
- Defined and documented a safe, secure process for implementing LANs onboard aircraft; results will provide a network assurance process for FAA certification engineers.

FY 2006:

- Completed research on object-oriented technology (OOT) in aviation that will provide input for policy and guidance on the use of OOT systems and support harmonization with international certification authorities on the use of OOT.
- Evaluated the criteria and use of microprocessors in aviation and the identification of safety concerns for microprocessors; results will be used to develop test methods for modern, complex microprocessors that will improve the process of certifying aircraft avionics.

FY 2005:

- Studied deterministic operations of Ethernet equipment and provided evaluation criteria for the certification of Ethernet databases; results were incorporated into a handbook that provides network designers with guidelines for developing Ethernet databases that will be deployable in certifiable avionics systems.
- Completed research on software development tools that led to a handbook for developers and certifying authorities to use to evaluate the tools from the system and software safety perspective and provided a basis for future software development tool qualification guidelines.

- Completed research on software verification tools that identified specific evaluation criteria that could be used to determine whether the performance of the tool was acceptable and thereby improve the ability of the certification engineer to qualify software using these tools.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aircraft Icing

- Initiated collaborative flight research to acquire atmospheric data for high ice water content environments.
- Continued experimental work on the physics of engine icing in high ice water content environments.
- Completed the development of methods for simulation of ice pellet and some mixed conditions for determination of fluid failure and allowance times
- Initiated the evaluation of Remote Onboard Ground Ice Detection System (ROGIDS) for pretakeoff contamination check and other applications. Results will be used to develop data package for advisory material.
- Continued development of methods to test engines in simulated high ice water content environments.
- Initiated research on aerodynamic effects of ice on 3-D lifting surfaces

Digital System Safety

- Evaluated Phase 5 onboard network security and integrity issues to insure security protection requirements are consistent with aircraft safety.
- Continued to evaluate of COTS technology in complex and safety-critical systems for obsolescence and life cycle maintenance of aviation electronics.
- Continued to evaluate verification and validation techniques for safety-critical digital systems.
- Completed investigation into the feasibility of using reverse engineering as a viable alternate means of compliance for achieving objectives of DO-178B.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

Researchers will continue to refine laboratory methods to determine anti-icing fluid holdover times and allowance in a variety of environmental conditions, including new mixed conditions. Investigation of the enhancement and validation of icing simulation methods, with an emphasis on engine testing in high ice water content conditions, will continue. Researchers will also continue to evaluate onboard network security and integrity issues, software development techniques and tools (combined integration and development techniques for highly-integrated aircraft systems with verification and validation techniques), and, COTS technology in complex and safety-critical systems.

New Initiatives

None.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aircraft Icing

- Reduced Accidents During Flight In Glaciated, Mixed-phase and Supercooled Large Drop (SLD) Icing Conditions
  - Conduct analysis of data for characterization of high ice water content environments potentially hazardous to engines.
  - Continue experimental work on the physics of engine icing in high ice water content environments.
  - Develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments.
  - Continue development of methods to test engines in simulated high ice water content environments.
- Reduced Accidents During Flight In 14 CFR Part 25, Appendix C Icing Conditions
  - Continue research on aerodynamic effects of ice on 3-D lifting surfaces.

- Reduced Accidents During Takeoffs In Icing Conditions
  - Continue the development of improved methods for simulation of ice pellet and mixed conditions for determination of fluid failure and holdover times and allowance times.
  - Continue evaluation of ROGIDS for pretakeoff contamination check and other Begin developing data and methods to support the evaluation of aircraft engines for operation in high ice water content environments

Digital System Safety

- Software Development Techniques and Tools
  - Determine software development assurance level for highly integrated aircraft systems
  - Evaluate model-based development criteria considered by industry and address technical and certification issues.
  - Continue to evaluate verification and validation techniques for safety-critical digital systems.
  - Complete investigation into the feasibility of using reverse engineering as a viable alternate means of compliance for achieving objectives of DO-178B.
- Onboard Network Security and Integrity
  - Complete Phase 5 onboard network security and integrity issues to insure security protection requirements are consistent with aircraft safety and certification. Continues input to RTCA SC-216. This is a multi-phase activity.
- Airborne Electronic Hardware Design Techniques and Tools
  - Continue to evaluate AEH techniques and tools for qualification, verification, and assurance.
- COTS Technology in Complex & Safety-Critical Systems
  - Continue to evaluate COTS technology in complex and safety-critical systems for obsolescence and life cycle maintenance of aviation electronics.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	91,657
FY 2010 Enacted	4,482
FY 2011 Request	6,635
Out-Year Planning Levels (FY 2012-2015)	26,842
Total	129,616

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Digital System Safety	842	737	1,080	1,158	2,200
Atmospheric Hazards – Aircraft Icing	1,316	1,052	1,811	1,526	1,919
Personnel Costs	1,614	1,653	1,832	1,660	2,308
Other In-house Costs	76	132	115	138	208
Total	**3,848**	**3,574**	**4,838**	**4, 482**	**6,635**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	3,848	3,574	4,838	4,482	6,635
Development (includes prototypes)	0	0	0	0	0
Total	**3,848**	**3,574**	**4,838**	**4,482**	**6,635**

A11.d – Atmospheric Hazards – Aircraft Icing/Digital System Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
064-110 Digital System Safety							
Digital System Safety	**2,200**						
Determine software development assurance level		♦	◊	◊	◊	◊	◊
Evaluate model-based development criteria		♦	◊	◊			
Evaluate verification and validation techniques		♦	◊	◊	◊		
Investigate the feasibility of using reverse engineering.		♦	◊				
Evaluate onboard network security and integrity		♦	◊	◊	◊	◊	◊
Evaluate AEH techniques and tools for qualification, verification, and		♦	◊	◊	◊	◊	
Evaluate COTS technology in complex and safety-critical systems		♦	◊	◊	◊	◊	
Determine applicability of safety engineering and reliability engineering				◊	◊	◊	
064-111 Atmospheric Hazards-Aircraft Icing							
Aircraft Icing	**1,919**						
Characterize high ice water content atmospheric environments for engines and conduct analysis		♦	◊				
Conduct experimental work on the physics of engine icing in high ice water content environments.		♦	◊	◊			
Develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments			◊	◊	◊	◊	
Develop methods to test engines in simulated high ice water content environments		♦	◊	◊	◊		
Conduct research on aerodynamic effects of ice on 3-D lifting surfaces.		♦	◊	◊			
Develop improved methods for simulation of ice pellet, mixed, and other conditions for determination of fluid failure and holdover times and allowance times		♦	◊	◊	◊		
Evaluate ROGIDS for pre-takeoff contamination check and other applications; develop data package for SAE spec and advisory material		♦	◊	◊	◊		
Conduct research on aerodynamic effects of ice on 3-D lifting surfaces.		♦	◊	◊			
Personnel and Other In-House Costs	**2,516**						
Total Budget Authority	**6,635**	**4,482**	**6,635**	**6,675**	**6,715**	**6,722**	**6,730**

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

Budget Item	Program Title	Budget Request
A11.e	**Continued Airworthiness**	**10,801,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Continued Airworthiness (formerly known as the Continued Airworthiness/ Aging Aircraft Program) contributes to FAA's strategic goal of increasing aviation safety by reducing the number of accidents associated with failure of aircraft structure, engines, and systems. The program promotes the development of technologies, procedures, technical data, and performance models to prevent accidents and mitigate accident severity related to civil aircraft failures as a function of their continued operation and usage. The program is focused on long-term maintenance of the structural integrity of fixed wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and safety of electrical wiring interconnect systems (EWIS), mechanical systems, and flight controls.

Agency Outputs: The FAA issues rules and advisory materials for regulating aircraft design, construction, operation, modification, inspection, maintenance, repair, and safety. Further understanding of the technologies, procedures, technical data, and analytical models produced by the Continued Airworthiness Program provide a major source of technical information used in developing these regulations and related advisories. Through this research, FAA also works with industry to provide the aviation community with critical new safety technologies and data.

Research Goals: The goal of the Continued Airworthiness Program is to understand and develop methods to counter the effects of age and usage on the airworthiness of an aircraft over its lifetime, including potential effects of modifications and repairs. The program conducts research in developing technologies and processes, and assesses current practices in order to eliminate or mitigate the potential failures related to aircraft aging processes, thereby reducing the number and severity of accidents.

To satisfy these goals the program conducts research to assess causes and consequences of airplane structural fatigue, corrosion, and other structural failures, and develop effective analytical tools to predict the behavior of these conditions. This includes research on nondestructive inspection (NDI) technologies being developed to detect these conditions. Similar research is conducted on aircraft engines and rotorcraft. Aircraft systems research to understand the causes and consequences of EWIS and mechanical systems failures, and the relationship of these failures to other aircraft systems and safety completes the program.

- BY FY 2011, complete a study of safe life and risk-based fleet management for small-airplane continued operational safety.
- By FY 2011, assess performance of in-situ damage detection technologies for inspection of remote and inaccessible areas in aircraft. In-situ monitoring provides the means to monitor structural behavior and identify damage not normally found between major maintenance checks.
- By FY 2011, complete study to assess need for new rudder design standards in transport category aircraft and need for new pilot training standards with regard to rudder usage.
- BY FY 2012, assess performance of traditional and advanced inspection systems necessary for evaluating the strength of bonded aircraft structures. The continued airworthiness of bonded aircraft structures, whose use is increasing, will require technologies to find hidden damage in these joints.
- By FY 2013, develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems (HUMS) for usage credits.
- By FY 2013, develop a predictive methodology for damage tolerance risk assessment and risk management for continued operational safety of small airplanes.
- By FY 2013, assess performance of an advanced inspection system for identifying environmental damage of composite structures, such as by chemical, UV, and water ingress.
- By FY 2014, provide technical data to develop guidelines for implementing structural health monitoring (SHM) in commercial transport category airplanes.

Customer/Stakeholder Involvement: The Continued Airworthiness Program coordinates with an extensive network of government and industry groups, including:

- Subcommittee on Aircraft Safety of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review program activity, progress, and plans.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and the development of alternate means of compliance with existing rules.
- Aviation Rulemaking Advisory Committees – industry representatives propose cost-effective rulemaking and research to address aircraft safety issues.
- Aircraft manufacturers, operators, foreign airworthiness authorities, academia, and industry trade groups consult on a wide range of current and future aging aircraft and continued airworthiness issues.

R&D Partnerships: The Continued Airworthiness Program activities are closely coordinated with industry, NASA, and the Department of Defense (DoD). The FAA maintains interagency agreements with NASA, the U.S. Navy, the U.S. Air Force, and the Department of Energy. The FAA, DoD, and NASA have co-sponsored 12 joint Aging Aircraft Conferences.

The FAA collaborates closely with several private and public organizations, including:

- Metallic Materials Properties Development and Standardization (MMPDS) Government/Industry Steering Group – a joint government and industry working group that funds and develops the metallic materials properties handbook.
- Cooperative Research and Development Agreement with Boeing for joint research on structural integrity of bonded repair and emerging structural technologies.

Accomplishments: The Continued Airworthiness Program conducts a broad array of projects to meet the goals described above. Technical reports documenting the accomplishments of most projects are available on-line at http://actlibrary.tc.faa.gov.

Outstanding program accomplishments include:

FY 2009:

- Developed a comprehensive analysis tool for the risk assessment and risk management of small airplane continued operational safety with regard to fatigue crack initiation.
- Completed initial phase of joint research with Boeing on the structural integrity of bonded repair technology at FAA's full-scale structural test and evaluation (FASTER) facility
- Completed studies to quantitatively determine the impact of process variables on the performance of FPI and integrate results into industry inspection standards.
- Completed initial evaluation of thermal acoustic technology as a potential replacement for FPI in inspecting critical engine components.
- Completed testing of single-element, dual-load-path flight control linkages from transport category aircraft for corrosion and other anomalies that could affect safety.
- Completed upgrade of Arc Fault Evaluation Laboratory to accommodate more sophisticated separation and segregation testing of aircraft wiring (EWIS research).

FY 2008:

- Developed software for predictive methodology for the risk assessment and risk management of small airplane continued operational safety with regard to fatigue crack initiation.
- Completed assessment of reliability of various advanced inspection technologies in detecting second layer cracks in typical transport aircraft fuselage structure.
- Completed validation and demonstration of HUMS processes and methods for flight regime recognition on Bell 206 rotorcraft using the HUMS AC.
- Completed initial study on certification standards and design issues for rudder control systems.
- Completed an advanced risk assessment tool for conducting hazard analysis of EWIS systems. The tool used a probabilistic method to support compliance with FAR 25.1309 requirements.

FY 2007:

- Completed the airworthiness evaluation of an aged Raytheon Beech 1900D.
- Completed the destructive and extended fatigue testing of fuselage sections from a retired Boeing 727. Results support formulation of policy on use of teardown data for airworthiness certification.
- Conducted the field test of a magnetic carpet probe for rapid and wide-area inspection of aircraft engine critical rotating components.
- Completed assessment of ASTM and new fatigue crack growth test methods for use in addressing rotorcraft fatigue life.
- Developed methodology to evaluate mechanical systems on current transport category aircraft for safety and reliability.

FY 2006:

- Completed development of the MMPDS Handbook of FAA accepted material properties, which replaces MIL-HDBK-5 previously cancelled by the DoD. The MMPDS Handbook is an essential reference for aircraft manufacturer design engineers and is used by FAA for aircraft certification.
- Completed aircraft wire degradation research on common types of aircraft electrical wire as a function of laboratory controlled aging processes. Data generated are used to evaluate potential methods of monitoring wire performance in aircraft and wire reliability assessment methods.
- Completed research on the use of composite doublers as a safer, more cost-effective means for repair of damaged metallic aircraft structure.
- Completed development of a low cost, field prototype, generic scanning and imaging system that can be readily coupled to existing aircraft inspection devices, thereby improving flaw detection in metal and composite structure.
- Completed second-phase development of a magnetic carpet probe for rapid and wide-area inspection of aircraft engine critical rotating components. This technology is a potential replacement of fluorescent penetrant inspection (FPI).

Previous Years:

- Established the FAA Arc Fault Evaluation Laboratory and initiated the evaluation of advanced circuit protection technologies and experiments to quantify damage created by arc fault conditions.
- In cooperation with industry, developed, validated, and facilitated the adoption of improved inspection procedures for detecting cracks and corrosion in rotorcraft.
- Demonstrated phased array inspection technology for critical engine titanium forgings. Phased array technology reliably detects smaller material flaws in critical engine component forgings.
- Developed rotorcraft component damage part database that allows determination of the origin and causal factors of rotorcraft structure and component failures.
- Developed the fatigue crack growth database that is used in support of damage tolerance assessments of airframe structure.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed and validated a model-assisted probability of detection methodology to determine quantitative inspection reliability data, eliminating the need to conduct expensive and time consuming tests currently required to establish inspection reliability. Accurate probability of detection data is critical to determining the life of safety critical components.
- Continued development of probabilistic structural risk assessment and risk management methodologies for small airplanes.
- Continued damage tolerance and durability research for emerging structural technologies such as integral structure fabricated by friction stir welding to ensure safety, support maintenance, and support future certification policies and guidance.
- Developed technical data for certification process for rotorcraft HUMS systems using condition-based maintenance approach for mechanical systems.

- Completed interim reliability assessments of conventional and advanced inspection devices to detect hidden flaws in thick, complex composite laminates.
- Completed study on usage, design, and training issues for rudder control systems in transport aircraft.
- Completed development of damage-tolerant design methods for aircraft propellers

FY 2011 PROGRAM REQUEST:

Ongoing Activities

The FY 2011 funding request will support Continued Airworthiness Program research requirements that contribute to FAA's aviation safety goal. The program will continue its focus on providing data on developing technologies, technical information, procedures, and practices that help ensure the safety of aircraft structures and systems in the civil aircraft fleet. Research will continue on the development of certification processes for HUMS systems for rotorcraft, and on monitoring the development of health monitoring systems for commercial airplanes. Research will continue on the development and evaluation of risk assessment and risk management methods for the continued operational safety of small airplanes. Research will continue on flight controls and mechanical systems, focusing on assisting pilots with advanced displays and systems to avoid problems in both transport category and general aviation airplanes. Researchers will also continue efforts on investigation of nondestructive inspection techniques for critical engine components. Research on nondestructive inspection of structures will continue its focus on the development of methods and technologies to assure the long term safety of metallic, composite, and bonded structures. Finally, research will begin on advanced electrical power systems for NextGen use.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed EWIS separation and segregation advisory guidance. This research supports development of guidelines for the design and modification of aircraft EWIS and improves safety by ensuring that adequate clearances for EWIS separation and segregation are provided in EWIS installation.
- Complete a study of safe life and risk-based fleet management for small airplane continued operational safety.
- Continue damage tolerance and durability research for emerging structural technologies to ensure safety, support maintenance, and support future certification policies and guidance.
- Continue to lead the MMPDS steering group in updating metallic properties handbook.
- Continue research to develop rotorcraft data that provide guidance for the certification of HUMS systems for usage credits.
- Develop technical data on regulatory issues for ongoing fly-by-wire and fly-by-light working groups.
- Continue research to develop the potential of advanced or emerging NDI techniques for critical engine components.
- Assess advanced inspection systems to perform large area inspection of composite airplane components.
- Develop enhanced models of full stall departure characteristics for transport airplanes.
- Develop functional, safety, and certification information for advanced flight displays to meet NextGen trajectory management needs.
- Continue research on minimum performance criteria and certification requirements for automatic envelope protection and automation systems for general aviation.
- Conduct research to develop technical data to evaluate and assess commercial aircraft health monitoring systems for certification and continued airworthiness requirements.
- Develop technical data for standards on NextGen electrical power systems and components.

APPROPRIATION SUMMARY

	Amount($000)
Appropriated (FY 1982-2009)	405,544
FY 2010 Enacted	10,944
FY 2011 Request	10,801
Out-Year Planning Levels (FY 2012-2015)	43,582
Total	470,871

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Continued Airworthiness	14,211	11,679	9,839	6,847	6,949
Personnel Costs	4,159	3,946	4,447	3,831	3,517
Other In-house Costs	251	320	303	266	335
Total	**18,621**	**15,945**	**14,589**	**10,944**	**10,801**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	18,621	15,945	14,589	10,944	10,801
Development (includes prototypes)	0	0	0	0	0
Total	**18,621**	**15,945**	**14,589**	**10,944**	**10,801**

A11e –Continued Airworthiness Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
065-110 Continued Airworthiness							
Structural Integrity and Inspection Systems Research	**3718**						
Develop risk-based fleet management methods for small-airplane continued operational safety		♦	◊	◊	◊		
Conduct research on application of damage tolerance methods to emerging structural technologies		♦	◊	◊	◊	◊	
Continue to lead the MMPDS steering group in updating metallic properties handbook		♦	◊	◊	◊		
Assess damage detection technologies for remote/inaccessible areas in aircraft		♦	◊				
Investigate advanced NDI systems for composite and bonded structures.		♦	◊	◊	◊	◊	◊
Rotorcraft Structural Integrity and Safety	**1150**						
Establish guidance for certification of HUMS applications for usage credits		♦	◊	◊	◊		
Investigate regulatory issues for ongoing fly-by-wire and fly-by-light working groups			◊	◊	◊		
Continued Airworthiness of Aircraft Engines	**569**						
Develop monitoring of machining process to prevent manufacturing-induced surface anomalies on critical engine components		♦	◊				
Develop potential of advanced NDI techniques for critical engine components.		♦	◊	◊	◊		
Continued Airworthiness of Aircraft Systems	**1512**						
Provide technical guidance on pilot rudder usage, design, and training issues		♦	◊				
Develop enhanced models of full stall departure characteristics for transports			◊	◊	◊		
Develop data for advanced flight displays to meet NextGen trajectory management needs			◊	◊	◊		
Continue research on envelope protection and automation systems for general aviation		♦	◊	◊			
Assess EWIS separation and segregation standards and develop advisory guidance		♦					
Develop technical data to evaluate and assess aircraft health monitoring systems			◊	◊	◊	◊	◊
Develop technical data for standards on NextGen electrical power systems and components			◊	◊	◊		
Personnel and Other In-House Costs	**3,852**						
Total Budget Authority	**10,801**	**10,944**	**10,801**	**10,856**	**10,911**	**10,909**	**10,906**

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

Budget Item	Program Title	Budget Request
A11.f	**Aircraft Catastrophic Failure Prevention Research**	**$1,165,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The Aircraft Catastrophic Failure Prevention Program supports FAA's strategic goal of increasing aviation safety by reducing the number of fatal accidents from uncontained engine failures and engine malfunctions. The program develops technologies and methods to assess risk and prevent occurrence of potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems. Its researchers assess the use of advanced materials to protect aircraft critical systems and passengers in the event of catastrophic engine failures. The program also uses historical accident data and National Transportation Safety Board recommendations to examine and investigate:

- Turbine engine uncontainment events, including the mitigation and modeling of aircraft vulnerability to uncontainment parameters stated in AC 20-128, Phase II.
- Fan blade out analysis and other engine related impact events like bird strike and ice ingestion.
- Propulsion malfunction indications in response to Aerospace Industries Association (AIA) recommendations and proposed solutions.

Agency Outputs: With technical data from the Aircraft Catastrophic Failure Prevention Program, FAA establishes certification criteria for aircraft and revises regulations to certify new technologies. The agency also publishes ACs to outline acceptable means for meeting these rules. The program's objective is to ensure safe aircraft operation in the public domain.

Research Goals: To reduce the number of fatal accidents from uncontained engine failures, the program develops data and methods for evaluating aircraft vulnerability to uncontained engine failures and provides analytical tools for protecting identified critical systems that may need shielding from uncontained engine debris. Through the LSDYNA Aerospace Users Group, FAA is working with industry to establish standards for finite element analysis and guidance for use in support of certification.

- Continue through 2014, the FAA/NASA/Industry sponsored quality control program for modeling aircraft impact problems.
- By 2013 develop and verify a generalized damage and failure model with regularization (MAT 224) for aluminum and titanium materials impacted during engine failure events.

Customer/Stakeholder Involvement: The program collaborates with a broad cross section of the aviation community, including:

- Subcommittee on Aircraft Safety of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and development of alternate means of compliance with existing rules.
- The Aviation Rulemaking Advisory Committee (ARAC) – helps to ensure the effectiveness of the agency's rule making. Members of the subcommittee and full committee identify research requirements, priorities, and provide guidance for the update of documents such as AC20-128, and encourage industry's full participation in implementing new rules.

R&D Partnerships: The Aircraft Catastrophic Failure Prevention Program partners with industry and other government agencies including:

- NASA and industry in support of the development and validation of explicit finite element analysis. The industry participates in the LSDYNA Aerospace Users Group to support quality control reviews of the code and also critique research objectives in material testing, model development and verification. NASA and FAA are teamed to develop high quality test data and analytical models that support the Aerospace Users Group efforts. The end goal is to develop guidance for the use of LSDYNA in the certification process.

- The AIA Transport Committee – with participation of FAA and industry, has examined propulsion system malfunctions, identified inappropriate crew response, and recommended development of specific regulations and advisory materials to correct safety hazards.

Accomplishments: Results of Aircraft Catastrophic Failure Prevention Program research provide the technical basis for FAA rule changes and new or modified ACs. Researcher results are also provided to airframe and engine manufacturers and designers.

Engine Uncontainment Research

FY 2009:

- Continued FAA/NASA/industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA).
- Completed testing of 2024 aluminum necessary to populate the new Material Model 224 failure map in LSDYNA.

FY 2008:

- Continued FAA/NASA/Industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA)
- Continued to improve material models for incorporation into the LSDYNA code that are verified and accepted by the aerospace users group as standardized models.

FY 2007:

- Completed testing and modeling of fabrics used in gas turbine engine containment systems. Test results will be compared with analytical results from fabric model version 3.1
- Completed testing and material model development for aluminum using the Johnson-Cook formula.
- Developed an oversight process that ensures consistent results as computers and programs continue to evolve for generic aerospace problems run in LSDYNA

FY 2006:

- Delivered the UEDDAM, version 3.0 for evaluation of uncontained engine debris hazards to aircraft. UEDDAM uses a Monte Carlo approach to perform the vulnerability analysis in design cases where the released multiple fragments are analyzed.
- Conducted a workshop for the Department of Defense and ARAC on UEDDAM in November 2005.

FY 2005:

- Developed fabric attachment data and designs for fuselage shielding. Fabric material models were used to design full scale shields to be tested in an aircraft fuselage.
- Completed full-scale fabric shielding demonstration test of various fabric attachment designs in a retired commercial airplane at Naval Air Warfare Center (NAWC), China Lake.

Previous Years:

- Conducted a workshop for engine certification engineers on non-linear finite element modeling of turbine engine containment systems at the Los Angeles Aircraft Certification Office (ACO).
- Completed a collaborative effort with NASA, the U.S. Navy, and the U.S. Air Force to perform the first full-scale engine disk crack detection demonstration.
- Developed test data and improved analytical modeling of fabric shielding with revision to the fabric material model.
- Conducted a workshop for engine certification engineers on non-linear finite element modeling of turbine engine containment systems at the Boston ACO.
- Developed a significant database of small and full-scale test data to understand the interaction of multiple ballistic fabric layers in engine fan blade out containment systems.

Propulsion Malfunction

FY 2009:

- Propulsion malfunction research completed a demonstration of the information-based display for the engine lubrication system.

FY 2008:

- Continued to develop an information-based oil display system.

FY 2007:

- Completed detailed study of propulsion malfunctions classified as mechanical damage. Research developed a set of indications that can be added to the flight deck as indications and annunciations to inform the crew that a malfunction exists on a specific engine. This effort recommended a focused follow-on effort to study an information based oil system display.

FY 2005:

- Completed detailed study of propulsion malfunctions classified as Sustained Thrust Anomalies. Research developed a set of indications that can be added to the flight deck as indications and annunciations to inform the crew that a malfunction exists on a specific engine.

Previous Years:

- Completed an in-depth analysis of 80 in-service propulsion system malfunctions and developed recommendations for potential propulsion indication improvement.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop a modular Uncontained Engine Debris Damage Assessment Model (UEDDAM) (version 4) to be compatible with Department of Defense code upgrades for supportability and incorporate industry recommended improvements.
- Continue FAA/NASA/industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA).
- Complete development of Material Model 224 for fragments impacting 2024 aluminum structure.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

Research will continue on the NASA/FAA/industry program for modeling aircraft engine failures in LSDYNA. The FAA/NASA/academia will continue to evaluate improved material models and incorporate them into LSDYNA upon acceptance by the Aerospace Users Group. Users' guidelines and training will continue to be developed and made available through George Washington University.

New Initiatives

No new initiatives are planned in FY 2010.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Engine Uncontainment Research

- Continue FAA/NASA/industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA).
- Complete testing of titanium necessary to populate the material failure map of LSDYNA MAT224
- Continue collaboration with NAWC China Lake to maintain the UEDDAM code

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	36,510
FY 2010 Enacted	1,545
FY 2011 Request	1,165
Out-Year Planning Levels (FY 2012-2015)	4,701
Total	43,921

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Aircraft Catastrophic Failure Prevention Research	947	1,684	0	947	750
Personnel Costs	533	482	415	555	384
Other In-house Costs	32	36	21	43	31
Total	**1,512**	**2,202**	**436**	**1,545**	**1,165**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	1,512	2,202	436	1,545	1,165
Development (includes prototypes)	0	0	0	0	0
Total	**1,512**	**2,202**	**436**	**1,545**	**1,165**

A11.f - Aircraft Catastrophic Failure Prevention Research Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
066-110 Aircraft Catastrophic Failure Prevention Research							
Engine Uncontainment Research	**750**						
Continue FAA/NASA/industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA)		♦	◊	◊	◊	◊	◊
Complete development of Material Model 224 for fragments impacting 2024 aluminum structure		♦					
Develop modular UEDDAM Code (version 4)		♦					
Continue collaboration with NAWC China Lake to maintain the UEDDAM code			◊	◊	◊	◊	◊
Complete Testing of Titanium necessary to populate the material failure map in LSDYNA MAT224			◊				
Complete verification of MAT 224 for Aluminum and Titanium					◊		
Personnel and Other In-House Costs	**415**						
Total Budget Authority	**1,165**	**1,545**	**1,165**	**1,171**	**1,177**	**1,177**	**1,176**

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

Budget Item	Program Title	Target-Level Request
A11.g	**Flightdeck/Maintenance/System Integration Human Factors**	**$7,174,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety and Greater Capacity.

Intended Outcomes: The Flightdeck/Maintenance/System Integration Human Factors Program helps achieve FAA's Flight Plan goals for increased safety and greater capacity by:

- Developing more effective methods for pilot, inspector, and maintenance technician training.
- Enhancing the understanding and application of risk and error management strategies in flight and maintenance operations.
- Increasing human factors considerations in certifying new aircraft and in equipment design and modification.
- Improving pilot, inspector, and maintenance technician task performance.
- Developing requirements, knowledge, guidance, and standards for design, certification, and use of automation-based technologies, tools, and support systems.
- Addressing human task/performance and human-system task/performance requirements associated with transitioning NextGen capabilities.

Agency Outputs: The Human Factors Research and Engineering Program provides the research foundation for FAA guidelines, handbooks, advisory circulars, rules, and regulations that help to ensure the safety and efficiency of aircraft operations. It also develops human performance information that the agency provides to the aviation industry for use in designing and operating aircraft, and training pilots and maintenance personnel.

Research Goals:
By FY 2012:

- Develop flight path and energy state management guidance for air carrier flight deck training systems and procedure design.
- Provide human factors guidance for Automatic Dependent Surveillance-Broadcast (ADS-B) equipment design and operation.
- Provide human factors guidelines for advanced instrument procedure design and use.
- Provide guidance for fatigue mitigation in the maintenance environment.
- Define the work, task, education, and training requirements for the NextGen era aircraft maintenance technician.
- Address human automation integration issues regarding the certification of pilots, procedures, training, maintenance, and equipment associated with enhanced communication/navigation/surveillance (CNS)/Air Traffic Management (ATM) operations necessary to achieve NextGen capabilities.

Customer/Stakeholder Involvement: Program researchers work directly with colleagues in FAA, other government agencies, academia, and industry to support the following R&D programs and initiatives:

- NASA's Aviation Safety Program.
- The FAA's Voluntary Safety Program Office initiatives including Advanced Qualification Program (AQP), Flight Operations Quality Assurance (FOQA), and Aviation Safety Action Program (ASAP).
- The FAA/Industry Safer Skies initiative – analyzes U.S. and global data to find the root causes of accidents and proposes the means to prevent their occurrence.
- The FAA Research, Engineering and Development Advisory Committee – Representatives from industry, academia, and other government agencies annually review the activities of the program and provide advice on priorities and budget.

R&D Partnerships: The Flightdeck/Maintenance/System Integration Human Factors Program collaborates with industry and other government programs through:

- Joint Safety Analysis Teams and Joint Safety Implementation Teams within the Safer Skies Agenda – coordinated with NASA and industry, these efforts stress human factors issues in developing intervention strategies for the reduction of air carrier and general aviation accidents.
- DoD Human Factors Engineering Technical Advisory Group – FAA participates in this group to promote a joint vision for automation and related technical areas.
- Domestic and international aviation maintenance industry partners like Boeing, Continental Airlines, British Airways, and the International Association of Machinists– the emphasis is on achieving research results that can be applied to real-world problems.
- Society of Automotive Engineers G-10 subcommittees – FAA participates on all of the Society's subcommittees involving human factors to adapt their findings to aviation standards, guidelines, etc.
- Fifteen FAA cooperative research agreements with universities supporting research on air carrier training, flight deck automation, aviation accident analysis, general aviation, and aviation maintenance technician and inspector training.

Accomplishments: The program's accomplishments include:

FY 2009:

- Completed study addressing non-alert symbology for Airborne Separation Assurance Systems to assist RTCA SC-186 Cockpit Display of Traffic Information (CDTI) Working Group in addressing non-concurrence in the preliminary Minimum Operational Performance Standards (MOPS) document.
- Developed countermeasures crew multi-tasking.
- Developed best practices for Line Operations Safety Audits (LOSA).
- Completed *Aviation Maintenance Safety Action Program Maintenance Program Development* Handbook.
- Developed small unmanned aerial systems (UAS) Maintenance Handbook.

FY 2008:

- Conducted research and provided results to SAE International Aerospace Behavioral Engineering Technology Committee to update an aerospace industry recommended practice on electronic symbols. Aerospace recommended practices are used by industry to demonstrate means of compliance with FAA regulations.
- Completed Human Factors Analysis and Classification System on-line database. This provides capability for FAA personnel to access key human factors information associated with NTSB accident investigations from 1990-2006.
- Completed research on electronic flight bag (EFB) related safety events. Results will be used to update an Advisory Circular and a new Flight Standards handbook on EFBs.

FY 2007:

- Completed development of human factors Certification Job Aid for FAR Parts 25 and 23 flight decks.
- Completed development of the Human Factors Certification Job Aid and made it available to the aviation community through a web site application.
- Disseminated to the scientific community findings regarding simulator platform motion and its impact on pilot performance during specific maneuvers.
- Completed an international survey of human factors programs in maintenance organizations, providing information on training, error management, fatigue management, and other issues for FAA and industry.

FY 2006:

- Updated the Human Factors Certification Job Aid with Part 25 Advisory Circulars and information on design of flight deck equipment, tasks and procedures, and testing assumptions. The job aid helps government and industry to minimize the likelihood of design induced human performance errors.
- Developed practical customized assessment tools to help FAA certifiers and inspectors, system designers and operators standardize and streamline evaluations of electronic flight bags.
- Improved a LOSA methodology that has been adopted by the International Civil Aviation Authority (ICAO) to help air carriers identify human-centered safety vulnerabilities.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Information Management and Display

- Developed research platform and initiated instrument procedures design research project addressing charting and depiction of performance based navigation procedures.
- Conducted usability assessment of surface moving maps that display township position in surface operations.
- Updated human factors guidance for electronic flight bag certification, operational approval and training, based on performance data.
- Developed guidance to address human factors issues associated with use of synthetic vision for primary and multifunction displays.
- Developed proactive methods for general aviation data collection to facilitate risk assessment and accident prevention.

Human-Centered Automation

- Developed research platform to support research that will provide guidance for use by FAA Certification and Flight Standards personnel to evaluate traffic displays and traffic applications/operations that use ADS-B technology.
- Investigated automation and new technology impacts on aviation maintenance process, safety, tasks, technician skills, and need for regulation.
- Developed advanced automation training tools for pilots reflecting results of an industry study and Performance-Based Operations Aviation Rule-Making Committee (PARC) team data.
- Developed human factors guidance for advanced autopilots and automation technologies in small airplanes.

Human Performance Assessment

- Developed the Maintenance LOSA safety audit tools for maintenance and ramp operations that will evaluate a maintenance organization's effectiveness.
- Developed guidance materials, tools, and administrative process to manage and/or regulate aircraft maintainer fatigue.
- Provided human factors guidance for the operation of UAS within the NAS.
- Continued to develop improved methods to report, record and analyze flight safety data to reduce the likelihood of air carrier incidents and accidents.

Selection and Training

- Continued development of international standards for simulator fidelity.
- Developed training for visual approaches for low-time pilots.
- Developed best practices for Voluntary Safety Data teams.
- Determined the appropriate training intervals to reduce pilot skill decay.

FY 2011 PROGRAM REQUEST:
The program will continue to focus on providing technical information and advice to improve pilot, inspector, maintenance technician, and aviation system performance. The emphasis will remain on developing guidelines, tools, and training to enhance error capturing and mitigation capabilities in the flight deck and maintenance environments, and on developing human factors tools to ensure that human performance considerations are adequately addressed in the design, certification, and operational approval of flight decks, equipment, and procedures. Additional emphasis will be placed on encouraging maintenance shops and repair stations to have human factors maintenance programs and to offer maintenance human factors training.

Ongoing Activities

Information Management and Display

- Identify human factors issues in instrument procedures design.
- Develop guidance for moving map displays in surface operations.
- Develop guidance to address human factors issues associated with using synthetic vision for primary and multifunction displays.

Human-Centered Automation

- Develop human factors guidance for ADS-B equipment certification and operational approval.
- Investigate and revise technician skill, knowledge, and work force needs for emerging aviation and ground-air integrated maintenance personnel and determine potential for new guidance materials and updated regulation.
- Develop advanced automation training tools for pilots reflecting results of an industry study and Performance-Based Operations Aviation Rule-Making Committee (PARC) team data.
- Develop human factors guidance for advanced autopilots and automation technologies in small airplanes.

Human Performance Assessment

- Design a safety audit tool for maintenance and ramp operations to evaluate a maintenance organization's effectiveness.
- Identify effective methods for mitigating maintainer fatigue.
- Provide human factors guidance for the operation of UAS within the NAS.

Selection and Training

- Develop guidance and training material to improve consistency of safety team decisions.
- Identify training and checking approaches for jet upset recovery using advanced and existing simulators.
- Continue development of international standards for simulator fidelity.

New Initiatives

Human-Centered Automation

- Investigate safety and task impacts and process changes to maintenance caused by automation, new technologies, and air-ground integration.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:
Information Management and Display

- Completed instrument procedures design research project addressing charting and depiction of performance based navigation procedures and produce draft report.
- Complete usability assessment of surface moving maps that display township position in surface operation report.
- Update human factors guidance for electronic flight bag certification, operational approval and training based on performance data.
- Develop guidance to address human factors issues associated with using synthetic and enhanced vision to support equivalent visual operations.

Human-Centered Automation

- Develop human factors guidance for ADS-B equipment certification and operational approval.
- Investigate and revise technician skill, knowledge, and work force needs for emerging aviation and ground-air integrated maintenance personnel and determine potential for new guidance materials and updated regulation.
- Investigate safety and task impacts and process changes to maintenance caused by automation, new technologies, and air-ground integration.
- Develop human factors guidance for advanced autopilots and automation technologies in small airplanes.
- Develop advanced automation training tools for pilots reflecting results of an industry study and Performance-Based Operations Aviation Rule-Making Committee (PARC) team data.

Human Performance Assessment

- Test and field the Maintenance LOSA safety audit tool for maintenance and ramp operations that will evaluate a maintenance organization's effectiveness.
- Deliver and implement guidance materials, tools, and administrative process to manage and/or regulate aircraft maintainer fatigue.
- Provide human factors guidance for the operation of UAS within the NAS.
- Develop mitigation strategies for human factors issues that are contributing to very light jet incidents.

Selection and Training

- Validate training for visual approaches for low-time pilots.
- Develop guidance and training material to improve consistency of safety team decisions.
- Identify training and checking approaches for jet upset recovery using advanced and existing simulators.
- Continue development of international standards for simulator fidelity.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	220,528
FY 2010 Enacted	7,128
FY 2011 Request	7,174
Out-Year Planning Levels (FY 2012-2015)	29,425
Total	264,255

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Flightdeck/Maintenance/System Integration Human Factors	4,954	5,957	4,714	3,995	3,623
Personnel Costs	2,902	3,066	2,587	2,919	3,309
Other In-house Costs	143	177	164	214	242
Total	**7,999**	**9,200**	**7,465**	**7,128**	**7,174**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	7,999	9,200	7,465	7,128	7,174
Development (includes prototypes)	0	0	0	0	0
Total	**8,099**	**9,200**	**7,465**	**7,128**	**7,174**

A11.g – Flightdeck/Maintenance/System Integration Human Factors Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Information Management and Display	**1,100**						
Identify human factors issues in instrument procedures design		♦	◊	◊	◊	◊	◊
Develop guidance for moving map displays in surface operations		♦	◊	◊			
Update human factors guidance for electronic flight bag certification, operational approval and training based on performance data		♦	◊	◊			
Develop guidance to address human factors issues associated with using synthetic and enhanced vision to support equivalent visual operations		♦	◊	◊	◊		
Human-Centered Automation	**1,073**						
Develop human factors guidance for ADS-B equipment certification and operational approval		♦	◊	◊	◊	◊	
Investigate automation and new technology impacts on aviation maintenance process, safety, tasks, technician skills, and need for regulation		♦	◊	◊	◊	◊	◊
Develop advanced automation training tools for pilots reflecting results of an industry study and Performance-Based Operations Aviation Rule-Making Committee (PARC) team data		♦	◊	◊			
Develop human factors guidance for advanced autopilots and automation technologies in small airplanes		♦	◊	◊	◊		
Human Performance Assessment	**730**						
Design a safety audit tool for maintenance and ramp operations to evaluate a maintenance organization's effectiveness.		♦	◊	◊	◊	◊	◊
Identify effective methods for mitigating maintainer fatigue		♦	◊	◊	◊		
Provide human factors guidance for the operation of unmanned aerial vehicles within the NAS l		♦	◊	◊	◊		
Develop mitigation strategies for human factors issues that are contributing to very light jet incidents		♦	◊	◊	◊		
Selection and Training	**720**						
Develop guidance and training material to improve consistency of safety team decisions		♦	◊				
Identify training and checking approaches for jet upset recovery using advanced and existing simulators		♦	◊	◊			
Continue development of international standards for simulator fidelity		♦	◊	◊			
Personnel and Other In-House Costs	**3,551**						
Total Budget Authority	**7,174**	**7,128**	**7,174**	**7,253**	**7,336**	**7,390**	**7,446**

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

Budget Item	Program Title	Budget Request
A11.h	**System Safety Management**	**$11,907,000**

Goals:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes: The System Safety Management Program (formerly known as the Aviation Safety Risk Analysis Program) helps achieve FAA's strategic goal of increasing aviation safety by promoting and expanding safety information sharing and safety risk management initiatives efforts. The program develops risk management methodologies, prototype tools, technical information, and safety management system procedures and practices that will improve aviation safety. In addition, the program aims to develop an infrastructure that enables the free sharing of de-identified, aggregate safety information that is derived from various government and industry sources in a protected, aggregated manner. It also conducts operational research to leverage proposed new technologies and procedures that may enhance pilot and aircraft safety during terminal operations.

Agency Outputs: The program will develop an infrastructure that enables the free sharing of de-identified, safety information that is derived from various government and industry sources in a protected, aggregated manner. In addition, the program is providing methodologies, research studies, and guidance material that provide aviation safety inspectors, aircraft certification engineers, analysts, and managers the capabilities of systematically assessing potential safety risks and applying proactive solutions to reduce aviation accidents and incidents. The program is also conducting operational research and analysis to maintain or improve safety and improving terminal area efficiency.

Research Goals: To reduce the number of aviation accidents and incidents by developing a secured safety information and analysis system that provides access to numerous databases, maintains their currency, enables interoperability across their different formats, provides the ability to identify future threats, conducts a causal analysis of those threats, and recommends solutions.

- By 2011, develop automated tools to monitor each database for potential safety issues and to analyze disparate data drawn from multiple sources, enhancing discovery, identification, and evaluation of safety risks.
- By 2012, demonstrate a working prototype of network based integration of information extracted from diverse, distributed sources.
- By 2013, develop advanced infrastructure and laboratory for conducting and sharing analysis tools and aggregated safety information that allows industry stakeholders to perform standardized data analysis and vulnerability discovery on a wide variety of diverse sets of data.
- By 2013, develop a collection of enterprise business objects that provides a system view of real-time NAS facility operations combined with available ASIAS baseline data.
- By 2014, develop a user interface that allows safety oversight personnel the capability to monitor National Airspace System (NAS) facility operations.
- By 2015, demonstrate a two-thirds reduction in the rate of fatalities and injuries*

To reduce the risk for passengers and crews and enhance the traffic control process in the terminal area operations, human-in-the-loop (pilot/controller) simulation, evaluations and operational flight data analysis will be conducted.

- By 2011, complete an evaluation air traffic and flight procedures for terminal area operations using pilot-in-the-loop flight simulator
- By 2012, develop methods to model unusual attitude encounters outside the normal operating envelope, allowing FAA to approve advanced flight simulators that more realistically model the behavior of an actual aircraft.
- By 2012, identify new navigation technologies and data requirements for the development of new procedures to enhance the capacity and safety of the terminal area.
- By 2013, identify contributing factors and develop models for landing performance of selected make, model, and series aircraft using standard operating practices to improve the safety and capacity in terminal areas.

* The two-thirds reduction in the rate of aviation fatalities and injuries is based on a 2004 baseline.

Customer/Stakeholder Involvement: The program encourages broad industry and government participation across all projects.

- Subcommittee on Aircraft Safety of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rule making and the development of alternate means of compliance with existing rules.
- The Joint Planning and Development Office (JPDO) Safety Working Group – a national-level integrated safety management framework that addresses all facets of the air transportation system, building safety design assurance into operations and products.
- Commercial Aviation Safety Team – a FAA/industry collaborative effort to develop and implement data-driven safety initiatives.
- Airline industry groups to ensure that research capabilities are properly focused and benefit stakeholders beyond commercial aviation industry including, but not limited to, manufacturers of very light jets and other advanced aircraft systems.

R&D Partnerships: The Program partners with industry, academia, and other governmental agencies, including:

- National Aeronautics and Space Administration via collaborative agreements to integrate advanced research text and digital analysis products into the Aviation Safety Information and Analysis Sharing (ASIAS) research efforts.
- The Civil Aviation Authority of the Netherlands to conduct joint research on aviation system safety initiatives via a Memorandum of Cooperation.
- Technical expertise from air carriers to provide industry reviews and recommendations regarding safety and efficiency of terminal area operations as well as air carriers' cooperation with data sharing agreements and governance models that allow for the free sharing of aviation data in accordance with approved voluntary safety information sharing agreements.
- Center of Excellence for General Aviation Research (CGAR) via Grants to increase data and tools available for cooperative GA safety analyses among industry stakeholders.

Accomplishments: Significant accomplishments from prior years include:

Risk Management Decision Support

FY 2009:

- Completed a model which identifies and incorporates the gap analysis between 14 CFR Parts 121, 135, 145; maps to the two top levels of ACOSM, and can be interfaced with International Aviation Transportation Association Operational Safety Audit (IOSA).
- Determined injury ratios for well-defined unsafe conditions (e.g., structure failure, electrical system failure, landing gear vibration, powerplant failure, and so forth) on aircraft systems or components.

FY 2008:

- Defined a modified air carrier operations systems model (ACOSM) model that incorporates the regulations and relationships between Title XIV of the Code of Federal Regulations (14 CFR) Parts 121, 145, 135, 91, 191, 61, 141 and is compatible with the top level architecture of IOSA).
- Completed a gap analysis of FAA Safety Management System standards, FAA and international regulatory standards.

- Released a prototype decision support system that provides the FAA with improved certificate management and oversight capabilities. The major products will be identification of databases within FAA purview, redesigned databases, and possible location of and access to existing databases needed to populate the described methodology.
- Developed a technology transfer plan for the updated prototype software tool that contains the integrated framework and methodology for the identification, classification, and assessment of aviation maintenance and flight operations hazards; Added a repair station node which links to the prototype.

- Continue risk management concept, model and analytical tool development in support of commercial and general aviation.

FY 2007:

- Produced technical descriptions of the various business relationships between 14 CFR 121 operators and 14 CFR 145 repair stations; the models will be used to identify the hazards and assess the risks involved these types of relationships.
- Completed a prototype software tool that contains an integrated framework and methodology for the identification, classification, and assessment of aviation maintenance and flight operations hazards.

FY 2006:

- Released a working prototype of an integrated framework that describes the methodology for identification, classification, and assessment of aviation system hazards and risks.
- Developed a preliminary methodology which provides a baseline assessment of the current safety oversight for effectiveness, efficiency, and sustainability and identifies data inputs and could provide metrics such as the responsiveness of the air carriers to corrective and preventive actions, effects of oversight on safety precursors, inspection output and inspector workload and readiness.

Aviation Safety Information and Analysis Sharing

FY 2009:

- Completed the ASIAS CONOPS that is focused on the new data sharing concepts among commercial aviation stakeholders.
- Developed an ASIAS architecture for the implementation of emerging technologies and system to support the sharing of information between commercial aviation stakeholders.
- Developed automated tools to monitor databases for potential safety issues.
- Developed prototype ASIAS system and associated reports that show the benefit of using diverse textual and digital data sets for analyzing commercial aviation safety metrics and enhancements.
- Conducted analytical studies including Runway Safety Study, Terrain Area Warning System Study, Airline Benchmarks and Commercial Aviation Safety Team (CAST) Safety Enhancement Metrics

FY 2008:

- Created Governance structure and mechanisms for utilizing airline data to look at safety issues across multiple commercial aviation carriers.
- Identified studies to be completed in FY-08 related to Runway Safety and Terrain Area Warning Systems
- Identified initial set of core metrics for monitoring known risks identified through Commercial Aviation Safety Team (CAST) safety enhancements
- Identified initial set of commercial airline industry benchmarks that allow airlines to understand how their operations are performing in comparison to other airlines participating in the ASIAS program
- Completed initial acquisition of new types of data for analyzing safety issues around the airport and runway.

FY 2007:

- Released first draft of the ASIAS Concept of Operations (CONOPS) that is focused on the new data sharing concepts among commercial aviation stakeholders.

Aircraft Maintenance - Maintainability and Reliability

FY 2009:

- Developed technical data to be used for the development of standards for carbon monoxide detection devices and inspection methods to determine the integrity of exhaust systems.

FY 2007:

- Proposed a new quality management system to perform and monitor tool calibration at maintenance facilities; the new system will improve safety by reducing aircraft maintenance errors due to the use of out-of-tolerance tools.

FY 2005:

- Completed enhancements to the Maintenance Malfunction Information Reporting (MMIR) System with capability to collect usage and flight profile data – the helicopter industry and FAA are using the MMIR data to improve maintenance reliability and product design.

Safety Analysis Methodology

FY 2007:

- Completed a methodology to provide a different level of certification credit for design features intended to reduce flight crew errors.

FY 2005:

- Provided technical data on standard probabilities of certain environmental and operational conditions to support transport airplane certification for safety assessment purposes.

Terminal Area Safety

FY 2009:

- Developed testing procedures and requirements to identify required navigational performance (RNP) constraints with regard to operation on Radius-to-Fix (RF) legs.
- Evaluated air traffic and flight procedures for terminal area operations by using human-in-the-loop flight and air traffic simulators.
- Produced video on "Aircraft Laser Illumination - awareness for the aviation community".
- Analyzed operational landing distance performance of a typical regional jet aircraft model.

FY 2008:

- Completed the evaluation of stopping distances for two typical subsonic narrow body jet aircraft in commercial operations. The data will aid in understanding causes of aircraft overruns.
- Conducted a survey of area navigation (RNAV) and flight management systems to determine the current and projected capabilities with regard to radius-to-fix (RF) path terminators.
- Conducted bench test of currently RF-capable RNAV and flight management systems against a representative group of terminal and instrument approach procedures to evaluate capabilities and constraints for RF path terminators.

FY 2007:

- Completed flight evaluation of the critical terminal area situations under which red Land and Hold Short Operations lights must be illuminated and extinguished during high capacity operations at an airport by using pilot-in-the-loop flight simulation.
- Developed assessment tools and procedures to evaluate pilot workload during various flight conditions by using the LifeShirt® technology in simulated flight operations.

FY 2006:

- Developed methods to identify commercial aircraft touchdown points during commercial operations by using instrument landing systems (ILS) or non-ILS information, these methods will aid in understanding causes of aircraft overruns and runway excursions.

FY 2005:

- Provided measures of pilot reaction to laser illumination collected using FAA's B-737 flight simulator to support AC 70-1 "Outdoor Laser Operations" and AC 70-2 "Reporting of Laser Illumination of Aircraft".

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Risk Management Decision Support

- Demonstrated a one-third reduction in the rate of fatalities and injuries through the development of an analytical method and associated metrics.
- Completed a safety impact assessment of very light jets (VLJs) in the NAS.

Aviation Safety Information and Analysis Sharing

- Expanded ASIAS architecture to include the sharing of air traffic information and air carrier information among industry stakeholders.
- Continued development of automated tools to monitor databases for potential safety issues.
- Expanded prototype system to include the concepts of sharing information and applications among industry stakeholders from an enterprise-level, allowing diverse industry stakeholders to analyze data on an industry-wide basis rather than individual organizational level. The prototype system will contain a technical process

to query de-identified safety data from any participating airline Flight Operations Quality Assurance or Aviation Safety Action Program, aggregate it through a distributed database and make it accessible to appropriate industry stakeholders. The ASIAS prototype will be demonstrated in 2012.

- Conducted analytical studies, e.g., aircraft hazard analysis, determination of risk values for potential unsafe\ conditions, and flight crew intervention design credit, using ASIAS and other aviation safety data

Terminal Area Safety

- Completed testing procedures and requirements to identify required navigational performance (RNP) constraints related to terminal area operations.
- Evaluated air traffic and flight procedures for terminal area operations by using the pilot-in-the-loop flight simulators.
- Completed evaluating risks associated with undesired laser cockpit illumination.
- Analyzed the operational landing distance performance of selected aircraft make/model/series.
- Develop models of unusual attitude (wake, stall) encounters outside the normal operating envelope, allowing FAA to approve advanced flight simulators that more realistically model the behavior of an actual aircraft.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

Government, industry, and academia aviation safety subject matter experts will be invited to demonstrate a working prototype of a network-based integration of information extracted from diverse, distributed sources. The research will continue to develop innovative, advanced tools and methodologies that will for the first time be able to convert and integrate aviation safety data that is currently distributed across multiple organizations and archives into information on the operational performance and safety of the aviation system. Using ASIAS and other aviation safety data, analytical studies to identify safety issues and verify mitigation and safety enhancements will continue. Research and analysis will continue to ensure that the FAA maintains a desired level of safety while accommodating the need for more efficient use of the terminal area.

New Initiatives

None

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aviation Safety information Analysis and Sharing (ASIAS)

- Continue to develop an advanced infrastructure and laboratory for conducting and sharing analysis tools and aggregated safety information that allows industry stakeholders to perform standardized data analysis and vulnerability discovery on a wide variety of diverse sets of data.
- Continue development of automated tools to monitor databases for potential safety issues.
- Expand prototype system to include the concepts of sharing information and applications among industry stakeholders from an enterprise-level, allowing diverse industry stakeholders to analyze data on an industry-wide basis rather than individual organizational level. The prototype system will contain a technical process to query de-identified safety data from any participating airline Flight Operations Quality Assurance or Aviation Safety Action Program, aggregate it through a distributed database and make it accessible to appropriate industry stakeholders. The ASIAS prototype will be demonstrated in 2012.
- Conduct analytical studies, e.g., aircraft hazard analysis, determination of risk values for potential unsafe conditions, and flight crew intervention design credit, using ASIAS and other aviation safety data.
- Develop methods and risk models to evaluate advanced aircraft systems and component integration.

NAS Facility Services Data

- Develop a Facility Operations Module that includes enterprise-level business objects that store and make accessible data elements that are specific to NAS safety oversight.
- Develop a flexible user interface that provides safety oversight personnel the capability to monitor NAS facility operations as they occur with respect to failures, risk and other off-nominal occurrences.

Terminal Area Safety

- Continue testing procedures and requirements to identify RNP constraints related to terminal area operations.
- Conduct multiple operational evaluations of new technologies and procedures using human in the loop flight and air traffic simulators to improve flight safety and terminal area efficiencies
- Analyze the operational landing distance performance of selected aircraft make/model/series.
- Develop models of unusual attitude encounters outside the normal operating envelope, allowing FAA to approve advanced flight simulators that more realistically model the behavior of an actual aircraft.
- Identify new cockpit centric navigation technologies and data for the development of new procedures to enhance the safety and capacity within the terminal area.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	91,403
FY 2010 Enacted	12,698
FY 2011 Request	11,907
Out-Year Planning Levels (FY 2012-2015)	47,434
Total	163,442

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
System Safety Management	3,232	6,402	9,608	9,879	8,926
Personnel Costs	1,947	2,892	2,669	2,531	2,652
Other In-house Costs	113	223	211	288	329
Total	**5,292**	**9,517**	**12,488**	**12,698**	**11,907**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	5,292	9,517	12,488	12,698	11,907
Development (includes prototypes)	0	0	0	0	0
Total	**5,292**	**9,517**	**12,488**	**12,698**	**11,907**

A11.h - System Safety Management Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
060-110 System Safety Management							
Risk Management Decision Support	**0**						
Develop method and associated metrics to measure progress in reducing the rate of fatalities and injuries		♦	◊	◊	◊	◊	◊
Conduct System Safety Assessment of VLJs		♦					
Aviation Safety Information Analysis and Sharing	**5,320**						
Complete ASIAS CONOPS focused on the new data sharing concepts among commercial aviation stakeholders.		♦					
Develop advanced infrastructure and laboratory for conducting and sharing analysis tools and aggregated safety information		♦	◊	◊	◊		
Develop automated tools to monitor databases for potential safety issues		♦	◊	◊	◊	◊	◊
Develop prototype ASIAS system and associated reports		♦	◊	◊			
Conduct analytical studies using ASIAS and other aviation safety data		♦	◊	◊	◊	◊	◊
Develop methods and risk models to evaluate advanced aircraft systems and component integration.		♦	◊	◊	◊		
NAS Facility Service Data	**2,320**						
Develop Facility Operations Module			◊	◊	◊		
Develop a flexible user interface that provides safety oversight personnel the capability to monitor NAS facility operations			◊	◊	◊		
Terminal Area Safety	**1,286**						
Develop testing procedures and requirements to identify RNP constraints		♦	◊	◊			
Evaluate air traffic and flight procedures for terminal area operations by using human-in-the-loop flight and air traffic simulator		♦	◊	◊	◊	◊	◊
Evaluate devices and risks associated with undesired laser cockpit illumination		♦					
Identify contributing factors and develop models for landing performance of selected make/model/series aircraft using standard operating practices to improve the safety and capacity in terminal areas		♦	◊	◊	◊		
Develop models of unusual attitude encounters outside the normal operating envelope		♦	◊	◊			
Identify new cockpit centric navigation technologies and data for the development of new procedures to enhance the safety and capacity within the terminal area			◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**2,981**						
Total Budget Authority	**11,907**	**12,698**	**11,907**	**11,913**	**11,915**	**11,841**	**11,765**

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

Budget Item	Program Title	Request
A11.i	**Air Traffic Control/Technical Operations Human Factors**	**$10,475,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, and Organizational Excellence.

Intended Outcomes: The Air Traffic Control/Technical Operations (ATC/TO) Human Factors Program supports FAA strategic goals for increased safety and greater capacity by developing research products and promoting the use of those products to meet the future demands of the aviation system. The human factors research program for FY 2011 will emphasize the concept of Human System Integration (HSI) and safety aspects of the functions performed by air traffic controllers and technical operations personnel. The HSI concept will address the interactions between workstation design, personnel selection, training, and human error/safety. The program will examine the roles of controllers and maintainers at increased capacity levels and how those roles are best supported by allocation of functions between human operators and automation to enhance safety and minimize the potential for human error. The ATC/TO program generates requirements for human interface characteristics of future air traffic and technical operations (maintainer) workstations and enhances our understanding of the role that system design plays in mitigating human error including operational errors, runway incursions, and errors that result in NAS equipment outages. Additionally, researchers are developing effective methods to present weather information to air traffic specialists for severe weather avoidance and accident prevention, developing methods to select new air traffic service providers and maintainers so that the applicant screening process is valid, reliable, and fair, and improving human-system integration in the maintenance arena to increase reliability and availability of the NAS.

The research program works to improve system safety by:

- Developing:
  - A technical operations Human-System Integration roadmap that complements the introduction of advanced technology and automated capabilities as the NAS increases dependence on automation and leased services for critical data sources in the NAS that were formerly controlled by the FAA.
  - Methods to identify new potential human error problems as the air traffic service providers' roles and responsibilities change as a result of increasing automation levels.
  - Organizational changes to transform the technical operations Air Traffic Organization (ATO) safety culture.
  - Effective methods to present air traffic specialists weather information for accident prevention through severe weather avoidance.
- Improving:
  - Effectiveness of safety analyses that concentrate on detecting the potential for human error during the concept and research phases of system development.
  - Methods to select and train new air traffic service providers and maintainers.

The program works to improve the ATC and technical operations contribution to system capacity by:

- Developing:
  - Integrated workstations that allow technical operations specialists to meet increased availability and service demand.
  - Methods to assess the value of proposed changes to workstations to determine if human-in-the-loop performance is enhanced.
  - Advanced workstation concepts for maintenance workstations that use automation and advanced technology to increase availability of the NAS, decrease the probability of system outages, and decrease the cost of air traffic services.
- Improving:
  - Human-system integration in a manner that allows air traffic service providers and pilots to cooperatively manage traffic loads as cockpit technology and air traffic workstations are more closely connected to efficiently move NAS air traffic.

- Allocation and sharing of roles and responsibilities between air traffic service providers and pilots as technology evolves to meet future demands.

Agency Outputs: The Air Traffic Control/Technical Operations Human Factors Research Program provides leadership and products to motivate NAS evolution to assure that the system's human component will reliably perform to meet the flying public's needs. Outputs include:

- Air traffic workstations and concepts that increase workforce productivity by identifying key workload factors that must be mitigated to enable the humans in the system to manage the future NAS traffic flow.
- Human reliability analytical tools and methods to assess and mitigate the potential for human error.
- Assessments of the effectiveness of fatigue risk management strategies.
- ATO safety culture transformation through research in the Technical Operations community to identify effective interventions to move the ATO toward a "Just Culture."
- Future air traffic service provider and maintainer personnel selection criteria to enhance screening process efficiency and effectiveness.
- Guidelines and standards for design of computer-human interfaces used in Technical Operations.

Research Goals:

- By FY 2011, complete a study to determine the feasibility of performing a quantitative analysis of human reliability in the air traffic domain.
- By FY 2011, initiate a study to determine the effectiveness of fatigue management changes in air traffic control.
- By FY 2012, improve computer-human interface design to reduce information overload and resulting errors.
- By FY 2012, apply program-generated human factors knowledge to improve aviation system personnel selection and training.

Customer/Stakeholder Involvement: The ATC/ATO Human Factors research program receives requirements from its internal FAA sponsoring organizations, primarily the following FAA ATO Air Traffic/Technical Operations research groups:

- Advanced Air Traffic Systems Requirements Group – En Route and Terminal Service units as well as System Engineering in Operations Planning, operational personnel and systems developers articulate human factors research requirements for measuring the proposed technology benefits to controllers and maintainers. FAA Flight Standards and Aircraft Certification organizations participate in the research requirements definition associated with pilot/controller interface with air-ground integration weather aspects as the FAA moves toward a vision of the future NAS.
- Individual and Team Performance Requirements Group – ATO Safety, En Route, Terminal, Technical Operations and System Engineering service units participate to identify human performance research needs involving fatigue, safety culture, human error hazard identification, age, operational errors, runway incursion prevention, and supervisor practices.
- Advanced Technical Operations Systems Requirements Group – The Technical Operations, En Route, and Terminal service units recommend NAS infrastructure operational and maintenance research including ATC systems maintenance displays, controls, and maintainability features specification.
- Personnel Selection and Training Requirements Group – ATO Technical Training and Development, Human Resources, FAA Academy, Workforce Services, and the Financial Services groups address personnel selection and training including the ability to successfully screen applicants for controller positions and for reduced training cost and time.

R&D Partnerships:

- Collaborative research with NASA includes fatigue risk management, training effectiveness, and innovative human error safety analytical techniques.
- Collaboration with EUROCONTROL includes joint development of a Human Reliability Assessment Tool, participation in semi-annual Air Traffic Management (ATM) Seminars, and leadership of an Action Plan 15 Safety workgroup to identify ATM human factors issues.
- Cooperation with the ICAO-endorsed NOSS Collaborative (Normal Operations Safety System/Threat & Error Management) to assess controller safety.

- Cooperative research agreements are in place with Massachusetts Institute of Technology, Georgia Institute of Technology, St. Louis University, Ohio State University, and American Institutes for Research.

Accomplishments: Program highlights include:

FY 2009:

- Developed a tool for human reliability analysis in collaboration with EUROCONTROL human factors experts to assess the impact of changes to air traffic management planned by both the US and European air traffic service providers.
- Delivered a human factors specification/standard for the design of TO workstations.
- Initiated a Human System Integration study of the impact future air traffic maintenance concepts on the Technical Operations workforce.
- Conducted simulations to determine the appropriate use of data communications in terminal airspace.
- Conducted preparations for an air-ground integration simulation regarding improved weather products at the controller workstation to enhance safety in the NAS.
- Calculated safety risks of an operational error (OE) occurring as a function of the amount of time spent on position.

FY 2008:

- Completed tower simulation infrastructure to support NextGen human factors research for the airport domain.
- Application of en route workstation research concepts that are being transferred to the operational arena as the data communications program matures through the initial integration of this technology.
- Completion and dissemination of a tower supervisor best practices study to suppress the potential for runway incursions and operational errors.
- Validated the Human Error Safety Risk Assessment (HESRA) research tool on a wake turbulence system in the early stages of development to manage safety risk prior to system development and fielding. This research tool will be transferred to the operational domain via the Safety Management System (SMS) toolbox.
- Completed first stage of safety culture enhancement by transfer of the technical operations aviation safety action program (ASAP) to the operational domain.
- Completed data collection for the technical operations work force anthropometric measurement database.
- Developed a maintenance domain alerts and alarms human factors design standard.
- Conducted a NOSS trial in a FAA facility to demonstrate the utility of the concept and provide unique safety data for the participating facility.
- Initiated a maintainable and extensible job/task analysis information database providing the ability to access, update, and report requirements in parallel with NextGen development.
- Developed and validated a technically sound computer-based practical color vision test that relates to ATC tasks.

FY 2007:

- Completed simulations that evaluate capacity enhancements when en route workstations are provided with data communications and aircraft self-spacing and self-separation provisions.
- ATC safety alerts study completion in response to National Transportation Safety Board concerns that controllers are not responding properly to prevent mid-air collisions and controlled flight into terrain accidents.
- Tower situation display demonstration with integrated flight data to reduce display clutter and integrate tower controller tasks.
- Initiation of a tower controller external vision requirements study to support staffed virtual tower development with no direct airport surface view.
- Safety Culture improvement project expansion to more facilities enabling the technical operations community to improve safety
- Transfer of the National Air Traffic Professionalism Program (NATPRO) to the En Route service unit as a research product that is making the transition to the operational domain.

- Updated en route and terminal job task analyses and developed air traffic controller performance standards.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed a human factors display standard that will be used as a system design requirements document to leverage past lessons learned and aid the move toward a common display platform for all air traffic domains where similar display requirements exist.
- Conducted simulations and analyses of controller time-on-position as it relates to operational errors. The analyses will seek to find the minimum time on position that provides an adequate level of situation awareness and the maximum time beyond which mental fatigue induces human error.
- Refined a tool for human reliability analysis in collaboration with EUROCONTROL human factors experts to assess the impact of changes to air traffic management planned by both the US and European air traffic service providers.
- Conducted a survey to determine the effectiveness of controller fatigue management changes introduced in FAA Orders during 2009
- Continued a Human System Integration Study of the impact future air traffic maintenance concepts on the Technical Operations workforce.

FY 2011 PROGRAM REQUEST

The program will continue to provide research that will operate in concert with other human factors system development activities that are focused on the NextGen solutions being proposed for the future NAS. This research program addresses human performance issues in ATC systems acquisition, design, operation, and maintenance over the next several years with an emphasis on safety, training and personnel selection as part of the Human System Integration concept. The human factors research program will continue to emphasize the safety aspects of NAS enhancements as NextGen changes emerge and change the interactions between the actors and systems in the NAS. The proactive analysis of human error causal factors continues to be the focus of a portion of this research program.

Advanced Air Traffic Systems

- To support the Agency goal to reduce General Aviation (GA) accidents the Flight Standards organization in collaboration with the ATO Safety service unit has requested that the Human Factors Research Program develop human factors display requirements for controller weather information. Weather is a major factor in GA fatalities and controllers are in a unique position to aid pilot decision-making.
- The ATO Terminal service unit has noted that there are a plethora of alerts and alarms in airport traffic control towers. Many new systems, including NextGen systems, are proposing to bring new displays and alerts to the tower on a piecemeal basis. The Terminal service unit has requested the development of a human factors display standard for tower air traffic control alerts.

Individual and Team Performance

- In response to NTSB concerns regarding controller fatigue the Human Factors research program has worked with the ATO to institute changes to controller scheduling policy. The ATO Safety service unit has requested that we determine the effectiveness of controller fatigue mitigation strategies associated with changes to controller scheduling requirements.
- An important component of the ATO safety program concerns the enhancement of our safety culture. The Technical Operations Safety Culture Transformation project in this research program has been successful and the initial phase is making the transition to an operational program. The technical operations service unit has requested that we continue work in human error reduction and reporting by expanding the application to the management portion of the organization.

Advanced Technical Operations Systems

- The Technical Operations service unit has indicated that maintenance technicians are confronted with as many as 40 different interfaces with non-standard characteristics that must be memorized and manipulated. This service unit has offered a research requirement to standardize the user interface by developing human

factors requirements for a standard graphical user interface on maintenance work stations and system displays used by maintainers.
- The future concept of operations for maintenance of air traffic systems will involve an increase reliance on conducting maintenance from remote locations. The Technical Operations service unit has requested the continued development of human factors information requirements for remote maintenance monitoring.

Personnel Selection and Training

- The ATO is making significant investments in the procurement of new training simulators for tower cab controllers. The Terminal service unit has requested that we complete a training effectiveness evaluation methodology and apply the methodology to a new tower simulator by 2011.
- Previous color vision tests for air traffic controllers were not job related and not tied to the use of color on air traffic displays. The aero medical representatives in the controller selection process have requested the continued testing and validation of a newly developed occupational test of ATC specialist color vision that is job related.
- Potential changes to the air traffic system purport to encompass a shift in the job of the controller due to the increased use of automation and new concepts in traffic management and aircraft navigation. If these changes take place there may be a need for new controller selection criteria. The identification of the new criteria requires a Strategic Job Analysis for air traffic controllers.
- The FAA is rapidly changing the types of technology and maintenance concepts used by air traffic systems. The technical operations community has identified the need to review the selection criteria for maintenance personnel by performing an update of the air traffic systems maintainer Job Task Analysis.

New Initiatives

New research will focus on human factors engineering design aspects of HSI. This will also require an updated maintenance concept including increased availability of NAS systems, a maintainer personnel roadmap and a concerted effort to reduce the effects of human error during the maintenance process:

- Update the Human Factors Design Standard. This document was published in 2003 and is cited as a design standard in every major FAA procurement that has a human interface. Planned publication for the document is 2013 and will be coordinated with the Department of Defense Mil-Std-1472 update currently under way.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Air Traffic Systems

- Developing human factors display requirements for weather information as technology provides weather information to the cockpit as well as the controller work station.
- Developing a human factors display standard for tower air traffic control displays.

Individual and Team Performance

- Determine the effectiveness of controller fatigue mitigation strategies associated with changes to scheduling requirements.
- Continue work in human error reduction and reporting by expanding the application of research in transformation of the ATO safety culture.

Advanced Technical Operations (TO) Systems

- Develop human factors requirements for a standard graphical user interface on maintenance work stations and system displays used by maintainers.
- Continue development of human factors information requirements for remote maintenance monitoring

Personnel Selection and Training

- Complete a training effectiveness evaluation methodology and apply to a new tower simulator.
- Complete the development and testing of a occupational test of ATC specialist color vision
- Complete the Strategic Job Analysis for air traffic controllers
- Complete an update of the air traffic systems maintainer Job Task Analysis

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	182,574
FY 2010 Enacted	10,302
FY 2011 Request	10,475
Out-Year Planning Levels (FY 2012-2015)	43,439
Total	246,790

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Air Traffic Control/Technical Operations	4,130	4,333	4,142	4,389	4,302
Personnel Costs	5,285	5,443	6,128	5,617	5,800
Other In-house Costs	239	224	299	296	373
Total	**9,654**	**10,000**	**10,469**	**10,302**	**10,475**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2007 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	9,654	10,000	10,469	10,302	10,475
Development (includes prototypes)	0	0	0	0	0
Total	**9,654**	**10,000**	**10,469**	**10,302**	**10,475**

A11.i – Air Traffic Control/Technical Operations Human Factors Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
082-110 Air Traffic Control/Technical Operations Human Factors							
Advanced Air Traffic Systems	**850**						
Developing human factors display requirements for weather information		♦	◊	◊			
Developing a human factors display standard for tower air traffic control displays		♦	◊	◊	◊	◊	◊
Update to Human Factors Design Standard			◊	◊	◊		
Individual and Team Performance	**1,200**						
Determine the effectiveness of controller fatigue mitigation strategies		♦	◊				
Continue research in transformation of the ATO safety culture		♦	◊	◊	◊	◊	
Technical Operations (TO)	**1,202**						
Develop human factors standard graphical user interface on maintenance work stations		♦	◊				
Development of human factors information for remote maintenance monitoring		♦	◊	◊			
Personnel Selection and Training	**1,050**						
Complete a training effectiveness evaluation methodology and apply to a new tower simulator		♦	◊				
Complete the development and testing of a occupational test of ATC specialist color vision		♦	◊				
Complete the Strategic Job Analysis for air traffic controllers		♦	◊				
Complete an update of the air traffic systems maintainer Job Task Analysis		♦	◊				
Personnel and Other In-House Costs	**6,173**						
Total Budget Authority	**10,475**	**10,302**	**10,475**	**10,633**	**10,799**	**10,934**	**11,073**

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

Budget Item	Program Title	Budget Request
A11.j	**Aeromedical Research**	**$11,217,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety.

Intended Outcomes:

Civil Aerospace Medical Institute (CAMI) Aeromedical Research Program

The Aeromedical Research Program supports FAA's Flight Plan Goal for Increased Safety by:

- Investigating and analyzing injury and death patterns in civilian flight accidents and incidents to determine their cause and develop preventive strategies.
- Supporting FAA regulatory and medical certification processes that develop safety and health regulations covering all aerospace craft occupants and their flight environments.
- Recommending and developing equipment, technology, and procedures for optimal:
  - Evacuation and egress of humans from aerospace craft;
  - Dynamic protection and safety of humans on aerospace craft; and
  - Safety, security, and health of humans on aerospace craft.

Research program outcomes include improved safety, security, protection, survivability and health of aerospace craft passengers and aircrews. The Aeromedical Research Program supports FAA's Flight Plan goals to reduce air carrier fatalities, reduce the number of fatal accidents in general aviation and support FAA organizational excellence by:

- Exploiting new and evaluating existing bioaeronautical guidelines, standards, and models for aerospace craft cabin equipment, procedures, and environments.
- Providing research data to serve as the basis for new regulatory action in evaluation of existing regulations to continuously optimize human performance, health, and safety at a minimum cost to the aviation industry.
- Analyzing pilot medical and flight data, information from accidents and incidents, and advanced biomedical research results to propose standards and assess certification procedures that optimize performance capability.
- Evaluating the complex mix of pilot, flight attendant and passenger activities in a wide range of environmental, behavioral, and physiological situations to propose standards and guidelines that will enhance the health, safety, and security of all aerospace travelers.

Airliner Cabin Environment Research Program

The Airliner Cabin Environment Research Program supports FAA's Flight Plan Goal for Increased Safety by:

- Developing and testing adaptive environmental control techniques to enable a safe and healthy cabin air environment including during in-flight incidents.
- Validating software tools and methods to mitigate possible air contamination incidents during flight and ground operations.
- Developing advanced air chemistry models for interaction of atmospheric ozone and volatile organic compounds.
- Developing advanced methods to automatically analyze textual safety reports and extract system performance information for prognostic identification of safety risks for system operators and designers.
- Developing advanced scientific models and experimental data of airborne and surface transmission of existing and emerging infectious diseases within aircraft.
- Evidence-based development of appropriate hazard identification and risk management criteria guidelines to maximize safety and health in the air transportation system in response to infectious disease.
- Recommending and developing equipment, technology, and procedures for optimal:

- Evidence-based development of appropriate policy, regulations and guidelines to maximize safety and health from the cabin air quality environment;
- Identifying hazards and characterizing risks of the major infectious diseases likely to be carried on-board aircraft;
- Providing air quality incident identification to alert crew to potential problems and provide signals to the environmental control system for appropriate response; and
- Providing for safety, security and health of passengers and crewmembers on commercial aircraft.

Agency Outputs: Agency outputs proceed from the FAA Office of Aviation Medicine (AAM), specifically, 1) the Civil Aerospace Medical Institute (CAMI) and 2) the FAA National Air Transportation Center of Excellence (CoE) for Research in the Intermodal Transportation Environment (RITE).

CAMI Aeromedical Research Program

CAMI's Aeromedical Research Program provides research data to assess new technology, and evaluate existing bioaeronautical guidelines, standards, and models for aerospace craft cabin equipment, procedures, and environments. Aeromedical research serves as the basis for new regulatory action and evaluation of existing regulations to continuously optimize human performance and safety at a minimum cost to the aviation industry. This research program analyzes pilot medical and flight data, information from accidents and incidents, and advanced biomedical research results to propose standards and assess certification procedures that optimize performance capability. This research program is conducted by in-house resources, specifically the CAMI Aerospace Medical Research Division and supports Airliner Cabin Environment Research efforts.

Airliner Cabin Environment Research Program

The FAA National Air Transportation Center of Excellence (CoE) for Research in the Intermodal Transportation Environment (RITE) was formulated in response to issues raised in a 2002 National Research Council Report regarding Airliner Cabin Environment and the Health of Passengers and Crew during normal and events outside the normal operational envelope. RITE addresses public, aircrew, and congressional concerns regarding these issues including: disease transmission, contaminant transport, ozone (including chemical reactivity of aircraft cabin interiors), pesticides (residual and sprayed), and contaminants that may be carcinogenic used as additives in hydraulic and lubricating fluids in aircraft engines and Auxiliary Power Units (APUs) and identified as possible neurological toxins in crew members. RITE also conducts R&D on cabin air quality sensors, advanced environmental control systems, and on chemical and biological agents, disinfection techniques and aircraft materials compatibility with disinfection processes. The research is primarily conducted by universities and the industry. Established in 2004 by the FAA Administrator, RITE is led by Auburn University, with Harvard and Purdue Universities as Technical Co-Leads. Other member universities include Boise State University, Kansas State University, the University of California at Berkeley, and the University of Medicine and Dentistry of New Jersey.

The FAA and RITE are uniquely positioned to provide evidence based research data to assess new technologies, provide hazard identification and risk assessment for aircraft cabin environmental events and provide appropriate guidelines, propose standards, and models for aircraft cabin equipment, procedures, and environments. The airliner cabin environment research program serves as the basis for new regulatory action and evaluation of existing regulations to continuously optimize the safety and health of passengers and crewmembers at a minimum cost to the aviation industry.

Research Goals:

CAMI Aeromedical Research Program

- By 2012, validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability.
- By 2012, establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.
- By 2015, apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors.

- By 2015, incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control.
- By 2015, develop advanced methods to extract aeromedical information for prognostic identification of human safety risks.
- By 2015, develop a methodology to compile, classify, and assess aviation-related injuries, the mechanisms that resulted in these injuries, and their relationship to: autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic testing: Aerospace Accident Injury and Autopsy Data System (AAIADS)

Airliner Cabin Environment Research Program

- By 2011, apply and validate advanced air sensing technology for volatile organic compounds in the aircraft cabin environment.
- By 2011, develop bleed air contamination models of engine compressors and high temperature air system for effects on health and safety of passengers and crew.
- By 2012, complete experimental projects in support of regulatory, certification, and operations for existing Aviation Rulemaking Committees by providing data and guidance for new or revised regulation of airliner cabin environment standards.
- By 2012, develop and validate chemical kinetic models for bleed air systems for health and safety effects on passengers and crew.
- By 2013, develop advanced data and mathematical models for cabin air purification systems.
- By 2015, establish design criteria for aircraft cabin air quality sensing systems.
- By 2015, demonstrate advanced methods to remove contaminants from bleed air and non-bleed air ventilation systems.

Customer/Stakeholder Involvement:

CAMI Aeromedical Research Program

- Directly supports the bioaeronautics agenda set forth in the Executive Office of the President, National Science and Technology Council, National Plan for Aeronautics Research and Development and Related Infrastructure (NPARDRI), released 1/10/2008.
- Directly supports the bioaeronautics agenda set forth in the Executive Office of the President, Office of Management and Budget (OMB) and Office of Science & Technology Policy (OST) FY 2009 Administration R&D Budget Priorities, 8/14/2007 (EOP).
- Provides research for FAA, European Aviation Safety Authority and Transport Canada under the Aircraft Cabin Safety Research Plan. This is a coordinated, living plan to maximize the cost/benefit of aerospace craft cabin safety research nationally and internationally.
- Supports multi-year collaborative studies by FAA and other government and industrial entities to evaluate flight crew and passenger symptomatology, disease, and impairment.
- Supports the NextGen Implementation Plan, Smart Sheets, Solution Set Increased Safety, Security and Environmental Performance, Safety Management Systems.

Airliner Cabin Environment Research Program

- The Airliner Cabin Environment Research Program directly supports the FAA's Statutory Authority, 49 USC 40101D, 44701A, 40 FR 29114 DOT, 49 CFR 830.5, Public Law 106-81, 14 CFR 1.1, 21, 25, 121, 125, and 135 to protect the health and safety of passengers and crewmembers.
- The Executive Office of the President, National Science and Technology Council, National Plan for Aeronautics Research and Development and Related Infrastructure.
- The Executive Office of the President, OMB and OST FY 2009 Administration R&D Budget Priorities.
- White House Implementation Plan for National Strategy for Pandemic Influenza.
- World Heath Organization International Health Regulations agreed to by the Secretary, Department of Transportation

- Supports multi-year collaborative studies by FAA, other government agencies, and industrial entities to evaluate airliner cabin environment to protect the safety and health of passengers and crewmembers.
- Supports the Wendell H. Ford Aviation Investment and Reform Act of the 21 Century section 725; Public Law 106-181.
- Supports the FAA National Air Transportation Center of Excellence for Research in the Intermodal Transport Environment
- Supports the White House Implementation Plan for National Strategy for Pandemic Influenza.
- Provides collaborative research with the Civil Aviation Authority-United Kingdom on cabin air quality.
- Supports the Health and Human Services Implementation Plan to characterize viral subtypes and enable detection and investigation of suspected cases and detect increase in disease activity in the aircraft cabin environment.

R&D Partnerships:

CAMI Aeromedical Research Program

- Direct collaboration with the DoD, NASA, and NTSB on accident investigation, crashworthiness, in-flight turbulence, aerospace medicine, ocular injury from lasers, and exposure to cosmic radiation.
- Develops Cooperative Research and Development Agreements (CRDA) and Memorandums of Understanding/Agreement (MOA/U) with industry to ensure collaborative projects benefiting both FAA and the aviation industry.
- Participates in North Atlantic Treaty Organization (NATO) aerospace medical advisory groups, the European Union, and many academic institutions and government laboratories.
- Established National Research Council (NRC) postdoctoral programs to conduct research in molecular biology, bioinformatics, environmental physiology, and other aviation medicine fields at CAMI.
- Established a professional relationship with over 90 organizations and 55 committees including holding fellowships and other leadership positions. These scientific, medical, and bioengineering relationships include working in partnership on a multitude of efforts with these organizations including the following:
  - Cabin Safety Harmonization Working Group
  - Seat Certification Streamlining Effort
  - The National Safety Council
  - Society of Automotive Engineers
  - Aerospace Medical Association
  - Civil Aviation Medical Association
  - American Society of Mechanical Engineers
  - American Ophthalmological Society
  - Society of Forensic Toxicologists
  - American Academy of Forensic Science

Airliner Cabin Environment Research Program

RITE has over 30 industry partners participating in the research and development effort. RITE researchers and Office of Aerospace Medicine staff members collaborate with leading organizations associated with aerospace medicine, aviation health, airliner cabin environment and safety, including:

- Direct coordination and collaboration with the DoD
- Direct coordination and collaboration with Department of Homeland Security, Transportation Security Administration
- Environment Protection Agency
- Health and Human Services
- Centers for Disease Control and Protection
- National Institute for Occupational Health and Safety
- International Civil Aviation Organization.
- International Aviation Transportation Association
- Air Transport Association
- Boeing
- Delta

- Honeywell
- American Society of Heating, Refrigerating and Air-Conditioning Engineers
- American Society for Testing and Materials International
- Memorandum of Cooperation with the Civil Aviation Authority-United Kingdom to collaborate and coordinate airliner cabin environment research in sampling and analyzing air quality in aircraft cabins.
- Develops cooperative research and development agreements with industry to ensure collaborative projects benefiting both FAA and the aviation industry.
- Participates and coordinates airliner cabin environment research with Air Transportation Association Medical Committee and Cabin Technical Operations Committee.

Accomplishments:

FY 2009

CAMI Aeromedical Research Program

Aeromedical Systems Analysis

- Obesity in Civil Aviation – Cross-functional Study: demographic findings in obese pilots, Body Mass Index of insulin-dependent Pilots, toxicology, medical certification, and autopsy Findings.
- Internet Research Assistant Panel Review –Open Source Software and Aeromedical Websites.
- Successfully testified for the FAA in 2 court proceedings regarding research on spatial disorientation.
- Collaborated with National University of Colombia (NUC): Ischemic Heart Disease in Airline Transport Pilots.
- Under the ongoing FAA adoption of SMS, developing Probabilistic Risk Assessment (PRA) techniques to use with aeromedical certification decision making. Collaboration with NASA.
- Completed the Segmented Regression Analysis for detecting sharp changes ("breakpoints") of a response function at an increase or decrease of an influential factor. This approach allows the assessment of regulatory changes.
- Collaborated with Ministry of Health, Iraq: Psoriasis and Coronary Artery Diseases in the U.S. Civilian Pilot Population.
- Collaborated with NUC and 4th Military Medical University of China: review of aeromedical certification records - Diabetes.
- Performed Aviation Safety 2008: Year in Review.
- Aircraft Accident – Injury and Autopsy Data System (AA-IADS): Functional Requirements Phase completed; Design Phase initiated.
- FAA AAM Aerospace Accident Review Program: Developed centralized medical aircraft accident review program to acquire/store pilot medical information for all fatal and high profile accidents.
- Evaluated Next-Generation Vision Testers for Aeromedical Certification of Aviation Personnel (pilots, maintenance personnel, and inspectors). These new visual screeners (testers) have been implemented by AAM for the aeromedical certification of pilot applicants.
- Revised the American National Standards Institute (ANSI) Z136.6: American National Standard for Safe Use of Lasers Outdoors.
- Developed an Aerospace Standard (AS) to establish performance criteria for control measures to prevent harmful exposure of flight crew.
- Monitored and assessed visual effects and operational problems resulting from pilot exposure to laser and high-intensity lights.

Accident Prevention and Investigation

- Developed new procedure for screening human specimens from aviation accidents. The old method required the use of 2 different pieces of equipment and took twice as long as the new method that only requires the use of 1 instrument.

- Artificial formation of carbamazepine from oxcarbazepine: Helped to differentiate the two compounds derived from this anticonvulsant and mood stabilizing drug. It is used primarily in the treatment of epilepsy and bipolar disorder.
- Distribution of Oxycontin™ (oxycodone) in postmortem fluids and tissues – Collaboration with Biochemistry Research Team. This information will help elucidate the significance of an oxycodone concentration in a tissue specimen when no blood is available for analysis (35% of analyses).
- Assessment of the 2nd seven years of FAA's Postmortem Forensic Toxicology-Proficiency Testing Program. This research verifies that CAMI maintains continuous state-of-the art analytical capabilities for aviation related toxicological substances.
- Revised Alcohol Testing in the Workplace - Book Chapter. Medical Review Officer Handbook – Chapter 3: "Laboratory Procedures and Analysis" 9th Edition, Quadrangle Research, Research Triangle Park, NC.
- Aerospace toxicology overview for the period of 1960–2007. This review addresses the historical aspects and recent advances in the field.
- Toxicological findings in fatally injured obese diabetic pilots involved in aviation accidents. These findings will be helpful in adjudicating aeromedical certification issues associated with obese and/or diabetic pilots.
- Assessed the Increased Cannabinoids Concentrations Found in Specimens From Fatal Aviation Accidents Between 1997 and 2006.
- Developed first-generation gene-expression-based assay for fatigue using a limited sample set.
- Investigated RNA source for gene expression from buccal cells - non-invasive, easy to collect, facilitates experimental design.
- Investigated physiological effects of 6,000 ft and 7,000 ft cabin altitudes on compromised passengers with chronic and stable cardiac/ pulmonary disease. Performed cytokine analysis. Supports ACER Program.
- Explored hypoxia-induced expression changes from decreased cabin oxygen levels at altitudes significant to the aviation industry.

Protection and Survival

- Computer simulation of airliner emergency evacuation: Continued application of the cabin evacuation model to assess factors that predict evacuation event outcomes. Utilize the model to evaluate changes to aircraft cabin layouts and procedural changes that would have impacted an evacuation in a negative manner. Apply lessons learned to research and the development of improved safety training programs.
- Evaluated the Comprehension of Symbolic Exit Signs (design and presentation context) by the general public.
- Inflation Performance of Emergency Escape Slides at High Altitude. Assisted in the evaluation of high-altitude performance of a set of slides from a single airplane type, in order to gain specific performance information that can be used to develop computation correction factors to assist certification of slides for operations at high-elevation airports and to support potential technical revision of TSO C69.
- Evaluated the Effective Presentation Media for Passenger Safety Briefings.
- Aviation Child Restraints: Combined sled tests and computer modeling to develop specifications and test requirements to support certification of advanced aviation child restraint systems and revision of TSO-C100.
- Side Facing Seat Certification: Developed comprehensive technical requirements from existing research results to support new certification policy.
- Head/Neck Injury Potential: Assessed head/neck injury potential for various aircraft interiors. Expansion of FAA Technical Center side impact project to include head/neck injury potential in the fore/aft direction.

Aviation Physiology

- Computer simulation of airliner emergency evacuation: Continued application of the cabin evacuation model to assess factors that predict evacuation event outcomes. Utilize the model to evaluate changes to aircraft cabin layouts and procedural changes that would have impacted an evacuation in a negative manner. Apply lessons learned to research and the development of improved safety training programs.
- Developed programs used worldwide to determine radiation exposures of air travelers.
- Worked with NASA and NOAA in providing information to pilots on exposures from galactic and solar cosmic radiation.
- Maintained the FAA Solar Radiation Alert System.

Airliner Cabin Environment Research Program

- Completed a laboratory study of ozone reactions with common aircraft cabin materials as well as ozone reactions with clothing, perfumes, skin oils, etc. Determined that resultant carbonyls, dicarbonyls, acids, and miscellaneous other volatile organic compounds adversely affect perceived air quality and may affect passenger and crew health.
- Completed initial experimental campaign of airliner pesticide sampling measurements on both domestic and international flights.
- Performed statistical analyses on physiological data from study of the effects of 7000 ft cabin altitudes on health-compromised, older people. Found a ~ 50% decrease in arterial blood oxygen at simulated altitudes as compared with the ground level baseline. Determined that age is the most highly correlated parameter, i.e., older people tend to desaturate more.
- Performed statistical analyses of 4300+ health surveys of flight attendants for underlying and occupational-related health conditions. Quantified the percentage that reported one or more work related injuries/illnesses last year and determined that respiratory symptoms were the greatest cause of visits to medical providers.
- Completed measurements of cabin air quality (ozone, carbon monoxide, carbon dioxide, volatile organic compounds, PM2.5, etc.) on 40 flight segments.
- Tricresyl phosphate sensor: Tricresyl phosphate is one of the key bleed air contaminants of potential concern. Refined the successful laboratory technique and packaged the components to enable a future demonstration of the technology in a bleed air simulator.
- Determined exhaled bioaerosol characteristics and used the data to develop a computational model of airborne disease transmission on aircraft
- Developed an experimental protocol and laboratory facility to assess potential hydrogen embrittlement of high strength steels due to exposure to vaporized aircraft disinfectants.
- Completed a preliminary flammability study on the effects of hydrogen peroxide on common aircraft textiles.
- Completed a feasibility study of the ability of modern atmospheric databases and models to predict atmospheric ozone and improve the ability of airline flight planners to meet ozone regulations.

FY 2008

CAMI Aeromedical Research Program

Aeromedical Systems Analysis

- The aerospace Medical Research Scientific Information System (SIS) software was documented for use by aeromedical research scientists.
- Completed phase I of a cross functional study of diabetes in civil aviation.
- Continued the development of an Aerospace Accident Injury and Autopsy Data System (AAIADS) – realized significant coordination & collaborative activities.
- Accepted FAA Accident Autopsy Program responsibilities.
- Completed the program on quality control and assurance concerning the use of the CAMI Data Imaging and Workflow System (DIWS).
- Completed the Quality Control and Assurance Software Tool (computer code) to facilitate risk management processes in medical certification of aircrew.
- Examined the frequency and rate of aviation-related laser incidents by year and location.
- Evaluated All-Strobe Approach Lighting Systems.
- Evaluated new design Optometric Test Devices.
- Provided recommendations regarding Infrared Radiation Transmittance and Pilot Vision Through Civilian Aircraft Windscreens
- Provided Safety Considerations for High-Intensity Lights Projected into the Navigable Space: SAE G10-T Working Group: Aerospace Recommended Practice (ARP) document.
- Assessed the Medical Certification Of Civilian Pilots Fitted With Multifocal Contact Lenses and those Considering Laser Eye Surgery.

- Assessed Aircraft accidents and incidents associated with visual effects from bright light exposures during low-light flight operation
- Assessed Laser Exposure Incidents: Pilots Ocular Health And Aviation Safety Issues.

Accident Prevention and Investigation

- Compared usage of both illegal drugs and abused prescription medications in pilots involved in civil aviation accidents with that of the general population in the United States.
- Examined the Vitreous Fluid and/or Urine Glucose Concentrations in 1,335 Civil Aviation Accident Pilot Fatalities.
- Completed the formulation of the ISO 27368 Blood Gas Analysis International Standard.
- A new equation was developed to prevent false negative drug results.
- Biomarker Response to Altitude: The test phase of two studies to assess gene expression changes that occur as a result of exposure to decreased oxygen levels have been completed.
- Biomarker Response to Alcohol: Gene expression studies have been developed to identify biomarkers associated with alcohol consumption of levels up to 0.08%.
- Biomarker Response to Fatigue: A preliminary study of the effects of fatigue was undertaken in collaboration with the United States Air Force.

Protection and Survival

- Evacuation Models: A computer simulation of airliner emergency evacuation was developed and demonstrated for both narrow and wide body aircraft.
- Comprehension of Safety Material and Signs - Commercial Airliner "EXIT" signs and symbols were evaluated.
- Comprehension of Safety Briefing Card Pictorials and Pictograms was evaluated.
- Mathematical Prediction of the Effectiveness of Emergency Evacuation Aids (slides) – model continued development
- Assessed the inflation Performance of Emergency Escape Slides at High Altitude.
- Occupant Seat/Restraint Models: Measures of accuracy for dynamic mathematical models have been developed and tested.
- Side Facing Seat Safety Criteria: A study of the injury potential of side facing seats using a specialized anthropomorphic test dummy has been completed.
- Assessed head and neck injury potential for occupants of typical aircraft seats and interior configurations during forward impacts.

Aviation Physiology

- Software: Refined equations used for the calculation of radiation doses received by pilots and crew were completed and implemented into the early warning radiation alert system.
- Determined the cosmic radiation exposure of aircraft occupants on simulated high-latitude flights during solar proton events from 1986 through 2008.
- In conjunction with Harvard University, a study was completed on the effect of normal cabin altitude in an older (50-80 years old) and less than healthy (smokers/cardiac conditions) passenger population.
- Supported the field evaluation of whole airliner decontamination technologies; wide-body aircraft with dual-use application for railcars in support of the RITE effort.
- Contributed to the development of Guidelines for Life Support Equipment and Cabin environment issues - crew and passenger safety requirements for very high altitude air or spacecraft.
- Contributed to training recommendations for occupants of orbital or suborbital vehicles.
- Conducted a review of Technical Order and AC addressing the exposure of pilots & crew to excessive levels of carbon monoxide.

Airliner Cabin Environment Research Program

- Aircraft Decontamination System: Complete field evaluations of an aircraft thermal decontamination system. The system uses the complementary dual decontamination technologies of thermal desorption (high temperature and relative humidity) and vaporized hydrogen peroxide to kill a full spectrum of biological agents. The evaluations were performed on a McDonnell Douglas DC-9 and a Boeing-747 aircraft.
- In conjunction with CAMI, a study was completed to assess the physiological effects of 7,000 ft cabin altitudes on passengers with chronic and stable cardiac and/or pulmonary disease.

- Extensive study ongoing of the chemicals deposited on high efficiency particulate air (HEPA) filters during airliner service; identification of key markers of contamination.
- Development of miniature sensor array for chemical and physical assessment of the aircraft cabin.
- Laboratory demonstration of an electrochemical sensing technique for the detection of tricresyl phosphate - one of the principal chemicals of concern during contamination of bleed air from jet engine lubricants.
- Identified previously unanticipated ozone reaction chemistry to form volatile organic compound contaminants.
- Collected 4,000 health surveys of flight attendants for underlying and occupational related health conditions and begun statistical analysis air quality incidents.
- Developed protocol for measuring critical cabin pressures for at-risk passengers and crewmembers.
- Developed protocol for onboard pesticide sampling.
- Initiated research collecting baseline data for volatile organic compound contaminants on loaded filters.
- Completed materials compatibility studies of aluminum aerospace alloys and airliner cabin textiles with prototype decontamination technology.

FY 2007

CAMI Aeromedical Research Program

- Evaluated the medical aspects of extending first-class FAA medical certificate to 12 months for pilots under age 40.
- Development of software and procedures to support quality assurance evaluation of airman medical records.
- Development of an Aircraft Accident/Injury and Autopsy Data System (AA-IADS).
- Evaluated aircraft windscreen transmittance characteristics as they relate to emerging laser technologies employed in the NAS.
- Performed analysis of civilian air show accidents.
- Evaluated the effectiveness of simulators in upset recovery training.
- Determined the distribution of fluoxetine, vardenafil, glucose, hemoglobin A1c, and sedating antihistaminics levels in postmortem cases from aviation accidents.
- Determined molecular changes as a result of decreased cabin oxygen levels at altitudes with significance to both the aviation industry and military pilots.
- Provided engineering/biodynamic requirements to support revision to TSO-C100 and SAE AS5276.
- Supported development of a cabin evacuation design computer model for very large transport aircraft by developing passenger management strategies using research data from flight attendant location trials.
- Evaluated presentation media for maximum effectiveness in passenger safety briefings.
- Initiated collaborative research with industry partners to develop modeling strategies and validation techniques applicable to aircraft seat certification by analysis.
- Reviewed accidents involving Commemorative Air Force Aircraft 1968 to 2005.
- Evaluated design requirements for pulse oxygen systems to support development of engineering certification criteria.
- Determined the clinical aspects of radiation exposure resulting from a terrorist attack.

Airliner Cabin Environment Research Program

- Collected extensive ozone measurements in aircraft cabins during flight.
- Developed advanced computer simulations for evaluation of airflow and contaminant transport inside aircraft cabins.
- Developed an 11-row airliner mock-up for experimental validation of computational models.
- Completed development and full scale demonstration of prototype biological decontamination system for narrow-body and wide-body aircraft using thermal heat and vaporized hydrogen peroxide.
- Evaluation completed for a range of commercial off-the-shelf biosensors for aircraft cabin environment.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

CAMI Aeromedical Research Program

Aeromedical Safety Management System

- Completed application of Aerospace Medical Research Scientific Information System (SIS): DIABETES.
- Aerospace Accident Injury and Autopsy Data System (AAIADS) continued development.

Accident Prevention and Investigation

- Gene Expression Changes in Response to Fatigue: Continued to develop methods and tools.
- Analyzed post-mortem aviation accidents specimens for fatigue gene expression.
- Assessed prevalence of abused drugs.
- Developed analytical procedures to assess the smoke toxicity of advanced materials for post-crash survivability.
- Developed analytical procedures to assess alternative aviation fuels vapor toxicity.

Protection and Survival

- Completed Aviation Child Restraint Certification: Develop the specifications and test requirements - TSO-C100.
- Completed Evaluation of Passenger Aircraft Safety and Emergency Information Resources.
- Completed Mathematical Prediction of Emergency Evacuation Performance.
- Completed assessment of Inflation Performance of Emergency Escape Slides at High Altitude.
- Seat Cushion Component Test Methods: Develop methods for replacement of worn seat cushions.

Aviation Physiology

- Completed methodology to evaluate Pulse Oxygen Systems.
- Completed evaluation of Hypoxia Training Devices: Compared learning experience and symptoms when using portable devices (tent, mask) and an altitude chamber to make an individual hypoxic.

Airliner Cabin Environment Research Program

- Developed and collected data to identify technologies and/or operational procedures to reliably bring cabin ozone and cabin pressure levels within current FARs or to address potential rulemaking activities for revising cabin pressure and ozone regulations.
- Quantified the effects of cabin pressure on individuals at risk due to age and/or health status.
- Conducted preliminary assessment of the compatibility of aircraft materials, such as high strength steels and aerospace composites materials, with decontamination technology to determine which products are safe to use on aircraft and which could damage the aircraft materials and potentially compromise the continued airworthiness of the aircraft.
- Demonstrated the feasibility of detecting tricresyl phosphate (TCP) from hot air streams to determine whether TCP levels that could affect health of the crew can be detected in aircraft cabins.
- Developed state-of-the-art computer simulation for influenza transmission within aircraft cabins to determine where bioaerosol droplets may be spread in addition to nearby infected passengers.
- Conducted preliminary assessment of the effectiveness of new influenza control methodologies to mitigate spread of influenza to passengers and crew members.
- Evaluated exposure risk for pesticides and volatile organic compound contaminants to determine levels of contaminants and the potential health effects to humans.
- Collected and analyzed data on airliner cabin environment relative humidity, temperature, ozone, carbon dioxide, volatile organic compounds, and sound levels to determine levels and potentially revise or create new regulations.
- Collected baseline data for volatile organic compound contaminants on loaded aircraft filters to determine what can be detected on aircraft filters and what, if any, effects there may be from the contamination to passengers and crew members.
- Developed and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants.

- Validated computational models of chemical air contaminants, such as volatile organic compounds, to evaluate health and safety impacts on passengers and crew.
- Provided scientific knowledge base on medical effects of combined exposures to carbon monoxide, carbon dioxide and ozone from mild hypoxic conditions associated with reduced air pressures.
- Evaluated toxicological aspects of cabin environmental (air) quality: development of reference laboratory to support aircraft cabin air contaminants analysis.
- Validated computational models of air contaminants, volatile organic compounds; biological and viral contaminants to evaluate health impacts on passengers and crew.
- Characterized the potential impact on aircraft fuel efficiency gains due to new environmental control system materials, sensing systems and methodologies.
- Developed updated scientific databases of atmospheric ozone concentrations and route planning tools.

FY 2011 PROGRAM REQUEST:

CAMI Aeromedical Research Program

Ongoing Activities

- Validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability.
- Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.
- Apply advances in gene expression technology, toxicology, and bioinformatics to define human response to aerospace stressors including alcohol, drugs, hypoxia, and fatigue. Develop methods to collect and assess environmentally responsive genes and their protein products in the context of normal and abnormal physiologic states. Utilize machine learning techniques to develop a robust gene-set predictive for these stressors, towards a "genomics black-box" to support accident investigation and minimize risk to human safety and health.
- Incorporate aerospace medical issues in the development of safety strategies concerning upset recovery, controlled flight into terrain (CFIT), and other forms of loss of aircraft control: As adaptive-control techniques are developed, assess pilot performance relative to aeromedical considerations - e.g., transfer of training from various classroom methodologies in the ground, to operations in static and dynamic simulators emulating physiologically stressful flight conditions (e.g., altitude and acceleration/acrobatic maneuvers), and ultimately in-flight.
- Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks. Evaluate factors pertinent to aeromedical safety including disqualifying pathologies; pilot age; fatigue; the physiologic basis of issues commonly labeled "pilot error" such as spatial disorientation, loss of situational awareness, and confusion; assessment of toxicological findings in terms of historical medical certification data; detection and aeromedical assessment of new medications and their interactions; effectiveness of emergency response procedures and equipment; and special issues (stow-always, type aircraft, laser/radiation threats, and commercial space transportation). Enable evidence-based medical certification and effective knowledge management. Develop new metrics to better understand aeromedical certification trends and future requirements to facilitate this process, including related education/training programs.
- Develop a methodology to compile, classify, and assess aviation-related injuries, the mechanisms that resulted in these injuries, and their relationship to: autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic testing: Aerospace Accident Injury and Autopsy Data System (AAIADS).

New Initiatives

- Injury Criteria for Obliquely Oriented Seats: Occupant injury mechanisms and test methods and instrumentation and/or modeling techniques required to assess the injury potential.
- Prevention of Injuries That Impede Egress: Unconsciousness related to measurable impact parameters; Relationship between test measurements and probability of injury established; Injury mitigation capabilities of available technologies evaluated; Leg injuries related to measurable impact parameters; Relationship between test measurements and probability of injury established, Injury mitigation capabilities of available technologies evaluated; and derive injury criteria.

- Develop and maintain analytical tools; empirical data and scientific expertise to support regulatory actions; standards development; accident investigations; and enhanced safety of airplane interior arrangements and emergency equipment/ operations.
- Identification, assessment, and development of improved evacuation equipment and evacuation aids, such as lighting, aural way-finding systems, and symbolic information media.

Airliner Cabin Environment Research Program

Ongoing Activities

- Evaluate synergistic health effects of carbon monoxide, carbon dioxide and ozone under mild hypoxic conditions.
- Collect and analyze data on airliner cabin environment relative humidity, temperature, ozone, carbon dioxide, volatile organic compounds, and sound levels to determine potential health effects.
- Evaluation of exposure risk for pesticides and volatile organic compounds contaminants.
- Collect baseline data for measuring volatile organic compound contaminants on loaded aircraft filters.
- Develop advanced air chemistry models for interaction of atmospheric ozone and volatile organic compounds and their effects on cabin air quality.
- Develop real-time intelligent sensing of cabin air quality on airliners.
- Develop advanced microstructured catalytic materials for ozone conversion.
- Apply advances in weather modeling to predict atmospheric ozone disturbances that could affect cabin air quality.
- Asses risk and manage the infectious disease transmission on airliners.
- Continue preliminary assessment of aircraft material compatibility of high strength steels and aerospace composites materials with disinfection technologies.
- Quantify the effects of cabin pressure on individuals at risk due to age and/or health status.
- Evaluate and identify technologies and/or operational procedures to reliably bring cabin ozone and cabin pressure levels within current FARs.

New Initiatives

- Develop and test adaptive environmental control techniques to enable a safe and healthy cabin air environment including in-flight incidents.
- Validate software tools and methods to mitigate air contamination incidents during flight and ground operations.
- Identify potential impacts of more fuel efficient advanced airliner environmental control system and related engine designs on cabin air quality.
- Assess role of advanced weather modeling technology to predict atmospheric ozone disturbances in the aircraft cabin.
- Preliminary assessment of the efficacy of new influenza control methodologies.
- Evaluate viral outbreak mitigation strategies and methodologies for cost effect reduction of impact to the air transportation system.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS**:**

CAMI Aeromedical Research Program

Aeromedical Systems Analysis

- Provide incidental medical findings and injury description and injury mechanisms analysis to support the development of prevention and mitigation strategies: Aircraft Accident Injury and Autopsy Data System (AA-IADS).
- Conduct a Risk Assessment of Selective Serotonin Reuptake Inhibitors (SSRIs) use in civil aviation.

Accident Prevention and Investigation

- Quantify the effects and impact of fatigue in aviation using gene expression research.
- Determine the usefulness of blood from aviation accidents as a RNA source for gene expression analysis.

- Determine the prevalence of psychotropic drugs in pilot fatalities from civil aviation accidents.
- Assess unapproved medications found in fatally injured pilots involved in homebuilt-aircraft accidents.
- Correlate the incidence of quinine positives in aircraft fatalities with elevated serotonin metabolite ratios.

Protection and Survival

- Develop methods to qualify replacement elements for worn seat cushions used in energy absorbing seats.
- Develop Mathematical Prediction of Emergency Evacuation Performance.
- Conduct the performance evaluation of Inflatable Emergency Equipment for Ditching Scenarios.

Aviation Physiology

- Calculate galactic cosmic radiation dose rates in the atmosphere at altitudes above 60,000 feet.
- Develop a Windows version of the CARI program.
- Evaluate and develop oxygen system guidelines for high altitude aircraft.

Airliner Cabin Environment Research Program

- Provide scientific knowledge base on medical effects of combined exposures to carbon monoxide, carbon dioxide and ozone from mild hypoxic conditions associated with reduced air pressures.
- Evaluate toxicological aspects of cabin environmental (air) quality: development of reference laboratory to support aircraft cabin air contaminants analysis.
- Validate computational models of air contaminants, volatile organic compounds; biological and viral contaminants to evaluate health impacts on passengers and crew.
- Characterize the potential impact on aircraft fuel efficiency gains due to new environmental control system materials, sensing systems and methodologies.
- Develop updated scientific databases of atmospheric ozone concentrations and route planning tools.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	140,813
FY 2010 Enacted	10,378
FY 2011 Request	11,217
Out-Year Planning Levels (FY 2012-2015)	46,548
Total	208,956

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
CAMI Aeromedical Research	1,504	1,712	2,038	3,811	2,847
Airliner Cabin Environment Research	0	0	0	0	1,700
Personnel Costs	5,313	5,893	6,177	6,342	6389
Other In-house Costs	145	155	180	225	281
Total	6,962	7,760	8,395	10,378	11,217

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	6,962	7,760	8,395	10,378	11,217
Development (includes prototypes)	0	0	0	0	0
Total	6,962	7,760	8,395	10,378	11,217

A11.j – Aeromedical Research Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
086-110 CAMI AEROMEDICAL RESEARCH (CAMI)	**2,847**						
1. Validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability.		♦	◊	◊			
2. Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.		♦	◊	◊			
3. Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors.		♦	◊	◊	◊	◊	◊
4. Incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control.		♦	◊	◊	◊	◊	◊
5. Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks.		♦	◊	◊	◊	◊	◊
6. Develop a methodology to compile, classify, and assess aviation-related injuries, the mechanisms that resulted in these injuries, and their relationship to: autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic testing: Aerospace Accident Injury and Autopsy Data System (AAIADS).		♦	◊	◊	◊	◊	◊
086-111 Airliner Cabin Environment Research	**1,700**						
1. Develop and analyze methods to detect and analyze aircraft cabin contamination.		♦	◊				
2. Computational models of air contaminants, volatile organic compounds, biologicals and virals		♦	◊				
3. Advanced air sensing technology for volatile organic compounds.		♦	◊	◊			
4. Bleed air contamination models of engine compressors and high temperature air system.		♦	◊	◊			
5. Support of regulatory, certification, and operations for existing Aviation Rulemaking Committees.		♦	◊	◊	◊	◊	◊
6. Chemical kinetic models for bleed air systems for health and safety effects on passengers and crew.		♦	◊	◊	◊		
Personnel and Other In-House Costs	**6,670**						
Total Budget Authority	**11,217**	**10,378**	**11,217**	**11,390**	**11,570**	**11,718**	**11,870**

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

Budget Item	Program Title	Budget Request
A11.k	**Weather Program**	**$16,505,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety and Greater Capacity; and supports the Next Generation Air Transportation System (NextGen) weather operational improvements.

Intended Outcomes: The Weather Program contributes to FAA's strategic goals for increased safety and capacity. The Weather Program provides improved weather information to minimize impacts on NAS operations. The Weather Program supports NextGen goals through research of the advanced forecast capabilities detailed in the NextGen Integrated Work Plan (IWP) and the FAA NextGen Implementation Plan 2009. Efforts undertaken in collaboration with the National Weather Service (NWS) and NASA, increase FAA's ability to provide the operational improvements required for NextGen. These improvements include short-term and mid-term forecasts of naturally occurring atmospheric hazards, such as turbulence, severe convective activity, icing, and restricted visibility. Improved forecasts enhance flight safety, reduce air traffic controller and pilot workload, enable better flight planning, increase productivity, and enhance common situational awareness.

Agency Outputs: The Weather Program provides new and improved weather products that support legacy NAS systems, NWS, and near term NextGen capabilities as well as enablers necessary for mid-term and far-term term benefits. Weather products are enhanced by upgrading algorithms for existing NAS platforms such as the Weather and Radar Processor, the Integrated Terminal Weather System, the Operational and Supportability Implementation System, and the Enhanced Traffic Management System. The NWS platforms also use the algorithms developed. Research is an integral element in providing the advanced forecast and nowcast information that can be integrated into decision support tools. This information will be transitioned by the FAA's Reduce Weather Impact (RWI) portfolio to accomplish this. The information will be developed in accordance with the NextGen Network Enabled Weather (NNEW) dissemination standards. This will allow universal access to weather information through net centric capabilities.

The Weather Program will develop advanced forecast capabilities consistent with the operational improvements specified in the NextGen IWP and FAA NextGen Implementation Plan 2009. To support transition of these advanced capabilities to operations, the Weather Program will utilize the Network-Enabled Verification System (NEVS) to verify the performance of these capabilities as well as live demonstrations of these scientific advancements. These advanced capability requirements for NextGen include the following:

- Advanced Convective weather forecast - high-resolution, deterministic & probabilistic 0-8 hour forecasts for convection for aviation end users
- Hourly (Nowcasts) & 0-18 hour probabilistic forecasts of turbulence for use by Air Traffic Controllers (ATC), Aviation Operations Centers (AOC), & the pilot in the cockpit to enhance safety and capacity
- Hourly (Nowcasts) & 0-12 hour probabilistic forecasts for in-flight icing including its severity for use by ATC, AOC, and the pilot in the cockpit for preflight planning
- Analysis and 0-12 hour probabilistic forecasts of ceiling, visibility, & flight category for use by ATC, AOC, & the pilot in the cockpit, & to support estimation of capacity resources at airports as well as increased GA safety

The weather capabilities developed by the FAA provide the following benefits:

- Depiction of current and forecasted in-flight icing areas – enhances safety and regulatory adherence
- Interactive data assimilation, editing, forecast and dissemination tools – improves aviation advisories and forecasts issued by the NWS as well as accessibility to users of aviation weather information
- Depiction of current and forecast precipitation type and rate – enhances safety in the terminal area
- Depiction of current and forecast terminal and en route convective weather – enhances terminal and en route capacity
- Short-term prediction and forecast of ceiling and visibility in the national area – enhances en route safety
- In-situ, remote detection, and forecast of en route turbulence, including clear-air turbulence – enhances en route safety

Research Goals: Research is on-going to provide weather observations, warnings, and forecasts that are more accurate, accessible, and efficient, and to meet current and planned regulatory requirements. The goals of the focused research endeavors are:

- By FY 2012 to meet the NextGen requirements for 2013 IOC segment one; to develop timely and accurate deterministic and an initial set of probabilistic aviation weather forecasts for operational use by ATM, dispatchers, and pilots.
- By FY 2016 in support of NextGen segment two requirements, increased maturity of probabilistic forecasting; integration of ground, airborne, and satellite weather observation information in real time; methods to translate greater weather uncertainty and longer look ahead times; levels into operational impact linked to advances in risk based decision-making tool from Single Authorative Source (SAS).
- By FY 2020 in support of NextGen segment three requirements, enhanced accuracy of net-enabled deterministic and advanced probabilistic weather forecast information assimilated into NAS decision making. Weather observations integrated into an operational network from ground, airborne, and satellite sensors for extended weather forecast that will be disseminated in real-time from a mature SAS for operational use by ATM, dispatchers, and pilots.

Customer/Stakeholder Involvement: The Weather Program works within FAA, industry and government groups to assure its priorities and plans are consistent with user needs. This is accomplished through:

- Guidance from the Joint Planning and Development Office (JPDO) Next Generation Air Transportation System initiative and the Integration and Implementation Office with the FAA.
- Guidance from the FAA Research, Engineering, and Development Advisory Committee.
- Inputs from the National Aviation Weather Initiatives, which are strongly influenced by other NAS drivers including "Safer Skies" and Flight Plan Safety Objectives.
- Inputs from the aviation community, such as the annual National Business Aircraft Association /Friends/Partners in Aviation Weather Forum, JPDO, RTCA, and scheduled public user group meetings.
- Close collaboration with FAA organizations internal to the Agency such as the Air Traffic Organization Oceanic and Off-Shore Programs Office, various FAA Aviation Safety Offices.
- Feedback received from documents and publications.

R&D Partnerships: The Weather Program collaborates with the Department of Commerce in promoting and developing meteorological science, and in fostering support of research projects through the use of private and governmental research facilities. The program also leverages research activities with members of industry, academia, and other government agencies through interagency agreements, university grants, and Memorandums of Agreement.

Partnerships include:

- National Center for Atmospheric Research (in-flight icing, convective weather, turbulence, ceiling and visibility, ground de-icing, modeling, weather radar techniques).
- National Oceanic and Atmospheric Administration laboratories (convective weather, turbulence, modeling, weather radar techniques, quality assessment/verification).
- Massachusetts Institute of Technology's Lincoln Laboratory (convective weather).
- National Weather Service's Aviation Weather Center and Environment Modeling Center (modeling).
- NASA Research Centers (in-flight icing, turbulence, satellite data).
- Universities (modeling).
- Airlines, port authorities, cities (user assessments).

Accomplishments:

FY 2009:

- Obtained approval to test Alaskan in-flight icing forecast capability.
- Completed guidance for certification of weather radars with forward-looking turbulence detection capability.
- Developed prototype Network-Enabled Verification Service for meeting System-Wide Information Management architecture requirements.

FY 2008:

- Implemented an experimental rapid refresh Weather Research and Forecast (WRF) model.
- Implemented turbulence detection algorithm into NEXRAD operations.

FY 2007:

- Implemented in-flight icing severity nowcast capability operationally
- Obtained approval of turbulence detection algorithm by NWS NEXRAD System Recommendation and Evaluation Committee for operational implementation.
- Provided Helicopter Emergency Medical Services Aviation Digital Data Service (ADDS) enhancement to enable emergency medical services pilots to make NO-GO weather decisions.

FY 2006:

- Obtained approval of in-flight icing severity nowcast capability for operational use.
- Implemented four-hour winter precipitation capability into Weather Support to Decision Making System.
- Implemented terminal convective weather forecast capability into Integrated Terminal Weather System.

FY 2005:

- Implemented improved accuracy and resolution of data on upper winds, temperature, and moisture through 13 kilometer rapid-update-cycle analyses and forecasts at the NWS.
- Implemented in-flight icing nowcast capability with higher resolution into ADDS.

Previous Years:

- Achieved the Department of Commerce 2003 Silver Medal.
- Implemented operationally new capabilities of:
- Current and up to two-hour forecast of convective weather.
- Current and up to 12-hour forecast of in-flight icing conditions
- Current and up to 12-hour forecasts of clear-air turbulence above 30,000 feet.
- Up to 12-hour forecast of marine stratus burn-off at San Francisco International Airport.
- Implemented operationally at the NWS the enhanced ADDS with a flight path tool depicting vertical cross sections of weather along user-specified flight routes.
- Completed convective storm growth and decay field tests in Dallas, Orlando, Memphis, and New York. This research resulted in the accurate short-term prediction of the initiation, growth, and decays of storm cells, and enhanced the strategic and tactical flow management planning that allows more effective routing of traffic to and from airports and runways.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Upgraded in-flight icing forecast and nowcast severity capability for WRF rapid refresh.
- Developed High Ice Water Content algorithm and provide support to field program in Puerto Rico.
- Transitioned probabilistic and mountain-wave turbulence forecast capability for implementation on operational ADDS.
- Developed CONUS 0-6 hour advanced storm prediction capability via NextGen Net-Enabled Weather standards.
- Transitioned CONUS display of ceiling, visibility, and flight category analysis capability for implementation on operational ADDS.
- Transitioned Rapid Refresh Weather Research and Forecast (WRF) model for implementation into NWS operations.
- Utilized rapid refresh WRF model forecasts to produce probabilistic forecasts for convection, and ceiling and visibility.
- Integrated Canadian radar data into real-time national 3D mosaic.
- Demonstrated initial operating capability for Network-Enabled Verification System (NEVS) utilizing advanced storm prediction capability data.
- Conducted quality assessment evaluations, utilizing automated verification tools, of weather research capabilities to support the FAA/NWS NextGen Weather Evaluation Capability process.

- Developed specification for operational approval of liquid water equivalent technology for ground icing guidance.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

The weather program will continue to develop/enhance forecast/nowcast capabilities, to support FAA safety and capacity Flight Plan goals and meet NextGen requirements, through the conduct of applied research in naturally occurring atmospheric hazards including turbulence, severe convective activity, icing, and restricted visibility. In FY 2011, additional turbulence forecast capabilities are being developed to enhance en route safety and capacity, an advanced convective weather forecast is be developed to enhance terminal and en route capacity, an in-flight icing forecast capability for Alaska is being developed to enhance safety especially for general aviation, and a ceiling and visibility forecast capability is being developed to enhance en route safety especially for general aviation and a volcanic ash dispersion forecast capability is being developed to enhance en route safety and capacity. Capabilities developed transition to NWS, FAA, and industry weather systems.

New Initiatives

No new initiatives are planned in FY 2011

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Utilize High Ice Water Content prototype algorithm to support field program.
- Develop 0-6 hour advanced probabilistic storm prediction capability.
- Approval of convectively-induced turbulence capability for operational use on ADDS.
- Develop CONUS ceiling, visibility, and flight category forecast capability.
- Test radar-based freezing drizzle algorithm.
- Conduct quality assessment evaluations, utilizing NEVS, of weather research capabilities to support the FAA/NWS NextGen Weather Evaluation Capability (NWEC) process.
- Evaluate liquid water equivalent technology system for measurement of freezing rain, freezing drizzle, snow, and ice pellets.
- Test 3KM High Resolution Rapid Refresh WRF Model at NOAA.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	388,581
FY 2010 Enacted	16,789
FY 2011 Request	16,505
Out-Year Planning Levels (FY 2012-2015)	64,224
Total	486,099

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Weather Program	18,432	15,936	15,855	15,750	15,547
Personnel Costs	1,035	863	979	862	712
Other In-house Costs	78	89	134	177	246
Total	19,545	16,888	16,968	16,789	16,505

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	19,545	16,888	16,968	16,789	16,505
Development (includes prototypes)	0	0	0	0	0
Total	19,545	16,888	16,968	16,789	16,505

A11.k – Weather Program – Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
041-110 Aviation Weather Analysis and Forecasting	**5.700**						
Convective Analysis and Forecast Improvement							
Developed CONUS 0-6 hr adv storm pred cap via NNEW stds		♦		◊	◊	◊	◊
Develop 0-6 hr adv probabilistic storm prediction capability			◊				
Integrated Canadian radar data into real/time national 3D mosaic		♦					
Test radar-based freezing drizzle algorithm			◊				
Analysis and Forecast Improvement	**7.304**						
Upgraded in-flight icing fc & nc severity for WRF RR		♦					
Developed HIWC alg & provide support to field program		♦					
Utilize HIWC prototype alg to support fld prog in Australia			◊				
Transition AK in-flight icing forecast capability for implementation on operation ADDS.					◊		
Obtain FAA approval to test global in-flight icing forecast capability						◊	
Transitioned rapid refresh WRF model for implem. into NWS		♦					
Utilized RR WRF model fcs for probabilistic conv & C&V		♦					
Test 3KM High Resolution Rapid Refresh WRF model at NOAA			◊				
Transition probabilistic and mountain wave turbulence forecast capability for implement on operational ADDS		♦					
Approval of convectively-induced turb capability for oper use			◊				
Transitioned CONUS display of ceiling, vis. & flt. category analysis capability for impl. on oper. ADDS		♦					
Develop CONUS ceiling, visibility, and flight category forecast capability			◊				
Obtain FAA approval to test AK C&V forecast						◊	◊
Verification and Technology Implementation	**2.543**						
Demonstrate IOC for NEVS utilizing adv storm prediction capability data		♦					
Conduct QA evaluations, utilizing NEVS for NWEC process			◊	◊	◊	◊	◊
Implement FAA approved products at the AWC		♦	◊	◊	◊	◊	◊
Developed specification for operational approval of liquid water equivalent for ground de-icing guidance		♦					
Evaluate liquid water equivalent technology system for msr of freezing rain, frz drz, snow and ice pellets			◊				
Personnel and Other In-House Costs	**958**						
Total Budget Authority	**16,505**	**16,789**	**16,505**	**16,377**	**16,233**	**15,952**	**15,662**

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

Budget Item	Program Title	Budget Request
A11.l	**Unmanned Aircraft Systems Research**	**$3,694,000**

GOALS:
This program supports the following Flight Plan goal: Increased Safety and NextGen Implementation Initiatives

Intended Outcomes: The Unmanned Aircraft Systems (UAS) Research Program supports FAA's strategic goal of increasing safety by conducting research needed to ensure the safe integration of the UAS in the NAS. It also supports FAA efforts in NextGen implementation by studying safety implications of new aircraft technology to the NAS and supporting the development of new regulatory standards to implement these new technologies. The program's research activities focus on new technology assessments, methodology development, data collection and generation, laboratory and field validation, and technology transfer.

Agency Outputs: Researchers are developing methodologies and tools to establish regulatory standards on UAS design and performance characteristics while operating in the NAS. They are evaluating technologies, conducting laboratory and field tests, performing analyses and simulations, and generating data to support standardization of UAS civil operations. New standards are being implemented to establish UAS certification procedures, airworthiness standards, operation requirements, inspection and maintenance processes, and safety oversight responsibilities. Policies and guidance materials are also being published to equip FAA certification engineers and safety inspectors with the knowledge and tools they need to ensure the safe integration of UAS into the NAS.

Research Goals: To safely integrate UAS into the NAS, FAA needs to develop airworthiness standards, devise operational requirements, establish maintenance procedures, and conduct safety oversight activities. The program is structured into seven research areas: technology survey; system safety; detect, sense and avoid (DSA); control, command, and communication (C3); flight termination, certification and airworthiness standards, and maintenance and continuing airworthiness issues. The research began with a baseline survey to determine the existing technologies used in UAS and needs of corresponding regulatory standards. Technologies used to avoid mid-air collisions due to UAS operations will be examined and tested. Communications issues that may arise due to the introduction of UAS into the NAS, as well as necessary safety procedures for the flight termination of UAS, will be researched. A system safety approach based on regulatory framework will be developed to identify the potential hazards, perform risk assessments, and evaluate mitigation strategies for UAS safe operations in the NAS. Data systems will be established to collect data on UAS design, operation, and maintenance that will provide technical information to support the development of design and operation standards and provide technical basis for safety oversight.

- By FY 2012, determine performance characteristics and operational requirements for DSA technologies.
- By FY 2012, analyze data on the safety implications of system performance impediments to C3 in different classes of airspaces and operational environment.
- By FY 2012, develop risk management concepts, models, and tools for unmanned aircraft systems.
- By FY 2015, conduct field evaluations of UAS technologies in an operational environment, including DSA, C3, and flight termination technologies. The documented results will be used to develop certification and airworthiness standards.

Customer/Stakeholder Involvement: Full and safe integration of UAS into civil aviation requires FAA to work closely with other government and private agencies that have experience in developing and operating UAS:

- FAA Research, Engineering, and Development Advisory Committee Aircraft Safety Subcommittee – subcommittee representatives from industry, academia, and other government agencies annually review the activities of the program.
- Technical Community Representatives Groups – FAA representatives apply formal guidelines to ensure that results derived from these research activities will be implemented to meet the stated Agency Outputs as outlined above.
- Department of Defense (DoD) – the DoD is the largest UAS user requesting unrestricted access to the NAS. The FAA will collaborate with DoD through Memorandum of Understanding (MOU) and Interagency Agreements (IA) to leverage resources and implement new technologies for civil applications.

- Other Government agencies including Department of Homeland Security (DHS), Department of Commerce (DOC), state government agencies, and independent organizations that utilize UAS for national security, earth science and oceanic studies, and commercial applications.
- JPDO – the JPDO has identified UAS integration to NAS and new aircraft technology as one of the emerging challenges to the nation's air transportation system. In particular, the NextGen related research will be coordinated with the JPDO Aircraft Working Group activities in support of aircraft equipage requirements and necessary enablers to fully utilize NextGen capabilities.
- RTCA Special Committee 203 (Unmanned Aircraft Systems – members of this U.S. Federal Advisory Committee and its special committees (SC) help to ensure the effectiveness of the agency's rulemaking by identifying command and control as well as sense and avoid requirements

R&D Partnerships:

- IA's with other government agencies (DoD, DHS, DOC, state governments) and Memorandum of Cooperation (MOC) with foreign civil aviation authorities.
- FAA Air Transportation Center of Excellence – various consortiums of university and industry partners who conduct R&D for FAA on a cost-matching basis, which currently consists of seven centers in different technical disciplines.
- The Civil Aviation Authority of the Netherlands to conduct joint research on UAS initiatives via an MOC.

Accomplishments:

FY 2009:

- Continued technology surveys on UAS designs and operations.
- Continued technology surveys on UAS flight termination and recovery.
- Determined performance characteristics and operational requirements for DSA technologies.
- Established UAS data collection and information system
- Initiated the development of regulatory-based causal factor framework (RCFF) to establish a SMS approach to assess UAS safety risk analysis and mitigation strategies.
- Continued FAA-US Air Force joint flight tests to study on-board DSA technology.
- Continued to identify potential safety implications of system performance impediments to C3.
- Developed risk management concepts, models, and tools for unmanned aircraft systems.
- Performed risk analysis to determine impacts of specific hazards, mitigation strategies, recommended approaches, safety measurements, and oversight requirements.

FY 2008:

- Completed technology surveys of UAS propulsion systems and regulatory gap analyses.
- Completed survey of existing DSA capabilities and regulatory requirement analysis.
- Developed UAS hazard categorization and analysis system (HCAS) within the regulatory framework including standard taxonomy.
- Completed the second sets of FAA-United States Air Force (USAF) joint flight tests to study on-board DSA technology with multiple sensors and data fusion system.
- Conducted technology survey on UAS designs and operations.
- Begin determining potential safety implications of system performance impediments to C3.
- Conducted technology survey on UAS flight termination and recovery.

FY 2007:

- Completed the first set of FAA-USAF joint flight tests to evaluate a DSA technology.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Technology Surveys

- Completed technology surveys on UAS designs and operations.
- Completed technology surveys on UAS flight termination and recovery.

Detect and Avoid

- Determined performance characteristics and operational requirements for DSA technologies.
- Initiated the system-level safety risk assessment of UAS DSA technologies.
- Continued FAA-USAF joint flight tests to study on-board DSA technology.

Command and Control

- Determined potential safety implications of system performance impediments to C3.

Safety Management System - Risk Modeling

- Using RCFF, established a SMS approach to assess UAS safety risk analysis and mitigation strategies.
- Developed risk management concepts, models and tools for unmanned aircraft systems.
- Performed risk analysis to determine impacts of specific hazards, mitigation strategies, recommended approaches, safety measurements, and oversight requirements.
- Developed the UAS data collection and information system and conducted system safety analysis on specific UAS operations.

FY 2011 PROGRAM REQUEST:

Ongoing Activities:
Researchers will continue the development of methodologies to study UAS system safety while operating in the NAS while interacting with existing NAS users. Will continue the development of the regulatory-based causal factor framework (RCFF) concept, which, once developed, will provide a systematic means to conduct safety risk analyses and assess risk mitigations. Researchers will apply the RCFF approach to determine safety requirements of DSA technologies utilized on various types of UAS operating in different classes of airspace. Researchers will also apply the RCFF approach to assess C3 safety leading to UAS airworthiness requirements.

New Initiatives:
None.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Detect and Avoid

- Determine performance characteristics and operational requirements for DSA technologies. Included will be the development and evaluation of specific DSA technologies including both on-board and ground based systems in compliance of regulatory requirements (airworthiness and flight operations).
- Determine system-level safety requirements of UAS DSA technology by applying the RCFF approach.
- Continue FAA-USAF joint flight tests to study on-board DSA technology.

Command and Control

- Continue to identify potential safety implications of system performance impediments to C3.
- Develop and evaluate UAS C3 technologies to ensure operational safety including data link requirements, frequency spectrum technology, availability and reliability, communicating with ATC, and interactions with other NAS users by applying the RCFF approach.

Safety Management System - Risk Modeling

- Continue using RCFF to establish a SMS approach to assess UAS safety risk analysis and mitigation strategies.
- Continue development of risk management concepts, models, and tools for unmanned aircraft systems.
- Perform risks analyses to determine impacts of specific hazards, mitigation strategies, recommended approaches, safety measurements, and oversight requirements.
- Continue development of UAS data collection and information system and conduct system safety analysis on specific UAS operations.
- Initiate the collection of UAS operation data and perform analyses to develop technical information required to support establishment of regulatory standards

Minimum Requirements for UAS Control Stations

- Develop information to support the definition of minimum human factors requirements for UAS control stations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	$5,996
FY 2010 Enacted	3,467
FY 2011 Request	3,694
Out-Year Planning Levels (FY 2012-2015)	14,870
Total	28,027

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Unmanned Aircraft System Research	1,200	2,768	735	2,368	2,450
Personnel Costs	0	136	1,080	1,024	1,135
Other In-house Costs	0	16	61	75	109
Total	**1,200**	**2,920**	**1,876**	**3,467**	**3,694**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	1,200	2,920	1,876	3,467	3,694
Development (includes prototypes)	0	0	0	0	0
Total	**1,200**	**2,920**	**1,876**	**3,467**	**3,694**

A11.l – Unmanned Aircraft Systems Research Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
069-110 Unmanned Aircraft System Research							
Technology Surveys	**0**						
Completed technology survey on UAS designs and operations		♦					
Completed technology survey on UAS flight termination and recovery		♦					
Detect and Avoid	**1,350**						
Determine performance characteristics and operational requirements for DSA technologies		♦	◊	◊	◊		
Joint USAF-FAA flight tests on DSA technology		♦	◊	◊	◊	◊	
Conduct system-level safety risk assessment of UAS DSA technology applying RCFF approach		♦	◊	◊	◊		
Command and, Control	**300**						
Determine potential safety implications of system performance impediments to C3		♦	◊		◊		
Develop and evaluate UAS C3 technologies to ensure operational safety including data link requirements, frequency spectrum technology, availability and reliability, communicating with ATC, and with other NAS users			◊	◊	◊	◊	◊
Conduct C3 field tests and evaluate technologies				◊	◊		
Flight Termination	**0**						
Determine requirements, risks, and mitigation strategies for flight termination				◊	◊		
Conduct flight termination procedure field test and evaluate technologies						◊	◊
Safety Management System – Risk Modeling	**500**						
Using RCFF, establish a SMS approach to assess UAS safety risk analysis and mitigation strategies		♦	◊	◊	◊	◊	◊
Develop risk management concepts, models and tools for unmanned aircraft systems		♦	◊	◊	◊		
Perform risks analyses to determine impacts of specific hazards, mitigation strategies, recommended approaches, safety measurements, and oversight requirements		♦	◊	◊	◊	◊	◊
Develop UAS data collection and information system and conduct system safety analysis on specific UAS operations		♦	◊	◊	◊	◊	◊
Collect UAS operation data and perform analyses to develop technical information required to support establishment of regulatory standards			◊	◊	◊	◊	◊
Minimum Requirements for UAS Control Stations	**300**						
Develop information to support the definition of minimum human factors requirements for UAS control stations.			◊	◊			
Personnel and Other In-House Costs	**1,244**						
Total Budget Authority	**3,694**	**3,467**	**3,694**	**3,710**	**3,725**	**3,720**	**3,715**

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

Budget Item	Program Title	Budget Request
A11.m	**NextGen – Alternative Fuels for General Aviation**	**$2,000,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes:

The NextGen - Alternative Fuels for General Aviation will address the use of alternative and renewable fuels for GA to lessen aviation environmental impacts (air and water quality). These activities will be coordinated with the FAA Office of Aviation Policy, Planning, and Environment (AEP). The program also conducts research to test new unleaded fuels and piston engine modifications to seek a safe alternative to current leaded aviation gasoline (avgas).

Agency Outputs:

The FAA issues certification standards and Advisory Circulars, and reviews the specifications and practices recommended by recognized technical societies (ASTM International, SAE International) to maintain the airworthiness of aircraft engines, fuels, and airframe fuel management systems. The agency also publishes information and sponsors technology workshops, demonstrations, and other means of training and technology transfer. The NextGen - Alternative Fuels for General Aviation provides the technical information, R&D resources, and technical oversight necessary for the agency to enhance the airworthiness, reliability, and performance of propulsion and fuel systems.

Research Goals:

The elimination of lead emissions from piston powered aircraft is the primary goal of this research. Various alternatives to achieve this goal will be explored through this research, including:

- Investigation of unleaded replacement alternatives to current leaded avgas (100LL) used in piston engines. To the greatest extent possible the replacement alternative(s) should be equivalent in performance to 100LL and be a seamless, transparent change to a general aviation (GA) pilot.
- Technologies for modification of piston engines to enable their safe operation using unleaded fuel.
- Qualification and certification methodologies for alternative fuel safety performance.
- Investigation of fleet lead emissions which will support evaluation of various approaches to for achieving emissions reductions.

Expected milestones include:

- By FY 2012, complete fleet impact study of imminent lead removal from aviation gasoline and impact on certification methodologies.
- By FY 2012, complete feasibility assessment of reducing the current lead levels in aviation gasoline as a temporary measure toward full lead removal and impact on certification methodologies.
- By FY 2014, complete upgrades to engine test facilities to enable piston engine performance and detonation evaluation across the entire operating envelope, including high altitude, high/low temperature, and high/low humidity conditions.
- By FY 2014, develop an unleaded aviation gasoline anti-knock rating method that allows for correlation to the leaded octane ratings of existing piston engines.
- By FY 2014, complete engine tests on representative high power density engines to characterize safety impacts from operation on reduced octane alternative unleaded aviation fuel.
- By FY 2015, develop engine test methods to evaluate the performance, durability and operability of unleaded aviation gasolines.
- By FY 2015, develop and validate analytical test methods to evaluate the fit-for-purpose of unleaded aviation gasolines.
- By FY 2015, evaluate the technology of modifying general aviation piston engines to run on unleaded fuels.
- By FY 2015, evaluate and characterize all candidate replacement formulations for 100LL.

- By FY 2015, complete research on safety impact of variations to current aviation specification from use of biofuels.
- By FY 2015, complete research comparing use of high aromatic biofuels to current aviation gasoline on CO, CO_2, and NO_x greenhouse gas pollutants.

Customer/Stakeholder Involvement: The NextGen-Alternative Fuels for General Aviation works with the following industry and government groups:

- Subcommittee on Aircraft Safety of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure that the program's research projects support new rulemaking and development of alternate means of compliance with existing rules.
- The Coordinating Research Council (CRC) Unleaded Aviation Gasoline Development Group – representatives from ExxonMobil, ConocoPhillips, ChevronTexaco, British Petroleum, Cessna, Hawker Beechcraft, Teledyne Continental, and Lycoming Engines facilitate two-way transfer of technology between government and industry to benefit all participants.
- Aerospace manufacturers
- Aerospace repair stations and maintenance organizations
- Aerospace industry associations
- Private, commercial, government, and military operators
- International airworthiness authorities
- Standards development groups, such as ASTM International
- Academia and national laboratories

R&D Partnerships:

- CRC Unleaded Aviation Gasoline Development Group – includes ExxonMobil, ConocoPhillips, ChevronTexaco, British Petroleum, Cessna, Hawker Beechcraft, Teledyne Continental, and Lycoming Engines; this group facilitates two-way transfer of technology between government and industry to benefit all participants.
- General Aviation Manufacturers Association Future Avgas Strategy and Transition Plan (GAMA FAST) – includes engine and airframe OEMs; this group is developing a plan for the introduction of unleaded fuel to replace 100LL and assess the impact on the current fleet of aircraft and engines.
- The FAA General Aviation Center of Excellence in conjunction with direct grants with the Embry Riddle Aeronautical University and the University of North Dakota – this relationship will support flight testing and engineering analysis of candidate unleaded fuels.

Accomplishments:

None, this is a new program starting FY 2011.

FY 2011 PROGRAM REQUEST:

- Laboratory characterization and engine ground testing of candidate unleaded fuels to replace 100LL avgas.
- Conduct research into technology of modifying general aviation piston engines to run on unleaded fuels.
- Investigate fleet lead emission impacts as a function of various lead reduction options.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Conduct initial feasibility study, including economic feasibility, environmental impacts, and assessment of potential for GA aircraft renewable alternative fuels.
- Provide data and report on laboratory characterization and engine ground testing of candidate unleaded fuels to replace 100LL avgas.
- Conduct research into technology of modifying general aviation piston engines to run on unleaded fuels.
- Provide data and report on laboratory characterization and engine ground testing of ultra-low lead fuels to replace 100LL avgas.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	0
FY 2010 Enacted	0
FY 2011 Request	2,000
Out-Year Planning Levels (FY 2012-2015)	8,000
Total	

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NextGen – Alternative Fuels for General Aviation	0	0	0	0	2,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**2,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	2,000
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**2,000**

A11.m – NextGen – Alternative Fuels for General Aviation **Products and Activities**	**FY 2011 Request ($000)**	**Program Schedule**					
		FY 2010	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
NextGen – Alternative Fuels for General Aviation	**2,000**						
Study fleet impact of imminent lead removal from aviation gasoline.			◊	◊			
Assess feasibility of reducing the current lead levels in aviation gasoline as a temporary measure toward full lead removal.			◊	◊			
Upgrade engine test facilities to enable piston engine performance and detonation evaluation across the entire operating envelope.			◊	◊	◊	◊	
Develop unleaded aviation gasoline anti-knock rating method that correlates to the leaded octane ratings of existing piston engines.			◊	◊	◊	◊	
Develop engine test methods to evaluate the performance, durability and operability of unleaded aviation gasolines.			◊	◊	◊	◊	◊
Develop and validate analytical test methods to evaluate the fit-for-purpose of unleaded aviation gasolines.			◊	◊	◊	◊	◊
Conduct engine tests on representative high power density engines to understand potential safety impacts from operation on GA alternative fuels.			◊	◊	◊	◊	
Evaluate technology of modifying GA piston engines operating with GA alternative fuels.			◊	◊	◊	◊	◊
Evaluate and characterize candidate GA alternative fuels as replacements for 100LL.			◊	◊	◊	◊	◊
Complete research on safety impact of variations to current aviation specification from use of alternative fuels.			◊	◊	◊	◊	◊
Complete research comparing use of high aromatic biofuels to current aviation gasoline on CO, CO_2, and NO_x greenhouse gas pollutants.			◊	◊	◊	◊	◊
Personnel and Other In-House Costs							
Total Budget Authority	**2,000**	**0**	**2,000**	**2,004**	**2,007**	**1,999**	**1,990**

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

Budget Item	Program Title	Budget Request
A12.a	**Joint Planning and Development Office (JPDO)**	**14,292,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: As the steward of NextGen, the JPDO seeks to address long-term imbalances in aviation capacity and demand. At the same time, it seeks to ensure that the future operating environment is safe, well managed, environmentally responsible, and harmonized with international standards. JPDO's mission is to lead the transformation of today's aviation system into that of the future, the scope of which contributes to all of FAA's current strategic goals.

NextGen is expected to yield significant benefits in terms of delay reduction, fuel savings, additional capacity, improved access, enhanced safety, and reduced environmental impact. Last year we estimated that NextGen would reduce delay by 35-40 percent in 2018 compared to what the system would experience without NextGen. We are currently preparing an updated, detailed breakdown of the near- to mid-term NextGen benefits. This analysis will be completed in the near future, and updated annually in conjunction with FAA's budget submission.

Agency Outputs: The JPDO is responsible for defining and facilitating the implementation of NextGen. At this stage in the transformation, outputs are a series of plans and analyses that define a proposed end-state and a path for achieving it. The objective is to drive collaborative decisions—involving government and industry—that will ultimately achieve the transformation.

Research Goals:
FY 2011

- Continue to refine NextGen foundational documents: Concept of Operations, Enterprise Architecture, and Integrated Work Plan within the Joint Planning Environment (JPE).
- Enhance the JPE planning information to reflect integration of net-enabled weather into automation decision making, enhanced operational scenarios that describe information sharing and procedures between flight/ airline operations and NextGen trajectory based flight processing including air navigation service provider, flight operations center, and flight crew roles and responsibilities.
- Continue development of an inter-agency integrated surveillance architecture, concept of operations and funding profile, and governance process recommendation.
- Continue coordination of Network Enabled information sharing standards for participating agencies & organizations including multi-agency governance processes.
- Develop FY2013 formulation package to support NextGen resource planning and performance measurement; track and ensure that partner agencies are implementing programs that support a transition to the end-state architecture as defined in the Integrated Work Plan.
- Develop FY2013 formulation package to support NextGen resource planning and development of the NextGen business case.
- Develop FY2013 NextGen business case including results of environmental mitigation methods and benefits.
- Continue Dynamic Airspace Configuration research transition planning that facilitates a concept for efficient partitioning of airspace and allocation of resources to meet far-term NextGen Capacity needs.
- Continue to coordinate and conduct demonstrations that will test operational concepts, address operational challenges, and provide alternatives for architectural trade-offs. Update the JPE to include demonstration results.

FY 2013-2015

- Continue research and development to support all NextGen solution sets.

FY 2016 and Beyond

- Continue development to support all NextGen solution sets.
- Identify alternatives as a result of needed research that may be immature.

Customer/Stakeholder Involvement: The JPDO is truly a collaborative enterprise. Employees from NASA and the Departments of Transportation, Commerce, Defense, and Homeland Security actively lead and/or participate in JPDO activities. Similarly, the JPDO Board includes executives from each department/agency, as well as the White House Office of Science and Technology Policy. And the Senior Policy Committee includes Secretaries, Deputy Secretaries, and/or Administrators from the participating organizations, as well as the Director of the Office of Science and Technology Policy.
The private sector is also an integral part of JPDO's work. In FY 2006, the NextGen Institute was established as an alliance of major aviation stakeholder communities. The Institute operates under guidelines set forth in the funding agreement between FAA/JPDO and the host organization, the National Center for Advanced Technologies. The agreement states that the Institute will be governed by a 16-member council that is broadly representative of the aviation community. The Institute supports JPDO by recruiting and assigning industry experts to participate in forums and perform funded technical work. The Institute has already hosted a series of workshops to gather input on research, demonstrations, operational concepts, and financial implications. The Institute performs a variety of tasks in support of the planning process including studies, demonstration support, and strategic assessments and recommendations for NextGen design issues.

Accomplishments: Major accomplishments and associated benefits of the JPDO efforts include the following:

FY 2009

- Deployed the web-based Joint Planning Environment (JPE) a portal that presents and relates NextGen Enterprise Architecture, Concept of Operations, Integrated Workplan, and Business Case information.
- Enhanced the JPE to reflect a federated architecture for participating agencies' Enterprise Architectures.
- Developed FY 2011 Formulation Package to support NextGen resource planning and development of the NextGen business case.
- Developed FY 2011 NextGen business case and released NextGen foundational documents consistent with FY 2011 plans and priorities: Concept of Operations, Enterprise Architecture, and Integrated Work Plan.
- Continued to coordinate with aviation and aeronautics research programs to ensure that research results in decisions that influence the most effective investment and implementation decision-making.
- Multi-sector Planner Research Transition Team defined roles & responsibilities that support efficient traffic flow for mid-term operations (2010-2018).
- Consistent with the refined foundational documents, continued to identify and facilitate all pre-implementation activities to support identification and resolution of policy issues, optimized technology transfer, risk management and a broad range of analysis to support decision making.
- Tracked and coordinated changes with partner agencies to ensure that implementing programs supported a transition to the end-state architecture as defined in the Integrated Work Plan.
- Continue to coordinate and conduct demonstrations that validated operational concepts, addressed operational challenges, and provided alternatives for architectural trade-offs. Demonstrations explored human factors and safety characteristics of trajectory-based operations, high density airport operations, airspace security, and globally interoperable system integration

FY 2008

- Developed FY 2010 Formulation Package to support NextGen resource planning and development of the NextGen business case.
- Developed FY 2010 NextGen business case
- Released the Enterprise Architecture and Concept of Operations supporting FY 2010 planning.
- Released the Integrated Work Plan Version 1, which outlines the steps necessary to achieve the Concept of Operations.
- Expanded NextGen Business Case including initial life-cycle cost/benefit analysis.
- Refined program processes including risk management.
- Defined Net Enabled Information Sharing (NEIS) framework and multi-agency governance
- Established NextGen Network Enabled Weather Program Office and multi-agency governance
- Defined Aviation Safety Information Analysis and Sharing Concept and multi-agency governance
- Established four Research Transition Teams: Trajectory Management, Integrated Arrival/Departure/Surface, Multi-sector Planner, and Dynamic Airspace Configuration, that defined initial plans for research transition from NASA to the FAA in these areas.

FY 2007

- Released Version 2 of the Enterprise Architecture and Concept of Operations.
- Released the initial baseline version of the Integrated Work Plan, which outlines the steps necessary to achieve the Concept of Operations.
- Completed the first NextGen Research and Development Plan, a 5-year view of the research and investment activities required to revise, coordinate, and cost the research and implementation agendas.
- Completed the first NextGen business case (Exhibit 300).

FY 2006

- Developed the NextGen Block-to-Block Concept of Operations and coordinated it through the NextGen stakeholder community for comment and feedback.
- Developed the NextGen Block-to-Block Enterprise Architecture, aligned the Architecture with the Concept of Operations, and began coordination and review through the NextGen stakeholder community.
- Baselined the Operational Improvement Roadmap to set research targets for the Integrated Product Teams.
- Published the NextGen FY 2008 Agency Budget Guidance for Research and Implementation, which begins to align programs to NextGen and identify key research areas.
- Delivered the FY 2005 Progress Report to Congress describing the JPDO's progress in carrying out the NextGen Integrated Plan.
- Developed initial JPDO Systems Engineering Management Plan (SEMP) to facilitate interaction with other agencies and stakeholders.
- Established the Architecture Integration Council, which includes the chief architects for all partner agencies. This body will ensure the cooperation and engagement of the relevant agencies' chief architects during development of the NextGen architecture.

FY 2005

- Made significant progress in resource alignment within the federal government and U.S. industry to develop and implement the NextGen in the most expedient and cost-effective manner.
- Produced and updated the NextGen Integrated Plan as the long-term strategic business plan, detailing goals, objectives, and requirements for eight transformational areas.
- Established and staffed—with federal and industry participants—eight integrated product teams to work collaboratively with government and industry to develop research agendas and strategies for achieving NextGen.
- Performed the first major evaluation of the Operational Vision in Portfolio Segments, to validate the ability to deliver two to three times today's capacity.
- Established the NextGen Operational Improvement Roadmap to guide the transition from today's system to the next generation.
- Developed initial NextGen Segment Portfolios of policy, research and modernization requirements based on the OI Roadmap.

FY 2004

- Initiated resource alignment within the federal government and U.S. industry to develop and implement the NextGen in the most expedient and cost-effective manner.
- Produced the outline for the Integrated National Plan as the long-term strategic business plan for NextGen that detailed NextGen goals and objectives, and requirements for transformation in eight specific areas, each individually significant yet interdependent on the others.
- Produced the framework for establishing with federal and industry participants eight integrated product teams that would work collaboratively with government and industry to plan for and develop research agendas and strategies for achieving NextGen.
- Established the framework for the NextGen Operational Improvement (OI) Roadmap to guide the transition from today's system to the NextGen.
- Developed initial plan for the NextGen Segment Portfolio's of needed policy, research and modernization requirements based on the NextGen OI Roadmap.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Updated the Joint Planning Environment (JPE) a portal that presents and relates NextGen Enterprise Architecture, Concept of Operations, Integrated Workplan, and Business Case information.
- Developed FY2012 Formulation Package to support NextGen resource planning and development of the NextGen business case.
- Developed FY2012 NextGen business case and released NextGen foundational documents consistent with FY 2011 plans and priorities: Concept of Operations, Enterprise Architecture, and Integrated Work Plan.
- Continued to coordinate with aviation and aeronautics research programs to ensure that research results in decisions that influence the most effective investment and implementation decision-making.
- Consistent with the refined foundational documents, continued to identify and facilitate all pre-implementation activities to support identification and resolution of policy issues, optimized technology transfer, risk management and a broad range of analysis to support decision making.
- Tracked and coordinated changes with partner agencies to ensure that implementing programs supported a transition to the end-state architecture as defined in the Integrated Work Plan.
- Continue to coordinate and conduct demonstrations that validated operational concepts, addressed operational challenges, and provided alternatives for architectural trade-offs. Demonstrations explored human factors and safety characteristics of trajectory-based operations, high density airport operations, airspace security, and globally interoperable system integration
- Continued development of the Enterprise Architecture and Concept of Operations aligned with the Integrated Work Plan. The Enterprise Architecture is a structured documentation of NextGen, capturing the activities, capabilities, data interchanges, and salient relationships associated with NextGen. The Concept of Operations provides a textual operational description of NextGen in the 2025 timeframe. This is a key source to inform and initiate a dialog with the stakeholder community.
  - The Integrated Work Plan provides a long-term transition plan from the current system to that reflected in the Enterprise Architecture and Concept of Operations. It provides a framework to support ongoing planning and will be refined over the planning process to detail analysis of implementation alternatives, risks, costs and benefits as well as prioritization and allocation of resources.
  - These documents will provide the necessary foundational information to define implementation and research guidance to NextGen partner agencies.
- Engaged the Senior Policy Committee on near-term, high priority policy decisions in support of FY012 planning. Continue to use the NextGen Institute to access world-class private sector expertise, tools, and facilities for application to NextGen activities and tasks. The studies to be conducted by the Institute in FY 2010 will further address strategic trade studies that consider the technical, economic, operational, policy, organizational, and temporal dimensions of the NextGen design space.
- Conducted detailed planning and coordinate demonstrations to be undertaken in FY 2010, including Oceanic Trajectory-Based Operations, High Density Airport Operations, Domestic Trajectory-Based Operations, Network Enabled Weather, and Global Interoperability. These demonstrations will test operational concepts, demonstrate technologies that could address operational challenges, and provide alternatives for architectural tradeoffs.
- Continued system-of-system modeling, simulation, and evaluation to ensure benefits, costs, and trade-offs across the full range of NextGen goals.
- Continued outreach efforts aviation trade associations and non-traditional organizations (e.g., groups representing both leisure and business travelers) to solicit views as to how NextGen can best meet the needs of the traveling public.
- Updated, coordinate, and validate NextGen concepts.
- Coordinated aviation and aeronautics research programs to achieve the goal of more effective and directed research that will result in only performing the most promising and applicable research.
- Set goals, priorities and metrics and reporting structure, and coordinate research activities within JPDO member agencies and with U.S. aviation and aeronautical firms.
- Facilitated the transfer of technologies from research programs that are ready for implementation (e.g., NASA and DoD Advanced Research Projects Agency program) to the federal agencies with operational responsibilities and to the private sector, as appropriate.
- Continued to refine research plans, which will describe research and supporting activities required to drive implementation decisions to effect the NextGen transformation.

- Continued refining foundational documents—Concept of Operations, Enterprise Architecture, and Integrated Work Plan—in response to the outcome of demonstrations, research, changes in agency budgets, etc.
- Continued modeling planned improvements to test their efficacy in accomplishing NextGen goals.
- Conducted analyses, trade studies, and demonstrations to select the best approaches/alternatives for transforming the current air transportation system to NextGen.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

- Continue modeling, simulation, and evaluation to ensure benefits, costs, and trade-offs are understood across the full range of goals.
- Revise, coordinate, and cost the research and implementation agendas for subsequent years.
- Refine NextGen business case and work with agencies and industry on research areas and implementation of NextGen-related programs.
- Continue refining foundational documents—Concept of Operations, Enterprise Architecture, and Integrated Work Plan —in response to the outcome of demonstrations, research, changes in agency budgets, etc.
- Refine NextGen metrics.
- Plan FY 2012 operational demonstrations.
- Continue alignment of agency goals and objectives with NextGen goals and objectives.

New Initiatives

- Coordinate demonstrations that will test operational concepts, demonstrate technologies that could address operational challenges, and provide alternatives for architectural tradeoffs.
- Facilitate the transfer of technologies from research programs that are ready for implementation (e.g., NASA, FAA, DHS and DoD Advanced Research Projects Agency program) to the federal agencies with operational responsibilities and to the private sector, as appropriate.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Planning and Agency/Industry Alignment

- Update, coordinate, and validate NextGen concepts.
- Coordinate aviation and aeronautics research programs to achieve the goal of more effective and directed research that will result in only performing the most promising and applicable research.
- Set goals, priorities and metrics and reporting structure, and coordinate research activities within JPDO member agencies and with U.S. aviation and aeronautical firms.
- Facilitate the transfer of technologies from research programs that are ready for implementation (e.g., NASA and DoD Advanced Research Projects Agency program) to the federal agencies with operational responsibilities and to the private sector, as appropriate.

Systems Integration and Transformation Analysis

- Continue to refine research plans, which will describe research and supporting activities required to drive implementation decisions to effect the NextGen transformation.
- Continue refining foundational documents—Concept of Operations, Enterprise Architecture, and Integrated Work Plan—in response to the outcome of demonstrations, research, changes in agency budgets, etc.
- Continue modeling planned improvements to test their efficacy in accomplishing NextGen goals.
- Conduct analyses, trade studies, and demonstrations to select the best approaches/alternatives for transforming the current air transportation system to NextGen.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	72,893
FY 2010 Enacted	14,407
FY 2011 Request	14,292
Out-Year Planning Levels (FY 2012-2015)	58,345
Total	159,937

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Joint Planning & Development Office	16,112	12,910	11,221	11,528	10,819
Personnel Costs	1,867	1,256	2,663	2,622	3,152
Other In-house Costs	121	155	610	257	321
Total	**18,100**	**14,321**	**14,494**	**14,407**	**14,292**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	18,100	14,321	14,494	14,407	14,292
Development (includes prototypes)	0	0	0	0	0
Total	**18,100**	**14,321**	**14,494**	**14,407**	**14,292**

A12.a - Joint Planning & Development Office Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Joint Planning & Development Office							
Planning and Agency/Industry Alignment:							
Update and carry out an integrated plan for a Next Generation Air Transportation System.	**1,049**	♦	◊	◊	◊	◊	◊
Coordinate and facilitate the transfer of technologies from aeronautics research programs and direct research that will result in achieving NextGen.	**268**	♦	◊	◊	◊	◊	◊
Systems Integration and Transformation Analysis:							
Accomplish the coordination to create and carry out the plan to achieve more directed programs through applicable research and systems integration.	**2,087**	♦	◊	◊	◊	◊	◊
Develop Enterprise Architecture for systems-of systems engineering and expand lower levels of the enterprise.	**2,084**	♦	◊	◊	◊	◊	◊
Evaluate and validate cross IPT, integrated system-wide concepts, procedures, policies, business cases, etc. to assure potential alternatives exist that could meet all the National Plan Objectives.	**1,855**	♦	◊	◊	◊	◊	◊
Conduct policy analyses that focus on early decisions to establish guiding principles for the transformation	**1,287**	♦	◊	◊	◊	◊	◊
Model the planned system improvements to validate their efficacy in accomplishing the NextGen goals. Update roadmaps and research agenda's as required.	**344**	♦	◊	◊	◊	◊	◊
Assist agencies in selecting the best approaches/alternatives for transforming the current air transportation system to NextGen;	**1,345**	♦	◊	◊	◊	◊	◊
Conduct and report interagency budget analysis and progress	**500**	♦	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**3,473**						
Total Budget Authority	**14,292**	**14,407**	**14,292**	**14,420**	**14,563**	**14,640**	**14,722**

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

Budget Item	Program Title	Request
A12.b	**NextGen - Wake Turbulence**	**$10,685,000**

GOALS:
This program supports the following Flight Plan goal: Greater Capacity.

Intended Outcomes: The NextGen Wake Turbulence Program addresses FAA's goal for capacity and the DOT reduced congestion strategic goal outcome of "Meet new and growing demands for air transportation services through 2011 and beyond." The program provides the research to achieve near-term objectives of increasing airport runway capacity by reducing aircraft wake separation minima under certain conditions. The program also provides the research and analysis to answer the NextGen era questions of:

- What wake turbulence mitigations will be required in implementing Trajectory Based Operations?
- How can more aircraft be accommodated in high demand airspace (terminal and en-route) and still be safe in terms of wake turbulence?

In FY 2011, the NextGen Wake Turbulence Research will continue its NextGen near term and mid-term research agenda, addressing wake turbulence restrictions in today's terminal and en route airspace and in the future NextGen airspace designs. Program outcomes include:

- Increased runway capacity in Instrument Meteorological conditions and capacity for more flights in high usage airspace, and

More capacity efficient wake separations are provided to aircraft with the same or reduced safety risk.

Agency Outputs: The NextGen -Wake Turbulence Program conducts applied research to improve, in terms of flight efficiency and safety, aircraft separation processes associated with today's generalized and static air navigation service provider (ANSP) wake turbulence mitigation based separation standards. As an example, during periods of less than ideal weather and visibility conditions, implementation of an ANSP decision support tool that adjusts required wake separations based on wind conditions, would allow air traffic control to operate these airports at arrival rates closer to their visual flight rule arrival capacity. Additionally, the research program is developing wake mitigation application solutions that safely enable reduced aircraft separations in congested air corridors and during arrival and departure operations at our nation's busiest airports. The research program in FY 2011 will continue work begun in FY 2008 to address the feasibility and benefit of a wake avoidance decision support capability for the flight deck.

Research Goals:

- By FY 2012, determine the NAS infrastructure requirements (ground and aircraft) for implementing the NextGen "Trajectory Based Operation" and "High Density" concepts within the constraints of aircraft generated wake vortices and aircraft collision risk.

Customer/Stakeholder Involvement: The program addresses the needs of the FAA Air Traffic Organization (ATO) and works with the agency's Aviation Safety organization to ensure new capacity efficient procedures and technology solutions are safe and that the airports and air routes targeted for their implementation are those with critical needs to reduce airport capacity constraints and air route congestion. The program works with controllers, airlines, pilots and aircraft manufacturers to include their recommendations and ensure that training and implementation issues are addressed in the program's research from the start.

Customers:

- Pilots;
- Air navigation service provider personnel;
- Air carrier operations; and
- Airport operations.

Stakeholders:

- Joint Planning and Development Office;
- Commercial pilot unions;
- FAA air navigation service provider unions;
- Other ICAO air navigation service providers; and

- Aircraft manufacturers.

R&D Partnerships: In addition to maintaining its partnership with the agency's Aviation Safety organization, this research program accomplishes its work via working relationships with industry, academia, and other government agencies. The coordination and tasking are accomplished through joint planning/reviews, contracts and interagency agreements with the program's partners:

- Volpe National Transportation Systems Center;
- Mitre/Center for Advanced Aviation System Development (CAASD) [NG];
- NASA Langley Research Center (NASA Sponsored Research);
- EUROCONTROL and associated research organizations (coordination and shared research);
- Massachusetts Institute of Technology's Lincoln Laboratory [NG];
- National Center of Excellence for Aviation Operations Research [NG];
- National Institute of Aerospace [NG]
- CSSI, Incorporated. [NG]

Accomplishments: The following represent major accomplishments of the wake turbulence program:

- FY 2009 - Developed airport specific procedure modifications to enable dependent ILS approaches to closely spaced parallel runways.
- FY 2009 – Developed concept that for some airports, would allow B-757 and heavier aircraft to be the leader in dependent paired instrument approaches to the airport's closely spaced parallel runways.
- FY 2009 – Developed concepts for better merging of aircraft in an airports terminal airspace, in terms of wake mitigation constraints, for the NextGen midterm timeframe
- FY 2009 – Submitted for coordination a modification to the wake turbulence separations applied to B757-200 and B757-300 aircraft, resulting in an increased runway throughput for airports having B757 aircraft as a major component of their operations.
- FY 2009 – Repositioned wake measuring pulsed LIDARS to airports having significant B-757 and heavier aircraft operations. Collected data will be used in defining more capacity efficient air traffic control procedures for aircraft wake turbulence mitigation.
- FY 2008 – Developed a national air traffic control order for conducting dependent integrated landing system staggered approach operations on closely spaced parallel runways at five airports (Boston, Cleveland, Philadelphia, Seattle and St Louis).
- FY 2006-2008 - Evaluated reports of wake turbulence encounter as part of the FAA Safety Management System assurance process for changes to air traffic control procedures.
- FY 2005-2008 – Provided wake turbulence evaluation support in the integration of a new aircraft into the National Airspace System.
- FY 2004-2008 – Cooperative data exchange with European wake turbulence data collection efforts.
- FY 2002-2008 – Developed the most extensive wake turbulence transit and characterization data base in the world, used to determine feasibility of proposed changes to air traffic control's wake turbulence mitigation procedures.
- FY 2007 - Implement dependent staggered ILS approaches to St. Louis closely spaced parallel runways 12R/L and 30R/L.
- FY 2007 - Complete FAA assessment of NASA's concept for wind dependent wake turbulence mitigation procedure for aircraft arriving on closely spaced parallel runways.
- FY 2005-2007 – By analysis, simulation and evaluation prototype; demonstrated feasibility of a cross-wind based air traffic wake turbulence mitigation decision support tool concept for enabling more closely spaced departures from an airport's closely spaced parallel runways.
- FY 2006 – Provided wake turbulence information necessary for the ICAO determination of wake turbulence mitigation separations required for the A-380 aircraft.
- FY 2006 – Completed a detailed proposal for modifying the current air traffic wake turbulence mitigation procedures used for dependent staggered instrument landing system (ILS) approaches to an airport's CSPR.

- FY 2005-2006 – Enhanced the pulsed Light Detection and Ranging (LIDAR), which can measure distance, speed and rotation, for wake data collection capability, enabling it to capture wakes from both arriving and departing aircraft.
- FY 2005 – Utilizing analyses of the wake turbulence data collected at San Francisco International Airport (SFO) and Lambert – St. Louis International Airport (STL) upgraded FAA's wake turbulence encounter model used for evaluating proposed changes to air traffic control procedures for routing aircraft into and out of airports.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continued wake data collection and analyses at additional airports to support airport specific changes to air traffic control procedures for aircraft dependent instrument approaches to an airport's closely spaced parallel runways.
- Evaluated reports of wake turbulence encounter as part of the FAA Safety Management System assurance process for changes to air traffic control procedures.
- Analyzed wake turbulence data base and provided the analysis information to continue upgrading computational models of wake vortex transport and decay.
- Accomplished air traffic procedure/air route proposal reviews utilizing the enhanced suite of wake turbulence encounter analysis tools.
- Initiate development of wake turbulence transport and decay modeling tools for use in evaluating proposed trajectory based operational concepts.
- Developed airport specific procedure modifications to enable dependent instrument approaches to closely spaced parallel runways.
- Development of an air navigation service provider concept feasibility prototype decision support system for use in reducing required wake mitigation separations in dependent instrument landing system arrivals of B-757 and heavier aircraft on an airport's closely spaced parallel runways.
- Continue to conduct experiments/analyses and aviation community forums to define in terms of a wake turbulence hazard – what is an "unacceptable" level of wake turbulence for an encountering aircraft.
- Continued development of ground based situational display concepts (and aircraft based as necessary, working jointly with EUROCONTROL) relative to separation constraints (wake, weather, and visibility) required for implementation of the NextGen concept for air routes and approach/departure paths.

FY 2011 PROGRAM REQUEST:

In FY 2011, FAA must continue its development of the capabilities needed to enable aircraft separation processes supportive of NextGen shared separation and dynamic spacing super density operations. These capabilities are highly dependent on technologies that accurately predict aircraft tracks, the track/decay of their generated wake vortices and the provision of this information to pilots and controllers. Some aspects of the NextGen Concept of Operations are dependent upon the aircraft being a participant in efficient, safe air traffic control processes that would minimize the effects of required wake turbulence mitigation on the flow of air traffic in all weather and visibility conditions. The Wake Turbulence Program's research will result in enhanced technology assisted processes for safely mitigating aircraft wake encounter risks while optimizing capacity, for all flight regimes, including the effects of weather.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continue to incorporate wake transport/decay and aircraft navigation performance analysis results into FAA wake encounter risk models.
- Provide engineering and analysis support to develop airport specific procedure modifications to enable dependent instrument approaches to the airport's closely spaced parallel runways.
- Continued data collection to determine the characteristics of wake vortices generated by departing and arriving aircraft. Data will be used in development of air navigation service provider decision support tools in reducing the required wake mitigation separation applied to airport single runway arrivals and departures.
- Continue development of wake turbulence transport and decay modeling tools for use in evaluating proposed trajectory based operational concepts.

- Continued development of ground and aircraft based situational display concepts (joint work with EUROCONTROL) relative to separation constraints (wake, weather, and visibility) required for implementation of the NextGen concept for air routes and approach/departure paths.
- Continue development of modeling tools to evaluate system-wide safety risk associated with the NextGen pair-wise separation concepts.
- Continue to conduct experiments/analyses and aviation community forums to define in terms of a wake turbulence hazard – what is an "unacceptable" level of wake turbulence for an encountering aircraft.
- Initiate detail development of a decision support tool concept for use in determining when to apply reduced air traffic control wake mitigation separations during single runway instrument approach operations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	45,168
FY 2010 Enacted	10,631
FY 2011 Request	10,685
Out-Year Planning Levels (FY 2012-2015)	43,142
Total	109,626

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts					
Wake Turbulence	2,833	12,543	9,734	9,821	9,517
Personnel Costs	222	251	374	700	910
Other In-house Costs	11	19	24	110	258
Total	**3,066**	**12,813**	**10,132**	**10,631**	**10,685**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	3,066	12,813	10,132	10,631	10,685
Development (includes prototypes)	0	0	0	0	0
Total	**3,066**	**12,813**	**10,132**	**10,631**	**10,685**

A12.b NextGen - Wake Turbulence Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
111-130 NextGen - Wake Turbulence	**9,517**						
Evaluate reports of wake turbulence encounter		♦	◊	◊	◊	◊	◊
Continued data collection and analysis to determine the characteristics of wake vortices generated by aircraft – for enhancing the fidelity of wake models		♦	◊	◊	◊	◊	◊
Incorporate wake turbulence data analysis results into wake transport and decay models and utilize the models to review proposed air route and terminal airspace change proposals		♦	◊	◊	◊	◊	◊
Develop airport specific procedure modifications to enable dependent instrument approaches to closely spaced parallel runways		♦	◊	◊	◊		
Continued data collection and analysis to determine the characteristics of wake vortices generated by aircraft – for use in determining potential achievable separation reduction in single runway operations		♦	◊	◊	◊	◊	◊
Development of modeling and other analysis tools required for evaluation of wake encounter risks of trajectory based operations		♦	◊	◊	◊		
Accomplish wake turbulence encounter assessments of potential air traffic routing and separation changes associated with evolution to NextGen		♦	◊	◊	◊	◊	◊
Development of ground based and flight deck based situational display concepts for showing separation constraints for aircraft operating in NextGen air corridors and high density airspace		♦	◊	◊	◊	◊	◊
Conduct experiments/analyses and aviation community forums to define in terms of a wake turbulence hazard – what is an "unacceptable" level of wake turbulence for an encountering aircraft		♦	◊	◊	◊	◊	◊
Complete development of ANSP feasibility prototype decision support system for use in reducing required wake mitigation separations in dependent instrument approaches for aircraft following B-757 and heavier aircraft landing on the adjacent closely spaced parallel runway		♦					
Detail development of DST concept for use in determining air traffic control wake mitigation separations applied during single runway instrument approach operations			◊	◊	◊	◊	
Develop modeling tools to evaluate system-wide safety risk for NextGen era reduced separation standards		♦	◊	◊	◊		
Personnel and Other In-House Costs*	**1,168**						
Total Budget Authority	**10,685**	**10,631**	**10,685**	**10,742**	**10,799**	**10,800**	**10,801**

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

Budget Item	Program Title	Budget Request
A12.c	**NextGen – Air Ground Integration Human Factors**	**$10,614,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: By 2017, demonstrate that NextGen operations, procedures and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft across the full range of environmental conditions.

Integration of air and ground capabilities poses challenges for pilots and air traffic service providers. A core human factors issue is ensuring the right information is provided to the right human operators at the right time to make the right decisions. Transitions of increasingly sophisticated automation and procedures must be accompanied by supporting interoperability with baseline systems and refinement of procedures to ensure efficient operations and to mitigate potential automation surprises. Additionally, NextGen systems, procedures and training must support safe and effective planned and unexpected transitions between NextGen and legacy airspace procedures.

The safety factors that primarily have an impact on separation assurance must be jointly approached by both the flight deck and air traffic research communities. The increased levels of automation and new enabling technologies that will likely transform the National Airspace System (NAS) in the future will bring new human factors challenges. As the NAS moves toward a more automated system and roles and responsibilities change in a series of planned steps, intent information as well as positive information on delegation of authority must be clear and unambiguous. This changing environment requires a close examination of new types of human error modes to manage safety risk in the human factors domain. Equipment design methods, training, and procedures must be developed to decrease error likelihood and/or increase timely error detection, for example in the case of blunders on closely spaced parallel approaches.

Many of the emerging NextGen concepts imply that a flight plan will become an air-ground performance contract that meets the user's needs, will be executed by the flight deck, and protected by the air traffic service provider. There are multiple parameters in aviation such as weather, unanticipated traffic, sudden denial of airspace or airport assets, emergencies, and a myriad of other factors that will require close monitoring to meet the expected flight performance goals.

Changes in roles and responsibilities will occur not only between pilots and air traffic service providers, but also for both groups and the respective automation they use to achieve NextGen safety and efficiency gains. Issues such as mode confusion, transitions, and reversions must be understood and addressed to ensure appropriate levels of situation awareness and workload are maintained.

The NextGen environment will include an increased reliance on collaborative and distributed decision making. Information must be provided to participants, e.g., pilots, air traffic service providers and airline operation centers in a fashion that facilitates a shared understanding of phenomena, such as weather, wake, etc. The format, content, timeliness and presentation of that information must be well integrated with other information provided to decision makers and their decision support tools.

Operational Improvements (OIs) to be addressed from an integrated air-ground perspective include provision for spacing, merging and passing in en route airspace via Cockpit Display of Traffic Information (CDTI) and Automatic Dependent Surveillance - Broadcast (ADS-B), with procedures for less than current levels of aircraft separation. Lateral and in-trail separation would be reduced to near Visual Flight Rules (VFR) levels for single runway and for converging and closely spaced parallel runway operations using CDTI, ADS-B and wake vortex ground detection. Aircraft-to-aircraft separation would be delegated to the flight deck in oceanic airspace, with reduced longitudinal and lateral spacing via Required Navigation Performance (RNP), ADS-B/CDTI and data communication.

Agency Outputs: The NextGen Air Ground Integration research program addresses flight deck - air traffic service provider integration for each operational improvement or NextGen application considered, with a focus on those issues that primarily affect the pilot side of the air-ground integration challenge. The program collaborates with the NextGen Self Separation Human Factors Program to ensure robust examination of NextGen human factors issues. Through use of modeling, simulation, and demonstration, the program assesses interoperability of tools, develops

design guidance, determines training requirements, and verifies procedures for ensuring safe, efficient and effective human system integration in transitions of NextGen capabilities.

Outputs include:

- Defining, understanding, and developing guidance to successfully implement the changes in roles and responsibilities between pilots and controllers, and between humans and automation required for NextGen capabilities and applications.
- Defining human and system performance requirements and guidance for the design and operation of aircraft and air traffic management systems to include examination of information needs, human capabilities, interface design and systems integration issues.
- Developing and applying risk and error management strategies, mitigating risk factors, and reducing human errors.

Research Goals: Research will support development of policy, standards and guidance required to design, certify and operate NextGen equipment and procedures from the perspective of air-ground integration. Additionally, this research will include integrated demonstrations of NextGen procedures and equipment in the context of ongoing air-ground integration human factors research.

- By 2016 complete research to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures.
  - By 2011 develop initial taxonomy describing the relationship between pilots/ATC and associated automated systems.
  - By 2013 complete initial research to evaluate and recommend pilot-ATC procedures for negotiations and shared decision making NextGen activities.
  - By 2015 complete research to identify and recommend mitigation strategies to address potential coordination issues between humans and automated systems.
  - By 2016 complete research to identify methods for effectively allocating functions between pilots/ATC and automated systems as well as mitigating any losses of skill associated with these new roles and responsibilities.
- By 2016 complete research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment.
  - By 2011 initiate development of guidance to support certification and flight standards personnel in assessing suitability of design and training methods to support human error detection and correction.
  - By 2013 complete initial research investigating methods to mitigate mode errors and unintended use of NextGen equipment.
  - By 2014 develop initial guidance on training methods to support detection and correction of human errors in near to mid-term NextGen procedures.
  - By 2016 complete research and modeling activities to identify, quantify and mitigate potential human errors in the use of NextGen equipment and procedures.
- By 2016 complete research on human systems integration issues related to information needs, human capabilities and limitations, interface design and system integration required to support effective guidance for NextGen equipment design, procedure development and personnel training.
  - By 2012 initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations.
  - By 2013 complete initial research to identify cognitive tasks, associated information needs and recommended display methods for tasks that require shared flight deck-ATC information.
  - By 2013 complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.
  - By 2013 complete initial research to address human-automation integration issues regarding the certification of pilots, procedures, training and equipment necessary to achieve NextGen capabilities.
  - By 2014 complete initial research to provide recommendations for displays, alerts, procedures and training associated with data communications.

- By 2014 complete research to provide initial recommendations for equipment design, procedures and training to support use of 2 ½ to 4 D trajectories.
- By 2016 complete research to assess procedures, training, display and alerting requirements to support development and evaluation of planned and unplanned transitions between NextGen and legacy airspace procedures.

Customer/Stakeholder Involvement: Program researchers work directly with colleagues in FAA, other government agencies, academia, and industry to support the following R&D programs and initiatives:

- Guidance from the Joint Planning and Development Office (JPDO) Next Generation Air Transportation System (NextGen) initiative.
- NASA's Aviation Safety and Airspace Programs.
- Close collaboration with FAA organizations, notably Flight Standards and Aircraft Certification in the AVS line of business.
- Collaboration with specific FAA programs such as the Surveillance and Broadcast Services (SBS), DataComm and the NextGen-Wake programs.
- FAA Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the activities of the program and provide advice on priorities and budget.

R&D Partnerships: The NextGen Air Ground Integration research program collaborates with industry and other government programs through:

- Collaborative research with NASA on its safety, airspace and air portal projects including the identification of human factors research issues in the NextGen as technology brings changes to aircraft capabilities.
- Complex full mission demonstrations using a distributed simulation architecture that leverages NASA cockpit and Air Traffic Management (ATM) simulation facilities and other resources.
- Cooperative research agreements used with universities to address NextGen human factors issues.
- Coordination on research issues and plans with aircraft and avionics manufacturers and operators as well as international civil aeronautics authorities.

ACCOMPLISHMENTS

FY 2009

Roles and Responsibilities

- Initiated development of a standard taxonomy for describing the relationship between flight deck and Air Traffic Control (ATC) automated systems and human operators in the context of NextGen equipment and applications.
- Initiated investigation of shared decision making methods considering potential decisions shared between flight deck, Air Navigation Service Provider (ANSP) and Aircraft Operations Center (AOC) personnel.

Human System Integration

- Established preliminary equipment categories for legacy Flight Management Systems and associated cockpit displays to support future human factors evaluations of the acceptability of using legacy avionics equipment in NextGen procedures.
- Began work to identify standard methods for conducting task analyses of flight deck-ATC activities for NextGen airspace procedures.

Error Management

- Initiated development of structured method to assist certification personnel in identifying risk areas related to human error and assessing system resilience to error for new and modified systems and procedures.
- Began assessment of nature and impact of potential errors in oceanic in trail procedures.

Integrated Demonstrations

- Developed an initial simulation and demonstration roadmap laying out incremental objectives, simulation requirements, assumptions, and risks.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS

Roles and Responsibilities

- Developed initial guidance addressing allocation of functions between the aircrew and automation.
- Developed initial guidance on procedures for flight deck-ANSP negotiations.

Human System Integration – Information Needs

- Developed initial guidance for the design of NextGen flight deck and ATC displays and alerts, including those required for oceanic in trail procedures.
- Continued research to identify human factors issues associated with instrument procedure design and to develop human factors guidelines for instrument procedures.

Human System Integration – Human Capabilities and Limitations

- Initiated development of a methodology to address the human capabilities and limitations of pilots (including single-pilot aircraft) to conduct a range of NextGen airspace procedures in normal and non-normal situations.
- Evaluated flight technical error in all four dimensions for TBO.

Human System Integration – System Integration

- Initiated research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.
- Conducted research to support guidance for data communications procedures, training, displays and alerts.

Risk and Error Management

- Delivered initial results of proactive analyses of human error hazards to understand and predict human error vulnerabilities.
- Assessed human error impact and mitigation in oceanic in-trail procedures and RNP operations.

FY 2011 PROGRAM REQUEST:

The program will continue to assess human system integration issues in use of airborne NextGen concepts, capabilities, and procedures, and ATM leading to a full mission demonstration. Each of these research areas, although general in nature, will continue to be conducted in the context of specific near-to mid-term NextGen applications such as closely spaced parallel operations, oceanic in-trail procedures, etc.

Roles and Responsibilities

- Define a taxonomy for describing the relationship between flight deck and ATC automated systems and human operators within NextGen applications.
- Assess human-automation coordination methods for performance costs and benefits in the context of near-term NextGen applications.
- Initiate research to identify design and procedural methods to support collaboration and negotiation between flight deck, ANSP and AOC personnel.
- Assess various strategies for Pilot Flying/Pilot Not Flying responsibilities and coordination procedures.

Human System Integration – Information Needs

- Assess pilot information needs associated with dynamic allocation to ensure awareness of need of re-allocation, awareness that reallocation has occurred, and to ensure the pilot has the information required to effectively assume responsibility for a function.
- Develop recommendations to support guidance on minimum flight deck wake turbulence display and alerting requirements to include priority, type of alert and synchronization between flight deck and ATC systems.

- Determine which pilot and controller tasks are associated with NextGen flight procedures, using task and information needs analysis techniques, and develop guidelines for each type of procedure in NextGen.

Human System Integration – Human Capabilities and Limitations

- Continue development of a methodology to address the human capabilities and limitations of pilots (including single-pilot aircraft) to conduct a range of NextGen airspace procedures in normal and non-normal situations.
- Assess/evaluate flight deck human decision making capabilities and limitations in the context of near to mid-term NextGen applications.

Human System Integration – System Integration

- Assess human factors issues associated with use of legacy avionics in NextGen procedures.
- Initiate research to develop flight crew training recommendations for error detection and correction for NextGen operations for single pilot and two pilot crews.

Risk and Error Management

- Develop guidance to support certification personnel in evaluating risks and mitigation of human error and potential unintended uses of new technology in NextGen systems and procedures.
- Determine the expected nature, frequency and potential impact of pilot errors that may lead to exceeding RNP containment criteria.
- Develop a structured method (e.g., checklist, decision aid, analysis process) to assist certification personnel in evaluating system resilience to human error, and for identifying and estimating risk of human error (before and after application of risk mitigation) for new or modified technologies and procedures.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Roles and Responsibilities

- Define a standard taxonomy for describing the relationship between flight deck and ATC automated systems and human operators in the context of NextGen equipment and applications.
- Select the most likely human-automation coordination methods and assess the performance costs and benefits of these human-automation coordination strategies in the context of near-term NextGen applications.
- Initiate research to identify design and procedural methods to support collaboration and negotiation between flight deck, ANSP and AOC personnel.
- Assess various strategies for Pilot Flying/Pilot Not Flying responsibilities and coordination procedures.

Human System Integration – Information Needs

- Assess pilot information needs associated with dynamic allocation to ensure awareness of need of re-allocation, awareness that reallocation has occurred, and to ensure the pilot has the information required to effectively assume responsibility for a function.
- Continue research to support guidance for data communications procedures, training, displays and alerts.
- Develop recommendations to support guidance on minimum flight deck wake turbulence display and alerting requirements to include priority, type of alert and synchronization between flight deck and ATC systems.
- Determine which pilot and controller tasks are associated with NextGen flight procedures, using task and information needs analysis techniques, and develop guidelines for each type of procedure in NextGen.

Human System Integration – Human Capabilities and Limitations

- Continue development of a methodology to address the human capabilities and limitations of pilots (including single-pilot aircraft) to conduct a range of NextGen airspace procedures in normal and non-normal situations.
- Assess/evaluate flight deck human decision making capabilities and limitations in the context of near to mid-term NextGen applications.

Human System Integration – System Integration

- Continue research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.

- Initiate research to develop flight crew training recommendations for error detection and correction for NextGen operations for single pilot and two pilot crews.

Risk and Error Management

- Develop guidance to support certification personnel in evaluating risks and mitigation of human error and potential unintended uses of new technology in NextGen systems and procedures.
- Determine the expected nature, frequency and potential impact of pilot errors that may lead to exceeding RNP containment criteria.
- Develop a structured method (e.g., checklist, decision aid, analysis process) to assist certification personnel in evaluating system resilience to human error, and for identifying and estimating risk of human error (before and after application of risk mitigation) for new or modified technologies and procedures.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	2,554
FY 2010 Enacted	5,688
FY 2011 Request	10,614
Out-Year Planning Levels (FY 2012-2015)	42,666
Total	61,522

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NextGen - Air Ground Integration Human Factors	0	0	2,485	5,448	10,035
Personnel Costs	0	0	69	212	416
Other In-house Costs	0	0	0	28	163
Total	**0**	**0**	**2,554**	**5,688**	**10,614**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	2,554	5,688	10,614
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**2,554**	**5,688**	**10,614**

A12.c – NextGen - Air Ground Integration Human Factors Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
111-110 NextGen - Air Ground Integration	**1,989**						
Roles and Responsibilities							
Conduct research to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures:		♦	◊	◊	◊		
Define a standard taxonomy for describing the relationship between flight deck and ATC automated systems and human operators in the context of NextGen equipment and applications.			◊	◊			
Select the most likely human-automation coordination methods and assess the performance costs and benefits of these human-automation coordination strategies in the context of near-term NextGen applications.		♦	◊	◊			
Identify design and procedural methods to support collaboration and negotiation between flight deck, ANSP and AOC personnel				◊	◊	◊	
Assess various strategies for Pilot Flying/Pilot Not Flying responsibilities and coordination procedures.							
Human System Integration	4,830						
Conduct research on human systems integration issues related to information needs, interface design and system integration required to support effective guidance for NextGen equipment design, procedure development and personnel training:		♦	◊	◊			
Information Needs							
Assess pilot information needs associated with dynamic allocation to ensure awareness of need of re-allocation, awareness that reallocation has occurred, and to ensure the pilot has the information required to effectively assume responsibility for a function.				◊	◊	◊	◊
Develop recommendations to support guidance on minimum flight deck wake turbulence display and alerting requirements to include priority, type of alert and synchronization between flight deck and ATC systems.		♦	◊	◊	◊	◊	◊
Determine which pilot and controller tasks are associated with NextGen flight procedures, using task and information needs analysis techniques, and develop guidelines for each type of procedure in NextGen.							
Interface Design		♦	◊	◊			
Based on pilot and controller information needs, develop and evaluate recommended display methods to facilitate predicting/detecting/resolving undesired aircraft performance for range of trajectory types (2 ½ D – 4D) to include ensuring pilot and controller knowledge or proximity of current 2 1/2 to 4D trajectory to aircraft limitations.				◊	◊	◊	
For abnormal situations and degradation of a system function: Determine best method(s) to alert flight crew (both own-ship and other surrounding aircraft) and controllers of the nature and implications of system failure or degradation.							
System Integration		♦	◊	◊			
Assess human factors issues associated with use of legacy avionics in NextGen procedures			◊	◊	◊	◊	
Develop flight crew training recommendations for error detection and correction for NextGen operations for single pilot and two pilot crews.							
Risk and Error Management	2,717						
Conduct research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment:			◊	◊	◊	◊	◊
Develop guidance to support certification personnel in evaluating risks and mitigation of human error and potential unintended uses of new technology in NextGen systems and procedures		♦	◊	◊	◊		
Determine the expected nature, frequency and potential impact of pilot errors that may lead to exceeding RNP containment criteria.			◊	◊	◊		
Develop a structured method to assist certification personnel in evaluating system resilience and risk of human error							
Integrated Demonstrations	499	♦	◊				
Update simulation roadmap				◊	◊	◊	◊
Demonstrate pilot and controller functional capabilities via simulation (specific demonstrations executed under activities shown above)		◊	◊	◊			
Personnel and Other In-House Costs	**579**						
Total Budget Authority	**10,614**	**5.688**	**10,614**	**10,656**	**10,692**	**10,670**	**10,648**

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

Budget Item	Program Title	Budget Request
A12.d	**NextGen – Self-Separation Human Factors**	**$9,971,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes: By 2016, develop initial standards and procedures to enhance spacing of aircraft using Next Generation Air Transportation System (NextGen) capabilities. In the near term, this includes reduced aircraft separation and delegated separation.

New technologies such as Global Positioning System (GPS), Automatic Dependent Surveillance-Broadcast (ADS-B), and Cockpit Display of Traffic Information (CDTI) afford the possibility of transitioning from classic air traffic control separation assurance procedures to aircraft based spacing and separation. In the near to mid-term, these procedures will focus on reduced and delegated separation as well as supporting runway/surface awareness. Many NextGen enhanced capabilities are based on various aircraft oriented activities such as spacing, merging, passing, and closely spaced parallel operations, etc. Research will assess the human factors risks and requirements associated with these various spacing policies, procedures and maneuvers. The research results will provide technical information to support the development of standards, procedures, and training by Flight Standards to implement NextGen. Human factors research required to provide the scientific and technical information to address human performance issues includes:

- Providing human factors assessments on new information requirements to allow pilots to safely maintain aircraft separation, especially during low visibility ground operations.
- Providing robust assessments of reduced separation procedures to ensure non-normal and emergency operations are evaluated including system failures and reversion impacts. The NextGen benefits associated with reduced aircraft spacing in high density terminal airspace also leave fewer buffers to accommodate non-normal events. The impact on safety and efficiency will be addressed.
- Understanding changing roles and responsibilities associated with shifting separation responsibility between pilot and controller during delegated separation operations.
- Developing advanced methods including efficient and standardized procedures to certify pilots and automation for different separation operations.
- Assessing risk of pilot error during reduced and delegated aircraft spacing operations as NextGen technologies and procedures are implemented and integrated with legacy avionics.
- Providing requirements and guidance for training pilots to assure adequate understanding of automation functions and limitations as they apply to enhanced spacing and separation operations.

Agency Outputs: The NextGen – Self Separation Human Factors Research Program develops human factors scientific and technical information to address human performance and coordination among pilots and air navigation service providers (air traffic controllers), human system integration, and error management strategies to implement NextGen capabilities. Human factors technical information will also support the development of standards, procedures, training, policy, and other guidance material required to implement the operational improvements leading to enhanced aircraft spacing and separation.

Outputs include:

- Define the potential impact and human factors issues of new technologies such as enhanced vision, synthetic vision, and electronic flight bags on separation activities.
- Define human factors technical information needed to support the development of standards, procedures, and training by Flight Standards to implement plans for reduced aircraft separation and recovery to classic air traffic operations as a result of abnormal events.
- Develop procedures and training needed to implement new roles and responsibilities for pilots and controllers during delegated separation operations.
- Define human and system performance requirements for separation activities, e.g., spacing, merging, and passing.
- Develop and apply error management strategies, mitigate risk factors, and reduce automation-related errors associated with enhanced separation operations.

- Develop human factors criteria for the successful use of flight deck performance monitoring and decision support tools as they relate to enhanced separation maneuvers such as spacing, merging, and passing, and how conformance alerts are communicated and resolved between flight deck and ground monitors, for example in Area Navigation (RNAV)/Required Navigation Performance (RNP) approach and departure operations.

Research Goals: Conduct R&D to support the development of standards, procedures, training, policy, and other guidance material required to implement the NextGen operational improvements leading to enhanced aircraft spacing and separation including improved awareness of surface/runway operations, reduced separation, and delegated separation.

- By 2016, complete research to enable enhanced aircraft spacing for surface movements in low visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures.
  - By 2012 complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.
  - By 2014 evaluate and recommend minimum display standards and operational procedures for use of CDTI to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff and departure phases of flight.
  - By 2016 complete research to identify human capabilities and limitations with respect to ground collision avoidance and identify potential design solutions, training and procedures to mitigate risks associated with human performance.
- By 2015, complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment.
  - By 2011 complete initial research to evaluate the impact and potential risks associated with use of Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.
  - By 2012 initiate research to evaluate alternative methods of allocating functions and coordinating between automated systems, pilots, Air Traffic Control (ATC) and Airline Operations Center (AOC) personnel in reduced and delegated separation procedures.
  - By 2014 complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings, including closely spaced parallel operations.
  - By 2015 complete initial research on human performance considerations for design, training and operational procedures in conformance monitoring and detection/correction of nonconformance with reduced separation routings and procedures.
- By 2015, enable reduced and delegated separation in oceanic airspace and high density en route corridors.
  - By 2011, complete research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation.
  - By 2013 complete initial research to provide recommended guidance for design of cockpit displays and alerts to support delegated separation.
  - By 2015 complete research to support recommended procedures and training required to safely and efficiently transition to/from NextGen reduced and delegated separation procedures in normal and non-normal conditions.
- By 2015, develop a repository of NextGen human factors data containing research roadmaps, results, and data from relevant ongoing and historical research, demonstrations and operational experience to provide a foundation for flight deck human factors research to support policy decisions, standards development, certification and approval to enable NextGen operational improvements, and to ensure that the future system adequately considers human systems integration issues.

Customer/Stakeholder Involvement: Program researchers work directly with colleagues in FAA, other government agencies, academia, and industry to support the following R&D programs and initiatives:

- Guidance from the Joint Planning and Development Office (JPDO) NextGen initiative.
- NASA's Aviation Safety and Airspace Programs.

- Close collaboration with FAA organizations, notably Flight Standards and Aircraft Certification in the AVS line of business.
- Collaboration with specific FAA programs such as the Surveillance and Broadcast Services (SBS), DataComm and the NextGen-Wake programs.
- Collaboration with specific FAA programs such as the Surveillance and Broadcast Services (SBS), DataComm and the NextGen-Wake programs.
- FAA Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the activities of the program and provide advice on priorities and budget.

R&D Partnerships: The research program collaborates with industry and other government programs through:

- Collaborative research with NASA on its aviation safety and airspace projects including the identification of human factors research issues in the NextGen as technology brings changes to aircraft capabilities. Complex full mission simulations using an aviation simnet distributed simulation architecture will leverage NASA cockpit and Air Traffic Management (ATM) simulation facilities and other resources.
- Cooperative research agreements with universities to address NextGen human factors issues.
- Coordination on research issues and plans with aircraft and avionics manufacturers and operators.
- Coordination with appropriate RTCA Committees, e.g., Airborne Separation Assurance System.

Accomplishments:

FY 2009

Surface/Runway Operations Awareness

- Began to define pilot information requirements for the display and use of enhanced cockpit technologies (Enhanced Flight Vision Systems (EFVS)/Synthetic Vision Systems (SVS), TCAS, and CDTI to support all-weather operations.
- Initiated development of survey instruments and analysis techniques to evaluate airport signage and lighting effects on pilot navigation at night and in reduced visibility.

Reduced Separation

- Began to evaluate pilot conformance, conflict detection and avoidance capabilities, and recommend pilot training and performance standards to ensure safe separation.
- For closely spaced parallel operations, began research to determine CDTI and information requirements to support dual missed approaches, and to evaluate controller and flight crew workload and effects of blunder during the missed approach.

Delegated Separation

- For near to mid-term delegated separation procedures and applications for single-pilot operations, began to assess the impact of systems failures to prepare for development of procedures to safely and efficiently revert to backup separation methods.
- Began assessment of human factors issues for the design and pilot use of display technologies including CDTI and TCAS in delegated separation operations.

Cross-cutting

- Began human factors assessments of new information requirements for NextGen alerts and displays in reduced and delegated separation operations.
- Contributing to the development of a repository of NextGen human factors data, began a survey of human factors research relevant to near-to-mid-term NextGen applications, and a survey of the human factors issues that have arisen through operational experience with systems and procedures relevant to near to mid-term NextGen applications, as well as the projected needs based on NextGen planning documents.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS

Surface/Runway Operations Awareness

- Continued study to define pilot information display requirements for use of enhanced cockpit technologies, including EFVS/SVS, TCAS, and CDTI to support all-weather operations.
- Evaluated airport signage and lighting effects on pilot navigation at night and reduced visibility.

Reduced Separation

- Evaluated pilot conformance, conflict detection and avoidance capabilities, and recommend pilot training and performance standards to ensure safe separation.
- Developed recommendations for use of autopilot coupled collision avoidance and pilot procedures for overriding the automation in each flight phase.
- For closely spaced parallel operations, continued research to determine CDTI requirements to support dual missed approaches, and to evaluate controller and flight crew workload and effects of blunder during the missed approach.

Delegated Separation

- Developed initial methodology for conducting robust systematic assessments of separation procedures to ensure non-normal and emergency operations are evaluated.
- Identified the major human factors considerations requiring research to support evaluation and recommendation of minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.
- Continued analysis to evaluate pilot training requirements for use of limited delegation of separation authority in the oceanic environment.
- Developed recommendations for the design and use of display technologies by pilots, including CDTI and TCAS in delegated separation operations.
- For near to mid-term delegated separation procedures and applications for single-pilot operations, continued assessing the impact of systems failures and began development of procedures to safely and efficiently revert to backup separation methods.
- For oceanic pair-wise separation procedures, continued to determine information needs, time requirements and pilot accuracy for detection and resolution of potential conflicts.
- Continued to evaluate ADS-B/CDTI displays and procedures in a robust evaluation of merging and spacing operations for a range of controller-specified spacing and a variety of aircraft (not all same carrier or aircraft type).
- Developed initial methodology for conducting robust systematic assessments of separation procedures to ensure non-normal and emergency operations are evaluated.

Cross-cutting

- Provided human factors assessments of new information requirements for NextGen alerts and displays in reduced and delegated separation operations.
- Continued robust assessments of separation procedures to ensure non-normal and emergency operations are evaluated including system failures and reversion impacts.
- Provided guidance for training pilots to use automation in NextGen separation operations.
- Provided guidance for the integration and use of TCAS equipment and symbology in reduced and delegated separation operations.
- Continued to determine the expected nature, frequency and potential impact of instrument procedure design on pilot errors.
- Continued development of a repository of NextGen human factors data, incorporating results of efforts to survey human factors research relevant to near-to-mid-term NextGen applications, and surveys of the human factors issues that have arisen through operational experience with systems and procedures relevant to near to mid-term NextGen applications, as well as the projected needs based on NextGen planning documents.

FY 2011 PROGRAM REQUEST:

The program will continue to assess human system integration issues in use of airborne NextGen concepts, capabilities, and procedures, and Air Traffic Management (ATM) leading to a full mission simulation in 2016.

Surface/Runway Operations Awareness

- Complete the study defining pilot information display requirements for use of enhanced cockpit technologies to support all-weather operations.

- Complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.
- Evaluate the effects of EFVS Head-Up Display (HUD) clutter and masking on detection of potential ground conflicts during taxi operations across a range of visibility and lighting conditions.
- Conduct research on existing SVS and EFVS to evaluate time required, accuracy, and pilot workload associated with recognizing and reacting to potential ground collisions or conflicts with other aircraft, vehicles and obstructions across a range of visibility and lighting conditions, for single pilots and two pilot crews.

Reduced Separation

- For closely spaced parallel operations, complete research to determine CDTI requirements to support dual missed approaches, and to evaluate workload and effects of blunder during the missed approach.
- Continue research to evaluate the impact and potential risks associated with use of Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.

Delegated Separation

- Continue to evaluate ADS-B/CDTI displays and procedures in a robust evaluation of merging and spacing operations for a range of controller-specified spacing and a variety of aircraft (not all same carrier or aircraft type).
- Complete research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation.
- Develop human performance models to predict errors, their impacts on performance, and human responses for airborne merging and spacing, and CDTI-assisted visual separation (CAVS).
- For delegated separation applications, determine factors contributing to breakdowns in coordination and develop mitigating human factors recommendations for minimum equipment design, procedural and training methods.

Cross-cutting

- Continue development of a repository of NextGen human factors data, incorporating results of human factors research and human factors issues that surface during operational experience with systems and procedures relevant to near to mid-term NextGen applications
- For proposed delegated separation procedures and equipment, conduct task analysis (including cognitive task analysis) and training needs analysis, to support development of training guidance for NextGen applications and technologies.
- Continue research to develop risk and error management strategies to identify and mitigate human-system errors.
- Evaluate the performance costs and benefits of various methods of decision support to include ability of human operators to understand automated system strengths and weaknesses.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Surface/Runway Operations Awareness

- Complete the study defining pilot information display requirements for use of enhanced cockpit technologies to support all-weather operations.
- Complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.
- Evaluate the effects of EFVS HUD clutter and masking on detection of potential ground conflicts during taxi operations across a range of visibility and lighting conditions.
- Conduct research on existing SVS and EFVS to evaluate time required, accuracy, and pilot workload associated with recognizing and reacting to potential ground collisions or conflicts with other aircraft, vehicles and obstructions across a range of visibility and lighting conditions, for single pilots and two pilot crews.

Reduced Separation

- For closely spaced parallel operations, complete research to determine CDTI requirements to support dual missed approaches, and to evaluate workload and effects of blunder during the missed approach.
- Continue research to evaluate the impact and potential risks associated with use of Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.

Delegated Separation

- Continue to evaluate ADS-B/CDTI displays and procedures in a robust evaluation of merging and spacing operations for a range of controller-specified spacing and a variety of aircraft (not all same carrier or aircraft type).
- Complete research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation.
- Develop human performance models to predict errors, their impacts on performance, and human responses for airborne merging and spacing, and CDTI-assisted visual separation (CAVS).
- For delegated separation applications, determine factors contributing to breakdowns in coordination and develop mitigating human factors recommendations for minimum equipment design, procedural and training methods.

Cross-cutting

- Continue development of a repository of NextGen human factors data, incorporating results of human factors research and human factors issues that surface during operational experience with systems and procedures relevant to near to mid-term NextGen applications.
- Continue research to develop risk and error management strategies to identify and mitigate human-system errors.
- For proposed delegated separation procedures and equipment, conduct task analysis (including cognitive task analysis) and training needs analysis, to support development of training guidance for NextGen applications and technologies.
- Evaluate the performance costs and benefits of various methods of decision support to include ability of human operators to understand automated system strengths and weaknesses.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	8,025
FY 2010 Enacted	8,247
FY 2011 Request	9,971
Out-Year Planning Levels (FY 2012-2015)	40,074
Total	66,317

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NextGen - Self-Separation Human Factors	0	0	7,956	7,796	9,440
Personnel Costs	0	0	69	451	388
Other In-house Costs	0	0	0	0	143
Total	**0**	**0**	**8,025**	**8,247**	**9,971**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	8,025	8,247	9,971
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**8,025**	**8,247**	**9,971**

A12.d – NextGen - Self-Separation Human Factors Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
111-120 NextGen – Self-Separation Human Factors							
Surface/Runway Operations Awareness	**3,162**						
Conduct research to enable enhanced aircraft spacing for surface movements in low visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures:							
Complete the study defining pilot information display requirements for use of enhanced cockpit technologies, including EFVS/SVS, TCAS, and CDTI to support all-weather operations.		♦	◊				
Complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.		♦	◊				
Evaluate the effects of EFVS HUD clutter and masking on detection of potential ground conflicts during taxi operations across a range of visibility and lighting conditions.			◊	◊	◊		
For existing SVS and EFVS, evaluate time required, accuracy, and pilot workload associated with recognizing and reacting to potential ground collisions or conflicts with other aircraft, vehicles and obstructions across a range of visibility and lighting conditions, for single pilots and two pilot crews.			◊	◊	◊		
Reduced Separation	**1,424**						
Conduct research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment:							
For closely spaced parallel operations, complete research to determine CDTI requirements to support dual missed approaches, and to evaluate controller and flight crew workload and effects of blunder during the missed approach.		♦	◊				
Continue research to evaluate the impact and potential risks associated with use of Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.		♦	◊	◊			
Delegated Separation	**2,674**						
Conduct research to enable reduced and delegated separation in oceanic airspace and high density en route corridors:							
Continue to evaluate ADS-B/CDTI displays and procedures in a full evaluation of merging and spacing operations for a range of controller-specified spacing and a variety of aircraft (not all same carrier or aircraft type).		♦	◊	◊	◊		
Complete research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation		♦	◊				
Develop human performance models to predict errors, their impacts on performance, and human responses for airborne merging and spacing, and CDTI-assisted visual separation (CAVS).			◊	◊	◊		
For delegated separation applications, determine factors contributing to breakdowns in coordination and develop mitigating human factors recommendations for minimum equipment design, procedural and training methods			◊	◊	◊	◊	◊
Cross-Cutting	**2,180**						
Continue development of a repository of NextGen human factors data, incorporating results of human factors research and human factors issues that surface during operational experience with systems and procedures relevant to near to mid-term NextGen applications		♦	◊	◊	◊	◊	◊
For proposed delegated separation procedures and equipment, conduct task analysis (including cognitive task analysis) and training needs analysis, to support development of training guidance for NextGen applications and technologies.			◊	◊	◊	◊	
Continue research to develop risk and error management strategies to identify and mitigate human-system errors		♦	◊	◊	◊		
Evaluate the performance costs and benefits of various method(s) of decision support to include ability of human operators to understand automated system strengths and weaknesses.			◊	◊	◊		
Personnel and Other In-House Costs	**531**						
Total Budget Authority	**9,971**	**8,247**	**9,971**	**10,009**	**10,043**	**10,022**	**10,000**

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

Budget Item	Program Title	Budget Request
A12.e	**NextGen – Weather Technology in the Cockpit**	**$9,312,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety and Greater Capacity.

Intended Outcomes: By 2015, demonstrate that technology and automation, combined with policy, procedures, and regulatory oversight, meets the Next Generation Air Transportation System (NextGen) goal to reduce weather delays, leading to more efficient air traffic management (ATM) and improved aviation safety. Demonstrations will show that the technology and automation used in the cockpit provides pilots and aircrews with common weather situation awareness for safety and traffic flow management and assists airborne decision-making (e.g., adverse weather avoidance, etc.) by providing realistic, practical solutions to issues involving a myriad of variables.

The NextGen Concept of Operations (ConOps) requires technology and automation in the cockpit to produce a "common weather picture" that will enhance collaborative decision-making and improve the safety, capacity, and efficiency of air transportation system by identifying the safest and most efficient route for aircraft traversing areas impacted by adverse weather conditions. The germane characteristics of the technology generally identified in the NextGen ConOps are that it assists collaborative decision-making (pilot, controller, air traffic management, etc.), leverages both human and automation capabilities, and integrates weather data and information with other necessary operational information to provide decision support and increase situational awareness. In the near term, this technology will be implemented as machine to human interface requiring human analysis and "processing" of visual presentations. However, in the long-term, the technology and automation envisioned in the NextGen ConOps is expected to migrate to automated "processing" via machine-to-machine interface between ground-based and aircraft systems (e.g., analyzes and processing of data and information are performed automatically and recommendations are provided to the human overseeing the aircraft operation). As a result, the NextGen ConOps differs dramatically from current operations regarding weather procedures; therefore, an examination of the NextGen goals and related procedures is warranted.

Agency Outputs: One of the weather-related goals of NextGen is to reduce weather delays allowing more efficient and flexible air traffic management. The objective of the Weather Technology in the Cockpit program is to enable flight deck weather information technologies that will provide flight crews with timely, comprehensive weather information from on-board sensors, cross-link from nearby aircraft, and up-link from ground-based processors to support flight re-planning and weather hazard avoidance in flight, as well as in-situ observations to nearby aircraft for weather avoidance decisions and ground-based processors for direct and forecast use in ATM decision support processes.

The program research will be accomplished in three phases. Phase I will be applied research to identify the gaps, Phase II will be the analysis and verification of the gaps to allocate the actions for the research, and will also validate the capability to provide current weather technologies that are not being currently made available to the cockpit such as icing and turbulence products. Phase III will be the validation of the research and the weather technologies developed.

Phase I of the program research will be accomplished using the following framework:

- Needs/Benefits – Identify the minimum weather data link capabilities and services are necessary to support Now and Next Generation National Airspace Operations.
- Current Capabilities – From the minimum weather datalink capabilities and services, identify the commercial and government capabilities that in are in place.
- Planned Capabilities – From the minimum weather datalink capabilities and services, identify the planned (within 3 years) commercial and government capabilities that is planned without WTIC support.

The following is the research methods to accomplish Phase I:

- Requirements Development – Develop a comprehensive user information needs statement and concept of operations for utilizing weather information in cockpit decision making based on the NextGen Concept of Operations.

Technology Assessment – Assess currently available onboard weather information processors, cockpit/ground interface capabilities, and communications infrastructure, identify gaps, and identify emerging technological capabilities to address the gaps.

Phase II of the program research will be accomplished through the following framework:

- Gaps Verification – Identify and verify the gaps between the needs and current plus planned capabilities.
- Allocation of Actions – Identify the needs that require government actions and the commercial roles and expectations.

The following is the research methods to accomplish Phase II:

- Proof of Concept Demonstrations – Simulate, evaluate, and validate currently available but not fully developed systems for providing weather information to the cockpit.

- Weather Technology in the Cockpit Prototyping – Develop semi-automatic prototypes of weather information integration decision support tool modules for flight deck technologies (e.g., flight management systems (FMS), electronic flight bags (EFB), etc.), to perform full, mission demonstrations, and to assess the integration of navigation, flight, and weather information into cockpit decision-making processes.

Phase III of the program research is to develop Weather Technology in the Cockpit prototypes for validation. The methods to accomplish this capability are the following:

- Prototyped Automated Weather Decision Support Tools (DST) – Develop and verify the technologies and capabilities to support automated weather support tools

- Proof of Concept Demonstrations – Simulate, evaluate, and validate automated DST with a high fidelity system
- Policy, Standards, and Requirements – Develop standards and guidance necessary to obtain design approvals for weather decision support systems for use in the cockpit, define minimum pilot training requirements, develop procedures for weather separation on the flight deck, and recommend changes to FAA and international policies pertaining to the provision and utilization of weather information in the cockpit.

Research Goals: Research will enable the development of policy, standards, and guidance needed to safely implement weather technologies in the cockpit to provide shared situational awareness and shared responsibilities. The goals of the research are:

- By FY 2012, demonstrate currently available, but not fully developed systems for providing weather to the cockpit.
- By FY 2013, develop prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).
- By FY 2014, simulate, test, and evaluate cockpit use of weather decision support tools, including probabilistic forecasts.
- By FY 2014, simulate test, and evaluate fully integrated cockpit use of NextGen operational concepts, including weather technology in the cockpit.
- By FY 2014, support full mission demonstrations assessing weather information integrated in NextGen air and ground capabilities for controllers and pilots.
- By FY 2014, complete research necessary to develop guidance for airmen training and evaluation criteria and enhance the use of forecast products for pilot decision making.
- By FY 2015, demonstrate the integration of navigation and flight information, including weather information, into cockpit decision-making and shared situational awareness among pilots, dispatchers, air traffic controllers supported by NextGen air and ground capabilities.

Customer/Stakeholder Involvement: The Weather Technology in the Cockpit Program works with FAA organizations, other government agencies, and industry groups to ensure its priorities and plans are consistent with user needs. This is accomplished through:

- Guidance from the JPDO Next Generation Air Transportation System initiative through involvement in the Aircraft, Weather, and Integration Working Groups
- Inputs from the aviation community, including weather information providers, technology providers (e.g., avionics manufacturers, etc.), simulator training centers (e.g., Flight Safety, etc.)
- The annual National Business Aviation Association conference, the Friends/Partners in Aviation Weather Forum, scheduled public user group meetings, and domestic and international aviation industry partners
- Subcommittees of the FAA Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review program activity, progress, and plans.
- RTCA SC-206 and Society of Automotive Engineers G-10 subcommittees

R&D Partnerships: The Weather Technology in the Cockpit Program leverages research activities with members of other government agencies, academia, and the private sector through interagency agreements, university grants, and Memorandums of Agreement.

Partnerships include:

- National Center for Atmospheric Research.
- NASA Langley and Glenn Research Centers.
- Army Cold Regions Research and Engineering Laboratory.
- Public and private universities.
- Initiatives with airlines, pilots, and manufacturers.

Accomplishments: The Weather Technology in the Cockpit program was a new start in FY 2009. The program developed the initial Now Generation Concept of Operations v.01 for weather technology in the cockpit based on foundational elements identified in the NextGen Concept of Operations, weather dissemination management, and GA operations.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed Mid-Term Concept of Operations and obtained partners, stakeholder, and user concurrence for weather technology in the cockpit based on foundational elements identified in the NextGen Concept of Operations, including integration of weather in flight deck decision support tools, weather dissemination management, and GA operations.
- Based on capabilities described in the NextGen Concept of Operations, developed initial comprehensive weather information user needs statement for the cockpit environment in different types of operation (e.g., Part 121, Part 135, etc.) for each phase of flight (pre-flight, departure, en route, etc.) in the near-, mid-, and long-term NextGen operating environments.
- Assessed currently available onboard weather information processing technology.
- Identified the specific types of weather information being integrated into cockpit flight management systems (FMS) and the decisions supported by the information.
- Assessed currently available and emerging ground and cockpit communications interface technologies.
- Assessed currently available options for communications systems (air-ground, ground-air, and air-air).
- Assessed the bandwidth demand of graphical icing products (Current Icing Product and Forecast Icing Product) and graphical turbulence products (Graphical Turbulence Guidance) for potential delivery via existing and planned FAA data link services.
- Identified test bed(s) to develop prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).

FY 2011 PROGRAM REQUEST:

Ongoing Activities

Work will continue in FY 2011 on the development of prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.), and will continue research activities necessary to develop the concepts and

the requirements for the provision, use, and integration of weather technology and information in NextGen cockpit operations.

New Initiatives

The new research initiatives that will commence in FY 2011 are related to the cockpit decision support systems. There will be an emphasis on simulations to identify weather-alerting capabilities, specific cognitive or skill deficiencies related to weather knowledge and weather encounters.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Determine what incremental weather information is needed in cockpit operations and when is it needed for tactical (less than 20 minutes) decision support and situational awareness planning (121, 135, 91).
- Determine standards necessary for obtaining design approvals for cockpit weather decision support systems.
- Quantify the regulatory impact of employing new types of weather information, weather technologies, and operational concepts.
- Evaluate procedures for utilizing weather information in cockpit decision-making processes and define pilot training requirements.
- Recommend changes to national and international policies pertaining to the provision of aviation weather information.
- Research building prototypes of the integrated weather information with flight crew decision making processes through various flight deck technologies, such as Flight Management Systems, multi-function displays, etc.
- Research general aviation community to identify best practices to incorporate VFR ceiling and visibility limitations in conjunction with minimum safe altitudes (terrain avoidance planning).
- Research and evaluate currently available systems for providing weather information to the cockpit, in both machine-to-human and machine-to-machine modes, for the new types of operations anticipated in the fully implemented NextGen operating environment, including Trajectory-Based Operations (TBO), Equivalent Visual Operations (EVO), Super Density Operations.
- Research and simulate real world weather hazards to flight and determine most appropriate way to alert pilots of weather hazards influencing their flight.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	8,049
FY 2010 Enacted	9,570
FY 2011 Request	9,312
Out-Year Planning Levels (FY 2012-2015)	37,577
Total	64,508

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts					
Weather Technology in the Cockpit	0	0	7,894	8,945	8,369
Personnel Costs	0	0	155	539	764
Other In-house Costs	0	0	0	86	179
Total	0	0	8,049	9,570	9,312

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	8,049	9,570	9,312
Development (includes prototypes)	0	0	0	0	0
Total	0	0	8,049	9,570	9,312

A12.e – Weather Technology in the Cockpit Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
111-140 Weather in the Cockpit	**8,369**						
Concept and Requirements Development							
Develop comprehensive program plan for Weather Technology in the Cockpit.		♦					
Develop Concept of Operations for weather technology in the cockpit.		♦		◊	◊		◊
Develop comprehensive weather information user needs statement.		♦	◊				
Determine how the "common weather picture" is to be maintained when the 4D Wx Cube is being constantly updated (e.g., appropriate update rate impacts, workload).			◊	◊	◊	◊	
Technology Assessment	**0**						
Identify weather information currently being integrated in cockpit FMS		♦	◊				
Assess currently available onboard weather information processing technology		♦	◊				
Assess currently available and emerging ground and cockpit communications interface technologies		♦	◊				
Assess currently available options for communications systems (air-ground, ground-air, and air-air)		♦	◊				
Proof of Concept Demonstrations							
Simulate and evaluate candidate systems for weather in the cockpit		♦	◊	◊	◊		
Identify, validate, and document communications systems attributes affecting weather in the cockpit			◊	◊	◊		
Develop standards and guidance necessary to obtain design approvals of weather decision support tools			◊	◊	◊		
Simulate, test, and evaluate cockpit use of weather decision support tools and probabilistic forecasts				◊	◊	◊	◊
Simulate, test, and evaluate fully integrated cockpit use of NextGen operational concepts, including WTIC				◊	◊	◊	◊
Weather Technology in the Cockpit Prototype							
Develop prototype weather information integration modules for flight deck technologies (e.g., FMS, etc.)		♦	◊	◊	◊	◊	
Perform and support full mission demonstrations assessing weather information integrated in the cockpit				◊	◊	◊	◊
Policy, Standards, and Requirements							
Conduct research to develop guidance for airmen training and evaluation criteria		♦	◊	◊	◊	◊	◊
Conduct research to necessary to develop guidance to enhance use of forecasting products for pilot decision making		♦	◊	◊	◊	◊	◊
Conduct research necessary to evaluate procedures for including weather information in the flight deck decision making processes		♦	◊	◊	◊		
Quantify the regulatory impact of integrating weather into flight deck decision-making processes			◊	◊			
Recommend changes and revisions to US and international policies pertaining to WTIC				◊	◊	◊	◊
Personnel and Other In-House Costs	**943**						
Total Budget Authority	**9,312**	**9,570**	**9,312**	**9,360**	**9,407**	**9,406**	**9,404**

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

Budget Item	Program Title	Budget Request
A13.a	**Environment and Energy**	**$15,374,000**

GOALS:
This program supports the following Flight Plan goals: Greater Capacity and International Leadership.

Intended Outcomes: The Environment and Energy Program helps achieve FAA's environmental compatibility goal and supports the FAA Flight Plan. The program also provides fundamental knowledge and tools to support the Next Generation Air Transportation System (NextGen) research and development plan. The efforts complement activities in aircraft technology, alternative fuels, and operational solutions, environmental operational assessments and environmental management systems development under NextGen investments.

The Program specifically supports the following outcomes:

The Flight Plan Noise Exposure Performance Target to reduce the number of people exposed to significant noise by four percent per year through FY 2013 as measured by a three-year moving average, from the three-year average for calendar year 2000 – 2002. FY 2011 Target is -20%. Specific activities include:

- Conduct research and develop analytical tools to understand better the relationship between noise and emissions and different types of emissions, and to provide the cost-benefit analysis capability necessary for data-driven decision-making.
- Leverage a broad cross section of stakeholders through the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence (COE) to foster breakthrough scientific, operations, policy and work force advances to mitigate noise impacts.
- Identify and assess the impact and enable implementation of operational procedures to reduce noise in the National Air Space (NAS).
- Minimize the impact of aircraft noise – actions include: advancing the state of science/knowledge concerning effects of aircraft noise and assessing the need to refine noise impact criteria; improving aircraft certification standards and current operational procedures; and assessing the benefits of implementing improved noise control and mitigation measures.

The Flight Plan Aviation Fuel Efficiency Performance Target to improve aviation fuel efficiency by another 1 percent over the FY 2008 level (for a total of 7 percent) through FY 2009, and 1 percent each subsequent year through FY 2013 to 11 percent, as measured by a three-year moving average of the fuel burned per revenue mile flown, from the three-year average for calendar years 2000-2002. FY 2011 Target is - 8%. Specific activities include:

- Conduct research and develop analytical tools to better understand the relationship between noise, fuel burn and emissions and different types of emissions, and to provide the cost-benefit analysis capability necessary for data-driven decision making.
- Leverage a broad cross section of stakeholders through the PARTNER COE to foster breakthrough scientific, operations, policy and work force advances to mitigate emissions impacts.
- Assess the impact and enable implementation of operational procedures to enhance fuel efficiency and reduce aviation emissions in the NAS.
- Minimize the impact of aviation emissions – actions include: advancing the state of science/knowledge concerning atmospheric/health effects of aviation emissions; and improving aircraft certification standards and operational procedures; and assessing the benefits of implementing improved emissions control and mitigation measures.

The Flight Plan International targets to foster international environmental standards, recommended practices, and guidance material that are technically feasible, economically reasonable, provide a measurable environmental benefit and take interdependencies among various emissions and between emissions and noise into account. Specific activities include:

- Working with the international aviation community to reduce aircraft noise and emissions
- Improving aircraft noise and engine exhaust emissions certification standards and operational procedures.

- Promoting compatible land use.
- Assessing the benefits of abatement measures to reduce population impacted by aircraft noise.
- Assessing the benefits of measures to improve fuel efficiency and reduce aviation emissions, and the potential to reduce health and climate impacts.
- Assessing the interrelationships and tradeoffs between measures to reduce aircraft noise and engine exhaust emissions.

The Program also contributes to the following outcomes:

- Providing the foundation for the NextGen investments that help achieve and manage the NextGen goal to promote environmental stewardship by reducing significant community noise and air quality emissions impacts in absolute terms, limiting or reducing the impact of aviation greenhouse gas emissions on global climate, and balancing aviation's environmental impact with other societal objectives. Specific activities include:
  - Develop fundamental knowledge to aid in better science-based understanding of impacts of aircraft noise and aviation emissions on air quality and climate change to enable the NextGen goal of sustained aviation growth by 2025, while reducing significant community noise and air quality emissions in absolute terms.
  - Developing tools to assess the ability of technologies for airframes, more efficient engines, advanced propulsion concepts, new fuels, new materials, market based options and policies to reduce source noise and emissions.

Agency Outputs: The program is developing and validating methodologies, models, metrics, and tools to assess and mitigate the effect of aircraft noise and aviation emissions in a manner that balances the interrelationships between emissions and noise and considers economic consequences. It is also developing computer models and impact criteria for use by civil aviation authorities in assessing proposed actions. Researchers are also developing a better science-based understanding of the impacts of aircraft noise and aviation emissions.

Research Goals:

- By FY 2011, demonstrate enhanced capability to conduct comprehensive cost-benefit analyses of environmental policy options with quantified uncertainties.
- By FY 2011, deliver Version 1.0 of AEDT local for airport applications to Design Review Group.
- By FY 2011, develop architecture for AEDT noise and emissions modules communications
- By FY 2011, harmonize AEDT and Aviation environmental Portfolio Management Tool (APMT) databases for tradeoffs and interdependency analyses
- By FY 2011, continue to develop and implement as they become available methods and models to analyze aircraft, auxiliary power units, and ground support equipment emissions and their impact on air quality.
- By FY 2011, advance modeling capability for dispersion of chemically reactive aircraft plume
- By FY 2011, advance our understanding of the evolution of volatile PM emissions in order to specify measurement and sampling procedures.
- By FY 2011, develop new technical guidance for noise and aircraft engine emissions certification.
- By FY 2011, develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions.
- By FY 2011 provide computer models and impact criteria for use by civil aviation authorities in environmental assessments.
- By FY 2011, develop noise propagation models to better capture air turbulence, meteorology, terrain, and wave nature of low-frequency noise.
- By 2011, initiate effort to include renewable fuels analytical capability in aviation environmental models
- By 2011, provide analyses of the effects of application of cap and trade schemes to aviation
- By FY 2012, develop and disseminate a preliminary planning version of Aviation Environmental Design Tool that will allow integrated assessment of noise and emissions inventories at the local, regional and global levels.
- By FY 2013, develop and field a fully validated suite of tools, including the Environmental Design Space (EDS) and APMT, which will allow cost benefit analyses.

- By FY 2013, use collected hazardous air pollutant and particulate matter emissions data, directly measured from aircraft engines to replace, to the extent possible, approximation methods and factors used in modeling tools.
- By FY 2014, initiate development of simulation based environmental models
- By FY 2015, advance capability for aviation noise ,emissions and fuel burn related integrated impact assessment
- By 2015, initiate development of environmental models components to enable intermodal analyses
- By 2015, demonstrate a first version of a simulation based environmental model

In addition, the program is conducting government-industry sponsored research through the PARTNER COE to develop methodology and collect data to identify and more accurately characterize the sources and incremental impacts associated with aircraft noise and aviation emissions, and generate improved solutions to deal with these impacts. Specifics of these cooperative research efforts include:

- By FY 2011 develop and disseminate new methodologies and procedures to quantify and assess the impact of aircraft noise and aviation emissions for use by industry, government, and the public – also suggest a new metric to assess the acceptability of sonic boom from supersonic aircraft.
- By FY 2011, advance best practices in aviation emissions PM and HAPs measurements and characterize in-service aircraft
- By FY 2011, assess current understanding of aviation impacts on sleep disturbance and/or annoyance.
- By FY 2011, assess the impacts of aviation on regional air quality including the effects of PM emissions that result when aircraft climb and cruise
- By FY 2011, test and deploy elements of an Internet capability to educate and inform the public about aviation and the environment.
- By FY 2011, demonstrate capability to conduct comprehensive cost-benefit analyses of environmental policy options with quantified uncertainties.
- By FY 2011, Initiate investigation of the combined health effects from aircraft noise and emissions exposure.
- By FY 2011, begin investigating new methodologies to establish acceptability of noise from future unconventional aircraft such as open rotor-engine aircraft and low-boom supersonic jets.
- By FY 2011, assess the level of certainty of aviation's impact on climate change and advance the state of practical science research, with special emphasis on addressing the identified major uncertainties and gaps in our understanding of current and projected impacts of aviation on climate and to develop metrics that will enable us to characterize those impacts for purposes of advising options for mitigation.

Customer/Stakeholder Involvement: FAA works closely with other federal agencies, industry, academia, and international governments and organizations to design research and development (R&D) efforts that can mitigate the environmental impact of aviation. This unified regulatory approach to research identifies and influences technologies, models, regulations, certification criteria and policies that can improve our present and future global environment.

- The FAA Aviation Rulemaking Advisory Committee -- a formal standing committee composed of representatives from aviation associations and industry. The committee conveys its recommendations, advice, and information to FAA for consideration in rule making activities, and its harmonization working groups ensure that domestic and international aircraft noise certification regulations impose uniform standards upon the aircraft of all countries.
- International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) -- this committee establishes and continually assesses the adequacy of international aviation environmental standards for aircraft noise and engine exhaust emissions.
- The Federal Interagency Committee on Aviation Noise (FICAN) -- provides forums for debate over future research needs to better understand, predict and control the effects of aviation noise, and to encourage new technical development efforts in these areas. FICAN also evaluates such research and publishes its findings, which sometimes lead to recommendations on improving the state of the practice of aviation noise impact assessment and abatement. FICAN may conduct annual public forums in different geographic regions as a means to better align noise abatement research with local public concerns.
- Aviation Emissions Characterization (AEC) Roadmap – developed by government and industry to coordinate research and regulatory activities. The objective of this long-range coordination mechanism is to advance the necessary understanding of particle formation, composition, and growth and transport mechanisms for

assessing aviation's particulate emissions, secondary particulate formation from gaseous emissions, and hazardous air pollutants, and understanding their impact on human health and the environment. Ultimately, if warranted, this activity will help guide the development of aviation related technology that results in reduced emissions.

- NextGen -- FAA is leading an Environmental Working Group (EWG) responsible for leading environmental dimensions of the JPDO. The EWG comprises FAA, the National Aeronautics and Space Administration (NASA), the Environmental Protection Agency (EPA), DoD, Department of Commerce, Council on Environmental Quality, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The efforts of the EWG are centered on advancing the national vision and recommendations for aviation in the NextGen and in the congressionally mandated study on "Aviation and the Environment."
- Climate Change Science Program (CCSP) – The FAA is working with the CCSP program office and its individual member agencies to focus research efforts that address the uncertainties and gaps in our understanding of current and projected impacts of aviation on climate, and to develop metrics to characterize these impacts.
- Commercial Alternative Aviation Fuel Initiative (CAAFI) -- Concerns about rising fuel costs, energy supply security and the environmental effects of aviation are providing a significant stimulus to take a fresh look at the use of alternative fuels for aviation. To forge a way ahead, FAA founded the Commercial Aviation Alternative Fuels Initiative (CAAFI) together with Airports Council International-North America (ACI-NA), the Air Transport Association (ATA) and the Aerospace Industries Association (AIA). CAAFI is teaming with the DoD to leverage their substantial efforts advancing alternative fuels for military aviation– driven by energy security considerations. CAAFI is also working with other Federal agencies such as NASA.
- Aviation Climate Change Research Initiative (ACCRI) – The FAA worked with NASA and NOAA to establish the ACCRI. The primary objective is to coordinate and sponsor collaborative research efforts to reduce key scientific uncertainties in quantifying aviation-related climate impacts while providing timely scientific input to inform optimum mitigation actions and policies for NextGen and ICAO.

R&D Partnerships: Through a series of Memorandums of Agreement (MOA), FAA works closely with NASA to identify long-term source abatement technologies for noise and emissions. Together, the agencies also work with industry and academia to assess the possible global impact of aircraft engine exhaust emissions. In FY 2005, FAA signed an MOA with DoD to pursue joint activities to understand and mitigate aviation noise and emissions. The FAA is also pursuing collaborative agreements with DoE, and EPA to leverage resources to address aviation's environmental impact. The FAA plans to pursue collaborative agreements with the US Department of Health and Human Services, the US Department of Education, as well as international agencies and international researchers, to study the public health and welfare impacts of aircraft noise exposure.

- Through the JPDO NextGen, the program supports the EWG comprising FAA, NASA, EPA, DoD, Department of Commerce, Council on Environmental Quality, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The EWG is pursuing an intensive, balanced approach, emphasizing alignment across stakeholders in developing needed business and technology architectures and policy options and approaches, as well as other relevant tools, metrics, and products to address aviation's environmental impact.
- The Volpe National Transportation Systems Center continues, in collaboration with the Environment and Energy Program, to provide substantial technical assistance in the areas of aircraft noise and engine emissions measurement and assessment.
- FICAN also offers a forum for partnership, as the Committee comprises all federal agencies concerned with aviation noise. The FAA works with this committee to foster greater, more cost-effective partnering in aviation noise research among all agencies.

Accomplishments: The number of people exposed to significant noise levels was reduced by about 90 percent between 1975 and 2008. Today's aircraft are also 70 percent more fuel-efficient than jet aircraft of the 1960s. Reduced fuel consumption and technologies to reduce emissions have also led to a 90 percent reduction in carbon monoxide, smoke, and other aircraft emissions. Specific recent accomplishments include:

FY 2009:

- Developed methodologies to quantify and assess the impact of PM and HAPs.

FY 2008:

- Developed a comprehensive greenhouse gas life cycle assessment methodology for alternative fuels
- Released updated version of EDMS (Emissions and Dispersion Modeling System) model that allows emissions inventory and dispersion of airport hazardous air pollutants
- Released a simplified version of AEDT to support environmental assessment efforts of other Government agencies and research establishments
- Enhanced capability of EDS model as technology evaluator with addition of more engine and airframe combinations
- Conducted environmental assessments to support the NextGen program office and international negotiations
- Developed preliminary cost-benefit estimates of using ultra low sulfur jet fuels
- Developed estimates of health impacts for NextGen 2025 emission scenarios
- Improved climate model and advanced simulations and analysis for estimation of aviation climate impacts
- Developed a strategic noise research framework aimed at improving understanding and quantification of aviation's noise impacts, and developing more effective mitigation solutions.
- Develop and distributed APMT, the first generation of integrated noise and emission prediction and modeling tools, including an environmental cost module.
- Enabled implementation of a new continuous-descent approach noise abatement and fuel burn (emissions) reduction procedure at low-traffic airports during nighttime operations and optimize aircraft routing to reduce fuel usage.

FY 2007:

- Developed and demonstrated the first versions of AEDT, EDS and APMT. These tools will revolutionize approaches to aviation environmental assessment and regulation by enabling a comprehensive approach that assesses interdependencies and optimizes solutions based on cost-benefit analyses of impacts and mitigation. The tools will provide significant cost savings and other benefits to users.
- Released new versions of computer models to assess noise and emissions exposure incorporating the latest science and methodologies
- Completed the analyses supporting a Report to Congress, jointly with EPA, on the impact of aircraft emissions on air quality in nonattainment areas; ways to promote measures that allow aviation to enhance fuel efficiency and to reduce emissions; and opportunities to reduce air traffic inefficiencies that both waste fuel and increase emissions.
- Completed an assessment of the feasibility of using alternative fuels in commercial aviation. The assessment included a comprehensive assessment of well to tail emissions from coal and gas derived and renewable alternative fuels.

FY 2006:

- Released advanced version of highly influential advanced computer models for airport and heliport noise analysis –over 1000 users in over 40 countries. The models are used in over 160 U.S. airport studies involving more than $1.8 billion in airport noise compatibility grants, and recently provided the basis for an aircraft noise exposure prediction model for air tours in the Grand Canyon National Park.
- Released advanced version of a computer model that is used extensively by over 300 domestic and international users in airport air quality analyses and has won the EPA's highest endorsement.
- JPDO Environmental Integrated Product Team (E-IPT, now EWG) instituted a framework for establishing national goals for aviation and the environment and completed a "gap analysis" of environmental R&D programs necessary to meet NextGen goals.
- Reported to Congress regarding a comprehensive national study of ways to reduce aircraft noise and emissions.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise and Emissions Analyses and interrelationships

- Completed an annual assessment of noise exposure and fuel burn.

- Completed a significant example analysis to demonstrate the benefit of cost-benefit analyses.
- Delivered AEDT Version 3.0 for CAEP/8 related analysis.
- Delivered APMT Version 3.0 for CAEP/8 related analysis.
- Delivered EDS Version 3.0, including validated vehicle library and demonstrated capability within AEDT framework for CAEP/8 related analysis.
- Completed upgrades to INM (Integrated Noise Model), EDMS, MAGENTA (Model for Assessing Global Exposure to the Noise of Transport Aircraft), and SAGE (System for Assessing Aviation's Global Emissions) modules for incorporation into AEDT and to support existing customers as necessary.
- Continued comprehensive assessment, including quantified uncertainties, of EDS, AEDT, and APMT.
- Continued developments of tools to aid in demonstrating Continuous Descent Arrival (CDA) procedures in high-density environment.
- Continued development of tools to aid in demonstrating other environmentally beneficial procedures in the NAS.
- Developed beta version of integrated framework for AEDT, APMT, and EDS tools.
- Incorporated methodology to account for population growth in the environmental impact assessments.
- Tested and deployed first elements of the website to educate and inform the public about aviation and the environment and to enable the community to participate actively in public processes.

Aircraft noise

- Updated and/or developed, as well as published: procedures and technical guidance for noise certification of aircraft (transport category and subsonic jet airplanes, small propeller airplanes, and rotorcraft, as well as unmanned aerial vehicles, supersonic airplanes, and very light jets, if data are available) that are both harmonized internationally and simplified.
- Established comprehensive research plans to better understand which noise exposure metrics best correlate with health and welfare impacts such as community annoyance and sleep disturbance.
- Continued updating current understanding of aviation noise impacts on annoyance and or sleep disturbance.
- Continued work to establish acceptability of low-boom supersonic flight as perceived indoors.
- Continued developing noise propagation models to better capture effects of air turbulence, meteorology, and terrain on outdoor community noise.
- Assessed state of knowledge on potential health impacts of aircraft noise and investigate methodologies to incorporate these impacts in the APMT framework.
- Supported efforts to update land use planning compatibility guidance.
- Continued to assess potential global benefits of using newly-developed noise reduction technologies; identify technology goals for long term reduction of aircraft noise.
- Continued to improve NoiseQuest website and assess its efficacy.
- Assessed land use practice and investigated mitigation strategies beyond 65 dB DNL
- Conducted two COE focused sessions at a national and an international conference.

Aviation emissions

- Continued to develop and publish procedures and technical guidance materials for affordable engine exhaust emissions testing and certification that are both simplified and harmonized.
- Developed and disseminated methodologies and procedures to quantify and assess the impact of PM and HAPs emissions in the aviation environment.
- Assessed potential global benefits of using newly developed emissions reduction technologies, and identify technology goals for long term reduction of aircraft engine emissions and fuel burn.
- Advanced best practices in aviation emissions PM and HAPs measurements.
- Continued collecting PM and HAPs measurement data and develop speciation profiles to improve and/or replace approximation methods and advance those data sources in models used to isolate sources, and identify aviation's contribution to impacts.
- Continued comparison of detailed chemistry computations to aviation environmental tools approximations.
- Continued developing a model of near field plume evolution/expansion to feed air quality models.

- Assessed whether there are unique health impacts or other environmental effects, particularly for NextGen scenarios, including particulate matter emissions and hazardous air pollutants from aviation sources, with specific focus on the aircraft engine.
- Completed assessment of the impacts of aviation on air quality including the effects of particulate matter emissions attributable to aircraft climb and cruise operations.
- Initiated development of guidance material related to dispersion, chemical and transport modeling (i.e., assessment of aviation-related air pollutant concentrations that effect air quality).
- Continued evaluation of the necessity for establishing standards pertaining to particulate matter emissions from aircraft engines.
- Incorporate climate impacts metrics in environmental assessment models and examine their suitability for environmental cost-benefit analyses
- Conducted two COE focused sessions at a national and an international conference.
- Exercised databases of PM emissions to assess trends as a function of engine combustor technology and other emissions, and impacts on health and welfare, in order to advise options for mitigation, as required.
- Published guidance material related to dispersion, chemical and transport modeling
- Continue to develop and publish:
- Procedures and technical guidance materials for affordable engine exhaust emissions testing and certification that are both harmonized and simplified.
- Develop and disseminate methodologies and procedures to quantify and assess the impact of Particulate Matter (PM) and Hazardous Air Pollutant (HAP) emissions in the aviation environment.
- Assess potential global benefits of using newly developed emissions reduction technologies, and identify technology goals for long term reduction of aircraft engine emissions and fuel burn.
- Advance best practices in aviation emissions PM and HAPs measurements.
- Continue collecting PM and HAPs measurement data and develop speciation profiles to improve and/or replace approximation methods and advance those data sources in models used to isolate sources, and identify aviation's contribution to impacts.
- Continue assessment of the relative effect of various emissions on climate forcing functions.
- Continue comparison of detailed chemistry computations to aviation environmental tools approximations.
- Continue developing a model of near field plume evolution/expansion to feed air quality models.
- Assess whether there are unique health impacts or other environmental effects, particularly for NextGen scenarios, including particulate matter emissions and hazardous air pollutants from aviation sources, with specific focus on the aircraft engine.
- Continue assessment of uncertainty of impact of aviation on climate change.
- Complete assessment of the impacts of aviation on air quality including the effects of particulate matter emissions attributable to aircraft climb and cruise operations.
- Initiate development of guidance material related to dispersion, chemical and transport modeling (i.e., assessment of aviation-related air pollutant concentrations that effect air quality).
- Continue evaluation of the necessity for establishing standards pertaining to particulate matter emissions from aircraft engines.

FY 2011 PROGRAM REQUEST:

In accordance with the agency's mission and legislative mandates, FAA must assess and mitigate the environmental impacts of aviation. The FAA will continue to work with NASA, other Departments and Agencies, the manufacturing industry, and international authorities to support the development and implementation of aircraft environmental certification regulations through proactive response to changes in airplane and engine technology, measurement/analysis technology, regulatory policy, and international regulatory initiatives.

FAA will continue to work with NASA and other Departments and Agencies as appropriate in research efforts identifying noise and emissions reduction technologies that may enter the marketplace within the next 10-15 years. The agency will use these research findings to consider new environmental certification standards and procedures for the next generation of transport aircraft.

Ongoing Activities

Aerospace systems have historically been designed – and regulations for their certification and use have been written – as though aviation noise and various emissions had nothing to do with one another.
However, aviation noise and emissions are highly interdependent phenomena. Future environmentally responsible aviation policy and rule making must be based on a new, interdisciplinary approach. Furthermore, this approach must be made as affordable as it is effective.

Existing analytical tools are inadequate to assess interdependencies between noise and emissions or analyze the cost/benefit of proposed actions. Accordingly, FAA is developing a robust new comprehensive framework of aviation environmental analytical tools and methodologies to perform these functions. The long-term aim is to provide a seamless, comprehensive set of tools to address all aspects of noise and emissions. The elements of this framework include:

- EDS' capability to provide integrated analysis of noise and emissions at the aircraft level.
- AEDT comprises of other integrated aviation noise and emissions modules and incorporates input from EDS– will provide integrated capability of generating interrelationships between noise and emissions and among emissions at the local, regional and global levels.
- APMT incorporates input from AEDT, EDS and other modules – will provide the common, transparent cost/benefit methodology needed to optimize national aviation policy in harmony with environmental policy.
- These suite of tools will allow:
  - Government agencies to understand how proposed actions and policy decisions affect aviation noise and emissions.
  - Industry to understand how operational decisions affect proposed projects affecting aviation noise and emissions.
  - The public to understand how actions by government and industry affect aviation noise and emissions.

Anticipated benefits of this initiative include the ability to:

- Optimize environmental benefits of proposed actions and investments.
- Improve data and analysis on airport/airspace capacity projects.
- Increase capability to address noise and emissions interdependencies in the resolution of community concerns.
- Aid in more effective R&D portfolio management.
- Remove environmental roadblocks to capacity growth.
- Maximize efficiency of energy usage
- Continue global leadership for the United States in environmentally responsible aviation.

Other activities include:

- Continue activities through the PARTNER COE to develop methodology and collect data to identify and more accurately characterize the sources and incremental impacts associated with aircraft noise and aviation emissions, and generate improved solutions to deal with these problems.
- Provide analytical support to complete transition of existing analytical tool modules (e.g., INM, EDMS, SAGE, MAGENTA), to AEDT.
- Support FAA role in the International Civil Aviation Organization Committee on Aviation Environmental protection (ICAO/CAEP) working groups for assessing the technological, scientific, operational, and economic aspects associated with setting international standards and recommended practices for aircraft noise and engine exhaust emissions.
- Continue efforts to ensure the currency of the regulation and technical guidance materials concerning aircraft noise and engine exhaust emissions certification requirements.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise and Emissions Analyses and interrelationships

- Complete an annual assessment of noise exposure and fuel burn.
- Complete a significant example analysis to demonstrate the benefit of cost-benefit analyses.

- Develop architecture for noise and emissions modules communications
- Develop model for assessing global exposure to noise from transport aircraft
- Enhance aircraft noise and emissions modeling for airspace management activities
- Release screening model and its updates for airport air quality analyses
- Publish handbook for airport air quality analysis
- Develop guidance document for estimating and reducing emissions from airport ground support equipments
- Continue upgrades to and assessment of AEDT, EDS and APMT models and use these models for analyses to support the work program of the 9th cycle of CAEP
- Release AEDT model for local applications
- Harmonize AEDT and APMT databases and code management protocols
- Integrate cost and socio-economic data for APMT model
- Develop tools to aid in demonstrating other environmentally beneficial procedures in the National Airspace System (NAS).

Aircraft noise

- Continue to update and/or develop, as well as publish: procedures and technical guidance for noise certification of aircraft (transport category and subsonic jet airplanes – including open-rotor engine airplanes, small propeller airplanes, and rotorcraft, as well as unmanned aerial vehicles, supersonic airplanes, and very light jets, if data are available) that are both harmonized internationally and simplified.
- Begin investigating feasibility of more stringent international noise certification standards for transport category and subsonic jet airplanes.
- Continue assessing land use practice and investigating mitigation strategies beyond 65 dB DNL.
- Apply methodologies to incorporate potential health impacts of aircraft noise exposure within APMT
- Continue studies to:
  - Better understand which noise exposure metrics best correlate with health and welfare impacts such as community annoyance and sleep disturbance, according to comprehensive research plans.
  - Advance understanding of long-term health impacts of noise exposure
  - Establish acceptability of low-boom supersonic flight as perceived indoors.
  - Validate methodologies in noise propagation models to better capture the effects of air turbulence, meteorology, and terrain on outdoor community noise.
  - Assess potential global benefits of using newly-developed noise reduction technologies; identify technology goals for long term reduction of aircraft noise.
  - Identify technology goals for long term reduction of aircraft noise.
  - Support efforts to update land use planning compatibility guidance.
  - Improve interaction with the public on potential aviation noise impacts on communities

- With the "Aviation emissions activity," conduct two COE focused sessions at a national and an international conference.
- Publish COE PARTNER research findings

Aviation emissions

- Continue to develop and publish procedures and technical guidance materials for affordable engine exhaust emissions testing and certification that are both harmonized and simplified.
- Develop and disseminate methodologies and procedures to quantify and assess the impact of aircraft emissions on the aviation environment.
- Continue assessment of potential global benefits of using newly developed emissions reduction technologies, and identify technology goals for long term reduction of aircraft engine emissions and fuel burn.
- Continue advance best practices in aviation PM, HAPs and speciated HC emissions measurements.
- Continue comparison of detailed chemistry computations to aviation environmental tools approximations.

- Continue development of a model of near field plume evolution/expansion to feed air quality models.
- Examine need for further assessment of the impacts of aviation on air quality including the effects of particulate matter emissions attributable to aircraft climb and cruise operations.
- Continue development of guidance material related to dispersion, chemical and transport modeling (i.e., assessment of aviation-related air pollutant concentrations that effect air quality)
- Continue evaluation of the necessity for establishing standards pertaining to particulate matter emissions from aircraft engines.
- With the "Aircraft noise" activity, conduct two COE focused sessions at a national and an international conference.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	184,078
FY 2010 Enacted	15,522
FY 2011 Request	15,374
Out-Year Planning Levels (FY 2012-2015)	59,722
Total	274,696

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Aircraft Noise	1,667	1,359	1,572	1,245	1,228
Engine Emissions	1,846	1,600	1,700	1,451	1,430
Noise & Emissions Analyses	10,320	10,213	9,900	10,100	9,957
Personnel Costs	2,005	2,036	2,127	2,319	2,276
Other In-house Costs	170	261	309	407	483
Total	**16,008**	**15,469**	**15,608**	**15,522**	**15,374**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	16,008	15,469	15,608	15,522	15,374
Development (includes prototypes)	0	0	0	0	0
Total	**16,008**	**15,469**	**15,608**	**15,522**	**15,374**

A13.a - Environment and Energy Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
091-016 Noise and Emissions Analysis							
Noise and Emissions Analysis	**9,957**						
Develop architecture for noise/emissions modules communication			◊	◊			
Develop model for assessing global exposure to noise from transport aircraft			◊	◊			
Validate the methodologies used to assess aircraft noise exposure and impact		♦		◊			◊
Release INM updates							
Enhance aircraft noise and emissions modeling for airspace management activities			◊	◊			
Release EDMS updates							
Forecast future global emissions and noise		♦	◊	◊	◊	◊	◊
Release screening model for airport air quality, version 1, and updates			◊		◊		
Validate methodologies used to assess aviation emissions and their impact on air quality		♦		◊			◊
Advance approximation methods for aircraft engine PM emissions		♦		◊		◊	◊
Publish handbook for airport air quality analysis and updates		♦	◊	◊	◊		◊
Guidance document for estimating and reducing emissions from ground support equipment			◊	◊		◊	
Resource and guidance materials, and assessment protocol concerning hazardous air pollutants		♦		◊		◊	◊
Develop AEDT		♦	◊	◊	◊	◊	◊
Release AEDT for local applications			◊		◊	◊	
Develop EDS/Develop APMT		♦		◊		◊	◊
Harmonize AEDT and APMT databases and code management protocols			◊	◊		◊	
Integrate cost and socioeconomic data			◊	◊	◊	◊	
Integrated noise and emissions impacts analysis		♦	◊	◊	◊	◊	◊
Aircraft Noise	**1,228**						
Update/develop procedures and technical guidance for aircraft noise certification		♦	◊	◊	◊	◊	◊
Assess land use practices and investigate mitigation strategies beyond 65 dB DNL			◊	◊	◊	◊	◊
Update and publish AC 36-4			◊		◊		
Investigate feasibility of more stringent international noise standard for transport category and subsonic jet airplanes				◊		◊	◊
Investigate which noise exposure metrics best correlate with health and welfare impacts			◊				
Apply methodologies to incorporate potential health impacts of aircraft noise exposure within APMT		♦	◊				◊
Engine Emissions	**1,430**						
Assess technological and scientific bases to support future ICAO engine emission standards			◊		◊		◊
Develop alternative, simplified engine exhaust emissions certification test procedures		♦		◊	◊	◊	◊
Update AC 34-1		♦		◊	◊		
Develop measurement/sampling protocol for PM emissions from aircraft engines		♦		◊	◊	◊	◊
Develop science/metrics and reduce uncertainties to assess impact of aviation emissions		♦	◊			◊	◊
Personnel and Other In-House Costs	**2,759**						
Total Budget Authority	**15,374**	**15,522**	**15,374**	**15,335**	**15,287**	**14,131**	**14,969**

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

Budget Item	Program Title	Budget Request
A13.b	**NextGen Environmental Research – Aircraft Technologies, Fuels and Metrics**	**$20,600,000**

Goals:
This program supports the following Flight Plan goals: Greater Capacity and International Leadership.

Intended Outcomes: The NextGen Technologies, Fuels and Metrics program helps achieve the NextGen goals to increase capacity by reducing significant community noise and air quality emissions impacts in absolute terms, and reducing aviation greenhouse gas emissions impacts on the global climate. The program is focused on reducing current levels of aircraft noise, air quality and greenhouse gas emissions and energy use and advancing sustainable alternative aviation jet fuels

The Program specifically supports the following outcomes:

Demonstrate aircraft and engine technologies that reduce noise and air quality and greenhouse gas emissions at the source to a developmental level that will allow quicker industry uptake of these new environmental technologies in order to produce a fleet that will operate more efficiently with less energy usage and permit expansion of airports and airspace capacity in a manner consistent with the environmental goals of the NextGen plan.

Specific activities include developing and demonstrating:

- Certifiable aircraft technology that reduces aircraft fuel burn by 33% compared to current technology, reducing energy consumption and greenhouse gas (CO_2) emissions;
- Certifiable engine technology that reduces landing and takeoff cycle (LTO) nitrogen oxide emissions by 60 percent, without increasing other gaseous or particle emissions, over the International Civil Aviation Organization (ICAO) standard adopted at the sixth meeting of the ICAO Committee on Aviation Environmental Protection (CAEP/6);
- Certifiable aircraft technology that reduces noise levels by 32 dB at each of the three certification points, relative to Stage 4 standards; and
- Determination of the extent to which new engine and aircraft technologies may be used to retrofit or re-engine aircraft so as to increase the level of penetration into the commercial fleet.

Demonstrate alternative fuels for aviation to reduce emissions affecting air quality and greenhouse gas emissions and increase energy supply security for NextGen.

Specific activities include developing and demonstrating:

- The feasibility of use of alternative fuels in aircraft systems, including successful demonstration and quantification of benefits and internationally agreed criteria to quantify relative carbon content; and
- Processing capability and technical data to support certification and assured safety of a "drop in" replacement for petroleum derived turbine engine fuels.

Determining the appropriate enhancements of goals and metrics to manage NextGen aviation environmental impacts that are needed to support Environmental Management Systems (EMSs) and achieve environmental protection that enables sustained aviation growth.

Specific activities include:

- Evaluate, establish and implement advanced metrics to better assess and control noise, air quality impacts and greenhouse gas emissions that may influence climate impacts from anticipated NextGen commercial aircraft operations.
- Evaluate and refine required technology and operational goals and targets to mitigate the environmental impact of NextGen and support NextGen EMS implementation.

Agency Outputs: The program is protecting the environment by reducing significant aviation environmental impacts associated with noise, exhaust emissions and energy production. The program is also seeking to enhance energy efficiency and availability. The program will advance and mature, collaboratively with industry, engine and airframe technologies to reduce aviation noise, air quality and greenhouse gas emissions and energy use. It will also provide data and methodologies to assess the life cycle environmental impact and support certification of alternative aviation fuels that could serve as "drop in" replacements for today's petroleum derived turbine engine fuels. This will lead to faster deployment of these fuels, and accompanying reductions in greenhouse gas and air quality emissions

from aviation. Ultimately the program will demonstrate advanced technologies and alternative fuels in integrated ground and flight demonstrations.

The program is also helping to achieve NextGen goals by improving metrics to define and measure significant aviation environmental impacts. The program will improve the fundamental understanding of aviation environmental health and welfare and climate impacts and translate impact into improved metrics that can be used to better assess and mitigate aviation's contribution. This program will identify the gaps in scientific knowledge to support NextGen; focus research in areas that will reduce key uncertainties to levels that allow action; and develop enhanced metrics to enable sound analyses. Ultimately, the program will enable the refinement of goals and targets to support the NextGen EMS to better manage and reduce aviation's environmental impacts.

Research Goals:

By FY 2015, complete system analyses and demonstrations of near-and mid-term CLEEN airframe and engine technologies to reduce noise, emissions and fuel burn in integrated flight demonstrations for civil subsonic jet aircraft

Airframe and engine technologies supporting milestones:

- Complete demonstration of first phase CLEEN technologies in ground rig tests. (by FY 2011)
- Complete demonstration of CLEEN technologies in ground rig tests. (by FY 2012)
- Demonstrate airframe and engine technologies to reduce noise, emissions and fuel burn in integrated ground demonstrations for civil subsonic jet aircraft. (by FY 2013)
- Complete system analyses to identify the most promising CLEEN technologies for flight tests. (by FY 2013)
- Initiate demonstrations of first round of CLEEN airframe and engine technologies to reduce noise, emissions and fuel burn in integrated flight demonstrations for civil subsonic jet aircraft (by FY 2013)
- Complete system analyses and identify and pursue the development of second round engine and airframe technologies that will be the most effective at producing environmental benefits. (by FY 2015)
- Complete demonstrations of first round of CLEEN airframe and engine technologies to reduce noise, emissions and fuel burn in integrated flight demonstrations for civil subsonic jet aircraft(by FY 2015)
- Develop plans for analyses and demonstration of evolving technologies in a potential second Phase to CLEEN (by FY2015)

By FY 2015, complete comprehensive assessment and research to support certification of "drop in" and renewable alternative turbine engine fuels and develop implementation plan to foster implementation in the commercial fleet.

Alternative fuels supporting milestones:

- Complete detailed feasibility study, including economic feasibility, environmental impacts, and assessment of potential for gas turbine renewable alternative fuels. (by FY 2011)
- Initiate efforts to experimentally assess environmental impacts and benefits and costs of renewable alternative turbine engine fuels. (by FY 2011)
- Develop internationally-agreed methodology to conduct environmental impact life cycle analyses for a range of renewable alternative turbine fuels (by FY 2012)
- Conduct a significant demonstration of "drop-in" alternative turbine engine fuels (by FY 2012)
- Conduct a study of strategies to incentivize implementation of renewable alternative fuels in commercial aviation (by FY 2012)
- Conduct safety assessment of renewable fuels (by FY 2013)
- Determine potential production capacity of alternative aviation fuels for aviation (by FY 2012)
- Conduct significant demonstration of additional "drop in" alternative turbine engine fuels. (by FY 2013)
- Complete assessment of benefits of use of alternative fuels in operational aircraft fleet (by FY 2013)
- Complete renewable alternative turbine engine fuels safety, environmental and business case assessments (by FY 2013)
- Complete transition plans for "drop-in" alternative fuels (by FY 2014)
- Complete renewable fuels safety assessment (by FY 2014)
- Complete transition plans for renewable alternative fuels (by FY 2015)

By FY 2016 identify and initiate assessment of non drop-in fuels.

- Conduct initial feasibility study, including economic feasibility, environmental impacts, and assessment of potential for non drop in alternative aviation fuels (by FY 2015)
- Conduct a demonstration of the performance characteristics of a non drop in alternative aviation fuel (FY 2016)

By FY 2015, investigate metrics, uncertainties on aviation emissions health and welfare and climate impact to facilitate NextGen EMS implementation.

Metrics supporting milestones:

- Complete preliminary assessment of aviation's impact on climate. (by FY 2011)
- Complete initial assessment of NextGen air quality and noise impacts. (by FY 2011)
- Continue refinements of aviation environmental impacts and metrics (by FY 2013)
- Reduce key uncertainties of aviation impacts to levels that better inform appropriate action. (by FY 2013)
- Refine metrics that more accurately capture aviation emissions health and welfare and climate impact and goals to facilitate EMSs implementation. (by FY 2014)
- Continue refined assessment of aviation environmental, health and climate impacts (by FY 2015)
- Complete an updated assessment of aviation environmental, health and climate impacts (by FY 2015)

Customer/Stakeholder Involvement: FAA works closely with other federal agencies, industry, academia, and international governments and organizations to design R&D efforts that can mitigate the environmental impact of aviation and explore alternative gas turbine fuels.

- NextGen -- FAA leads an Environmental Working Group (EWG) responsible for leading environmental dimensions of the JPDO. The EWG comprises FAA, NASA, the Environmental Protection Agency (EPA), DoD, Department of Commerce, Council on Environmental Quality, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The efforts of the WG are centered on advancing the national vision and recommendations for aviation in the NextGen and in the congressionally mandated study on "Aviation and the Environment", including advanced technology and alternative fuels development.
- Commercial Alternative Aviation Fuel Initiative (CAAFI) -- Concerns about rising fuel costs, energy supply security and the environmental effects of aviation are providing a significant stimulus to take a fresh look at the use of alternative fuels for aviation. To forge a way ahead, FAA founded the Commercial Aviation Alternative Fuels Initiative (CAAFI) together with Airports Council International-North America (ACI-NA), the Air Transport Association (ATA) and the Aerospace Industries Association (AIA). CAAFI is teaming with the DoD to leverage their substantial efforts advancing alternative fuels for military aviation– driven by energy security considerations. CAAFI is also working with other Federal agencies such as NASA.
- Climate Change Science Program (CCSP) – The FAA is working with the CCSP program office and its individual member agencies to focus research efforts that address the uncertainties and gaps in our understanding of current and projected impacts of aviation on climate, and to develop metrics to characterize these impacts.
- Aviation Climate Change Research Initiative (ACCRI) – The FAA worked with NASA and NOAA to establish the ACCRI. The primary objective is to coordinate and sponsor collaborative research efforts to reduce key scientific uncertainties in quantifying aviation-related climate impacts while providing timely scientific input to inform optimum mitigation actions and policies for NextGen and ICAO.
- Environmental Protection Agency – The FAA is working with the EPA to leverage the Life Cycle Analysis (LCA) model being developed by the EPA under the Energy Security and Independence Act of 2007 to expand applicability to aviation.

R&D Partnerships: As does the Environment and Energy Research Program and other NextGen activities, the NextGen Aircraft Technologies, Fuels and Metrics Program relies on a series of Memorandums of Agreement (MOA), to work closely with NASA and DoD. The FAA is also pursuing collaborative agreements with DoE, and EPA to leverage resources to address aviation's environmental impact.

- Through the JPDO NextGen, the program supports the EWG comprising FAA, NASA, EPA, DoD, Department of Commerce, Council on Environmental Quality, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The EWG is pursuing an intensive, balanced approach, emphasizing alignment across stakeholders in developing needed business and technology

architectures, as well as other relevant tools, metrics, and products to address aviation's environmental impact.

Accomplishments: This effort started in FY 2009 to address the challenges of NextGen. The program was stood up and contracts issued in 2009. However, relevant stakeholders have achieved significant accomplishments mitigating aviation's environmental impact. The number of people exposed to significant noise levels was reduced by over 90 percent between 1975 and 2008. Today's aircraft are also 70 percent more fuel-efficient than jet aircraft of the 1960s. Reduced fuel consumption has also led to a 90 percent reduction in carbon monoxide, smoke, and other aircraft emissions. The outputs of this program will continue to enable future environmental performance improvements.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise, emissions and fuel burn reduction technologies maturation

- Continued advancement of CLEEN system level assessments.
- Initiated CLEEN component level assessment.
- Conducted detailed integrated system level analyses to identify the most promising technologies.
- Identified CLEEN airframe and engine technologies to be pursued.
- Completed Round 1 demonstration of CLEEN technologies in ground rig tests.
- Completed preliminary design of CLEEN demonstration experiment.

Alternative turbine engine fuels

- Measured experimentally environmental impacts of "drop in" alternative turbine engine fuels.
- Initiated planning for comprehensive "drop in" alternative fuel demonstration
- Initiated efforts to experimentally quantify renewable fuels environmental impacts

NextGen Environmental Metrics, Goals and Targets

- Continued efforts to determine how projected NextGen operations-generated emissions and noise impact human health and welfare, and global climate and identify key uncertainties.
- Initiated implementation of research efforts necessary to reduce key uncertainties in our scientific understanding of environmental impacts and enhance models to assess those impacts for improved decision-making on mitigation and regulatory considerations.
- Continued comprehensive modeling efforts to establish the relationship between aviation engine exhaust and the gaseous and particulate matter emissions that are deposited in the atmosphere.
- Initiated a comprehensive particulate matter (PM), hazardous air pollutants (HAPs) and noise measurement campaign.
- Continued assessing potential metrics to quantify the climate related impacts of commercial aircraft operations.
- Continued baseline analyses of potential climate response due to aviation emissions with quantified uncertainties, based on the best available science and modeling tools.
- Initiated comprehensive assessment of NextGen air quality and noise impacts.

FY 2011 PROGRAM REQUEST:

Anticipated increases in air transportation demand will place significant environmental pressures on various segments of the NextGen. The primary environmental constraints on the capacity, efficiency and flexibility of the NextGen could be community noise, air quality, global climate impacts, and energy production and consumption. Environmental issues have constrained airport and airspace growth over the past decade. To ensure environmental impacts don't become a constraint on growth in NextGen, we need to accelerate introduction of quieter and cleaner technology in our fleets. Ninety percent of the environmental improvements (noise and emissions reductions) in the aviation system in the last 30 years have come from improved technology. Without a pipeline of near term (5-10 years) technology improvements, we cannot achieve the absolute reduction of significant noise and air quality impacts that we believe are necessary to

enable NextGen growth. We need robust research and development to enable technology solutions to manage and mitigate environmental constraints. The goal is to have a fleet of quieter, cleaner aircraft that operate more efficiently with less energy.

We are currently facing larger research and development challenges at a time when we need to make larger technological leaps. Solutions that involve technology improvements in engines and airframes in a foreseeable timeframe require successful maturation and certification of new technologies within the next 5-10 years. This initiative establishes a world-class research consortium that can pursue technology goals to significantly reduce aviation noise, emissions, and fuel consumption. Establishing a world-class research consortium with industry-targeted on maturing technology- will help accelerate introduction of quieter and cleaner technology in our fleets so environmental issues do not become constraints.

The NextGen environmental goal is to reduce significant health and welfare impacts of aviation community noise and air quality (namely NO_X) emissions in absolute terms, notwithstanding growth. Although there is no quantitative goal for greenhouse gas emissions, the NextGen environmental goal does call for limiting or reducing the impact of aviation greenhouse gas emissions on global climate. There is a need to explore the appropriate metrics and system goals to establish significant impacts. There is also a need to develop a robust science-based understanding of impacts of NextGen aviation emissions on earth's climate and translate these impacts into improved metrics that can be used to better assess and mitigate aviation's contribution to climate change. These goals and metrics will enable NextGen Environmental Management Systems (EMSs) to mitigate impacts in a dynamic and cost-beneficial manner.

Elements of this initiative include:

- In collaboration with industry, mature noise, emissions and fuel burn reductions technologies (previously conceived by NASA and industry to Technology Readiness Levels (TRL) of 3-4) to levels (TRL 6) that enable industry to expedite introduction of these technologies into current and future products.
- Advance the development of alternative "drop in" and renewable turbine fuels for aviation and assess their environmental impacts to expedite deployment.
- Develop metrics to better assess and control noise, air quality and climate impacts from NextGen commercial aircraft operations and establish goals and targets to support NextGen EMS implementation to mitigate impacts.

Ongoing Activities

Anticipated increases in air transportation demand will place significant environmental pressures on the national airspace system. Current operational trends show that environmental impacts resulting from aircraft noise and aviation emissions will be the principal constraint on the capacity and flexibility of the NextGen unless managed and mitigated. Aviation impacts affect community noise footprints, surface air quality, water quality, and the global climate. Environmental issues have already resulted in the delay and/or down-scaling of certain airport capacity projects over the past decade. Therefore, the NextGen environmental challenge is to reduce, in absolute terms the number of people exposed to significant noise levels; and the significant health and welfare impacts on the population of aviation

The challenge is also to reduce the impact of aviation greenhouse gas emissions on global climate – despite remaining scientific uncertainties regarding the nature of these impacts. And the overarching challenge is to better understand the impacts of aircraft noise and emissions on the population and climate, enabling appropriate mitigation actions. NextGen must achieve a balance between aviation's environmental impacts and other societal objectives, both domestically and internationally.

The FAA's strategic plan to address these challenges has five elements: (1) enhance scientific understanding and develop integrated environmental models; (2) accelerate air traffic management efficiencies and improvements; (3) hasten the development of promising environmental improvements in aircraft technology; (4) hasten the development renewable aviation alternative fuels; and (5) explore market-based measures to offer assistance in managing aviation emissions growth.

This program is focusing on efforts to accelerate the aircraft technology and aviation alternative fuels development/penetration cycle. It is also focusing on enhancing scientific understanding of metrics and targets that more accurately capture aviation noise and emissions health and welfare and climate impacts to enable cost beneficial actions to mitigate these impacts.

The effort is pursuing the national goals and objectives delineated in the Energy and Environment component of the National Plan for Aeronautics R&D and Related Infrastructure (http://www.ostp.gov/cs/nstc/documents_reports) which provides quantitative integrated energy, fuel efficiency, emissions and noise research goals.
The ongoing elements of the effort include:

1. Continue the Continuous, Low Energy, Emissions, and Noise (CLEEN) effort focused on accelerating the maturation of lower energy, emissions and noise technology for aircraft and advancing environmentally beneficial alternative fuels.
2. Continue efforts to develop the fundamental scientific understanding to enable Environmental Management Systems to dynamically manage aviation environmental impacts in a cost beneficial manner.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise, emissions and fuel burn reduction technologies maturation

- Advance CLEEN systems analyses for most promising technologies
- Continue CLEEN component level tests for most promising technologies
- Initiate Round 2 ground rig tests
- Continue design of CLEEN demonstration experiment

Alternative turbine engine fuels

- Complete detailed feasibility study, including economic feasibility, environmental impacts, and assessment of potential for gas turbine renewable alternative fuels. (by FY 2011)
- Develop federally-agreed methodology to conduct environmental impact life cycle analyses for a range of renewable alternative turbine fuels (by FY 2011)
- Initiate efforts to experimentally assess environmental impacts and benefits and costs of renewable alternative turbine engine fuels. (by FY 2011)

NextGen Environmental Metrics, Goals and Targets

- Continue analysis of targets to achieve NextGen environmental goals
- Continue efforts to determine how projected NextGen operations-generated emissions and noise impact human health and welfare, and global climate and identify key uncertainties.
- Continue research efforts necessary to reduce key uncertainties in our scientific understanding of environmental impacts and enhance models to assess those impacts for improved decision-making on mitigation and regulatory considerations.
- Continue comprehensive modeling efforts to establish the relationship between aviation engine exhaust and the gaseous and particulate matter emissions that are deposited in the atmosphere.
- Complete analysis of data collected during comprehensive particulate matter (PM), hazardous air pollutants (HAPs) and noise measurement campaign.
- Develop plans for next round of emissions and noise measurement campaign and analysis
- Continue assessing potential metrics to quantify the climate related impacts of commercial aircraft operations.
- Continue baseline analyses of potential climate response due to aviation emissions with quantified uncertainties, based on the best available science and modeling tools.
- Continue comprehensive integrated assessment of NextGen air quality and noise impacts.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	16,050
FY 2010 Enacted	26,509
FY 2011 Request	20,600
Out-Year Planning Levels (FY 2012-2015)	82,947
Total	146,106

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NextGen Environmental Research—Aircraft Technologies, Fuels and Metrics	0	0	15,829	25,351	19,043
Personnel Costs	0	0	221	954	1,150
Other In-house Costs	0	0	0	204	407
Total	**0**	**0**	**16,050**	**26,509**	**20,600**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	16,050	26,509	20,600
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**16,050**	**26,509**	**20,600**

A13.b- NextGen Environmental Research—Aircraft Technologies, Fuels and Metrics Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
111-150 NextGen Environmental Research							
Technology Maturation	**14,239**						
Establish CLEEN Consortium							
System Level Assessments		♦	◊	◊	◊	◊	◊
Component Assessments		♦			◊		
Rig Tests – Round 1		♦					
Rig Tests – Round 2			◊	◊			
Integrated Ground Demonstrators				◊	◊		
Flight Demonstrations					◊	◊	◊
Prepare Annual Report		♦	◊	◊	◊	◊	◊
Alternative Turbine Fuels	**2,467**						
"Drop in" Fuels Feasibility Study		♦					
Renewable Fuels Feasibility Study			◊				
Lifecycle and sustainability analyses for renewable fuels			◊				
Qualification testing		♦	◊	◊	◊		
Production Capacity Assessment				◊	◊	◊	
Renewable Fuels Safety Assessment				◊	◊	◊	
Renewable Alternative Fuels Demonstration					◊		
Transition Plans for "drop-in" fuels				◊	◊	◊	
Transition Plans for renewable alternative fuels					◊	◊	◊
Benefit assessment of use of alternative fuels in operational aircraft fleet					◊		
Assess feasibility of non drop-in alternative fuels							◊
Prepare Annual Report		♦	◊	◊	◊	◊	◊
Metrics, Goals and Targets	**2,337**						
Define potential metrics		♦					
Evaluate metrics and models		♦		◊		◊	
Advance measurement approaches		♦	◊	◊			
Climate impact assessments		♦	◊			◊	◊
Air Quality assessments		♦		◊		◊	◊
Noise assessments		♦		◊		◊	◊
Refine metrics			◊	◊		◊	
Assess efficacy of metrics			◊	◊		◊	◊
Upgrade Assessment Models		♦			◊	◊	
Integrated noise and emissions impacts analysis		♦	◊	◊	◊	◊	◊
Assessment of Environmental goal targets		♦	◊	◊	◊	◊	◊
Publish Research Reports		♦	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**1,557**						
Total Budget Authority	**20,600**	**26,509**	**20,600**	**20,691**	**20,778**	**20,752**	**20,726**

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

Budget Item	Program Title	Contract Dollars
A14.a	**System Planning and Resource Management**	**$1,733,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety. Greater Capacity, International Leadership, Organizational Excellence

Intended Outcomes: Demonstrate the value of working with international partners to leverage research programs and studies to improve safety and promote seamless operations worldwide. The ongoing activity will manage the FAA's R,E&D portfolio, meet the President's criteria for R&D, increase program efficiency, and maintain management and operating costs.

This activity produces the National Aviation Research Plan (NARP), an annual strategic plan for FAA R&D; administers the congressionally mandated R,E&D Advisory Committee (REDAC); conducts external program coordination; fosters future research opportunities; and provides program advocacy and outreach.

Agency Outputs: In FY 2011, the FAA will:

R,E&D Portfolio Development

- Publish the annual National Aviation Research Plan (NARP).
- Manage the R,E&D portfolio development.
- Prepare the annual R,E&D budget submission.
- Host two REDAC meetings and multiple subcommittee meetings. The Committee provides advice on and reviews plans for the annual FAA R&D budget, and produces periodic and special reports providing advice and recommendations to FAA on its R&D portfolio.

Research Partnerships

- Establish and cultivate research partnerships both domestically and internationally to leverage programs, laboratories, and facilities to support the implementation of NextGen operational improvements.
- Manage the formulation and execution of interagency agreements and action plans with external research partners such as NASA, Air Force Research Lab (AFRL), EUROCONTROL, and SESAR Joint Undertaking.
- Identify, validate, and catalog existing and needed research and technology activities internal and external to the FAA to support the operational needs of the FAA's NAS Enterprise Architecture.
- Conduct the 2011 USA/Europe Air Traffic Management R&D Seminar on NextGen and SESAR.

Performance Measurement

- Develop a strategic mapping for international collaboration.
- Identify a process to measure quality, timeliness, and value of collaboration.

Research Management Goals:

- In FY 2011, the FAA will maintain an R,E&D management workforce of no more than 10 percent of the total R,E&D workforce and will sustain the System Planning and Resource Management budget at 2 percent or less of the total R,E&D budget.
- In FY 2011, publish the NARP, which documents the annual R&D budget portfolio, describes activities of the RE&D Advisory Committee, and contains the FY 2011-2016 R&D plans.
- By 2011, develop a strategic mapping for international research collaboration.
- By 2011, identify a process to measure quality, timeliness, and value of international research collaboration.
- By 2016, determine the value of international research collaborations.

Customer/Stakeholder Involvement: The REDAC reviews FAA research commitments annually and provides guidance for future R,E&D investments. The members of this committee and its associated subcommittees are subject matter experts drawn from various associations, user groups, corporations, government agencies, universities, and research centers. Their combined presence in the REDAC fulfills a congressional requirement for FAA R&D to be mindful of aviation community and stakeholder input.

R&D Partnerships: DOT, JPDO, NASA, other Federal Agencies, and EUROCONTROL.

Accomplishments: Program accomplishments for FY 2009 include:

- Developed the FY 2011 R,E&D budget submission.
- Met the research goal for R,E&D management workforce and funding for System Planning and Resource Management.
- Managed two REDAC meetings and over twelve subcommittee meetings, where FAA's proposed FY 2011 R,E&D portfolio was reviewed.
- Published the 2009 National Aviation Research Plan and submitted to Congress with the President's FY 2010 Budget.
- Mapped FAA NextGen R&D programs to the JPDO Integrated Work Plan and the FAA's NextGen Implementation Plan.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed the FY 2012 R,E&D budget submission.
- Obtained REDAC guidance for the FY 2012 R,E&D portfolio.
- Obtained REDAC review of and recommendations for FY 2012 R,E&D portfolio.
- Provided strategic direction for the FAA R,E&D program.
- Delivered the 2010 National Aviation Research Plan to Congress with the President's FY 2011 Budget.
- Coordinated R&D activities with internal and external partners.
- Determined criteria for assessing the benefits of the international research collaboration.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

FAA will continue supporting the work of the REDAC in its task to advise the Administrator on the R&D program. In particular, it will seek the counsel and guidance of the committee for the FY 2013 program, review the proposed FY 2013 program prior to submission of the budget requirements to the DOT, and seek the committee's guidance during the execution of the R&D program. The agency will publish, as required by Congress, the National Aviation Research Plan and submit it to Congress concurrent with the FY 2012 President's Budget Request.

The program will review the President's R&D criteria, ensuring that the agency's R&D program remains viable and meets national priorities. It will also publish program activities and accomplishments, as well as foster external review of and encourage customer input to the R&D program.

The agency will maintain its field offices at the NASA Ames and Langley Research Centers as a vital part of efforts to coordinate and integrate the research and development programs of NASA and the FAA.

The program will manage the FAA R&D portfolio, identify high value products being produced by the R&D program, and promote the use of these products globally to benefit the international market. In FY 2011, this initiative will develop strategic mapping for international collaboration and identify a process to measure quality, timeliness, and value of collaboration.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS**:**

R,E&D Portfolio Development

- Prepare the FY 2013 R,E&D budget submission
- Manage FAA's R,E&D portfolio to meet efficiency goals
- Obtain REDAC recommendations on planned R,E&D investments for FY 2013.
- Support the REDAC in its preparation of other reports, as requested by the Administrator.
- Deliver the 2011 National Aviation Research Plan to the Congress with the President's FY 2012 Budget.

Research Partnerships

- Coordinate R&D activities with internal and external partners.

- Conduct the 2011 USA/Europe Air Traffic Management R&D Seminar on NextGen and SESAR.
- Update the Integrated Plan for Research Transition Teams with NASA.

Performance Measurement

- Develop strategic mapping for international research collaboration.
- Identify a process to measure quality, timeliness, and value of International research collaboration.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	$42,320
FY 2010 Enacted	1,766
FY 2011 Request	1,733
Out-Year Planning Levels (FY 2012-2015)	6,719
Total	52,538

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
R,E&D Plans and Programs	1,346	1,075	1,714	1,706	1,678
Personnel Costs	39	37	103	44	32
Other In-house Costs	3	72	0	16	23
Total	**1,388**	**1,184**	**1,817**	**1,766**	**1,733**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	1,388	1,184	1,817	1,766	1,733
Development (includes prototypes)	0	0	0	0	0
Total	**1,388**	**1,184**	**1,817**	**1,766**	**1,733**

A14.a – System Planning and Resource Management Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
011-130 R,E&D Plans and Programs							
R,E&D Portfolio Development	**221**						
Prepare guidance for budget formulation		♦	◊	◊	◊	◊	◊
Conduct R,E&D financial management		♦	◊	◊	◊	◊	◊
Prepare annual budget submissions		♦	◊	◊	◊	◊	◊
Congressionally Mandated	**438**						
Publish National Aviation Research Plan (NARP)		♦	◊	◊	◊	◊	◊
Conduct REDAC Meetings		♦	◊	◊	◊	◊	◊
Research Partnerships	**344**						
Sponsor NASA Field Offices		♦	◊	◊	◊	◊	◊
Facilitate the development of Integrated Plan for RTT with NASA		♦	◊				
Performance Measurement	**675**						
Determine measures for exchange of research information		♦					
Develop a strategic mapping for international collaboration		♦	◊				
Identify a process to measure quality, timeliness, and value of collaboration		♦	◊				
Calculate value of collaboration				◊	◊	◊	◊
Personnel and Other In-House Costs	**55**						
Total Budget Authority	**1,733**	**1,766**	**1,733**	**1,717**	**1,700**	**1,668**	**1,634**

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

Budget Item	Program Title	Budget Request
A14.b	**William J. Hughes Technical Center Laboratory Facility**	**$3,717,000**

GOALS:
This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: The FAA sustains research facilities located at the William J. Hughes Technical Center (WJHTC) in support of its R&D program goals. These facilities consist of the Flight Program's Airborne Laboratories, Simulation Facilities including the Target Generation Facility and the Cockpit Simulators, and the Concepts and Systems Integration Facilities, including the Human Factors Laboratory and the NextGen Integration and Evaluation Capability.

Agency Outputs: R&D programs require specialized facilities to emulate and evaluate field conditions. Human factors projects require flexible, high fidelity laboratories to perform full mission, ground to air, human-in-the-loop simulations. Researchers measure baseline human performance using existing ATC configurations, and deltas in performance when new systems or procedures are introduced in order to evaluate human factors issues. These laboratories are comprised of integrated cockpit and air traffic control workstation simulators, and the performance issues they delve into reflect the perspectives of the pilot and flight crew. Airborne and navigation projects require flying laboratories, aircraft utilized for research and development, which are specially instrumented and reconfigurable to support a variety of projects.

Research Goals: The FAA will work to provide an integrated laboratory platform for the purpose of demonstrating operational procedures, defining human and system performance requirements, full mission demonstrations integrating NextGen air and ground capabilities for pilot separation responsibility and controller efficiencies, and analysis, evaluation, and validation of R&D milestones.

Customer/Stakeholder Involvement: The WJHTC facilities directly support agency projects and integrated product teams in the following areas:

FAA's Air Traffic Organization (ATO) – The WJHTC laboratories support the ATO in the areas of capacity and air traffic management; communications, navigation, and surveillance; NextGen concept validation; weather; airport technology; aircraft safety; human factors; information security; environment and energy.

Communications, Navigation, and Surveillance – The Flight Program Team supports on-site flight tests of the Precision Runway Monitoring System in Detroit to aid in the development of a system for reduction of runway incursions.

Next Generation Air Transportation System (NextGen) – The WJHTC laboratories support concept validation and system integration.

Automated Dependent Surveillance-Broadcast – Numerous flight test hours have been expended in support of field testing the new ITT system in southern Florida. Each test leads to improvements made to enhance the overall system.

Terminal Instrumentation Procedures (TERPS) – Routine flight tests are ongoing in the development of GPS Helicopter precision approaches to a heliport.

Wide Area Augmentation System – The Flight Program Team has been working with the WAAS program, Bombardier Aircraft, Canadian Marconi, and Honeywell to design, test and certify a WAAS installation into a Bombardier Global 5000 aircraft.

R&D Partnerships: In addition to FAA's research programs, WJHTC laboratories partnerships include:

U.S. Air Force – The Flight Program Team has performed numerous test of the GPS signal security with the U.S. Air Force.

National Transportation Safety Board – The Flight Program Team has participated in the recreation of aircraft accidents for the purpose of collecting data in an attempt to determine the underlying cause.

Boeing - The Simulation team is working a under cooperative research and development to build capability to perform R&D of 4-D trajectory negotiation and execution, and Unmanned Aerial Systems (UAS)

EUROCONTROL - The simulation team exchanges aircraft modeling data for use in TGF

Industry –

- Flight tests are on-going to help develop and deploy the ITT ADS-B system in southern Florida as well as the work being done with Bombardier, Canadian Marconi, and Honeywell in the design, installation and certification on GPS WAAS onboard a Bombardier Global 5000 aircraft.
- The Simulation team has partnered with UFA Inc. to quantify voice recognition and response (VRR) system performance in Technical Center Human in the Loop (HITL) simulations.

Facilities supporting R&D Goals at the FAA's WJHTC: The following laboratory facilities provide the reliable test bed infrastructure to support these R&D customers, program goals, and outputs for the FAA:

Simulation Facilities – Target Generator Facility (TGF) and Cockpit Simulators

- Approach Procedures
- Next Generation Air Transportation System
- Airspace Design
- Operational Evolution Plan Concept Validation
- Dynamic Vertical Reduced Separation Minima
- Unmanned Aerial Systems
- ADS-B Concept Evaluation

Research & Development Flight Program – Airborne Laboratories

- Satellite Communications and Navigation Programs
- Separation Standards
- Wide Area Augmentation System
- Terminal Instrumentation Procedures
- Safety
- Runway Incursion
- Next Generation Air Transportation System
- Local Area Augmentation System
- ADS-B
- Common Automated Radar Terminal System

Concepts and System Integration Facilities

- Air Traffic Control Human Factors
- Airway Facilities Human Factors
- NextGen Integration & Evaluation Capability (NIEC)
- Airspace Design
- Unmanned Aerial Systems (UAS)
- ADS-B
- SWIM
- DataComm
- TMA

Accomplishments: The FAA's WJHTC's laboratory facilities provide the reliable test bed infrastructure to support R&D program goals and outputs. Outstanding program accomplishments include:

FY 2009:

Simulation Facilities

- Simulation Team integrated TGF and Boeing Simulation Lab for UAS simulation capability.
- Simulation Team added 4-D trajectory negotiation capability using AIDL to its B-737 flight management system trainer.
- Simulation Team completed the evaluation of the UFA VRR system.

Flight Program's Airborne Laboratories

- The Flight Program Team made improvements to its operational aircraft to enhance their ability to support project flight test. These included the installation of new antennas to support the ADS-B and NextGen programs and the modification of the aircraft to permit the display of Advanced Navigational signals unto the basic cockpit displays, into the Bombardier Global 5000 test aircraft (N47).

Concepts and Systems Integration

- The Research Development & Human Factors Laboratory (RDHFL) Future Terminal Workstation (FTWS) supported Human-in-the-Loop simulations that evaluated three user interfaces: STARS; STARS+ (STARS plus DataComm, ADS-B, use of RNAVs, tailored arrivals and functionality from DRS/ERAM; and FTWS: 2020 NextGen Automation Platform common EnRoute/TRACON UI extrapolated from future EnRoute Workstation simulations.
- The NIEC integrated UAS Pilot Stations to support demonstration for the FAA UAS Planning Team.
- The NIEC laboratory environment has been improved to enhance capabilities to support NextGen, including upgrades to the laboratory infrastructure and installing component systems to support DataComm, ADS-B, SWIM, TFMM, and TMA.

FY 2008:

- The Flight Program Team has participated in the development and acceptance flight testing of the ITT ADS-B system in southern Florida. These test consisted on numerous dual aircraft, highly scripted, flights to test system resolution, accuracy and performance.
- Simulation Team successfully implemented Boeing's Aircraft Intent Description Language (AIDL)
- Simulation Team successfully completed manual flight capability in its Embraer-175 cockpit simulator using the manufacturer's software.
- Research Development & Human Factors Laboratory (RDHFL) developed Aircraft Geometric Height Measurement Element (AGHME): 2006 – 2009 In support of Domestic Reduced Vertical Separation Minimum (D-RVSM) – consists of changing the current 2,000-ft vertical separation standard applicable to pairs of aircraft operating between 29,000 and 41,000 (flight levels 290 and 410), inclusive, to 1,000 ft. AGHME estimates aircraft geometric height. An already existing analysis process will then make use of this geometric height, in conjunction with other information, to determine aircraft height-keeping performance.

FY 2007:

- The Flight Program Team has participated in the development and improvement flight testing of the FAA's "Legacy" ADS-B system operational on the east coast of the US. These test consisted on numerous multi-aircraft flights to test system resolution, accuracy and performance.
- Simulation Team successfully completed baseline evaluations of the UFA VRR system.
- Simulation Team successfully demonstrated a control tower visualization capability.
- Research Development & Human Factors Laboratory (RDHFL) Future Terminal Workstation (FTWS): 2007-2010 The project is part of the Federal Aviation Administration (FAA) human factors research program to design and evaluate new air traffic control (ATC) capabilities for the 2015-2020 timeframe. The new capabilities include new automation tools; user interfaces (UIs) and interaction techniques, and ATC procedures. The FTWS project focuses on the environment known today as the Terminal Radar Approach Control (TRACON).
- The NextGen Laboratory Team gave several demonstrations of PAS throughout the week ending September 28, 2007, to the FAA UAS Planning Team, showing some basic scenarios in support of the SC203 Document concerning Unmanned Aerial Systems integration into the NAS.
- Research Development & Human Factors Laboratory (RDHFL) Tower Operations Digital Data System (TODDS): 2007 – 2010 Integrated tool to display aircraft location, electronic flight data, and other digital data for the ground and local controller positions in ATC Towers. Address the current limitations of paper and electronic flight strip systems by:
    - Consolidating information into a single source
    - Connecting flight data to aircraft position
    - Providing a means to organize flight data information spatially; touch screen displays
    - Presenting only the information that controllers need when they need it
    - Providing timing capability, reminders, and notices of expired information

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

The test beds at the WJHTC provide the necessary infrastructure for R&D programs to achieve agency goals. Specific milestones and products are contained within individual programs.

Simulation Facilities

- Simulation Team conducted human in the loop (HITL) simulations of UAS in the NAS.
- Simulation Team conducted an end-to-end evaluation of 4-D trajectory prediction and negotiation using TGF and B-737-800 cockpit simulator.

Flight Program's Airborne Laboratories

- The Flight Program enhanced our assets of flying laboratories to meet the anticipated future needs of our flight test customers. These include adding the capability to the Global 5000 to capture and record aircraft engine parameters such as: fuel flow, temperatures, pressures, etc.

Concepts and Systems Integration

- The NIEC team improved the laboratory environment to enhance our capability to support NextGen.

FY 2011 PROGRAM REQUEST:

Ongoing Activities

The FAA will continue to modify, configure, and sustain the research facilities located at the William J. Hughes Technical Center (WJHTC) to support its R&D program goals.

New Initiatives

No new initiatives are planned in FY 2011.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Simulation Facilities

- Target Generation Facility (TGF) will fully realize its capability to support air traffic control tower visualization and surface movement studies. This capability will support research in the areas of runway incursions, and taxi clearances.
- The Cockpit Simulation Facility (CSF) will achieve a fully integrated simulation environment with its B-737-800/900, EMB-175, and A-320 simulators.

Flight Program's Airborne Laboratories

- The Flight Program will work to enhance the flying laboratories to meet the anticipated future needs of our flight test customers. These include the capability to capture all "Flight Data Recorder" information and make it available to project personnel in a variety of formats. The first aircraft to be equipped with this capability will be the Global 5000.

Concepts and Systems Integration

- Research Development & Human Factors Laboratory (RDHFL) will continue to merge results from three ongoing projects: Future En Route Workstation (FEWS), Future Terminal Workstation (FTWS) and Tower Operations Digital Data System (TODDS). Lessons learned will be applied to continued development work on the common automation platform to create one UI for all ATC environments.
- The NIEC team intends on continuously improving the laboratory environment to enhance our capability to support NextGen.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	110,426
FY 2010 Enacted	4,588
FY 2011 Request	3,717
Out-Year Planning Levels (FY 2012-2015)	15,548
Total	134,279

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
WJHTC Laboratory Facility	779	667	684	1,833	1,251
Personnel Costs	2,584	2,642	2,672	2,675	2,377
Other In-house Costs	67	106	180	80	89
Total	**3,430**	**3,415**	**3,536**	**4,588**	**3,717**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	3,430	3,415	3,536	4,588	3,717
Development (includes prototypes)	0	0	0	0	0
Total	**3,430**	**3,415**	**3,536**	**4,588**	**3,717**

A14.b – WJHTC Laboratory Facility Products and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
011-140 WJHTC Laboratory Facility							
Simulation Facilities (Target Generator Facility, Cockpit Simulators)	**250**						
Approach Procedures		♦					
Next Generation Air Transportation System (NextGen)		♦	◊	◊	◊	◊	◊
Airspace Design		♦	◊	◊	◊	◊	◊
Operational Evolution Plan Concept Validation		♦					
Dynamic Vertical Reduced Separation Minima (DRVSM)		♦	◊	◊	◊	◊	◊
Unmanned Aerial Systems (UAS)		♦	◊	◊	◊	◊	◊
ADS-B Concept Evaluations			◊	◊	◊	◊	◊
Research & Development Flight Program (Airborne Laboratories)	**751**						
Satellite Communications and Navigation Programs		♦	◊	◊	◊	◊	◊
Separation Standards		♦	◊	◊	◊	◊	◊
Wide Area Augmentation System (WAAS).		♦	◊	◊	◊	◊	◊
TERPS		♦	◊	◊	◊	◊	◊
Safety		♦	◊	◊	◊	◊	◊
Runway Incursion		♦	◊	◊	◊	◊	◊
Next Generation Air Transportation System (NextGen)		♦	◊	◊	◊	◊	◊
Local Area Augmentation System (LAAS)		♦	◊	◊	◊	◊	◊
ADS-B		♦	◊	◊	◊	◊	◊
Common Automated Radar Terminal System		♦	◊	◊	◊	◊	◊
Concepts & Systems Integration	**250**						
Air Traffic Control Human Factors		♦	◊	◊	◊	◊	◊
Airway Facilities Human Factors		♦	◊	◊	◊	◊	◊
Operational Evolution Plan Concept Validation		♦					
NextGen Integration & Evaluation Capability			◊	◊	◊	◊	◊
Airspace Design			◊	◊	◊	◊	◊
Unmanned Aerial Systems (UAS)			◊	◊	◊	◊	◊
ADS-B			◊	◊	◊	◊	◊
SWIM			◊	◊	◊	◊	◊
DataComm			◊	◊	◊	◊	◊
TMA			◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**2,466**						
Total Budget Authority	**3,717**	**4,588**	**3,717**	**3,785**	**3,857**	**3,920**	**3,986**

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

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01A**	**Runway Incursion Reduction**	**$5,000,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety and Greater Capacity.

Intended Outcomes: The FAA has undertaken the Runway Incursion Reduction Program (RIRP) to minimize the chance of injury, death and damage, or loss of property caused by runway accidents or incidents within the civil aviation system. The program selects and evaluates runway incursion reduction technologies to validate their technical performance and operational suitability. Based on these evaluations, a business case for program implementation has been developed to support Agency investment decisions. Current program initiatives are aimed at evaluating pilot situational awareness tools.

The Program directly contributes to achieving Objective 3, "reduce the risk of runway incursions," of the FAA's Flight Plan 2009 –2013 strategic goal of Increased Safety.

Airports referred to in this program description include:

DFW	Dallas/Ft. Worth International Airport
SAN	San Diego International Airport
LGB	Long Beach – Daugherty Field
GEG	Spokane International, Washington
LAX	Los Angeles International
BOS	Boston Logan International
RNO	Reno, NV
SJC	San Jose, CA
MHT	Manchester, NH

Agency Outputs:

- Operational concepts, system prototypes, field test data, technical specifications and life cycle cost estimates for selected technology solutions.
- Safety Risk Management Plan (SRMP) and National Airspace System Change Proposals (NCPs) for implementing equipment into the National Airspace System (NAS).
- Non-technology solutions, such as improved airport markings/signage, education, training, and advisory circulars.

Customer/Stakeholder Involvement: Operational concepts, technical specifications and system evaluations for runway incursion reduction initiatives are fully coordinated with stakeholders within the air traffic service provider, pilot and airport operator communities. Reducing runway incursion incidents remains a top FAA priority – as reflected in Safety Objective 3 of the current FAA Flight Plan.

Accomplishments:

- Completed installation of RWSL test system at LAX.
- Initiated RWSL Field Operational Evaluation at LAX.
- Awarded 4 contracts for pilot LCGS procurement.
- Initiated installation of LCGS product at MHT, SJC, LGB, RNO airports.
- Completed RIL engineering tests at BOS.
- Established MOAS to support implementation of RWSL Test Systems at two additional airports, BOS, LAX.
- Conducted operational user evaluation of Low Cost Ground Surveillance System (LCGS) at GEG.
- Completed Final Approach Runway Occupancy Signal (eFAROS) field evaluation at DFW.
- Installed Runway Status Light (RWSL) Airfield Lighting Equipment (ALE) at LAX.

- Conducted initial investment analysis activity for LCGS program.
- Initiated procurement action to support pilot LCGS program.
- Completed engineering evaluation of Runway Intersection Lights (RILs) application at BOS.

R&D Partnerships: Partnerships for RIRP technology initiatives exist with several members of industry, with Federally Funded Research and Development Consortia (e.g., MIT Lincoln Laboratory, MITRE), with selected airport operators (e.g., DFW, SAN, LGB, GEG, RNO, SJC, MHT, BOS, LAX), and with other government agencies (e.g., the Volpe National Transportation Systems Center).

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop system enhancements for RWSL
- Conduct installation of LCGS at three additional airports.
- Complete investment analysis activity for LCGS.
- Conduct Runway Intersection Lights (RILs) operational trials.
- Develop a low cost Runway Status Lights (RWSL) system design for applications at non-ASDE-X airports.
- Initiate evaluation of LED technology for application in runway safety systems.
- Initiate evaluation of airport wireless data communication system design alternatives.

FY 2011 PROGRAM REQUEST:

The requested funding will allow the program to:

- Complete installation of LCGS at three additional airports.
- Complete investment analysis activity for LCGS.
- Conduct Runway Intersection Lights (RILs) operational trials.
- Develop a low cost Runway Status Lights (RWSL) system design for applications at non-ASDE-X airports.
- Evaluation of LED technology for application in runway safety systems.
- Evaluation of airport wireless data communication system design alternatives.

FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop system enhancements for RWSL.
- Continue testing of LCGS at four pilot site airports.
- Complete investment analysis activity for LCGS.
- Initiate LCGS investment analysis report.
- Complete RIL operational trials and refine logic.
- Develop low cost RWSL system design alternatives for application at4r4 non ASDE-X airports.
- Complete evaluation of LED technology for runway safety applications.
- Continue evaluation of airport wireless data com system design alternatives.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	80,735
FY 2010 Enacted	11,000
FY 2011 Request	5,000
Out-Year Planning Levels (FY 2012-2015)	12,000
Total	108,735

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Runway Incursion Reduction	8,000	8,000	12,000	11,000	5,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**8,000**	**8,000**	**12,000**	**11000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	8,000	8,000	12,000	11,000	5,000
Total	**8,000**	**8,000**	**12,000**	**11,000**	**5,000**

1A01A - Runway Incursion Reduction Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Runway Incursion Reduction	**5,000**						
Runway Status Lights (RWSL)							
Develop RWSL system enhancements		◇	◇	◇	◇	◇	◇
Initiate RWSL test system		◆					
Initiate RWSL Field Operation		◆					
Complete Install of RWSL test system		◆					
Complete RIL Shadow Ops Tests at BOS		◆					
Conduct RIL operational trials		◆					
Develop Low Cost RWSL system at non ASDE-X airports.		◆					
Initiate Evaluation of LED technology for runway safety systems		◆					
Initiate Evaluation of airport wireless data comm. Design alternatives		◆					
Complete RIL operational trials			◇				
Develop Low Cost RWSL System at non-ASDE-X airports			◇	◇	◇		
Complete evaluation of LED technology			◇				
Continue evaluation of airport wireless data com system design alternatives			◇	◇	◇		
Low-Cost Ground Surveillance (LCGS)							
Award contract for Pilot Program		◆					
Complete install at two airports by FY10		◆					
Complete install at two add'l airports by FY11		◆					
Complete Investment analysis activity		◆					
Continue testing of LCGS at 4 pilot sites			◇	◇	◇		
Complete LCGS investment analysis activity			◇				
Total Budget Authority	**5,000**	**11,000**	**5,000**	**3,000**	**3,000**	**3,000**	**3,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01B**	**System Capacity, Planning, and Improvement**	**$4,100,000**

GOALS:

This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: The System Capacity, Planning, and Improvements program identifies, evaluates, and formulates system capacity improvements for the NAS. This program sponsors NAS capacity and airport capacity studies where experts from the FAA, academia and industry collaborate to analyze and develop recommendations for improving capacity and system efficiency, and reducing delays at specific airports in alignment with FAA Flight Plan targets. In conjunction with providing recommendations for airport improvements, procedural updates, and simulation studies, this program delivers performance measurement systems and operations research to quantify the efficiency of the NAS and form the basis of proposals for system improvements. The Performance Data Analysis and Reporting System (PDARS) is a fully integrated performance measurement tool designed to help the FAA improve the NAS by tracking the daily operations of the air traffic control (ATC) system. The tracking and monitoring capabilities of PDARS support studies and analysis of air traffic operations at the service or national level. Also, the capacity and efficiency of the NAS is further expanded through capacity modeling which analyze the impact of NextGen operational improvements.

Agency Outputs: The System Capacity, Planning and Improvement (SCPI) program strives to deliver high-quality, cost-effective services to meet the needs of its customers and the users of the air transportation system. A component of this program, the Performance Data Analysis and Reporting System (PDARS), captures real-time performance data at major operational facilities. Airport design studies will continue to provide problem identification and solution sets at specific targeted airports. Strategic Goals and related performance metrics required by the Air Traffic Organization (ATO), and captured through the organization's Strategy 2014 Plan and the Agency's Flight Plan, will continue to provide a framework for assessing operational performance against Agency goals and targets. SCPI sponsors a wide range of tasks designed to measure, assess, and improve aviation capacity. The following programs are critical to the improvement of the aviation system:

Performance Data Analysis and Reporting System

- Supports the development of facility-level metrics that tie Agency goals to actions at the service delivery point and quantify specific outcomes. PDARS extracts radar data from the HOST, Automated Radar Terminal System (ARTS), and STARS computer systems. The system records and integrates flight plan and track data in an interactive database. The data is aggregated to establish outcome metrics such as time, distance, altitude, and reroutes, with the fidelity necessary to make meaningful distinctions between the performance of facilities (both en-route and terminal).

Performance Metrics Development

- Includes the planning, coordination, data collection, and implementation of performance measures used to assess NAS operations. These metrics are also included in the Agency's strategic planning documents and databases to determine whether or not the Agency is meeting its targets. Currently metrics have been developed to measure operational errors, runway incursions, on-time arrivals, delays, ground stop minutes, airport arrival efficiency rate, and airport arrival capacity. Forecasted metrics include the development of an indicator that effectively quantifies the impact of weather on NAS activity and the design of en route, system predictability, terminal departure, and efficiency rate metrics.

ATO Strategy 2014

- Provides focus and alignment to successfully implement FAA Flight Plan and ATO initiatives and all activities necessary to achieve our objectives. Strategy 2014 is a structured system used to identify Strategic Goals and Objectives with related measures or metrics which are used to determine the ATO's progress in achieving these objectives. Performance metrics are important both to senior management leading the ATO, and employees in operational roles driving functional excellence in order to achieve Agency and ATO Goals and Objectives. Strategy 2014 links effective measures across organizational tiers as those measures are cascaded to the field.

Airport Capacity Enhancement/Design Studies

- Investigates capacity and delay at major airports, both domestically and internationally. The FAA works with airports and other aviation industry stakeholders to conduct computer simulation and modeling studies

aimed at improving the operating efficiency of airports. The outputs are in the form of recommendations that can include any of the following: new runways, taxiways, intersections, operating procedures, or terminals.

NextGen Implementation Plan (NGIP) Performance Modeling

- Models the impact of *NGIP* capabilities on the performance of the NAS. The *NGIP* includes seven "solution sets" in the air traffic operations "domain," two in the airport development domain, and one in the aircraft and operator requirements domain. These solution sets are designed to maximize the capacity of the NAS over the next ten years, while ensuring the highest standards of safety. This activity will use fast-time models to analyze *NGIP* improvements in NAS performance retrospectively, and project anticipated improvements in performance prospectively.

International Air Navigation Service Provider (ANSP) Benchmarking

- Working with the Civil Air Navigation Services Organization (CANSO), compares the operational and financial performance of the ATO to that of other ANSPs.

Customer/Stakeholder Involvement: The success of the FAA depends on effective capacity programs involving all elements of the Agency, its customers, and its stakeholders. Field experts from the affected disciplines – concerned airports, air carriers, aviation interest groups, and FAA regional and local facilities – collaborate on diversified airspace and airport capacity task forces and projects.

The Office of Performance Analysis and Strategy is an active participant in formal advisory committees, informal seminars, and individual meetings with relevant industry elements regarding the NAS infrastructure.

R&D Partnerships:
Work with the National Center of Excellence for Aviation Operations Research (Nextor) and the Partnership for Air Transportation Noise and Emissions Reduction to study

- the causes and impacts of delay;
- the economic cost of delay;
- how to forecast future traffic, capacity, and environmental impacts of ATM inefficiencies; and
- strategies to increase capacity.

Accomplishments

- Developed software and hardware to allow integration of surface movement data (e.g., ASDE-X) with PDARS, and develop initial surface movement metrics. Establish PDARS connection to at least one facility providing such data.
- Played a key role in the development of automated delay reporting initiatives at the ATCSCC involving airborne holding information
- Added 4 FAA organizations/facilities to the PDARS network
- Enhanced the PDARS Enterprise Website to support broader use of PDARS.
- Integrated oceanic data into PDARS.
- As part of the ATO Strategy 2014 development process:
  - Developed the process and content for the goal area development meetings in all five goal areas and for the review of these results monthly with the Strategy Steering Group.
  - Maintained the web-based software application infrastructure to provide all ATO Service/ Business Units with centralized access to ATO and Service Unit cost and performance analysis, forecasting, reporting and initiative tracking capabilities; and
  - Prepared and coordinated the ATO updates for the FAA Flight Plan
  - Performed system and process modifications based on the general needs of stakeholders, maintenance of Strategic Management Process software application for Service Units, communication of strategy management best practices.
  - Reviewed and if deemed necessary, developed new measures to monitor and assess strategic objectives, strengthen existing metrics, validate continuing relevance of metrics on Strategy 2014.

- Future Airport Capacity Team (FACT) will continue to work with aviation stakeholders to develop a strategy for implementing solutions from the toolbox developed for each airport projected to have an anticipated capacity shortfall in 2025.
- Developed Biweekly Operations review, coordinating data intake from operational service units, analyzing data and presenting informational graphs, charts and talking points for discussion at Operational Executive Council meetings.
    - Operations Review currently is in the process of being automated, which will provide greater access to information, enhanced capacity for analysis and increased data consistency.
- Developed seasonally adjusted trajectory-based forecasts for use in DataComm Initial Investment Analysis.
- Developed Service Delivery Point (SDP) demand projections for terminal and en route.
- Completed deployment of PDARS to all TRACONs serving the 34 OEP airports in the continental United States.
- Used the NAS Strategy Simulator (NSS) to analyze the impact of the proposed FAA reauthorization language, and Congressional alternatives, on Airport and Airway Trust Fund receipts.
- Adapted a computable equilibrium model (GTAP) of to study EU-US Open Skies Agreement on North Atlantic operations in support of the ICAO North Atlantic (NAT) Economic and Financial Group (EFG).
- Completed a study of the economic impact of civil aviation on the U.S. economy.
- Developed an econometric model of NAT traffic.
- Completed and released the Future Airport Capacity Task (FACT) II report.
- Analyzed changes in excess fuel burn over the past seven years.
- Prepared the ATO FY 2008 Economic Outlook.
- Developed airport delay forecasts for major airports in response to Flight Plan initiative.
- Developed an *NGIP* "avoided delay" metric and prepared estimates of the expected value of this metric for the next 10 years.
- Completed a study of the economic impact of civil aviation on the U.S. economy.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop high level metrics, supporting metrics, targets and key initiatives for the five strategic goals in the new Five Year ATO Strategic Plan.
- Develop a new governance process for implementing and measuring the success of the ATO via the outcomes developed for the FAA Strategic Plan.
- Develop, analyze and report performance benchmarks with international partners
- Expand network to include existing airport ASDE-X surface surveillance data.
- Update current airport capacity estimates, and estimate future airport capacities considering fleet, infrastructure, and procedural changes to support Airport Design Teams, Future Airport Capacity Task (FACT) III report and NextGen modeling and analysis.

FY 2011 PROGRAM REQUEST:

The requested funding will support the Agency goals documented in the FAA Flight Plan by continuing to focus on maximizing airport capacity through improvements in runways, taxiways, navigational/guidance aids, and operational procedures that can result in increased capacity and reduced delays. The SCPI Program will effectively design data systems to measure and analyze operational performance for the assessment of system improvements. The program will also produce capacity studies and analyses to improve operational activity at the nation's most congested airports.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Coordinate the goals and objectives of the updated Strategic Flight Plan and Strategy 2014

APPROPRIATION SUMMARY

	Amount ($000)

Appropriated (FY 1982-2009)	47,658
FY 2010 Enacted	4,100
FY 2011 Request	4,100
Out-Year Planning Levels (FY 2012-2015)	26,000
Total	81,858

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
System Capacity, Planning, and Improvement	5,500	6,500	6,500	4,100	4,100
Personnel Costs	0	0	0	0	
Other In-house Costs	0	0	0	0	
Total	**5,500**	**6,500**	**6,500**	**4,100**	**4,100**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	
Applied	0	0	0	0	
Development (includes prototypes)	5,500	6,500	6,500	4,100	4,100
Total	**5,500**	**6,500**	**6,500**	**4,100**	**4,100**

1A01B - System Capacity, Planning, and Improvement Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
System Capacity, Planning and Improvement	**4,100**						
NAS Performance Measurement							
Prepare FAA Flight Plan		◆	◊	◊	◊	◊	◊
Update Strategy 2014		◆	◊	◊	◊	◊	◊
Integrate surface surveillance data into PDARS		◆					
Integrate oceanic data into PDARS		◆					
Integrate Micro EARTS data into PDARS		◆					
Airport Development							
Complete FACT II Next Steps report							
***NGIP* Performance Modeling**							
Estimate *NGIP* impacts on NAS		◆	◊	◊	◊	◊	◊
Total Budget Authority	**4,100**	**4,100**	**4,100**	**6,500**	**6,500**	**6,500**	**6,500**

◆ - Activities Accomplished ◊ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS. IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01C**	**Operations Concept Validation**	**$4,000,000**

GOALS:

This program supports the following Flight Plan goals: Increased Safety, Greater Capacity, and International Leadership

Intended Outcomes: Validated Operational Concepts and system designs will enable more efficient operations and changes in roles and responsibilities of the pilots and controllers for increased productivity and more efficient operations. This project assesses the interaction of changing roles and responsibilities of NAS service providers and pilots, airspace changes, procedural changes and new mechanized systems for distributing weather, traffic and other flight related information. It tests the assumptions behind common situational awareness and distributed information processing. It provides the high-quality performance requirements needed to ensure that the next generation of National Airspace System (NAS) ground and airborne support systems succeed. This process assesses and redirects the tactical and strategic assumptions behind controller and pilot roles and responsibilities, and decision support tools in general – as well as requirements affecting information type, display and update rate – for the mutual benefit of the public and the aviation community. Associated with the changes in roles and responsibilities are opportunities for restructuring the services provided by air traffic control facilities to best support the re-aligned roles of humans in the NAS as enabled by new automation and communication capabilities.

Agency Outputs: The project objective is to provide a well-defined and well-understood "validated" operational concept based on system modeling and simulation. This work evaluates and incorporates lessons learned from the recent delivery of decision support tools to provide guidance on how advanced decision support and operational enhancements will be integrated into the NAS. The program develops and exercises advanced analysis capabilities to consider the benefit and operational feasibility of technological and procedural changes. In particular, the program is analyzing the methods for more flexibly managing airspace and taking advantage of the differences between high and low altitude work, new opportunities for flow based trajectory management, and the expanded role of Traffic Flow Managers in managing airspace capacity versus limiting demand. It is looking at new ways of cost effectively expanding tower services and remotely providing tower services, and looking at effective ways to manage optimized descent profiles into terminal airspace. It looks at leveraging automation to change roles and responsibilities of NAS airspace users and service providers. Simulation and human-in-the-loop experimentation are used to integrate this new guidance revealing the type, update rate, and display requirements that need to be established to ensure optimum controller performance. The work program has three thrusts: ·Operational Concept Development, Concept Validation, and Concept System Design.

Research Goals:

2011 Demonstrate an increase in capacity and efficiency at 166% current traffic levels
2013 Demonstrate an increase in capacity and efficiency at 230% current traffic levels
2016 Demonstrate an increase in capacity and efficiency at 300% current traffic levels

Customer/Stakeholder Involvement: The RTCA Select Committee for Free Flight Implementation has been a strong external influence on the FAA in many aspects of operational concept development and validation. Additionally, the Agency works in conjunction with the JPDO to survey major stakeholders on their ranking of future concept sub-elements designed to support modernization. This level of stakeholder participation ensures that the evolving concepts are fully mindful of aviation user community requirements – an essential prerequisite to validating the concept of a modern NAS based on a shared, integrated infrastructure.

Operational concept development and validation will utilize an iterative approach with members from the FAA ATO Operational Service Units and representatives from the airspace user community, including pilots and flight operations centers. The iterative approach will present an initial concept or scenario and elicit feedback from impacted stakeholders. This feedback will be incorporated into future versions of the concept that will be reviewed by stakeholders. Concept validation activities employing human-in-the-loop simulation will utilize participants with experience in the task being validated. The Program will identify the precise mechanism for obtaining stakeholder participation. It is currently envisioned that this participation will be through the Next Generation Air Transportation System Institute.

R&D Partnerships: This work directly relates to the FAA/NASA Memorandum of Understanding on ATM research and development and to the objectives of the Next Generation Air Transportation System (NextGen) objectives advanced by the JPDO. Specifically, much of the research funded under this program is part of the Joint FAA/NASA Research Transition Team effort to ensure that planned research results will be fully utilized, and will be sufficient to enable implementation of NextGen Operational Improvements.

Accomplishments: Significant program accomplishments include:

FY 2009:

- Made recommendation on Big Airspace automation alternatives, conducted safety analysis and determined surveillance requirements for implementation of Big Airspace at operational test sites.
- Conducted validation activities for high altitude, generic airspace and procedures
- Conducted validation activities for Multi-sector planner concept
- Conducted fast-time analyses to support 2nd level concept validation
- Provided RTCA support for concept development and validation
- Conducted simulations to develop preliminary program requirements for Staffed NextGen Towers
- Continued FAA/EUROCONTROL effort on Operational Concept and Simulation and Modeling related Action Plans (i.e., AP 2, AP 5, AP9, AP16)

FY 2008:

- Provided RTCA Annual Funding
- Conducted FAA/EUROCONTROL Action Plan meetings such as Action Plan 2 - Operational Concept Development, comparing the JPDO operational concept for Trajectory Based Operations with the European SESAR concept, Action Plan 5 to develop an Operational Concept Validation and Verification Strategy, and Action Plan 16 to identify requirements for common four dimensional trajectories
- Conducted analysis of the automation alternatives for Big Airspace
- Modified human-in-the-loop laboratories, developed evaluation plan and conducted Cognitive Walkthrough Analyses on the Multi-Sector Planner concept down-selected in FY07.
- Developed NextGen Towers Operational Concept
- Developed preliminary NextGen Facilities Operational Concept

FY 2007:

- Provided RTCA Annual Funding
- Developed Traffic Flow Management 2nd level concept
- Conducted information flow analysis for a high altitude generic airspace operational concept
- Evaluated various concepts for a Multi-Sector Planner and down selected to the most viable concept
- Conducted analyses to support NextGen Facilities Executive Council Decision
- Developed common trajectory definition and analysis white paper
- Aligned the NextGen and NAS operational improvements
- Validated the Big Airspace Operational Concept

Previous Years:

- Provided RTCA Annual Funding
- Developed Big Airspace Operational Concept
- Developed two alternative concepts for a Multi-Sector Planner Strategic Controller
- Developed the international flight object

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop and validate second level operational concepts (multiple)
- Conduct joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.
- Conduct fast-time analyses to support concept validation
- Conduct human-in-the-loop simulations to support concept validation
- Expand cognitive and analytic models to support assessments.

- RTCA support for concept development and validation.
- Development of operational, information and performance requirements

FY 2011 PROGRAM REQUEST:

The FY 2011 funding request will be used for concept development, concept validation including benefits and safety analysis, and requirements development for lower level NAS concepts, such as requirements development and transition planning for flow based trajectory management, concept validation of airspace concepts, concept validation activities for automated tower services and remotely staffed tower services, and analysis and validation of requirements for optimized profile descent decision support capabilities. These activities will include validation of concepts for ground–ground and air-ground communications to support transfer of information and change the air traffic control paradigm, as well as to validate assumptions about flight deck evolution.

FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continue to develop and validate second level operational concepts (multiple).
- Conduct joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.
- Conduct fast-time analyses to support concept validation
- Conduct human-in-the-loop simulations to support concept validation
- Expand cognitive and analytic models to support assessments.
- RTCA support for concept development and validation.
- Development of operational, information and performance requirements

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	35,238
FY 2010 Enacted	8,000
FY 2011 Request	4,000
Out-Year Planning Levels (FY 2012-2015)	26,000
Total	73,238

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**		**FY 2011 Request**
Contracts:						
Operational Concept Validation	3,000	3,000	7,400	8,000		4,000
Personnel Costs	0	0	0	0		0
Other In-house Costs	0	0	0	0		0
Total	**3,000**	**3,000**	**7,400**	**8,000**		**4,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**		**FY 2011 Request**
Basic	0	0	0	0		0
Applied	0	0	0	0		0
Development (includes prototypes)	3,000	3,000	7,400	8000		4,000
Total	**3,000**	**3,000**	**7,400**	**8,000**		**4,000**

1A01C - Operations Concept Validation Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations Concept Validation	**4,000**						
Operational Concept Development							
High altitude, generic airspace		♦	◊	◊	◊	◊	◊
Multi-sector Planner		♦	◊	◊	◊	◊	◊
Flexible & dynamic airspace re-sectorization		♦	◊	◊	◊	◊	◊
Concepts of operations for the evolution of Traffic Flow Management		♦	◊	◊	◊	◊	◊
Phase 2/3 Concepts for NextGen Towers		♦	◊	◊	◊	◊	◊
4-D trajectory management, including 4-D Advanced Arrivals							
Concept Validation							
Validation Data Repository and metrics		♦	◊	◊	◊	◊	◊
Traffic Flow Management evolution		♦	◊	◊	◊	◊	◊
Multi-sector Planner		♦	◊	◊			
Airspace Concepts		♦	◊	◊	◊	◊	◊
Provision of NextGen Tower Services		♦	◊	◊	◊	◊	◊
4-D trajectory management, including 4-D Advanced Arrivals		♦	◊	◊	◊	◊	◊
SESAR Activities		♦	◊	◊	◊	◊	◊
Concept System Design							
Requirements Development to support concept implementation		♦	◊	◊	◊	◊	◊
RTCA							
Develop Aviation Community inputs to MASPS, MOPS and Integrated Plans to Support Future Concepts and Modernization		♦	◊	◊	◊	◊	◊
Total Budget Authority	**4,000**	**8,000**	**4,000**	**8,000**	**6,000**	**6,000**	**6,000**

NOTE: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01D**	**NAS Weather Requirements**	**$1,000,000**

GOALS:

This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes:
This program develops mission analysis and investment analysis for initial investment decision for aviation weather support to the NAS. The focus is upon NextGen including collaboration with SESAR and realignment of ICAO aviation weather standards. The purpose is to reduce the number of weather related accidents, reduce the number of aviation flight delays, diversions and cancellations, improve operational efficiency of the NAS, and harmonize ICAO standards with US practices in weather.

The funding supports contract services to identify future demand for services, identify technological opportunities to address that demand, identify projected supply of services, perform gap analysis, perform mission needs analysis, and conduct initial requirements definition. It also supports planning, analysis and documentation studies in support of initial investment decisions for new or modified aviation weather capabilities. Included are (1) policy studies related to the boundary between FAA, NWS, and DOD roles and responsibilities in providing weather support, (2) analysis of and plans for integration of weather information into decision support systems, and (3) standards development for surface and airborne observations forecasts, and ICAO SARPS.

This program also funds contract support to develop functional and performance requirements for weather information and for transitioning weather research into operations including evaluation of human factors, compatibility of new technology with procedures, and analysis of the impact of new information on controller and pilot workloads.

This work builds upon the similar work done under the RWI and NNEW programs. It provides additional detail to the requirements work from those efforts and updates the mission analysis and requirements development at the portfolio level.

Agency Outputs: This line item enables the Agency to develop greater capacity by developing policies, requirements and metrics to move weather capabilities in the National Airspace System from current state to meet NextGen objectives. The program funds analyses and studies that will assist in developing and validating requirements, defining the boundaries, contents, policies, participants and governance for the 4-Dimensional Weather Data Cube, develop and implement metrics for avoiding weather-induced delays and to better predict those delays and to identify research needed to increase capacity.

Research Goals:

- By 2010, complete safety studies for new aviation weather information products including de-icing/anti-icing (liquid water equivalent), WAFS icing, turbulence, and convection, NCV, and FIP-Severity
- By 2010, develop the WAFS Global 4-D Weather data set to support flight planning
- By 2011, develop functional and performance requirements for space weather information and space weather impacts
- By 2013, align ICAO SARPS with US current and NextGen weather standards

Customer/Stakeholder Involvement:

- External FAA users include pilots, dispatchers, airline operations centers, airport operators, and aviation meteorologists, all of whom are represented by entities that include ATA, NBAA, AOPA, ALPA, APA, RAA, SAMA, GAMA, IATA as well as individual airlines and others (see attached acronym list for clarification of unfamiliar acronyms);
- Internal FAA Service units representing controllers service providers in Terminal, En route/Oceanic, Flight Service, Systems Operations, Operations Planning, and Technical Operations Services;
- FAA Regulatory arm (aircraft certification and flight standards personnel);
- The Joint Program Development Office (JPDO);

- The weather and satellite services in the Department of Commerce, National Oceanic and Atmospheric Administration;
- ICAO and the World Meteorological Organization;
- The Office of the Federal Coordinator for Meteorology; and
- The National Aeronautics and Space Administration.

R&D Partnerships:
FAA's Air Traffic Organization, NextGen and Operations Planning, Aviation Weather Group, Weather Planning and Requirements Team partners with the Agency's Aviation Weather Research program, other Air Traffic Organization offices, Flight Standards, Aircraft Certification, and NWS offices as a part of the safety management system process. The office partners with Flight Standards and NWS personnel on a full range of aviation weather development activities. In the international arena, the office closely partners with ICAO and its contracting members.

Accomplishments:
The following summarizes major accomplishments to date:

- Developed various Concept and Requirements Definition (CRD) for weather.
- Developed JPDO Integration Plan which identifies the interface of weather information and decision support systems
- Continued to transition the research to operations process; develop G-AIRMET training requirements and changes to documents/orders.
- Conducted preliminary hazards assessment (PHA) for G-AIRMET and for LWE(de/anti-icing)
- Continued work to harmonize international and US standards and requirements to include plans for aligning ICAO SARPS/Guidance with NextGen/SESAR requirements; agree upon a WXXM standard; and develop requirements for World Area Forecast Services (WAFS).
- Continued to support a variety of research requirements to include service standards; turbulence EDR demonstration; QICP program; anti-icing improvements.
- Developed a reliable technique to measure avoidable weather delays as subset of overall weather delays.
- Developed and obtained agreement that defines a common weather exchange model for use by JPDO agencies, EUROCONTROL and ultimately becomes an ICAO standard.
- Updated aviation weather roadmap to integrate NextGen weather concepts
- Defined Single Authoritative Source of weather information for NextGen Air Traffic Management.
- Completed Operational Suitability and Environmental Description (OSED) for Weather and Aeronautical Information Data Link via joint RTCA/EUROCAE special committee.
- Prepared Reduce Weather Impact (RWI) *NGIP* Solution Set.
- Revised FAA NextGen Aviation Weather Strategic Plan (FY2008-2025)
- Initiated NextGen Weather Evaluation Capability Plan.
- Completed technology transfer into NAS operations of several new R&D products.
- Transferred other products into the final R&D phase.
- Conducted a safety risk assessment process for R&D products before being implemented on Government platforms.
- Represented U.S. aviation interests at ICAO to minimize operating costs for U.S. carriers.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop and coordinate functional and performance requirements for space weather information
- Complete safety analysis and develop SRM documents for G-AIRMET
- Complete safety analysis and develop SRM documents for LWE (ground de-icing/anti-icing)
- Complete safety analysis and develop SRM documents for WAFS icing, turbulence, and convection information
- Complete NCV safety analysis and develop SRM documents
- Complete FIP-Severity safety analysis and develop SRM documents
- Review, coordinate, and prepare updates to the ATO International Strategy and Work Plan

- Review, coordinate, and prepare updates to the US Work Plan for ICAO SARP implementation related to the NextGen 4-D Weather Data Cube
- Indentify and coordinate procedural changes for FAA Service Units and NWS necessary to comply with ICAO Annex 3 Amendment 75
- Develop safety risk management documentation for US/ICAO Annex 3 differences that affirm current US practices or lead to adoption of ICAO standards
- Complete gap analysis between 4-D Weather Functional Analysis and ICAO SARPS and map to each element of the 4-D Wx Data Cube at IOC to the appropriate chapter of ICAO Annex 3
- Develop a long-range plan for the inclusion of each evolutionary change of the 4-D Wx Data Cube in amendments to ICAO Annex 3 or an ICAO Manual
- Develop and coordinate the implementation of QMS for US-produced aviation weather information
- Develop and implement safety risk assessment process for new WAFS forecast products
- Develop a plan to implement finer resolution WAFS data sets fore region-specific areas (e.g., US and Europe)
- Coordinate the implementation of WAFS File Service (WIFS)
- Lead the development of the WAFS Global 4-D gridded data set to support flight planning
- Align NextGen with SESAR weather requirements and propose a joint package to ICAO to upgrade Annex 3 weather SARPS.
- Gather, verify, and process service standards data
- Review and publish service standards report
- Manage QICP process and complete QICP authorization for NWS

FY 2011 PROGRAM REQUEST:

The funding will continue to support contract services that allow the Aviation Weather Group to prepare for the future increased demand for aviation weather services. Specifically, the funding will enable the completion of space weather information requirements and safety studies for aviation weather information as part of the FAA Safety Management System process, as well as harmonization of US current and NextGen aviation weather standards with SESAR and ICAO SARPS/guidance.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Complete space weather information functional and performance requirements
- Promote terminal weather information modernization and incorporate NextGen terminal weather information standards into ICAO Annex 3
- Align NextGen with SESAR weather requirements and propose a joint package to ICAO to upgrade Annex 3 weather SARPS.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	13,978
FY 2010 Enacted	1,000
FY 2011 Request	1,000
Out-Year Planning Levels (FY 2012-2015)	11,100
Total	27,078

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NAS Weather Requirements	800	1,000	1,000	1,000	1,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**800**	**1,000**	**1,000**	**1,000**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	800	1,000	1,000	1,000	1,000
Total	**800**	**1,000**	**1,000**	**1,000**	**1,000**

1A01D - NAS Weather Requirements Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
NAS Requirements (Office of Weather Policy and Standards, NAS Weather Office, ATO-P)	**1,000**						
Aviation Weather Requirements Development							
Develop space weather functional and performance requirements		◆	◊				
Weather Policy Studies							
Develop service standards report.		◆	◊	◊	◊	◊	◊
Manage QICP approval process.		◆	◊	◊	◊	◊	◊
Complete NowGen weather support projects		◆	◊	◊			
Safety Studies							
Complete G-AIRMET Safety Assessment		◆					
Complete Anti/De-Icing Safety Study		◆					
Complete WAFS Icing, Turbulence, Convection Safety Study		◆					
Complete NCV Safety Study		◆					
Complete FIP-Severity Safety Study		◆					
International Standards							
Lead global alignment of ICAO SARPs with US current and NextGen weather standards.		◆	◊	◊	◊	◊	◊
Develop of the WAFS (Global 4-D Weather) in support of flight planning..		◆	◊				
Promote terminal weather modernization strategy and incorporate NextGen in ICAO Annex 3 for terminal weather (including observations and forecasts).		◆	◊	◊	◊	◊	◊
Provide support for space weather, radioactive (RA) SIGMET, and Volcanic Ash through the IAVWOPSG		◆	◊				
Support the METWSG and Regionalized SIGMET Advisory Centers concept and development		◆	◊				
Total Budget Authority	**1,000**	**1,000**	**1,000**	**1,000**	**3,300**	**3,400**	**3,400**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01E**	**Airspace Management Program**	**$1,000,000**

GOALS:
The program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

FAA Air Traffic Control Facilities Cited in this program description:

DFW	Dallas Ft. Worth International Airport	ZHU	Houston Air Route Traffic Control Center
HAATS	Houston Area Air Traffic System	ZJX	Jacksonville Air Route Traffic Control Center
IAH	George Bush Intercontinental Airport; Houston, Texas	ZKC	Kansas City Air Route Traffic Control Center
LAS	McCarran International Airport; Las Vegas, Nevada	ZLA	Los Angeles Air Route Traffic Control Center
NCT	Northern California Terminal Radar Approach Control	ZMA	Miami Air Route Traffic Control Center
PHX	Sky Harbor International Airport; Phoenix, Arizona	ZME	Memphis Air Route Traffic Control Center
ZAB	Albuquerque Air Route Traffic Control Center	ZOA	Oakland Air Route Traffic Control Center

Intended Outcomes: The Airspace Management Program (formerly National Airspace Redesign) directly supports all four objects of the "Greater Capacity" goal of the FAA's Flight Plan 2006-2010. Airspace redesign accomplished through the Airspace Management Program will create a modern and effectively managed national airspace redesign that:

- Increases system capacity and efficiency by removing as many airspace constraints as possible;
- Manages complexity and congestion without continuously increasing sector splitting and growth in the number of sectors;
- Increases flexibility and predictability for the benefit of air traffic controllers and aviation system users;
- Balances the access needs of the diverse set of aviation system users;
- Maintains the highest levels of system safety and security; and
- Reduces expected delays and inefficient routing over the next ten years in major metropolitan areas.

Agency Outputs: The Airspace Management Program serves as the FAA's primary effort to modernize the nation's airspace. The purpose of this national initiative is to review, redesign and restructure airspace. The program includes:

- Regional Optimization and Redesign projects involve airspace changes that are targeted at local problem, but can have larger system-wide impacts. These projects can be smaller in scale, utilizing available resources, or can be larger in scale, encompassing multiple facilities that cross several Service Areas or FAA Regions.
- National High Altitude and Oceanic Redesign are national level efforts that apply state-of-art design techniques in systematic way. These projects specifically leverage national automation and procedural enhancements. High Altitude Airspace Management has been a mechanism for influencing future infrastructure system requirements and the introduction of advanced concepts into airspace design. Oceanic Redesign capitalizes on the oceanic infrastructure and automation improvements across all oceanic and offshore facilities.

Customer/Stakeholder Involvement: The Airspace Management Program utilizes both formal and informal methods to solicit and include customer/stakeholder perspectives. Since the inception of FAA's national focus on airspace redesign, the program has worked with RTCA to communicate plans and receive appropriate feedback from the aviation customer community. Since 2001, the Airspace Working Group has been the main body to aid in understanding the operational views and perspectives of the diverse airspace customers and stakeholders. Airspace Working Group members represent major carriers, regional carriers, general and business aviation, and the military. Regarding environmental concerns, the Airspace Management Program communicates with communities through various forums and processes as prescribed by the National Environmental Policy Act.

Accomplishments: Through the Airspace Management Program (and its predecessor, National Airspace Redesign), the FAA has implemented many airspace changes that have resulted in significant operational improvements. These accomplishments include:

- NY/NJ/PHL Metropolitan Area Airspace Redesign (initial phases).
- Chicago Airspace Project (additional airspace changes for new runway).
- HAATS Airspace.
- Southern California Redesign (environmental analysis initiated)
- Western Corridor Airspace (including Southern Nevada Airspace)
- Airspace for new runways in Seattle and Washington DC metro areas
- NY/NJ/PHL Metropolitan Airspace Redesign – initial implementation of elements of Stage 1, including dispersal headings for departures at Newark, Kennedy, and Philadelphia
- Houston Area Air Traffic System (HAATS) Airspace – completion of Environmental Assessment, including public meetings, implementation of HAATS Phase 3A
- Chicago Airspace Project – implementation of departure portion of CAP Stage 2, including new southbound departure routes
- Northern California Redesign (ZOA) – completion of sectorization for Three Tier Redesign
- Las Vegas Redesign & Phoenix/Northwest 2000 – redesigned terminal/en route airspace and random navigation/area navigation (RNAV) procedures.
- Honolulu Redesign – improved departure coordination procedures for flights; reduced departure times.
- Great Lakes Integrated Design Plan – implemented new routes and improved procedures; reduced delays and restrictions.
- Choke Points – implemented new sectors and route changes; reduced delays, miles in trail, and other restrictions.
- High Altitude Redesign Phase 1 Initial – improved information about Special Use Airspace (SUA) availability and usage, implemented waypoints to circumnavigate SUA supporting improved flight planning information; reduced flying distance around SUA.
- Oakland Oceanic Gateway – created new oceanic route access points; allowed Pacific bound aircraft to achieve desired altitudes quicker, saving fuel and time.
- Denver South – created new routings for Denver satellite airports; reduced complexity.
- Anchorage Center Redesign – created an oceanic specialty, added a new sector, and revised other sector boundaries; improved controller workload balance.
- ZHU/ZMA/ZJX Boundary Realignment – revised the boundaries that divide control of Gulf airspace; improved safety for Gulf flights.
- High Altitude Redesign Phase 1 – instituted non-restrictive routing, Navigational Reference System, and Q-Routes.
- Denver Redesign – developed Ski Country procedures; better-managed delays and demand at key airports.
- NY/NJ/PHL Redesign – instituted "Dual Modena" departure routes; increased departure throughput, reduced departure restrictions, and reduced taxi-out delays.
- Atlantic Oceanic Redesign – instituted Coded Caribbean Routes; reduced coordination and communication errors, increased use of shorter distance access routes, and saved 11-35 miles for flights from Philadelphia and Boston to the Caribbean.
- ZME 5th Area Redesign and ZKC East End – realigned sectors; balanced workload and reduce complexity.
- HAATS Airspace and DFW RNAV – instituted new RNAV departures for DFW; tripled arrivals for IAH and expected to increase throughput.
- LAS Redesign – re-instituted RNAV procedures; reduced flight distances.
- Bay to Basin Redesign and ZAB Redesign – instituted new sectors in ZLA and ZAB; reduced restrictions upon LAS and PHX.
- Southern CA Redesign (LAX Departure Optimization) – instituted new departure routes; allowed for more fuel efficient departures and reduced the number of leveled-off departures by over 70 percent.
- Northern California Terminal Airspace Redesign – realigned airspace between NCT and ZOA; reduced FAA operational costs and reduced flight distances for customers.

- Florida Airspace Optimization – added new sectors and routes; reduced delays and restrictions in the busy east coast corridor.
- Central California Terminal Airspace – realigned en route airspace from Los Angeles center to Santa Barbara TRACON, providing enhanced service to general aviation customers in central California.
- Southern CA Redesign (LAX Arrival Optimization) – instituted new arrival routes; allowed for more fuel efficient arrival altitudes into LAX.
- High Altitude redesign Expansion Q-Routes – implemented remaining RNAV Q-routes for the southwest and southeast, expanding number of routes available to customers.
- Airspace for New Runways – implement airspace changes to support new runways, specifically Minneapolis, Cincinnati, St. Louis, Atlanta, adding new capacity and efficiency to the system.
- Midwest Airspace Enhancement – large scale redesign of terminal and en route airspace to reduce complexity in the busy Great Lakes Corridor and to leverage previous runways built in Cleveland and Detroit.
- Northern California Airspace Redesign (Dual Arrival Routes and Sector 33 Split) – en route airspace was realigned to add a new sector and to support improvements in arrival throughput at the Bay area airports.
- NY/NJ/PHL Metropolitan Area Airspace Redesign – published Final Environmental Impact Statement (FEIS) in August 2007 and signed Record of Decision (ROD) in September 2007
- Chicago Airspace Project – completed Stage 1, with new eastbound departure routes and supporting sectorization and airspace realignment changes

R&D Partnerships: The Airspace Management Program works closely with the FAA's Federally Funded Research and Development Center, MITRE's Center for Advanced Aviation Development (CAASD). MITRE-CAASD's work includes investigating, innovating, and developing modeling, simulation, and analysis capabilities facilitating airspace design. MITRE-CAASD will also research and explore issues that influence strategic policy in airspace management and design, such as sectorization concepts.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Infrastructure changes resulting from the airspace redesign supporting the Chicago and New York/Philadelphia metropolitan
- Infrastructure changes resulting from the airspace redesign supporting the Western Corridor project
- Infrastructure changes resulting from the airspace redesign supporting the High Altitude Airspace Management project
- Engineering analyses of operational feasibility of airspace concepts supporting transition to NextGen

FY 2011 PROGRAM REQUEST:
The airspace redesign projects supported by these requested funds are projected to deliver as much as $121 million of direct operating cost benefits by 2015. These benefits are realized through the reduction of restrictions, shorter flight distances, more fuel efficient routes, and reduced delays. The most significant benefits will be in the key metropolitan areas. Airspace redesign in New York and Philadelphia metropolitan areas will reduce delays by 20 percent in the next 10 years; based on today's flight statistics. In Chicago, airspace redesign will ensure return on the runway investments. With airspace changes and the new runway, delays can be reduced by as much as 60 percent. Airspace redesign will also provide internal FAA benefits. Without airspace redesign, sector splitting and growth in the number of sectors will be the only methods to manage complexity and congestion, increasing operations costs by millions every year. Reducing the number of sectors in the HAAM program through standardization and reallocation of airspace boundaries could provide a minimum of $20 million of annual FAA cost savings

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Infrastructure changes resulting from the airspace redesign supporting the New York/Philadelphia metropolitan phase II
- Conduct initial design and modeling for the Western Corridor project
- Develop plans for Denver Airspace
- Infrastructure changes resulting from the airspace redesign supporting the Chicago phase III
- Engineering analyses of operational feasibility of airspace concepts supporting transition to NextGen

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	10,800
FY 2010 Enacted	3,000
FY 2011 Request	1,000
Out-Year Planning Levels (FY 2012-2015)	20,000
Total	34,800

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airspace Management Program	2,800	5,000	3,000	3,000	1,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**2,800**	**5,000**	**3,000**	**3,000**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	2,800	5,000	3,000	3,000	1,000
Total	**2,800**	**5,000**	**3,000**	**3,000**	**1,000**

1A01E - Airspace Management Program Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airspace Design							
Equipment and other F&E expenditures to support Airspace Management Program projects	**1,000**						
Develop/Initiate regional optimization and redesign		◆	◊	◊	◊	◊	
Develop/Initiate high altitude and oceanic redesign		◆	◊	◊	◊	◊	
Total Budget Authority	**1,000**	**3,000**	**1,000**	**5,000**	**5,000**	**5,000**	**5,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08A**	**NextGen – Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	**$10,000,000**

GOALS:
The programs support the following *Flight Plan* goals: Increased Safety, Greater Capacity, and Organizational Excellence.

Intended Outcomes: By 2015, demonstrate improvements in air traffic controller efficiency (e.g., greater number of aircraft, fewer delays) and effectiveness (e.g., fewer operational errors) through the automation and standardization of operations, procedures, and information.

This program for NextGen Human System Integration (HSI) in system development will examine the roles of the various actors in the NAS including controllers, pilots, dispatchers, and maintainers to ensure safe operations at increased capacity levels and how those roles are best supported by allocation of functions between human operators and automation. The technologies being introduced by the NextGen Enterprise Architecture indicate the roles and responsibilities of controllers may change significantly if there is increased reliance on automation for conflict monitoring and if separation functions migrate to the aircraft flight deck. This program will support further development of systems in the Enterprise Architecture and the *NextGen Implementation Plan* (*NGIP*) solution sets by addressing human-system integration and human performance issues. The approach in this program is to use Human System Integration as a mechanism to bring cohesiveness to all the human-centered domains that bear on the people in the NAS. Some examples of the domains and major HSI issues are:

Human Factors Engineering:

- Deciding the appropriate role of the controller and aircraft operator relative to the automation when trajectory based operations are routinely used in the en route cruise regime.
- Develop integrated workstations that enable the delivery of services throughout the NAS using the technology being introduced in the Enterprise Architecture and NGIP.
- Ensuring that there is unambiguous transfer of separation responsibility between ground and flight deck elements of the system as aircraft make the transition between different types of airspace.
- Effectively using automation to aid the controller in conformance monitoring during trajectory based operations
- Providing the characteristics of usable merging and spacing tools in high density airspace to increase capacity and reduce environmental impact.
- Making appropriate use of automation to aid the controller in airspace segments where there are variable separation criteria.
- Avoiding the design of automated systems that are "brittle" and leave the controller and other actors in the NAS with inadequate clues regarding automation failures.

Human Error/Human Performance in NAS Safety:

- Preparing for degraded system modes so that safety can be maintained under emergency and off-normal conditions.
- Enhancing the response of the NAS to weather disruptions using collaborative air traffic management techniques to accommodate operator preferences.
- Managing safety risk associated with human errors as human operators interact in new or novel ways with automation that alters traditional relationship between actors in the air traffic system and between those actors and various automated system elements.

Personnel Selection:

- Predicting how the job of the controller will change in the NextGen environment and modifying the controller selection criteria and process to match the needs of the new job

Training:

- Ensuring that training needs for the NextGen controllers and maintainers are identified to prevent skill degradation in an automated NextGen environment
- Identifying new skills, knowledge, and abilities that will be needed by controllers and maintainers in the NextGen time frame

A systems approach to air-ground integration needs to address how to transition from current operations to new concepts taking into account changes in responsibilities and liabilities. This program is closely linked to the NextGen Self Separation and NextGen Air Ground Integration human factors research programs. Interoperability of air and ground decision support tools necessitates synchronization of conflict probe look-ahead times, 4-D intent information, and alerting functions for Cockpit Display of Traffic Information (CDTI) to enable the efficient and effective use of NextGen capabilities that rely on coordinated activities. Pilots and controllers need a shared understanding of how procedures change during transitions across different types of airspace (e.g., from a delegated separation regime to shared separation to traditional ground-based separation environments).

Agency Outputs: The Air Traffic Control/Technical Operations Human Factors Research Program provides leadership and products to motivate the evolution of the NAS to assure that the human component of the system will reliably perform to meet the needs of the flying public. Outputs include:

- Design concepts for en route, terminal and tower workstations for increasing the efficiency and effectiveness of the workforce.
- Develop human factors requirements for decision support tools, conformance monitors, advanced automation technologies and associated procedures.
- Investigate human-in-the-loop performance level or safety benefit associated with specific technologies and concepts to determine the contribution to efficiency, safety risks, and workload costs.
- Demonstrate a framework for using part task simulations, high fidelity simulations, and integrated full mission demonstrations to assess interoperability of air and ground systems
- Accelerate the development of training and selection procedures to transform the workforce into a new generation of service providers who can manage traffic flows in a highly automated system.

Research Goals:

- By 2010, Determine preliminary efficiency improvements when controllers use selected NextGen decision support tools and automation.
- By 2010, Explore the use of NextGen tools such as data communications, ADS-B, RNAV/RNP and improved conflict resolution tools to reduce controller workload in the terminal area including data entry requirements and workload benefits.
- By 2010, Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area
- By 2013, define the new role for the controller that is more strategic in nature in the en route and terminal domains.
- By 2013, demonstrate common situation awareness between flight operators and controllers to enable collaborative air traffic management.
- By 2013, define procedural requirements for controllers to manage and introduce change into the four dimensional (position plus time) dynamic environment.

Customer/Stakeholder Involvement: The ATC/TO Human Factors research program coordinates research priorities with its internal FAA sponsoring organizations and the JPDO.

- *Advanced Air Traffic Systems Requirements Group* – operational personnel and systems developers from the En Route and Terminal Service units as well as System Engineering in Operations Planning coordinates NextGen research requirements for measuring human factors benefits and impacts of proposed technologies to controllers, traffic management specialists, and maintainers.
- *Individual and Team Performance Requirements Group* – The Safety, En Route, Terminal, System Operations, Technical Operations and System Engineering functions participate to identify human performance research needs involving safety culture, human error hazard identification, age, operational errors, runway incursion prevention, and employee attitudes. The Safety Integrated Product Team of the JPDO participated in this requirements group.
- *Technical Operations Research Group* – The Technical Operations, En Route, and Terminal service areas recommend research for operation and maintenance of the NAS infrastructure including specification of displays, controls, and maintainability features of ATC systems.

- *Personnel Selection Research Group* – Human Resources, Workforce Services, Workforce Development, and the financial services groups address personnel selection and retention including the ability to successfully screen applicants for controller positions, and the need to reduce training cost and time.

R&D Partnerships:

- Collaborative research with NASA on its aerospace systems and air portal projects includes the identification of human factors research issues in the NextGen as technology brings changes to air traffic management.
- Collaboration with EUROCONTROL includes participation in semi-annual Air Traffic Management (ATM) Seminars and participation in ATM Safety Research symposiums.
- Program personnel represent the agency in the Normal Operations Safety Survey Study Group of the International Civil Aviation Organization.
- Grants will be used with universities to address NextGen human factors issues.

Accomplishments:

FY 2009:

Initiate Trajectory Based Operations

- Defined a preliminary set of roles and responsibilities for the actors in the NextGen NAS when interacting with anticipated automated functions to achieve the expected performance levels.
- Conducted a high fidelity TRACON simulation to assess efficiency from integrating NextGen concepts, capabilities, and procedures.

Increase Arrivals/Departures at High Density Airports

- Defined controller information requirements for merging and spacing operations in the terminal area.
- Assessed types and modes of human error in operations for merging and spacing.

Increase Flexibility in the Terminal Environment

- Assessed controller workload benefits from data communications for mixed equipage aircraft in the terminal area.

Improve Collaborative Air Traffic Management

- Developed initial collaborative ATM requirements, ensuring information and communication flows support common situation awareness for controllers, pilots, and dispatchers in the future NAS.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Initiate Trajectory Based Operations

- Define a preliminary set of roles and responsibilities for the actors in the NextGen NAS when interacting with anticipated automated functions to achieve the expected performance levels.
- Conduct analyses to assess efficiency from integrating NextGen concepts, capabilities, and procedures.

Increase Arrivals/Departures at High Density Airports

- Define controller information requirements for merging and spacing operations and continuous descent approach in the terminal area.
- Assess system performance requirements to recover from controller data entry errors.
- Assess types and modes of human error in operations for data communications.

Increase Flexibility in the Terminal Environment

- Assess controller workload benefits from data communications for mixed equipage aircraft in the terminal area.
- Deliver results of initial simulations to assess the benefits of automation in TRACON workstations

Improve Collaborative Air Traffic Management

- Develop initial collaborative ATM human factors requirements, ensuring information and communication flows support common situation awareness for controllers, pilots, and dispatchers in the future NAS.

Cross-concept Human Factors Issues

- Define initial stability and reliability requirements for decision support tools and automation to assure that they help the service provider achieve the expected benefits.

- Deliver results of simulations of conformance monitors in terms of feedback, false alerts, and other human factors characteristics to achieve the goal of the operation.
- Define threshold values of false alarms and other human factors characteristics that affect trust and usability of the tool.
- Build an initial "human performance budget" to determine the contribution of various NextGen concepts to capacity and safety.
- Perform analyses of the potential for human error using proactive human error analyses and modeling as changes to automation are considered.
- Perform analyses of selected off-normal and emergency conditions for NextGen concepts to assure that system design and personnel skills can maintain safety in the NAS under degraded modes.

FY 2011 PROGRAM REQUEST:

The program will accelerate and expand research addressing human performance issues in NextGen concepts.

Initiate Trajectory Based Operations (TBO)

- Defining concepts, decision support tools, and procedures for integrating TBO capabilities into controller workstations to ensure improvements in controller efficiency.
- Evaluating midterm workstation enhancements to ensure benefits intended from integration of data communications and NextGen operational concepts (e.g., variable separation criteria, merging and spacing, and continuous descent approach) are realized.

Increase Arrivals/Departures at High Density Airports

- Determine information requirements necessary to manage advanced operations such as merging, spacing, and passing in en route airspace.
- Assessing the potential for human error in human-automation interaction and developing guidance supporting error tolerance and recovery.
- Identifying the potential human error modes when various actors in the NextGen system communicate and carry out new roles and responsibilities.

Increase Flexibility in the Terminal Environment

- Determine how to integrate traffic flow management information into the terminal service provider workstation.
- Develop methods to display aircraft equipage differences to service providers in the terminal environment to enable the appropriate level of service.
- Develop integrated tower workstations that enable the provision of airport traffic services using the NextGen suite of technology.

Improve Collaborative Air Traffic Management (CATM)

- Perform human factors analyses of the CATM concept to determine the optimum communications and decision paths for negotiating access to NAS resources and stating preferences.

Reduce Weather Impact

- Specify the human factors characteristics of decision support tools that will be used in strategic and tactical decision making by members of the air traffic community when adverse weather has an impact on NAS capacity or safety of flight.

Cross-concept Human Factors Issues

- Define human factors characteristics of decision support tools in terms of stability and reliability to assure that they help the service provider achieve the expected benefits.
- Find the set of proposed changes in NextGen that provide the greatest human performance return on investment.
- Prepare for operations in off-normal and emergency conditions to assure that system concepts and personnel skills can maintain safety in the NAS.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Completion of the Air Traffic Controller Strategic Job Analysis to determine how the job of the controller will change in the NextGen environment and how it will impact personnel selection

- Completion of the first stage of a Common Air Traffic Control Workstation to address the convergence of en route and terminal services that can be provided from a tailored workstation
- Demonstration of an initial integrated en route workstation applicable to mid-term ERAM implementation
- Demonstration of an initial integrated tower workstation applicable to a variety of airport sizes and traffic levels.
- Demonstration of an initial TRACON workstation integrating automation to allow the terminal controller to operate on a more strategic level.
- Delivery of a Human Factors/Safety analysis to identify hazards and mitigations for human performance and human error in the NextGen environment

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	6,700
FY 2010 Enacted	10,000
FY 2011 Request	10,000
Out-Year Planning Levels (FY 2012-2015)	40,000
Total	66,700

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integrstion)	0	0	6,700	10,000	10,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**6,700**	**10,000**	**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	6,700	10,000	10,000
Total	**0**	**0**	**6,700**	**10,000**	**10,000**

1A08A – Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	**10,000**						
Trajectory Based Operations	**1,500**	◆	◊	◊	◊	◊	◊
High Density Airports	**2,000**	◆	◊	◊	◊	◊	◊
Flexibility in the Terminal Environment	**2,000**	◆	◊	◊	◊	◊	◊
Collaborative Air Traffic Management	**1,000**	◆	◊	◊	◊	◊	◊
Reduce Weather Impact	**500**	◆	◊	◊	◊	◊	◊
Cross-concept Human Factors	**3,000**	◆	◊	◊	◊	◊	◊
Total Budget Authority	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS. IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08B**	**NextGen - New Air Traffic Management Requirement**	**$23,000,000**

GOALS:

This program supports the Flight Plan goal for Greater Capacity

Intended Outcomes: The NextGen – New Air Traffic Management (ATM) Requirement program addresses the FAA's goal for capacity and the DOT Reduced Congestion Strategic Objective to "Advance accessible, efficient, inter-modal transportation for the movement of people and goods." It also supports the FAA's National Aviation Research Plan goal for "Fast, Flexible and Efficient" which supports development of a system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs. It fits within the Air Traffic Organization's pathway 4, "Ensure Viable Future" which has the goal to assure a sustainable and affordable Air Transportation System for the future. Furthermore, this program fits the NextGen goal of expanding capacity by satisfying future growth in demand (up to three times capacity) as well as reducing transit time.

The program will include research and development for new procedures and technologies both on the ground and in the air to increase efficiency of the NAS. Program outcomes include procedures, technologies, and tools to support trajectory-based operations in transitional airspace, such as between oceanic and domestic en route, as well as all airspace to outer markers (approach and departure).

Agency Outputs: The program will address several of the NextGen solution sets while aligning with the FAA Enterprise Architecture and will concentrate on final research and development activities to prepare capabilities to be transitioned into the NAS. These solution sets include the following: Trajectory Based Operations; High Density Arrivals/Departures and Airports; Flexible Terminal and Airports; Collaborative Air Traffic Management; and Networked Facilities. Research activities may contribute to more than one of these solution sets. Where appropriate, activities will be coordinated with MITRE and/or NASA to complete any required final research and development to transition their products into the NAS. Also as appropriate, these activities move into final development and implementation upon successful completion of Joint Resource Council 2-B level decisions.

Research Goals:

Trajectory Based Operations

Enable strategic planning and execution of flight trajectories throughout the airspace for equipped aircraft. This will require performance-based separation management, performance-based trajectory management operations and decision support tools, flight object information exchange, and airspace support.

- By 2013, develop requirements for development, negotiations and exchange standards trajectories
- By 2014, determine conflict resolution approaches using aircraft intent data
- By 2014, develop approaches for implementing flexible airspace management

High Density Arrivals/Departures and Airports

Using trajectory-based terminal operations and flow management, reduce spacing between aircraft. This will require implementation of high density corridors with reduced separation matching aircraft in transition to airport arrival capacity, enhanced surface technologies, parallel runway operations with reduced lateral separation, digital taxi clearance and conformance, expansion of terminal separation procedures throughout arrival and departure airspace. Higher performance navigation and communication capabilities will be necessary.

- By 2011, determine requirements for TCAS "8.0" to continue to provide effective collision risk safety net in an environment of closely space parallel RNP route form top-of-descent to the runway approaches for parallel runway operations with spacing down to 750 feet
- By 2013, develop concepts for surface traffic management with conformance monitoring

Flexible Terminal and Airports

Dynamically manage airspace and surface operations with appropriately equipped aircraft, as opposed to the static way of managing airspace today, to provide greater capacity, efficiency, and safety. Will be applicable to lower density terminal areas and either trajectory-based or classic operations can be conducted. This dynamic

management will require changes to procedures for low or zero visibility conditions, as well as, related decision support tools for both air and ground applications.

- By 2011, conduct tradeoff studies to determine approaches to future air-ground and ground-ground data communications requirements implementing flexible terminal management
- By 2014, determine mixed equipage trajectory-based routes for RNAV/RNP and continuous descent (CDA) operations

Collaborative Air Traffic Management
Optimize capacity to balance demand by strategic and tactical interactions with air traffic managers and flight operators. Requires shared data communication among pilots, dispatchers, and controllers and decision support tools for both air and ground applications. This includes developing a software assurance standard for integrating the air ground applications safely.

- By 2012, develop software assurance standard for integration of air and ground decision support systems
- By 2013, test initial concepts in partial collaborative decision making application
- By 2014, determine weather and performance requirements for decision support tools integration.

Customer/Stakeholder Involvement: The program addresses the needs of the FAA Air Traffic Organization (ATO) and works with the FAA Aviation Safety organization to ensure new procedures and solutions are safe and that the airports and air routes targeted for their implementation are those with critical needs to reduce air traffic delays and air route congestion thus providing more capacity. The program works with controllers, airlines, and pilots to include user recommendations and ensure that training and implementation issues are addressed in the program's research from the start.

Customers:

- Pilots
- Air navigation service provider personnel
- Air carrier operations
- Airport operations

Stakeholders:

- Joint Planning and Development Office
- Commercial pilot unions
- FAA air navigation service provider unions
- Other ICAO air navigation service providers
- Avionics and Aircraft manufacturers

R&D Partnerships: In addition to maintaining its partnership with FAA's Aviation Safety organization, this research program will accomplish its work via working relationships with industry, academia, and other government agencies. The coordination and tasking are accomplished through joint planning/reviews, contracts and interagency agreements with the program's potential partners:

- Volpe National Transportation Center
- MITRE/Center for Advanced Aviation and Systems Development (CAASD)
- NASA Ames, Glenn, and Langley Research Centers
- EUROCONTROL and associated research organizations

Accomplishments:
FY 2010:

Trajectory Based Operations

- Investigated compatibility of prototyped L-Band components with existing systems in the L-band particularly with regard to the onboard co-site interference and agree on the overall design characteristics; and
- Considered the design trade-offs and proposed the appropriate L-Band solution for input to a global aeronautical standardization activity.
- Analyzed common trajectory requirements and implementation strategy – identified trajectory differences, evaluated need and fidelity and proposed exchange standards

High Density Arrivals/Departures and Airports

- Determined TCAS effectiveness in the NextGen environment and define requirements for improved performance

Flexible Terminal and Airports

- Identified the portions of the IEEE 802.16e C-band standard best suited for airport surface wireless mobile communications and propose an aviation specific standard to appropriate standardization bodies;
- Evaluated and validated the performance of the aviation specific standard to support wireless mobile communications networks operating in the relevant airport surface environments through trials and testbed development; and
- Developed a channelization methodology for allocation of safety and regularity of flight services in the band to accommodate a range of airport classes, configurations and operational requirements.

Collaborative Air Traffic Management

- Conducted analysis of approaches/methodologies for software assurance of complex air-ground systems.
- Initiated development of a coordinated airborne and ground software assurance standard to support Air-Ground operational integrity.
- Analyzed of airborne SWIM – identified information distribution requirements for non-command and control information, evaluate alternative design and architecture, propose standard.

FY 2011 PROGRAM REQUEST:

In FY 2011, the FAA must begin developing the capabilities needed to make required capabilities supportive of NextGen solution sets. These capabilities are highly dependent on technologies that accurately predict the location and intent of aircraft and provide this information to other pilots and controllers. Some of the aspects of the NextGen Concept of Operations depend upon the aircraft as a participant in efficient, safe air traffic management. These capabilities also rely on procedures that keep traffic flowing smoothly in all weather and visibility conditions. The NextGen research initiative will result in enhanced methods of determining safe separation while optimizing capacity, for all flight regimes and all aircraft.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

TCAS 8.0

- Analysis, requirements, pseudo-code- supports provide effective collision risk safety net in an environment of closely spaced parallel RNP route from top-of-descent to the runway

L-Band Communications Standard

- Complete evaluation in relevant environments through trials and testbed development; and
- Propose the appropriate L-Band solution for input to a global aeronautical standardization activity

C-Band Standard

- Goal IEEE 802.16e C-Band standard best suited for airport surface wireless mobile communications
- Conduct evaluation of an aviation specific standard to support wireless "mobile" communications in relevant airport surface environments
- Develop a channelisation methodology for allocation of safety and regularity of flight services in the band to accommodate a range of airport classes, configurations and operational requirements.

Common Trajectory Requirements and Implementation Strategy

- Identify Trajectory Differences
- Evaluate Need and Fidelity
- Propose Standard for Exchange
- Analyze System changes and Allocations

Mid-term Advances in Tactical Flow

- Integration of EDA advances into ATM (allocation to ERAM & TMA)

RNAV/RNP via Data Communications

- Delivery across data communications-requirements
- "On the fly" development, evaluation and delivery

Airborne SWIM

- Identify information distribution requirements for non-command and control information

- Evaluate alternatives
- Propose standard (if required)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	5,400
FY 2010 Enacted	13,200
FY 2011 Request	23,000
Out-Year Planning Levels (FY 2012-2015)	165,200
Total	206,800

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts	0	0	0	0	
New Air Traffic Management Requirement			5,400	13,200	23,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**5,400**	**13,200**	**23,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	5,400	13,200	23,000
Total	**0**	**0**	**5,400**	**13,200**	**23,000**

1A08B – New Air Traffic Management Requirement Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
New ATM Requirement	**23,000**						
Trajectory Based Operations							
Continue to develop approaches for implementing flexible airspace management		◆	◊	◊	◊	◊	
Continue to develop requirements for interactive flight planning		◆	◊	◊	◊	◊	
Analysis of conflict resolution approaches using aircraft intent data			◊	◊	◊	◊	
Common Trajectory Requirements simulation and modeling		◆	◊	◊	◊	◊	
High Density Arrivals/Departures and Airports							
TCAS 8.0 analysis and requirements		◆	◊				
Surface management CNS technologies identification		◆	◊	◊	◊		
Flexible Terminal and Airports							
RNAV/RNP via Data Communications		◆	◊	◊	◊	◊	
Collaborative Air Traffic Management							
Efficient and safe certification methods of complex software systems (Software Standards)		◆	◊	◊			
Real time integrated decision making information (Weather Integration)		◆	◊	◊	◊	◊	
Shared data concepts (Airborne SWIM)		◆	◊	◊			
Reduce Weather Impacts							
Weather Radar Replacement (WRR) Engineering Trade Studies		◆	◊				
Total Budget Authority	**23,000**	**13,200**	**23,000**	**31,200**	**32,000**	**50,100**	**51,900**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

Budget Item	Program Title	Budget Request
1A08C	**NextGen - Operations Concept Validation – Validation Modeling**	**$10,000,000**

GOALS:

This Program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership

Intended Outcomes: The Operations Concept Validation Program addresses developing and validating future end-to-end (flight planning through arrival) operational concepts with special emphasis on researching changes in roles and responsibilities between the FAA and airspace users (e.g., pilots and airlines), as well as the role of the human versus systems, that will increase capacity and improve efficiency and throughput. It will identify procedures that can decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS. Furthermore, this program works toward developing operational methods that will meet the NextGen goal of expanding capacity by satisfying future growth in demand as well as reducing transit time (reduce gate-to-gate transit times by 30 percent and increasing on-time arrival rate to 95 percent.).

Agency Outputs: The research will provide an end-to-end NAS Operational Concept and a complete set of scenarios that describe operational changes for NextGen solution sets including: Trajectory Based Operations (TBO); High Density Arrivals/Departures and Airports; Flexible Terminal and Airports; Collaborative Air Traffic Management; and Networked Facilities. These products will be developed for the Midterm (2018) initially, and subsequently for the NAS in 2025.

Customer/Stakeholder Involvement: The Radio Technical Commission for Aeronautics (RTCA) Free Flight Steering Committee, the FAA's R,E&D Advisory Committee, the White House Commission on Aviation Safety and Security, and numerous other members of the aviation community have called for the development and validation of a Concept of Operations for modernizing the NAS. This concept must be consistent with the JPDO's concept for NextGen, and its impact on the FAA's ATO, including transition steps, must be identified and validated.

Operational concept development and validation will utilize an iterative work group approach with members representing each of the FAA ATO Operational Service Units and representatives from the airspace user community, including pilots and flight operations centers. The work group approach will present an initial concept or scenario and elicit feedback from impacted stakeholders. This feedback will be incorporated into future versions of the concept that will be reviewed by stakeholders. Concept validation activities employing human-in-the-loop simulation will utilize participants with experience in the task being validated. The Program will identify the precise mechanism for obtaining stakeholder participation. It is currently envisioned that this participation will be through the Next Generation Air Transportation System Institute.

R&D Partnerships: This program is encouraged by the JPDO to ensure the FAA's research and development activities support the evolution to NextGen. Participation of the JPDO assures that the Operational Concept activities reflect user community needs, and assures that identified improvements are evaluated for operational impacts on NAS users and FAA service providers.

The concept development and concept validation effort described here is also coordinated with the European community via agreements with the European Commission on SESAR. This cooperation ensures that unique solutions and transitions are not developed in different quadrants of the globe, a situation which would impose an undue burden on all carriers and manufacturers participating in the global airspace system.

Accomplishments:

FY 2009:

- Developed the Initial NAS End-to-End Mid-term (2018) Concept of Operation Narrative
- Developed f the Initial NAS End-to-End Mid-term (2018) Concept of Operation Detailed Operational Scenarios and Traffic Scenarios
- Validated the Data Communications Segment 2 Operational Concept and requirements development

- Developed Research Plan for the integration of four dimensional trajectories (4DT) across operational environments (e.g., terminal, traffic flow management, and en route operations) to determine the level of accuracy needed in each phase of flight
- Initiated planning activities to perform human-in-the-loop and fast-time simulations to validate the mid-term concepts with particular emphasis on roles and responsibilities

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Validation of Midterm Concepts
- Data Communications Segment 2 Requirements
- Develop Detailed scenarios for midterm
- Refine Midterm NextGen CONOPS
- Begin developing detailed scenarios for 2025
- Time Based flow management Integrated Research Plan and fast time simulations

FY 2011 PROGRAM REQUEST:

The FY 2011 research will provide an Initial End-to-End Midterm (2018) NAS Operational Concept and a complete set of scenarios that describe operational changes for NextGen solution sets including: Trajectory Based Operations (TBO); High Density Arrivals/Departures and Airports; Flexible Terminal and Airports; Collaborative Air Traffic Management; and Networked Facilities.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop Data Communications Segment 2/3 Requirements.
- Continue development of a detailed set of scenarios to be used in concept validation.
- Conduct human in the loop simulations of Trajectory Based Operations (TBO), particularly for integrated time based flow management.
- Refine the Midterm NextGen End-to-End CONOPS based on concept validation.
- Demonstrate an increase in capacity and efficiency at 166% current traffic levels

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	4,000
FY 2010 Enacted	10,000
FY 2011 Request	10,000
Out-Year Planning Levels (FY 2012-2015)	40,000
Total	64,000

Budget Authority ($000)		**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Request**	**FY 2010 Enacted**		**FY 2011 Request**
Contracts:							
NextGen Operations Concept Validation – Validation Modeling		0	0	4,000	10,000		10,000
Personnel Costs		0	0	0	0		0
Other In-house Costs		0	0	0	0		0
Total		**0**	**0**	**4,000**	**10,000**		**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)		**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Request**	**FY 2010 Enacted**		**FY 2011 Request**
Basic		0	0	0	0		0
Applied		0	0	0	0		0
Development (includes prototypes)		0	0	4,000	10,000		10,000
Total		**0**	**0**	**4,000**	**10,000**		**10,000**

1A08C – Next Gen - Operations Concept Validation – Validation Modeling Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Operations Concept Validation	**10,000**						
End-to-end mid-term (2018) concept of operation narrative		◆	◊	◊	◊	◊	◊
End-to-end mid-term (2018) concept detailed task list descriptions		◆	◊	◊	◊	◊	◊
End-to-end far-term (2025) concept of operations narrative		◆	◊	◊	◊	◊	◊
End-to-end far-term (2025) concept detailed task descriptions		◆	◊	◊	◊	◊	◊
Integration of 4DT across operational environments		◆	◊	◊			
Detailed operational scenarios to support mid-term concept validation		◆	◊				
Simulations to validate the mid-term concept		◆	◊	◊	◊	◊	◊
Detailed operational scenarios to support far-term concept validation		◆	◊	◊	◊	◊	◊
Simulations to validate the far-term concept					◊	◊	◊
Total Budget Authority	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

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FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08D**	**NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction**	**$15,000,000**

GOALS:
The programs support the following *Flight Plan* goals: Increased Safety and Greater Capacity.

Intended Outcomes: The Advanced Noise and Emissions Reduction and Validation Modeling program helps achieve the Next Generation Air Transportation System (NextGen) goal to increase capacity threefold while reducing significant environmental impacts in absolute terms.

The program will explore advanced operational procedures to enable absolute reduction of significant aviation environmental impacts and establishing the benefits and costs for adopting these new procedures. The program will also develop and advance analytical tools and metrics to implement Environmental Management Systems (EMSs) to manage and mitigate NextGen environmental impacts. The analytical efforts are providing sufficient knowledge of climate change effects of aviation to enable assessing the impacts of various means to mitigate these effects.

The program is also focused on assessing National Airspace System (NAS) infrastructure impacts of Continuous Low Energy, Emissions and Noise (CLEEN) technologies and alternative fuels developed under the Research, Engineering and Development program (RE&D) and establishing and advancing any NAS adaptation required to implement and benefit from these technologies and fuels.

The Program specifically supports the following outcomes:

Identify and explore how advances in Communication, Navigation and Surveillance technology can be leveraged in the short- to medium-term to further optimize advanced aircraft arrival and departure, surface and en route procedures to reduce noise, fuel burn and emissions. Develop airspace analytical tools for aviation noise and emissions impacts, and analysis of costs/benefits of mitigation techniques. Design, develop and demonstrate implementation of EMS approaches to dynamically manage environmental impacts on the NAS in the most efficient and effective manner possible. Specific activities include:

- Explore advanced aircraft arrival, departure and surface operations to reduce emissions, fuel burn and noise
- Advance noise, local air quality and climate impacts metrics to quantify and manage the impacts of operations associated with NextGen
- Develop decision support tools to dynamically manage environmental impacts via EMSs
- Conduct validation modeling of mitigation approaches
- Develop decision support tools to assess the benefits and costs and aid in the implementation of clean and quiet procedures in the NAS
- Determine and develop NAS infrastructure adaptation necessary to adopt new environmental technologies and advanced fuels.

Assess impacts of adopting new aircraft environmental technologies and advanced fuels for the NAS infrastructure and advance any NAS adaptation necessary to benefit from these technologies. Specific activities include:

- Assess the impacts of new aircraft technologies and alternative fuels on the NAS
- Identify and develop any new elements of NAS infrastructure required to support the operation of new aircraft and alternative fuel technologies
- Demonstrate flight and ground integration of new CLEEN technologies and alternative fuels in the NAS

Agency Outputs: The program is protecting the environment by reducing significant aviation environmental impacts associated with noise, emissions, and global climate impact. The program will explore, collaboratively with industry and academia, advanced operational procedures that mitigate NextGen environmental impact while satisfying safety requirements. The program will support the design, development and implementation of EMSs that will allow adapting environmental protection to the dynamic needs of the NAS. In addition, the program will establish the benefits and costs for adopting new procedures and practices and develop decision support tools that

can be introduced into the NAS in the short and medium term to enable better planning and decisions. Finally, the program will also establish and advance any NAS infrastructure adaptation required to support the operation of new aircraft technologies and alternative fuels.

Research Goals:

- By FY 2010, evaluate impacts of CLEEN technologies on NAS infrastructure integration.
- By FY 2010, evaluate benefits of alternative fuels on NAS infrastructure integration.
- By FY 2010, conduct demonstration of algorithms to enable clean and quiet operational procedures.
- By FY 2010, develop architecture for Environmental Management Systems (EMSs).
- By FY 2011, apply metrics for health and climate impacts to develop a sample NAS EMSs and define impact of mitigation actions.
- By FY 2011, conduct significant demonstration of environmental control algorithms for en route (Oceanic) operational procedure for reduced aircraft emissions that may influence climate.
- By FY 2011, define standards, policy and procedures for environmental control logic for use in automated systems for surface and arrival operations.
- By FY 2011, integrate modifications to static environmental analyses models to enable dynamic assessment and control of environmental impacts.
- By FY 2011, deliver specific recommendations for environmental procedures to be integrated and demonstrated within appropriate *NGIP* solution sets.
- By FY 2011, conduct demonstration of environmental control algorithms for advanced ground, terminal area, and en route operational procedures to reduce emissions and noise.
- By FY 2012, apply the Aviation Environmental Design Tool (AEDT) to evaluate environmental impact for regional airspace needs and support EMSs.
- By FY 2012, design significant demonstration of CLEEN mitigation technologies and NAS infrastructure integration.
- By FY 2012, design significant demonstration alternative fuels and NAS infrastructure integration.
- By FY 2012, conduct significant demonstration of alternative fuels integration into the NAS.
- By FY 2013, conduct significant demonstration of CLEEN mitigation technologies and NAS infrastructure integration.
- By FY 2013, conduct significant demonstration alternative fuels and NAS infrastructure integration.
- By FY 2013, define standards, policy and procedures for environmental control logic for use in automated systems for en route (Oceanic) operations.
- By FY 2014, define standards, policy and procedures for CLEEN technologies integration into NAS.
- By FY 2014, define standards, policy and procedures for alternative fuel integration into the NAS.
- By FY 2014, assess the potential environmental benefits of improved efficiency coupling of separate automated system for surface, en route and arrivals/departures.

Customer/Stakeholder Involvement: The FAA works closely with other federal agencies, industry, academia, and international governments and organizations to design R&D efforts that can advance understanding of aviation environmental health and welfare impacts.

- NextGen -- FAA is leading an Environmental Working Group (EWG) responsible for all environmental dimensions of the JPDO. The EWG comprises FAA, NASA, the Environmental Protection Agency (EPA), DoD, Department of Commerce, Council on Environmental Quality, Department of the Interior, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The efforts of the EWG are centered on advancing the national vision and recommendations for aviation in the NextGen and in the congressionally mandated study on "Aviation and the Environment", including advanced operational procedures, aircraft technologies and alternative fuels development.

R&D Partnerships: As does the Environment and Energy Research Program and other NextGen activities, the Advanced Noise and Emissions Reduction and Validation Modeling program relies on a series of Memorandums of Agreement (MOA), to work closely with NASA. In FY 2005, FAA signed an MOA with DoD to pursue joint activities to understand and mitigate aviation noise and emissions. The FAA is also pursuing collaborative agreements with DOE, and EPA to leverage resources to address aviation's environmental impact.

- Through the JPDO NextGen, the program established a Working Group comprising FAA, NASA, EPA, DoD, Department of Commerce, Council on Environmental Quality, and Office of the Secretary of Transportation, as well as industry, academia, local government, and community groups. The Working Group is pursuing an intensive, balanced approach, emphasizing alignment across stakeholders in developing needed business and technology architectures, as well as other relevant tools, metrics, and products to address aviation's environmental impact.

Accomplishments: This is a new effort to address the challenges of NextGen. However, relevant stakeholders have achieved significant accomplishments mitigating aviation's environmental impact. The number of people exposed to significant noise levels was reduced by about 90% between 1975 and 2006. Today's aircraft are also 70 percent more fuel-efficient-per-passenger-mile than jet aircraft of the 1960s. Reduced fuel consumption has also led to a 90 percent reduction in carbon monoxide, smoke, and other aircraft emissions.

FY 2009:

Advanced Operational Procedures

- Explored advanced algorithms and approaches for en route operations that reduce greenhouse gas emissions that may contribute to climate impacts
- Explored advanced algorithms and approaches for surface operations that reduce criteria pollutants that contribute to ambient air quality
- Explored advanced algorithms and approaches for terminal procedures that optimize noise and air quality emissions reductions

Environmental Management System

- Defined existing and planned environmental mitigation methods to counter NAS constraints (today and for NextGen)
- Modified the Aviation Environmental Design Tool (AEDT) to enable evaluating environmental impact for regional airspace needs and support EMSs
- Applied metrics for health and climate impacts to develop a sample NAS EMSs and define benefits of mitigation actions

CLEEN and Alternative Fuels and NAS Infrastructure Integration

- Evaluated potential benefits of CLEEN aircraft technologies on the NAS
- Evaluated potential benefits of aviation alternative fuels on the NAS
- Analyzed new aircraft types (e.g., aircraft featuring CLEEN technologies, VLJ, UAV, SBJ) to ascertain their influence on environmental impacts and assess approaches to optimize environmental performance

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Operational Procedures

- Conduct significant demonstration of environmental control algorithms for surface (taxi/ramp) area operational procedure to reduce emissions.
- Conduct significant demonstration of environmental control algorithms for terminal area operational procedure to reduce emissions and noise.
- Conduct significant demonstration of environmental control algorithms for surface (taxi/ramp) area operational procedure to reduce emissions.

Environmental Management System

- Initiate EMS outreach program to communicate EMS approach
- Identify refinements to improve NextGen EMS framework
- Initiate development of first phase of decision support tools for EMS
- Develop future concept and core requirements for IT systems to support reporting and integration of information for NextGen EMS
- Initiate first phase of pilots to test refined approaches and to support development of standardized approaches and tools for organizational level NextGen EMS
- Develop an approach to prioritize how early adopters should be targeted so as to achieve the greatest positive impacts for NextGen and the environment

- Research potential incentives to encourage action toward NextGen environmental goals, assess benefits and potential costs - Propose a framework (and schedule) for applying selected incentives
- Applied Research on the Methodologies and Metrics to Assess Health and Climate Change Impacts

CLEEN, Alternative Fuels, Market Measures, Standards and NAS Infrastructure Integration

- Define existing and planned environmental mitigation methods to counter NAS constraints (today and for NextGen)
- Continue analysis of environmental impacts of new aircraft types (e.g., aircraft featuring CLEEN technologies, VLJ, UAV) on the NAS and assess approaches to optimize system environmental performance
- Continue analysis of the environmental impacts of aviation alternative fuels on NAS and assess approaches to optimize system environmental performance
- Investigate potential metrics and define standards for aircraft CO2 emissions
- Investigate market based options, including Cap & Trade, to limit aircraft greenhouse gas emissions

FY 2011 PROGRAM REQUEST:

NextGen has adopted environmental goals to reduce significant noise and air quality impacts in absolute terms, to enhance fuel efficiency, to limit or reduce greenhouse gases. The growth enabled by NextGen will lead to significant increase in environmental impacts even in the near term which could restrict capacity growth and prevent full realization of NextGen. The solution is to reduce the increased environmental impacts of aviation through new operational procedures, technologies, alternative fuels, policies, standards and market based options to allow the desired increase in capacity. The ATO Capital environmental investments enable delivering the NextGen noise goal of reducing the number of people exposed to noise each year by 4% and improving fuel efficiency by at least 2% per year. Future environmentally responsible aviation environmental mitigation must be based on a new, interdisciplinary approach that addresses the relationship between noise and emissions and different types of emissions, and provides the cost-benefit analysis capability necessary for data-driven decision making.

This effort will lead to assessment of new and advanced aircraft and engine technologies, alternative fuels, improved operational procedures and analysis of policy, environmental standards and market based options to reduce emissions, fuel burn, and noise towards achieving NextGen environmental goals. The effort specifically focuses on explorations, simple demonstrations as well as methods to integrate these environmental impact mitigation and energy efficiency options with the NextGen infrastructure in a costs-beneficial manner. It will also provide ways to adapt the NAS infrastructure to fully exploit the benefits of these environmental mitigation and energy efficiency options.

Environment and Energy – Environmental Management System (EMS)

The NextGen Environmental Management System (EMS) will dynamically manage NextGen environmental impacts and help to define and identify optimum mitigation actions and their benefits in order to achieve NextGen environmental goals. The FY 2011 research will continue developing, refining and evaluating the EMS framework, decision support tools and outreach program to initiate, implement, coordinate and link EMS activities across NextGen participants and stakeholders. This program will also develop strategy and framework for incentives options that may be implemented to encourage EMS implementation. Additionally, this program will assess National Environmental Policy Act (NEPA) compliance of NextGen EMS and continue to evaluate environmental impacts metrics and analysis approaches to support EMS implementation.

Environment and Energy –Advanced Noise and Emission Reduction

The FY 2011 research will evaluate the potential NAS environmental benefits of new aircraft technologies and alternative fuels; initiate a comprehensive analysis of the impacts on the NAS of new aircraft types [e.g., aircraft featuring Continuous Lower Emissions, Energy, and Noise (CLEEN) technologies, Very Light Jet (VLJ) and Unmanned Aerial Vehicle (UAV)], and alternative aviation fuels; and explore and assess new operational procedures optimized for environmental and energy efficiency and environmental performance. This program will analyze impacts of potential policy, environmental standards and market based measures on the aviation system and NextGen environmental and energy efficiency goals. This program element will also identify ways to integrate mitigation options with the NAS infrastructure and demonstrate any NAS adaptation required to implement new CLEEN aircraft technologies, alternative fuels, environmental and energy efficient operational procedures, and policy, environmental standards and market based options.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Operational Procedures

- Conduct significant demonstration of environmental control algorithms for surface (taxi/ramp) area operational procedure to reduce emissions.
- Conduct significant demonstration of environmental control algorithms for terminal area operational procedure to reduce emissions and noise.
- Conduct significant demonstration of environmental control algorithms for surface (taxi/ramp) area operational procedure to reduce emissions
- Initiate investigation of potential operational changes required to optimize aircraft operations for greenhouse gas reductions

Environmental Management System

- Perform EMS Environmental Impacts Analysis and Metrics
- Implement and asses EMS Outreach Communications program
- Refine EMS Framework
- Develop EMS Decision Support Tools
- Design architecture for NextGen EMS IT system
- Perform EMS Pilot demonstration/Testing
- Initiate standardization of EMS approaches for organizational EMS
- Finalize strategy and framework for incentives and begin development of selected incentive programs
- Implement first phase of EMS and develop prioritization for EMS strategy
- Develop design and scoping of EMS performance tracking framework
- Analyyze NextGen EMS and NEPA compliance

CLEEN, Alternative Fuels, Market Measures, Standards and NAS Infrastructure Integration

- Define existing and planned environmental mitigation methods to counter NAS constraints (today and for NextGen)
- Continue analysis of environmental impacts of new aircraft types (e.g., aircraft featuring CLEEN technologies, VLJ, UAV) on the NAS and assess approaches to optimize system environmental performance
- Continue analysis of the environmental impacts of aviation alternative fuels on NAS and assess approaches to optimize system environmental performance
- Investigate potential metrics and define standards for aircraft CO2 emissions
- Investigate market based options, including Cap & Trade, to limit aircraft greenhouse gas emissions

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	7,000
FY 2010 Enacted	7,000
FY 2011 Request	15,000
Out-Year Planning Levels (FY 2012-2015)	72,000
Total	101,000

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Environmental Management System	0	0	4,500	3,000	6,000
Advanced Noise and Emissions Reduction	0	0	2,500	4,000	9,000
Personnel	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**7,000**	**7,000**	**15,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	7,000	7,000	15,000
Total	**0**	**0**	**7,000**	**7,000**	**15,000**

1A08D - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Environmental Management System	**6,000**						
EMS Environmental Impacts Analysis and Metrics		◆	◊	◊	◊	◊	◊
EMS Outreach & Communications		◆	◊	◊	◊	◊	◊
Development of EMS Decision Support Tools		◆	◊	◊	◊	◊	◊
EMS Pilots demonstrations and Testing		◆	◊	◊	◊	◊	◊
Standardization of EMS approaches for organizational EMS		◆	◊	◊	◊	◊	◊
Incentive Framework for Adoption of EMS		◆	◊	◊	◊	◊	◊
Implementation of EMS		◆	◊	◊	◊	◊	◊
EMS performance tracking framework		◆	◊	◊	◊	◊	◊
NextGen EMS and NEPA compliance		◆	◊	◊	◊	◊	◊
Publish results		◆	◊	◊	◊	◊	◊
Advanced Noise and Emissions Reduction	**9,000**						
Evaluation of NAS benefits of CLEEN aircraft technologies		◆	◊	◊	◊	◊	◊
Evaluation of NAS benefits of aviation alternative fuels		◆	◊	◊	◊	◊	◊
Evaluation of NAS-wide market based options		◆	◊	◊	◊	◊	◊
Environmental standards and NAS-wide benefits		◆	◊	◊	◊	◊	◊
Analysis of policy options and NAS-wide benefits		◆	◊	◊	◊	◊	◊
Significant exploration and demonstration of environmental control algorithms for surface (taxi/ramp) area operational procedures		◆	◊	◊	◊	◊	◊
Significant exploration and demonstration of environmental control algorithms for terminal area operational procedure		◆	◊	◊	◊	◊	◊
Significant exploration and demonstration of environmental control algorithms for en route		◆	◊	◊	◊	◊	◊
Publish Results		◆	◊	◊	◊	◊	◊
Total Budget Authority	**15,000**	**7,000**	**15,000**	**18,000**	**18,000**	**18,000**	**18,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08E**	**NextGen - Wake Turbulence – Re-categorization**	**$3,000,000**

GOALS:

This program supports the following *Flight Plan* goal: Greater Capacity.

Intended Outcomes: The Wake Turbulence – Re-Categorization project (Wake Re-Cat) addresses FAA's goal for capacity and the DOT Reduced Congestion Strategic Goal, Capacity Management Strategy: "Modify aircraft separation standards to increase airspace capacity and allow more efficient use of airspace." Redefining (based on enhanced understanding of aircraft generated wake turbulence and its transport/demise) the basis for the air navigation service provider's (ANSP) required minimum spacing between aircraft to mitigate the effects of wake turbulence is a major first step towards the NextGen efficient use of our nation's airspace. Wake Re-Cat provides the analysis, experimentation, and validation activities necessary to replace today's safe but capacity inefficient air traffic control wake mitigation procedures for separating aircraft. The work is conducted cooperatively with EUROCONTROL and will result in global changes to the ANSP wake turbulence mitigation procedures. Project outcomes include:

- Current 6 weight categories and safe separation distances adjusted to account for fleet mix changes since the last re-categorization effort in the early 1990s (adjustments will include additional factors beyond aircraft weight)
- Increased capability to safely place more aircraft in the same volume of airspace – resulting in ability to meet increased demand for air travel.

Increased opportunity and flexibility for safe aircraft pair-wise maneuvering within airspace and other system constraints

Agency Outputs: Wake Re-Cat uses applied research to develop the enhanced methods of defining wake safe separations between aircraft. Previously used methods are being reviewed and refined. Current wake characterization models are being enhanced to allow experimentation with the use of various aircraft design parameters as mechanisms for defining the strength and longevity of aircraft produced wake vortices. Results of the modeling efforts will be validated through field measurements. Wake encounter models will be developed, validated and integrated into aircraft simulators. Separation standards will be refined based on field data, analysis and pilot-in-the-loop simulations. Wake mitigation separation procedures developed for use by the ANSP will be evaluated using scenario based simulations to include human-in-the-loop simulations to insure usability and safe operations. Work will also include the development of the safety risk management documentation necessary for the implementation of the revised ANSP wake mitigation separation procedures.

Research Goals:

- By 2011 refine the boundaries of the current 6 weight categories and associated wake separation minima into a static wake-based set of categories and separation minima for National Airspace System (NAS) wide fleet mix and define automation requirements to support those modifications
- By 2011, in support of variable wake separations, determine optimal set of aircraft flight characteristics and weather parameters for use in setting wake separation minimums.
- By 2013, determine how best to incorporate the leader/follower based wake separation standards into the en-route and terminal automation platforms.
- By 2016, develop the algorithms that will be used in the ANSP (and potentially on flight deck automation systems) for setting dynamic wake separation minimum for each pair of aircraft.

Customer/Stakeholder Involvement: The Wake Re-categorization project addresses the needs of the FAA Air Traffic Organization (ATO) and works with the FAA Aviation Safety organization to ensure new procedures and solutions are safe for implementation both by the ANSP and for the flight deck. The project consults with aircraft manufacturers, controllers, airlines, airport operators and pilots to include their recommendations; ensure an open safety assessment process and a shared understanding of the results of the safety assessments. The project's emphasis is insuring user's training and implementation issues are addressed in the project's research from the start.

Customers:

- Pilots
- Air navigation service provider personnel
- Air carrier operations
- Airport operations
- Aircraft manufacturers

Stakeholders:

- Joint Planning and Development Office
- Commercial pilot unions
- FAA air navigation service provider unions
- Other ICAO air navigation service providers
- Aircraft manufacturer associations
- General aviation associations

R&D Partnerships: In addition to maintaining its partnership with FAA's Aviation Safety organization, this project will accomplish its research agenda via working relationships with industry, academia, and other government agencies. The coordination and tasking are accomplished through joint planning/reviews, contracts and interagency agreements with the program's partners:

- Volpe National Transportation Systems Center
- MITRE/Center for Advanced Aviation and Systems Development (CAASD)
- NASA Ames and Langley Research Centers
- EUROCONTROL and associated research organizations
- National Institute of Aerospace

Accomplishments: The following represent major accomplishments of the Wake Re-categorization project:

- FY2009 - Enhanced analysis tools (to include effects of wake encounter) for evaluating alternative methods of defining safe wake separations between various types of aircraft.
- FY2009 - Conducted analyses and aviation community forums to vet potential methods for specifying safe wake separations between various types of aircraft
- FY2009 - Developed an approach for evaluating the safety risks associated with the potential methods for setting wake separations between various groups of aircraft (i.e. Jumbo, Heavy, Large, Small, Very Small)
- FY2009 - Developed planning for human-in-the-loop ANSP simulations to evaluate usability of a proposed set of wake separation standards
- FY2009 - Developed potential methods for defining the minimum safe wake separations between aircraft, beginning with the more general groupings of aircraft types.
- FY2009 - Conducted analyses to link wake transport and decay characteristics to aircraft flight and surrounding weather parameters.
- FY2008 - Series of work sessions with several candidate sets of standards developed for evaluation
- FY2008 - Existing data sets and models examined for utility to this project
- FY2007 – Second international meeting - Developed strategy for accomplishing the re-categorization work
- FY2006 – First international meeting – reviewed history of wake separation standards setting and various potential approaches to accomplishing re-categorization.
- FY 2006 – Completion of a two year effort to determine required wake separation minimums for the A-380 and similar sized aircraft.
- FY 2004-2006 – Utilized wake turbulence data collected from ground based and aircraft based prototype pulsed LIDAR systems, along with wake turbulence transit and demise models for characterizing the wake generated by the A-380 aircraft in relation to the wake generated by the 747-400 aircraft.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Apply enhanced analysis tools (to include effects of wake encounter) for evaluating alternative methods of defining safe wake separations between various types of aircraft.
- Continue to conduct analyses and aviation community forums to vet potential methods for determining safe wake separations between various types of aircraft.
- Evaluate the safety risks associated with the potential methods for determining safe wake separations between various groups of aircraft (i.e. Jumbo, Heavy, Large, Small, Very Small)
- Conduct human-in-the-loop ANSP and Flight Deck simulations to evaluate usability of a proposed set of wake separation standards
- From the examined alternatives for defining safe wake separations between aircraft, develop a recommendation for a change to wake separation standards. This proposed change (proposed by both FAA and EUROCONTROL) will be sent to ICAO for international review.
- Using results from collected data, continue to upgrade analytical models - linking wake transport and decay to aircraft flight and surrounding weather parameters.
- Initiate development of wake separation standards that account for which aircraft is leading and which aircraft is following in terms of wake separation

FY 2011 PROGRAM REQUEST:
In FY11, FAA must continue developing the capabilities needed to enable separation requirements supportive of NextGen shared separation and dynamic spacing super density operations. Wake Re-cat addresses the existing wake separation standards and seeks to evolve from these static standards to ones that better address the variety of aircraft being separated and the weather conditions that impact the needed wake separations. Wake Re-categorization project is one component in the overall effort to apply technology toward achieving the envisioned NextGen number of aircraft operations in the NAS.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop and apply enhanced analysis tools (to include the effects of wake encounter) for evaluating alternative methods of defining safe wake separations between various types of aircraft
- Conduct analyses and aviation community forums to vet potential methods for determining safe wake separations between various types of aircraft
- Develop required changes and then support FAA's CARTS/STARS and ERAM automation programs in their development of software and adaptation to implement the wake separation standards recommended to ICAO.
- Complete follow-on analyses requested by ICAO to support the wake separation standards recommendation submitted to ICAO in FY10
- Continue the analyses and modeling to develop wake separation standards, processes, and procedures along with the associated benefit and safety analyses for wake separation standards that consider individual aircraft types both as wake generators (leader) and as aircraft following a wake generating aircraft (follower).
- Determine optimal set of flight characteristics and weather parameters for use in setting wake separation minimums
- Plan for conduct of simulations to evaluate the feasibility - in terms of air traffic control - of aircraft type specific leader/follower separation standards, processes and procedures.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	2,000
FY 2010 Enacted	2,000
FY 2011 Request	3,000
Out-Year Planning Levels (FY 2012-2015)	12,000
Total	19,000

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Wake Turbulence	0	0	2,000	2,000	3,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**2,000**	**2,000**	**3,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	2,000	2,000	3,000
Total	**0**	**0**	**2,000**	**2,000**	**3,000**

1A08E - NextGen - Wake Turbulence – Re-categorization Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Wake Turbulence – Re-categorization	**3,000**						
Develop and apply enhanced analysis tools (to include the effects of wake encounter) for evaluating alternative methods of defining safe wake separations between various types of aircraft	**500**	♦	◊	◊	◊	◊	
Conduct analyses and aviation community forums to vet potential methods for determining safe wake separations between various types of aircraft	**200**	♦	◊	◊	◊	◊	◊
Develop required changes and then support FAA's CARTS/STARS and ERAM automation programs in their development of software and adaptation to implement the wake separation standards recommended to ICAO.	**600**	♦	◊	◊	◊	◊	
Complete follow-on analyses requested by ICAO to support the wake separation standards recommendation submitted to ICAO in FY10	**400**	♦	◊				
Continue the analyses and modeling to develop wake separation standards, processes, and procedures along with the associated benefit and safety analyses for wake separation standards that consider individual aircraft types both as wake generators (leader) and as aircraft following a wake generating aircraft (follower)	**700**	♦	◊	◊	◊	◊	
Determine optimal set of flight characteristics and weather parameters for use in setting wake separation minimums	**400**	♦	◊				
Plan for conduct of simulations to evaluate the feasibility - in terms of air traffic control - of aircraft type specific leader/follower separation standards, processes and procedures	**200**		◊				
Personnel and Other In-House Costs							
Total Budget Authority	**3,000**	**2,000**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**

◆ - Activities Accomplished ◇ - Activities Planned

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In the F&E appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08F**	**NextGen – Operational Assessments**	**$10,000,000**

GOALS:

This program supports the following *Flight Plan* goal: Greater Capacity

Intended Outcomes: The NextGen Operational Assessments Program addresses the FAA's goal for greater capacity in the system. The program includes research and development of system wide assessment of NAS performance, safety and environmental impacts. The transition to NextGen requires the conduct of operational assessments to ensure that safety, environmental, and system performance considerations are addressed throughout the integration and implementation of NextGen. Such assessments are particularly important as the NextGen program begins to evaluate current airspace design and as new procedures are developed and implemented within the NAS. In FY 2011, funding is requested to continue conducting system wide operation performance, system wide safety assessments, environmental-specific assessment, and system risk management activities.

Agency Outputs: The program will support several of the NextGen solution sets through operational assessment of new capabilities and its impact on NAS-wide performance, safety and environment. These solution sets include the following: Trajectory Based Operations; High Density Arrivals/Departures and Airports; Flexible Terminal and Airports and Collaborative Air Traffic Management. Where appropriate, research and development and assessment activities will be coordinated with JPDO to complement JPDO NextGen working groups' activities on far term capabilities.

Research Goals:

- By 2012, enhance NAS wide model(s) to support operational assessments of the en route domains
- By 2012, continue to conduct safety assessment of NextGen capabilities
- By 2012, continue to conduct environmental assessment of NextGen capabilities
- By 2013, enhance NAS wide model(s) to support operational assessments of strategic flow management operations

Customer/Stakeholder Involvement: The program addresses the needs of the FAA Air Traffic Organization (ATO) and works with the FAA Aviation Safety and Aviation Environment organizations to perform comprehensive NAS wide operational assessments of NextGen capabilities. The program works with controllers, airlines and pilots to include user recommendations and ensure that implementation issues are addressed early on.

Customers:

- Air Navigation Service Provide personnel
- Air carrier operations
- Airport operations
- Pilots

Stakeholders:

- Joint Planning and Development Office
- FAA Air Traffic Operation service units, Aviation Safety and Aviation Environmental offices

R&D Partnerships: This program will partner with the FAA Aviation Safety and Aviation Environmental organizations, industry, academia and other government agencies. The coordination and tasking are accomplished through joint planning/reviews, contracts and interagency agreements with the program's potential partners:

- MITRE/Center for Advanced Aviation and Systems Development (CAASD)
- NASA Ames, Glenn and Langley Research Centers
- EUROCONTROL and associated research organizations
- Volpe National Transportation Center

Accomplishments: This was a new program in FY 2010.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Complete inventor and catalog of NAS wide operational models, safety models and environmental models
- Complete gap analysis of models
- Developed requirements for models enhancements
- Conduct limited NAS wide operational assessment of NextGen capabilities

FY 2011 PROGRAM REQUEST:

In FY2011, FAA must continue developing/enhancing the modeling capabilities to support the NextGen solution sets. These modeling capabilities will support the agency in assessment capabilities feasibilities, safety and environmental impacts. The output from NAS wide operational assessments will support service units and programs in developing system and interface requirements, procedural and training requirements, cost and benefits assessments and documentations.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Refine requirements for models enhancements.
- Continue to conduct a limited NAS wide operational assessment of NextGen capabilities.
- Develop an initial NAS wide model(s) to support operational assessments of the Airport and Terminal Domains.
- Conduct a limited safety assessment of NextGen capabilities.
- Conduct a limited environmental assessment of NextGen capabilities.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	0
FY 2010 Enacted	7.500
FY 2011 Request	10.000
Out-Year Planning Levels (FY 2012-2015)	40,000
Total	57,500

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts	0	0	0	0	0
Operation Assessments				7,500	10,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**7,500**	**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	7,500	10,000
Total	**0**	**0**	**0**	**7,500**	**10,000**

1A08F – NextGen – Operational Assessments Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
NextGen Operational Assessments	**10,000**						
Gap Analyses							
Assess and inventory of existing NAS wide operational models. Safety and environmental models		♦		◊		◊	◊
Develop requirements for model enhancements		♦	◊				
Model Developments							
Develop enhancements to NAS wide operational models, safety and environmental models		♦	◊	◊	◊	◊	◊
Modeling and Simulations							
Model NextGen capabilities for the Airports and Terminal domains			◊	◊	◊		
Model NextGen capabilities for the en route domain				◊	◊	◊	◊
Conduct limited NAS wide safety assessment of NextGen capabilities			◊	◊	◊	◊	◊
Conduct limited NAS wide environmental assessment of NextGen capabilities			◊	◊	◊	◊	◊
Conduct limited NAS wide operational assessment of NextGen capabilities		♦	◊	◊	◊	◊	◊
Total Budget Authority	**10,000**	**7,500**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
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FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A08G**	**NextGen - System Safety Management Transformation**	**$18,000,000**

GOALS:

The program supports the following Flight Plan goals: Increased Safety and International Leadership.

Intended Outcomes: This program enables NextGen by reducing the fatalities rate commensurate with the increases in capacity. By 2015, this program element will provide system knowledge to enable early identification of event precursors allowing intervention strategies to avoid accidents and incidents and to understand economic (including implementation) and operational impact (with respect to safety) of NextGen system alternatives. This will be done by encouraging and participating in global safety practices to ensure the safety of the traveling public and cargo. A cutting-edge operational data analysis capability will be developed that identifies safety issues. This research will promote expansion of the U.S. capability to meet national and international safety goals and objectives with less oversight of individual carriers. Understand which alternatives are most likely to decrease accidents rates as air traffic increases 3 times the current levels.

Agency Outputs: The program will develop an infrastructure that enables the free sharing of de-identified, safety information that is derived from various government and industry sources in a protected, aggregated manner. This will be accomplished through the following transformation directions:

- Develop a comprehensive, cooperative approach to safety across the system-of-systems at the national level.
- Develop a comprehensive set of safety management principles and practices to establish a common framework for the aviation community:
- Ensure an evolution of present certification, testing, and inspection of individual system elements to comprehensive approvals of operators' and manufacturers' safety management programs:
- Promote safety through training, sharing of safety data, and dissemination of lessons learned
- Establish a non-punitive reporting system, relieving concerns about corrective action processes.

Research Goals: The approach includes developing the information analysis and sharing capabilities to support the FAA and NextGen safety initiatives; generating guidelines and shared capabilities to help stakeholders successfully implement their own safety management systems; and modeling activities to help measure progress toward achieving FAA goals.

- 2011: Develop proof of concept for NextGen including a prototype to implement on a trial basis with selected participants that involve a cross-section of air service providers.
- 2012: Validate the Net Enabled Operations (NEO) Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders.
- 2013: Complete the Aviation Safety Information Analysis and Sharing (ASIAS) pre-implementation activities, including concept definition, with other JPDO member agencies, participants, and stakeholders.
- 2014: Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across the NextGen.

Customer/Stakeholder Involvement: Stakeholders are integral participants in the research effort by providing subject matter experts in the areas of safety, operations, design, production, and maintenance. In addition, stakeholders will share their data, processes, resources and tools with other participating stakeholders.

Stakeholders include, but are not limited to the following:

- Other government organizations, within and outside the JPDO
- Aerospace manufacturers
- Aerospace repair stations and maintenance organizations
- Air traffic service providers (civilian and military)
- Local and state governments (port authorities, funding offices)
- Aerospace industry associations

- Private, commercial, government, and military operators
- International airworthiness authorities
- Providers of other aviation products (e.g., ARINC, contract towers, weather service providers, Jeppesen)

R&D Partnerships: R&D Partnerships have not been established yet but may include academia, government and foreign research and government organizations.

Accomplishments:
The following are planning activities, completed by the JPDO, that have provided support to this effort:

- 2004 Next Generation Air Transportation System Integrated Plan
- 2006 Progress Report to the Next Generation Air Traffic System Integrated Plan
- 2007 Safety Management System National Standard
- 2007 Initial Safety Culture Improvement Plan
- 2007 Safety IPT Program Plan that integrates planning and research activities
- 2007 Proposed ASIAS (Aviation Safety Information Analysis and Sharing) Environment Concept of Operations
- 2007 ASIAS Related Implementation Guidance Material

FY 2009:
Safety Management Systems (SMS)

- Began developing selected prototype solutions based on National SMS requirements for management of safety risk of hazards that cross multiple agencies and users of the air transportation system.
- Assess integration of industry SMS with FAA's internal SMS and oversight responsibilities.

Aviation Safety Information Analysis and Sharing (ASIAS)

- Completed evaluation of current protection and assurance models and potential conflicts with privacy and consumer advocacy groups.
- Completed enhanced ASIAS Concept of Operations (ConOps) document to include NextGen member agency aviation safety information needs, expanding upon the existing ASIAS ConOps.
- Completed the baseline for the enhanced ASIAS, include information on infrastructure, data/information protection policies, information access policies, procedures, equipment, tools, processes, data architectures, resources and budgets, building upon existing ASIAS baseline.
- Completed an analysis to identify any gaps between the existing ASIAS baseline and the enhanced ASIAS ConOps.
- Completed interim implementation plan using expanded ASIAS ConOps and the results of the gap analysis. The interim plan will be used by JPDO member agencies to communicate required ASIAS implementation activities.
- Developed an ASIAS data management plan that addresses data set integration, data standardization, taxonomy issues, data quality issues; including data quality assessments and mitigation analyses.
- Used existing ASIAS ConOps and baseline and gap analysis products expand existing ASIAS architecture (AA) to meet Federal Enterprise Architecture (FEA) requirements. Develop and expand AA Framework and Standards documentation.
- Conducted ASIAS policy research to support the development of ConOps for all future enhancements of ASIAS.

Safety Risk Management (SRM)

- Began evaluating NextGen processes, components, and their relationships and rules to identify characteristics of the air transportation system which should be assessed for risk (complexity, dynamic, etc)

System Safety Assessment (SSA)

- Developed prognostic safety assessment methods for systems and operations
- Began baseline risk assessment for system-wide risks associated with current operations in (1) terminal area airspace, (2) transition airspace, or (3) en route airspace
- Conducted initial safety assessments of proposed concepts, algorithms, and technologies to indicate the relative safety impacts with respect to the baseline system
- Began developing a proof of concept of an assessment process, including data collection, risk baseline calculation, system impact assessment, development of a risk analysis function and application to a limited set of new NextGen technologies and procedures

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Safety Management Systems (SMS)

- Develop a detailed process that can be used to assess the Design Approval Holder compliance with SMS requirements.

Aviation Safety Information Analysis and Sharing (ASIAS)

- Begin making analytical text mining tools available for stakeholder use at the local level.
- Execute recommendations from the FY09 data quality assessment and mitigation analysis across all primary data sources of ASIAS.
- Further expand scope of ASAIS to include additional NextGen stakeholders and begin development of ConOps, baseline, gap analysis, and implementation plan for expanded version.
- Begin integration of initial limited set of data from JPDO participating agencies into ASIAS, using suitable data protection policies and procedures.

Safety Risk Management (SRM)

- Complete identification of all of the AVS organizations that conduct analyses, their analytical approaches, data, methods, taxonomies and standards.

System Safety Assessment (SSA)

- Develop a baseline risk assessments for surface operations component of system-wide risks associated with current operations in all system components.
- Conduct a proof of concept demonstration of an assessment process, including data collection, risk baseline calculation, system impact assessment, development of a risk analysis function and application to NextGen concept in surface operations.

FY 2011 PROGRAM REQUEST:

The FY 2011 research will continue development of methodologies that enable safety assessments of proposed NextGen concepts, algorithms, and technologies and provide system knowledge to understand economic (including implementation) and operational impact (with respect to safety) of NextGen system alternatives. Work will continue on a demonstration of a National Level System Safety Assessment working prototype that will proactively identify emerging risk across the proposed NextGen, with the intent of using what is learned in earlier years to define system performance requirements and provide the basis for a user and system performance requirements analysis. In 2011, refinement of a system-wide risk analysis of the NAS will lead to definition of system and user requirements to transition the baseline risk and forecasting capability into the ASIAS base platform. The research will continue to develop ASIAS capabilities to include enhancements that build upon and extend existing capabilities for managing and processing aviation performance data, advancing tools that convert both textural and numeric data into information, and creating visualization capabilities that aid casual/contributing factor analyses and risk assessment. NextGen member agency aviation safety information needs will be included. Research supports operational implementation by 2025.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Safety Management Systems (SMS)

- Develop a method that can be used for continual surveillance of the Design Approval Holder compliance with SMS requirements.

Aviation Safety Information Analysis and Sharing (ASIAS)

- Achieve capability across all commercial aviation nodes to fuse data from public and non-public sources while maintaining data protection.
- Conduct a demonstration project with a limited set of JPDO participants for analysis of safety metrics and directed studies.
- Integrate data from at least one international user of the US domestic airspace into ASIAS.

Safety Risk Management (SRM)

- Develop guidance on taxonomy, analytical methods and integrated evaluation applications that ensure that consistent risk assessment processes are employed throughout AVS.

System Safety Assessment (SSA)

- Develop a user and system requirements document for system baseline risk estimation.
- Develop a user and system requirements document for system forecast capability, including standard user requirements for development and installation of this capability into the operational ASIAS platform.
- Develop a user and system requirements definition of system safety metrics.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	16,300
FY 2010 Enacted	16,300
FY 2011 Request	18,000
Out-Year Planning Levels (FY 2012-2015)	72,000
Total	122,600

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts					
System Safety Management Transformation	0	0	16,300	16,300	18,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**16,300**	**16,300**	**18,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	16,300	16,300	18,000
Total	**0**	**0**	**16,300**	**16,300**	**18,000**

1A08G - NextGen - System Safety Management Transformation Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
System Safety Management Transformation							
Safety Management Systems	**2,000**						
Establish Design Approval Holder (DAH) SMS requirements, a process to assess DAH compliance with SMS requirements, and a method for continual surveillance of DAH SMS.		◆	◇	◇			
Develop a detailed process that can be used to assess the DAH compliance with SMS requirements.		◆					
Develop a method that can be used for continual surveillance of the DAH compliance with SMS requirements			◇				
ASIAS	**7,000**						
ASIAS stakeholders able to conduct custom analyses using selected ASIAS provided fused data and tools.		◆	◇	◇	◇	◇	◇
Begin making analytical text mining tools available for stakeholder use at the local level.		◆					
Achieve capability across all commercial aviation nodes to fuse data from public and non-public sources			◇				
Expand ASIAS to achieve statistically significant coverage of NAS operations		◆	◇	◇			
Begin integration of initial limited set of data from JPDO participating agencies into ASIAS		◆					
Further expand scope of ASAIS to include additional NextGen stakeholders		◆					
Conduct a demonstration project with a limited set of JPDO participants for analysis of safety metrics and directed studies			◇				
Integrate data from at least one international user of the US domestic airspace into ASIAS			◇				
Safety Risk Management	**2,000**						
Provide guidance on a unified framework in risk assessment and risk management (RARM) process and on a unified standard to improve RARM quality.		◆	◇	◇			
Complete identification of all of the AVS organizations that conduct analyses, their analytical approaches, data, methods, taxonomies and standards		◆					
Develop guidance on taxonomy, analytical methods and integrated evaluation applications			◇				
System Safety Assessments	**7,000**						
Baseline risk assessments for system-wide risks associated with current operations in all system components		◆	◇	◇	◇		
Develop a baseline risk assessments for surface operations component		◆					
Conduct a proof of concept demonstration of a NextGen concept in surface operations		◆					
Develop a user and system requirements document for system baseline risk estimation			◇				
Develop a user and system requirements document for system forecast capability			◇				
Develop a user and system requirements definition of system safety metrics			◇				
Total Budget Authority:	**18,000**	**16,300**	**18,000**	**18,000**	**18,000**	**18,000**	**18,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS. IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

Budget Item	Program Title	Budget Request
1A08H	**NextGen - Staffed NextGen Towers (SNT)**	**$6,000,000**

GOALS:
This program supports the following *Flight Plan* goal: Greater Capacity, Safety, and Organizational Excellence.

Intended Outcomes: The air traffic in the United States (U.S.) is expected to increase significantly over the next several decades. Some high-end estimates indicate that by the year 2025 the total passenger enplanements may more than double and total aircraft operations may triple in comparison to the traffic today. In the next 10-15 years, most US tower facilities will reach the end of their useful life. The cost of new tower construction is escalating and is rapidly reaching a point where requirements are exceeding budgets. The FAA has to develop new operational concepts to increase capacity and address the predicted growth in airport tower operations while still addressing the cost prohibitive nature of replacing air traffic control towers with new towers. Runway safety (reduced runway incursions) also needs to be enhanced to keep pace with traffic growth.

To achieve the end-state configuration for the proposed SNT capability, implementation will be done in three phases: Supplemental Configuration, Flexible Configuration, and Full SNT Configuration. The Supplemental SNT, Phase 1, provides surface and tower services through the use of an integrated display certified for separation assurance based on surveillance data as an enhancement to the current control paradigm. Under the Supplemental Configuration of SNTs, ANSP personnel will remain in the existing tower cab and will use the integrated display to increase airport capacity under IMC. By operating in this initial phase of SNT, ANSP personnel will gain valuable experience in the use of the new display. The Flexible SNT, Phase 2, provides surface and tower services either from a ground-level SNT facility or from the tower cab. The SNT facility provides advanced surface management and decision support tools to the ANSP. Such an operation will give ANSP personnel confidence in SNT operation because the existing tower will be available as a backup to SNT. The Full SNT, Phase 3, provides surface and tower services exclusively from a ground-level SNT facility. The SNT facility provides advanced surface management and decision support tools.

Agency Outputs: The research will provide preliminary program requirements and documentation to support investment analysis activities including a business case analysis report, implementation strategy and planning, and updated enterprise architecture products and amendments.

Research Goals: The research goals include standards and alternatives development in support of an initial investment decision to ensure the timely implementation of SNT into the NAS. It will also fund the sustainment of the SNT equipment installed at DFW and allow for refinement and analysis to be conducted at the field site in support of the investment analysis activities.

Customer/Stakeholder Involvement: This is a collaborative project with ATO Terminal Systems Engineering Planning. Additional stakeholders identified and coordinated with include the ATO Terminal NextGen Procedures Integration Office and the NextGen Facilities Solution Set Coordinator. SNT will also utilize feedback from the Tower Flight Data Manager user working group. This feedback will be incorporated into future concept revisions and SNT prototypes. SNT activities such as human-in-the-loop (HITL) simulations and field demonstrations will utilize participants with appropriate experience and expertise. It is currently envisioned that this participation will be with current supervisors and certified professional controllers.

R&D Partnerships: The SNT program includes R&D partnerships with MIT Lincoln Labs and MITRE CAASD. NASA and universities may also be used to research specific human factors or operational/technical issues.

FY 2011 PROGRAM REQUEST:
The FY2011 activities will provide preliminary program requirements, operational procedures, cost benefit information, standards and alternatives in support of an investment analysis. In addition, SNT equipment installed at DFW will be maintained allowing for additional field demonstrations.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop a Business Case Analysis Report
- Develop an Implementation Strategy and Planning
- Identify Risk Metrics for initial investment analysis
- Update Enterprise Architecture products and amendments
- Maintain critical issues matrix
- Maintain SNT equipment at DFW

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	0
FY 2010 Enacted	0
FY 2011 Request	6,000
Out-Year Planning Levels (FY 2012-2015)	0
Total	6,000

Budget Authority ($000)	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:				
NextGen - Staffed NextGen Towers	0	0	0	6,000
Personnel Costs				
Other In-house Costs				
Total	**0**	**0**	**0**	**6,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic				
Applied				
Development (includes prototypes)	0	0	0	6,000
Total	**0**	**0**	**0**	**6,000**

1A08H – Staffed NextGen Towers (SNT) Products and Activities	FY 2011 Request	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Staffed NextGen Towers	6,000						
Preliminary Program Requirements			◊	◊	◊		
Business Case Analysis Report			◊	◊			
Implementation Strategy and Planning			◊	◊	◊		
Risk Metrics			◊	◊			
Enterprise Architecture products and amendments			◊	◊	◊		
Critical issues matrix			◊	◊			
Maintain SNT equipment at DFW			◊	◊	◊	◊	◊
System Design					◊	◊	◊
Decision support tools					◊	◊	◊
Personnel and Other In-House Costs							
Total Budget Authority	**6,000**	**0**	**6,000**	**0**	**0**	**0**	**0**

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**4A09A**	**Center for Advanced Aviation Systems Development (CAASD)**	**$23,564,000**

GOALS:
The program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: The FAA applies knowledge and expertise developed at its Center for Advanced Aviation System Development (CAASD) to produce a safer, more efficient global air transportation system. Studies performed at CAASD comprise an essential component of FAA research, systems engineering, and technical analyses. CAASD, a Federally Funded Research and Development Center (FFRDC), is operated for the FAA by The MITRE Corporation under a Sponsoring Agreement.

Agency Outputs: CAASD research and development identifies and tests new concepts and technologies for the National Airspace System (NAS) in the areas of aviation safety, performance-based navigation, airspace design, and traffic flow management that impact worldwide standards and applications. CAASD produces detailed reports and briefings on subjects across the entire spectrum of their work program. CAASD also develops sophisticated models and prototypes to test concepts and/or systems proposed for use in the management and control of air traffic. Presently, some of these new products are helping to shape a Next Generation Air Transportation System (NextGen) that will be safer, more efficient, and more readily available.

Customer/Stakeholder Involvement: The FAA responds to a constant challenge to increase safety in the nation's civil aviation system while increasing capacity and efficiency. CAASD is playing an instrumental role in the achievement of the NextGen goals and objectives, providing key operational and technological inputs based on its many years of research and analysis in areas such as Air Traffic Management (ATM), communications, navigation, and surveillance operations/capabilities. CAASD contributes directly to the goals and activities of the RTCA Air Traffic Advisory Committee, which is the principal forum to bring industry, aircraft operators, and FAA representatives together to define the operational needs and to identify an affordable NAS Architecture capable of satisfying those needs. Additionally, CAASD efforts contribute to the FAA's global aviation goals and the goals of the International Civil Aviation Organization (ICAO) through international aviation standards development activities.

Accomplishments: CAASD supported the following accomplishments:

- Enhanced the en route Trainer prototype with additional student performance measures and Intelligent Training Systems (ITS) capabilities that include additional real-time performance feedback and skill development aids. These prototype enhancements will be assessed at ZID during developmental training. The enhancements' evaluation data supports en route Trainer prototype capability technology transfer and the en route Trainer investment decision.
- Developed additional capabilities (technology, tools, and strategies) that help air traffic controllers perform tasks for the mid-term and post mid-term concept of operations. Conducted HITL evaluations with operational personnel. Evaluations and analyses of future concepts and capabilities provide operational understanding for deciding the evolution of capabilities toward NextGen.
- Developed a concept of operations for en route wake turbulence avoidance and assessed the potential impact of integrating wake turbulence separation standards in the automation for conflict probe, conflict alert, or as a distinct capability.
- Conducted experiments in collaboration with other research and stakeholder organizations to improve the FAA's understanding of key benefits enablers for the future Traffic Flow Management (TFM) and NextGen operations. These experiments provided insight into the full benefits potential for future concepts and help identify concepts and capabilities holding the greatest promise for NAS stakeholders.
- Identified technical, operational, and safety risks and mitigations associated with implementing wind-dependent wake departure procedures nationally. This work helps with the implementation of new procedures that will safely increase departure capacity at relevant high density airports.
- Provided enhanced en route data for the identification of major issues and to facilitate investment and resource decisions.
- Provided technical and systems engineering analysis of Unmanned Aircraft Systems (UAS) operations concerning detect, sense and avoid concepts, air-ground communications requirements, and national and

international standards for development and operation, resulting in integrated guidance to commercial and government operators of UASs.

- Modeled and assessed the impact of procedures for new FY 2009 traffic management capabilities, airspace changes, and emerging operational issues that require procedure enhancements to provide better efficiency.
- Refined and validated other advanced, high-benefit NextGen cockpit-based ADS-B applications that will provide the greatest benefits to the FAA and user community. Applications included call sign, oceanic – in-trail, and extensions of CDTI Assisted Visual Separation in other conditions.
- Researched and explored sector and airspace management concepts (e.g. dynamic sectorization) in the mid-term for operational efficiency, productivity, and workload balancing to enable national decisions on airspace policy and facility structure
- Performed analyses that characterize the performance of critical capabilities in various operational conditions for the enroute mid-term concept. These detailed algorithmic analyses determined the sensitivity of key performance metrics to algorithm parameters (e.g., problem resolution). Such analyses and evaluations of future concepts and capabilities provide operational understanding for deciding the evolution path of NextGen capabilities.
- Developed detailed cross-domain operational and technical evolution plans for transitioning to proposed Performance-Based Air Traffic Management concepts for the mid-term. Assessed user benefits (e.g. capacity) that may be realized from the proposed concepts. Initiated development of terminal concept extensions to the current scope of the overall Performance-Based Air Traffic Management concept that could further enable the transition to NextGen.
- Developed and evaluated an evolving set of simulation capabilities and curriculum changes to be integrated into the overall controller training process to; improve the process; improve the quality and consistency of training; reduce the training time and costs to certify a controller; and facilitate a more effective implementation of the NextGen solutions.
- Conducted experiments in collaboration with other research and stakeholder organizations to improve the FAA's understanding of key benefits enablers for the future TFM and NextGen operations.
- Identified gaps in the TFM future vision, particularly how it leads to the NextGen. Started to address the identified gaps through concept development, refinement, and evaluation.
- Completed a benefits and safety assessment for mid-term wake vortex procedures for departures under pre-defined wind conditions.
- Conducted several HITLS and analyses further refining the next stage of Merging and Spacing (M&S)/Continuous Descent Arrival (CDA) concepts, algorithms, and simulations. These analyses allowed the applications' benefits to be expanded, providing additional benefits to airlines as well as the FAA.
- Performed HITLS and analyses in support of the Enhanced Airport Surface Alerting application. This application is being researched as a future cockpit-based application that will reduce runway incursions and thus enhance safety on the airport surface.

R&D Partnerships: Extensive partnerships have been forged with industry suppliers, aircraft operators, other government entities and other non-profit research institutions through the CAASD work program. These relationships include:

- Air Force Research Laboratory (UAS collision avoidance technology);
- Cargo Airlines Association, Embry-Riddle Aeronautical University (research on ADS-B and its use for situational awareness [traffic and weather information in the cockpit] and self-spacing);
- Commercial avionics industry (technology transfer of UAT Beacon Radio technology);
- New Mexico State University Physical Sciences Laboratory (research on UAS operations in the NAS);
- University of Alaska at Anchorage (ADS-B integration on UAS and operational applications);
- Aurora Flight Sciences (ADS-B integration on UAS and operational applications);
- University of North Dakota (research on ground radar surveillance of UAS);
- University of Virginia (software assurance);
- North Carolina Department of Transportation Aviation Division (ADS-B technology demonstrations and operational applications);
- EUROCONTROL (future ATM research information exchange and flight object interoperability proposed standard);
- Joint University Program (research on National Airspace System capacity and NextGen concepts);
- Massachusetts Institute of Technology, International Center for Air Transportation (UAS and National Airspace System capacity research);

- MIT Lincoln Laboratory (wake turbulence mitigation, safety analyses, UAS, and Traffic Flow Management under weather uncertainty);
- NASA Langley (wake vortex and surface issues - capacity improvement);
- The National Center for Atmospheric Research (NCAR) (aviation weather impact and mitigation, and weather integration);
- United Parcel Service (research on techniques for merging and spacing);
- NASA Ames (continuous descent arrivals and merging & spacing concepts, safety data analysis);
- Monash University, Purdue University (system-wide economic modeling for aviation);
- The National Center of Excellence for Aviation Operations Research (NEXTOR) (National Airspace System capacity analyses and operations research);
- George Mason University, Interdisciplinary Center for Economic Science (economic analyses);
- The Volpe National Transportation Systems Center (operational evaluation of Air Traffic Management research topics and environmental research);
- Partnership for Air Transportation Noise and Emission Reduction (PARTNER) (environmental research);
- Virginia Polytechnic Institute and State University (system capacity analysis & modeling);
- Santa Fe Institute (research on complexity and complex systems engineering);
- Embry Riddle Aeronautical University, Lockheed-Martin, NASA Ames & Langley, FAA Technical Center, Boeing, Federal Express, Crown Consulting, and Raytheon (development of the AviationSimNet standard for distributed Air Traffic Management simulation); and
- Airliner Cabin Environment Research (ACER) (cabin sensor prototyping and research).

In addition, CAASD has collaborative relationships with a number of the other R&D Programs described in this Plan. These relationships include Airspace Redesign, Aviation Safety Risk Analysis, Joint Planning and Development Office, NextGen-New ATM Requirement, Runway Incursion Reduction, Wake Turbulence, Unmanned Aircraft Systems Research, and the William J. Hughes FAA Technical Center.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Expand the scope of terminal training ITS evaluation activity to include field evaluation activities at a second site in order to validate adaptability and demonstrate shorter training cycle times as a cost savings to the FAA. Conduct a high level needs assessment for the FAA's TRACON facilities to help prioritize where to deploy terminal training ITS systems.
- Develop and refine the terminal automation roadmap that aligns with the emerging NextGen Implementation Plans and concepts. The roadmap will need to accommodate advancements in RNAV/RNP concepts, Big Airspace, Virtual Tower, TFM advanced concepts, high density airport operations, and increasingly complex wake vortex separation algorithms.
- Demonstrate the benefits of advanced intelligent training systems (ITS) and curriculum changes at different phases of en route training. Continue transfer of validated ITS capabilities as available. Technology transfer products will reduce acquisition risk and support more efficient en route controller training.
- Model and assess the impact of procedures for new FY 2010 traffic management capabilities, airspace changes, and emerging operational issues that require procedure enhancements for improved efficiency.
- Provide technical and system engineering analysis of UAS operations concerning detect, sense and avoid concepts, air-ground communications, requirements, and national and international standards for development and operation, resulting in integrated guidance to commercial and U.S. government operators of UAS.
- Provide technical and system engineering analyses and an infrastructure and capabilities that enable the sharing of de-identified, aggregate safety information, supporting expanded and more effective safety analysis of U.S. aviation called for by the Commercial Aviation Safety Team (CAST). Establish an architecture that supports scores of simultaneous data queries from approved industry studies as well as automated risk detection applications. The initiative, called Aviation Safety Information Analysis and Sharing (ASIAS), will result in early detection of emerging safety trends and permit early intervention by FAA and industry.
- Provide detailed concept and capability assessments as input to the FAA's selection process for the third iteration (i.e. WP3) of TFM system enhancements. Quantify FAA efficiency and productivity benefits resulting from the down-selected list of TFM operational enhancements. This will allow the FAA to better justified planned TFM F&E expenditures and provide additional context for the investment decision expected in FY 2010.
- Provide initial data from the terminal analysis core capability assessment to identify major issues and to facilitate investment and resource decisions.

FY 2011 PROGRAM REQUEST:
CAASD provides independent advanced research and development required by the FAA to obtain technical analyses, prototypes and operational concepts needed to fulfill the vision for the FAA's Flight Plan, the NextGen Integrated Plan, and the NAS enterprise architecture. CAASD has unique knowledge, skills, and capabilities in aviation research, systems engineering and analysis. Its expertise is critical to the FAA in transforming the nation's air transportation system in an effective and timely manner.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Conduct technology transfers for validated ITS capabilities and other advanced simulation capabilities to enable the FAA to acquire a permanent capability for all of its busy Terminal Radar Approach Controls (TRACONS). These technology transfers will reduce acquisition risk and support improved, more efficient en-route controller training.
- Further develop and evaluate the student model of advanced Intelligent Training Systems (ITS) for ongoing demonstrations and technology transfer to enable streamlined, effective training of new ATC automation capabilities and procedure changes that are necessary to transform training and support introduction of NextGen capabilities.
- Model and assess the impact of procedures for new FY 2011 traffic management capabilities, airspace changes, and emerging operational issues that require procedure enhancements for improved efficiency.
- Conduct multi-year research into capabilities that enable decision makers to understand and visualize the relative risk of individual UAS flight profiles. In FY2011, focus is on updating a baseline prototype UAS flight profile model. This work will result in greater UAS access to the NAS.
- Extend technical and system engineering analysis of UAS operations concerning detect, sense and avoid requirements, air-ground communications, and national and international standards for development and operation.
- Provide technical and system engineering analysis to evolve the infrastructure and capabilities that enable the sharing of de-identified, aggregate safety information, supporting expanded and more effective safety analysis of U.S. aviation called for by the CAST. Expand the architecture that supports scores of simultaneous data queries from approved industry studies as well as automated risk detection applications. Integrate data from foreign carriers, original equipment manufacturers, and JPDO member agencies into the ASIAS system.
- Refine the modernized TFM system's future concepts and capabilities for use by FAA as inputs planning and for future technology transfers. Increased technology transfer from research into development will reduce the risk of FAA's development activities.
- Provide data from the terminal analysis core capability to identify major issues for selected terminal facilities and to facilitate investment and resource decisions.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	259,664
FY 2010 Enacted	23,944
FY 2011 Request	23,564
Out-Year Planning Levels (FY 2012-2015)	106,317
Total	413,489

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Center for Advanced Aviation Systems Development (CAASD)	30,100	24,640	22,932	23,266	23,564
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**30,100**	**24,640**	**22,932**	**23,266**	**23.564**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	
Applied	0	0	0	0	
Development (includes prototypes)	30,100	24,640	22,932	23,266	23,564
Total	**30,100**	**24,640**	**22,932**	**23,266**	**23,564**

4A09A - Center for Advanced Aviation System Development Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Research, Engineering and Development	**23,564**						
Evolve/perform next phases of merging and spacing, cockpit display of traffic information assisted visual separation, and continuous descent arrivals simulations		◆	◊	◊			
Conduct analyses of key requirements issues (e.g. system safety) and plan for NAS evolution to inform NextGen decisions related to productivity improvements, including defining functional and system requirements and NAS architecture changes		◆	◊	◊	◊	◊	◊
Develop and validate student controller performance measures, real time performance feedback and skill development aids related to the evaluation of controller training technologies		◆	◊	◊	◊		
Conduct HITLS and analyses examining the potential benefits to and operational changes for ATC as the result of the eventual deployment of ADS-B on the ground and in the cockpit in the near-, mid-, and far-term					◊	◊	
Advance the maturity of TFM concepts to account for uncertainty in predictions and decision making by developing algorithms and prototype capabilities and conducting (HITL) evaluations		◆	◊	◊			
Provide assessments of TFM concept maturity, operational feasibility and implementation risks, including identification of cross-domain dependencies.		◆	◊	◊			
Develop an aviation environmental portfolio tool that allows the FAA to evaluate the impact of environmental policies on aviation demand and on the national economy.					◊	◊	◊
Develop information derived from enhanced data to address key FAA issues and inform decisions.		◆	◊	◊	◊	◊	◊
Enhance and extend terminal performance data used in FAA operational and investment decision making.		◆	◊	◊	◊	◊	◊
Air Traffic Operational Research and Special Situation Support							
Provide technical and operational expertise to enhance the quality and efficiency TRACON controller training through the use of advanced training technologies		◆	◊	◊	◊		
Provide technical and operational insight into systems that can be used to safely permit increase productivity and capacity in the terminal area.		◆	◊	◊	◊	◊	◊
Determine the potential safety risks, operational concepts, and standards associated with increased unmanned aircraft system access to the NAS		◆	◊	◊	◊	◊	◊
Provide technical and system engineering analysis, evolution planning, data and analytical model integration, requirement analysis, and validation experimentation for ASIAS.		◆	◊	◊	◊	◊	◊
Total Budget Authority	**23,564**	**23,944**	**23,564**	**23,594**	**24,148**	**24,703**	**33,872**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS. IN THE F&E APPROPRIATIONS, PERSONNEL AND OTHER COSTS ARE BUDGETED IN ACTIVITY 5, NOT THE PROGRAM BUDGET LINE ITEM.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
AIP	**N/A**	**Airport Cooperative Research – Capacity**	**$5,000,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes: The objective of the Airport Cooperative Research Program (ACRP) is to carry out applied research on problems that are shared by airport operators and are too difficult for individual airports to solve on their own. Additionally, ACRP studies issues that are not being adequately addressed by existing Federal research programs. ACRP undertakes research in a variety of airport subject areas, including design, construction, environment, maintenance, safety, security, policy, planning, human resources, administration, and operations.

Congress established ACRP through the Vision 100–Century of Aviation Reauthorization Act of 2003 (Vision 100). As called for in Vision 100, a Memorandum of Agreement was developed to provide organizational guidance for the three main entities that fund, administer, and oversee ACRP. The FAA funds the program. The National Academies, acting through its Transportation Research Board (TRB), administers the program. The ACRP Oversight Committee (AOC), an independent governing board comprised of airport managers and other aviation officials appointed by the U.S. Secretary of Transportation, selects all of the program's research projects.

Agency Outputs: The ACRP-Capacity program conducts research to provide better airport planning and design. Future aviation demand will rely on the ability of airports to accommodate increased aircraft operations, larger aircraft, and more efficient passenger throughput. This program will prepare for those future needs while simultaneously solving near-term and current airport capacity issues.

Research Goals: TRB annually solicits the aviation community for input on future research topics and industry concerns. New research priorities are therefore generated on a yearly basis under the direction of the AOC.

Customer/Stakeholder Involvement: ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, State and local government officials, equipment and service suppliers, airport users, educational institutions, other research organizations, and the general flying public. These stakeholders generate project ideas, guide projects while they are under way, and serve as the ultimate end-users of the final research products.

Representatives from these organizations also serve on the AOC where they help select ACRP research projects. Federal representation on the AOC is comprised of the FAA, along with NASA and the Environmental Protection Agency (EPA). The aviation industry is further represented on the AOC through the participation of the following groups: the Airports Council International (ACI), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA).

R&D Partnerships: ACRP is a cooperative partnership with airports and federal agencies to conduct airport research. The research will be conducted by universities, airports, and companies within the aviation industry.

Accomplishments

FY 2009:
Fast, Flexible, and Efficient

- Developing a guidebook for airport capital project delivery systems. This research reviews and assesses delivery acceleration strategies, techniques, and practices at program and project levels, from conception to completion. The research product serves as a comprehensive source of information on strategies, techniques, and practices that may be used to accelerate delivery and avoid delay throughout the entire process. (ACRP Report 21, formerly 1-05)
- Generating a unified database on passenger-related processing rates in an electronic spreadsheet or database format that is useful to planners, designers, and other interested parties. These results provide guidance on how best to collect passenger-related processing point data. (ACRP Report 23, formerly 3-02)
- Developing guidelines for the collection and use of geospatially referenced data for use in the management of airfield pavements. Such guidelines promote compatibility of data collected at different facilities; improve

integration, sharing, and analysis of data; provide an effective means for economically addressing issues of common concern; and help better manage investments in airfield pavements. (ACRP 09-01)

- Producing a guidebook that airport operators can use to compare and contrast various parking strategies and supporting technologies and then evaluate each for application to individual airport situations and demographics. The guidebook describes airport-parking strategies, categorizes each strategy, offers methods to evaluate each strategy, matches existing and emerging technologies that support each strategy, and provides guidance on how to implement each strategy and its supporting technology. (ACRP 10-03)

Human-Centered Design

- Developing an intuitive, easy-to-use guidebook of best practices for developing, soliciting, and managing airport agreements for use by airports of all sizes. The guidebook includes an interactive CD-ROM that contains templates with options and alternatives for each type of agreement. These include: agreements for airport use (airline and non-airline); design and construction; commercial development; commercial operations; management; intergovernmental relations; real estate; maintenance and operations of buildings and grounds; utilities; administrative services; military use; airport "through-the-fence" operations; common-use facilities; ground transportation; concessions for a variety of passenger services (rental car, parking, retail/food/beverage); and others as appropriate. (ACRP 01-02)
- Producing a handbook of airport operational and financial data that provides useful information and resources for airports as they implement systems necessary to effectively meet operational needs, make informed business decisions, and forecast operational and financial trends. This research: (1) assesses the current state of the industry related to managing appropriate data from business-related financial and operational activity, (2) develops guidelines and current best practices to fully integrate these data and the business-critical information that they indicate, (3) develops functional specifications for procuring open-architecture systems for integrating these data, and (4) describes a vision of an airport with fully integrated business, operational, and financial information systems. (ACRP Report 13, formerly 01-03)
- Developing a guidebook for airport-user survey methodology. This research examines issues such as: the selection of sample size and appropriate sample design; how to handle responses from large parties, such as tour groups or sports teams that have been encountered in the survey; and how to appropriately weight individual survey responses in presenting the survey results. (ACRP 03-04)
- Developing a user–friendly spreadsheet model (or models), with an accompanying manual, to analyze issues common to airport passenger terminal planning and design. This research produces a compendium that identifies the types, scopes, and availability of spreadsheet and discrete event models that can be used by airport operators for airport passenger terminal planning and design. The prime users of this project's products are intended to be employees of airport operators who are involved in terminal planning and design. (ACRP 07-04)

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fast, Flexible, and Efficient

- Developing passenger space allocation guidelines for terminal functional areas. The guidelines are based on level-of-service (LOS) scales developed from data collected at a sample of 10 airports. The guidelines will be used by airport operators, planners, and consultants in making decisions on development of new terminals and renovation of existing facilities. (ACRP 03-05)
- Preparing a comprehensive guidebook for planning and implementing automated people mover (APM) systems at airports. The guidebook includes a CD-ROM with interactive tools designed to assist airports to plan and implement an APM system. The scope of this research includes APM systems that provide transportation on airport grounds as well as access to remote facilities (e.g., airport parking, car rental facilities, hotels, off-airport public transportation, and other related activity centers). (ACRP 03-06)
- Developing a user-friendly guidebook for measuring performance of automated people mover (APM) systems at airports. The guidebook identifies a set of performance measures and associated data requirements for APM operators at airports to assess and improve performance, compare APM systems, and plan and design future APM systems. The performance measures address the efficiency, effectiveness, and quality of APM systems at airports, particularly focusing on impacts on APM passengers and on airport performance. (ACRP 03-07)
- Developing integrated strategic actions to enhance decision making to address the constrained aviation system capacity and growing travel demand in the high-density, multijurisdictional, multimodal, coastal mega-regions along the east and west coasts. The research results will be used by transportation agencies and operators, as well as for informing public officials at the federal, state, and local levels. (ACRP 03-10)

- Preparing a guidebook enabling airport operators to define more effectively airport peak-period and operational profiles necessary for facility and environmental planning. This guidebook includes an analytical toolbox and associated application and implementation procedures. The guidebook will help airport facility managers and operators evaluate (a) capacity requirements and operational improvements (e.g., examine how common-use or preferential gate use can accommodate increased passenger demand); (b) implications of designing facilities to accommodate alternative peak periods (e.g., those occurring more or less frequently); and (c) specific facility requirements as a function of larger-scale control totals (e.g., annual passengers or aircraft operations). (ACRP 03-12)
- Preparing a comprehensive guidebook that serves as a decision-support tool for planning, designing, and evaluating passenger conveyance systems at airports. This research examines how passenger conveyance systems operate and provide service to different areas within the airport environment. For the purpose of this research project, passenger conveyance components include, but are not limited to, escalators, elevators, moving walkways, wheelchairs, and passenger assist vehicles/carts. (ACRP 03-14)
- Developing a handbook that airport operators can use to assess the access impacts of constrained public and/or employee parking at airports. For airports where constrained parking exists or is expected, the handbook provides guidance on how to quantify the impacts of potential changes in airport customer and employee access resulting from strategies such as changes in parking rates, the provision of new or improved public or private transportation services, and the introduction of remote parking facilities. The handbook allows airport operators to better understand, anticipate, and evaluate changes in airport parking strategies at airports where constrained parking exists or is expected. (ACRP 10-06)
- Reporting on the state of airport system planning practices through a review of literature and survey of state aviation agencies, regional planning organizations, and the FAA. The primary audience for this synthesis report includes airport operators, regional planning agencies, state aviation agencies, and the national and regional FAA staff. (ACRP Synthesis 14, formerly 11-03 / S03-04)

Human-Centered Design

- Developing a practical, easy-to-use guidebook for managing small airports. The guidebook is designed to be useful to owners, operators, managers, and policy makers of small airports. To achieve this objective, the research: (1) identifies fundamental management principles, (2) identifies best practices for effective use and management of resources and facilities, and (3) presents the information in an attractive, convenient format. A major element of this research is the identification of best practices that achieve safe and efficient operations while maintaining compliance with regulatory requirements and federal obligations. (ACRP Report 16, formerly 01-01)
- Developing a guidebook for small airport marketing, external communications, and public information. The guidebook describes effective airport marketing practices, provides guidance in their use, and assists airports in developing an airport marketing strategy. (ACRP 01-04)
- Producing a practical, user-friendly guidebook that: (1) assists airport management in understanding the practical benefits of a performance-measurement system; (2) identifies methods to help airports discern how well they are meeting their customer and stakeholder expectations; (3) guides the development and implementation of the most appropriate performance-measurement system; and (4) provides examples of key performance indicators, and how to incorporate them into a system. Performance-measurement systems resulting from this guidebook enhances the decision-making process to improve service and efficiency. (ACRP 01-06)
- Developing a resource manual for airport and airline professionals that: (1) describes the current range of practices and characteristics of airport and airline relationships and their relative, underlying airport and airline business models; (2) identifies and briefly summarize rates and charges policies and guidance; (3) identifies, compares, and contrasts airport and airline critical issues, objectives, and considerations inherent in airport/airline agreements or other business arrangements; and (4) identifies and synthesizes the trade-offs and linkages among the critical issues as they relate to common objectives for airport/airline negotiations. (ACRP 01-07)
- Developing a guidebook for airport management and other relevant stakeholders to implement leasing, property management, and development agreements in the context of airport improvement and expansion plans. The research identifies and defines best management practices used in formulating airport leasing and development policies to support public and private investments for aeronautical and non-aeronautical uses at airports. This research assists airport proprietors in making planning, policy, and financial decisions that will protect both the federal and local investment in the national airport system. (ACRP 01-08)

- Preparing a guidebook that describes techniques that airports and communities can employ in their efforts to develop passenger air service. The guide includes fundamental information to assist airports and the communities they serve to understand the nature of ASD within the general context of the airport, community, and airline business perspectives. (ACRP 03-08)
- Preparing a practical guidebook for airport professionals, airport policy-making organizations, and industry associations that contains procedures, tools, and benefits for the strategic planning process. The guidebook addresses the use of continuous strategic planning and considers relevant policy, management, and technical issues at airports, recognizing local, national, and global uncertainties. (ACRP 03-09)

System Knowledge

- Developing a guidebook that defines and explains the various criteria used to identify objects that affect the airspace needed by an airport for its current and future operations, as well as the interrelationships between these criteria. The guidebook is intended to be used by airport operators, consultants, and surrounding communities in understanding the airport's current and future airspace needs and how objects individually and collectively can affect the safety, utility, and efficiency of their airport. (ACRP 03-13)

FY 2011 PROGRAM REQUEST:

The FAA has requested $15 million for ACRP in FY 2011 as part of the Airport Improvement Program. Of the total amount, $5 million will be provided for each of the 3 ACRP program areas of Safety, Capacity, and Environment.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fast, Flexible, and Efficient

- Producing a computer model that can be used by airport operators and planners to examine the impact of jet fuel price on supply and demand for air service at commercial service airports, and the resulting impact on airport development and finance. This model will be constructed using a software platform generally available at nominal cost, using specified airport parameters drawn from a broad list of relevant categories (ACRP 3-15)
- Developing a guidebook to assist airport planners with airfield and airspace capacity evaluation. The guidebook addresses airport airfield and airspace capacity planning at all types of airports. The research results will present capacity modeling guidelines that will improve the decision-making process for determining the appropriate level of modeling sophistication for a given planning study or capital improvement project and make the process more consistent from airport to airport. (ACRP 3-17)
- Documenting lessons learned during recent airport facilities openings so that effective airport terminal facility activation practices can be identified and shared across the industry. The target audience for this synthesis is terminal operators and those involved in the facility activation process. The research effort will include a literature review of facility activation techniques and interview of ten or more airport terminal operators that have recently opened a facility in order to identify steps undertaken for successful activations. (ACRP 11-03/S08-01)

Human-Centered Design

- Developing a handbook that identifies best management practices in all phases of development, management, financing, and oversight of airport capital plans and includes those elements, steps, and key milestones that are necessary to create a collaborative business process that ensures the consistent flow of information and maintains the capital plan. This includes reporting, updating, and tracking financial and individual project information and identifying the processes that facilitate communication between internal and external stakeholders (e.g., airlines, FAA, local and state officials). The handbook should also identify and translate the elements of the collaborative business process so that it can be incorporated into an information technology solution. (ACRP 1-10)
- Develop a resource manual to help airports and managers understand market potential and implementation requirements for an effective in-terminal concession program while recognizing evolving challenges. This Resource Manual will be a tool for use by airport staff involved in and responsible for the business decisions affecting the development of concession programs and plans. It will also serve as an informational tool for other stakeholders, including but not limited to, airport board members, airlines involved in creating concession programs and concessionaires. (ACRP 1-11)
- Develop an easy-to-read primer that speaks to two distinct audiences, the airport's executive manager and the information technology (IT) professional, in order to facilitate mutual understanding of each other's perspective of the fundamental considerations for IT at the airport. Fundamental considerations include functional architectural concepts, functional and strategic objectives, mutual and disparate expectations,

total costs (i.e., life-cycle, acquisition, implementation, activation, operation, and maintenance), benefits, consequences, priorities, risks, and other relevant considerations. (ACRP 1-12)

- Providing airport operators and users with a comprehensive tool for identifying potential sources of funding for airport environmental projects. The synthesis report will provide airport operators with a series of funding alternatives to facilitate important environmental projects being carried out that would otherwise be postponed. The research will highlight programs that airport operators can access for funding, but other programs found of interest to airlines, concessionaires, and lessees will be included to the extent identified. (ACRP 11-03/S02-05)
- Collecting and reporting on existing, common and successful methods and resources currently available to develop and train personnel for aviation and airport professions. The report will also identify additional research efforts needed to increase the number of experienced job seekers in the aviation industry and provide the entire industry a continuous resource of interns available to mentor and aid in meeting growing workload demands. The report will include a literature review, survey, and evaluation of survey results and a summary of common practices to develop and train personnel. (ACRP 11-03/S06-01)
- Describing the current state of ramp operational and safety techniques available to airports and their tenants, including airlines, ground handling agents, fuelers, caterers and others having significant levels of ramp activity. The synthesis report will provide a compilation of common practices currently in effect, rather than undertake any original research on potential future techniques. (ACRP 11-03/S10-05)
- Documenting how airports implement a pavement maintenance management program, including inspection and tracking pavement condition, scheduling maintenance, identifying necessary funds, and treating distresses in asphalt and concrete pavements. This research effort will document effective practices and differences in maintenance practices by pavement type, airport category and geographical location (e.g., weather and availability of materials). (ACRP 11-03/S09-02)

System Knowledge

- Developing, for a wide variety of types and sizes of airports, a resource manual with a searchable (by airport type and size) CD-ROM that contains an extensive list of airport performance indicators, categorized by functional type, and identifies a subset of fundamental "core" performance indicators within each category. The resource manual will present and define each indicator, suggest methods for collecting relevant data for each indicator, and generally, support the implementation of an airport's performance measurement system as intended in ACRP Project 01-06, "Guidebook for Developing an Airport Performance Measurement System." (ACRP 1-09)
- Prepare a compilation and analysis of economic and operational data for airport benchmarking purposes. These data could be used as part of cross sectional and time series analyses. This would permit measures of relative efficiency and performance to be developed. The output of this would be both a descriptive financial summary of the U.S. airport industry as well as specific analyses related to cost and performance for this important sector of the economy. (ACRP 1-13)
- Preparing a handbook for airport operators and planners to (1) identify issues and requirements relating to water resources (including quality and quantity, wetlands, and groundwater) that may affect the environmental review process linked to airport capacity improvements; (2) describe potential effects of not adequately addressing these issues and requirements; and (3) develop strategies airports can employ to implement improvements in a timely and cost-effective manner while protecting water resources. (ACRP 2-11)
- Developing a guidebook for use by airport operators and other air cargo industry stakeholders that provides tools and techniques for measuring existing and future economic impacts of air cargo activities at a national, regional, and local airport level in the context of changing market, financial, security, and other conditions. Critical issues in measuring economic impacts of air cargo activity at a given airport include, but are not limited to: (1) size of the air cargo market, (2) source and purpose of air cargo activity, (3) effect of changing fuel prices, (4) understanding complex linkages to changing economic conditions, (5) effect of increasing security requirements, and (6) availability and comparative cost of alternate cargo shipment modes. (ACRP 3-16)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	19,950
FY 2010 Enacted	5,000
FY 2011 Request	5,000
Out-Year Planning Levels (FY 2012-2015)	20,000
Total	49,950

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airport Cooperative Research - Capacity	5,000	5,000	5,000	5,000	5,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	5,000	5,000	5,000	5,000	5,000
Total	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

Airport Cooperative Research - Capacity Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airport Cooperative Research Program							
Capacity-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◇	◇	◇	◇	◇
Airport Parking Strategies and Technologies		◆					
Aviation Capacity in Coastal Mega-Regions		◆					
Automated People Mover Planning and Performance		◆					
Airport Peak-Period Operational Profiles		◆					
Airport Management – Contracts /Software/ Revenue		◆					
Small Airport Management BMPs		◆					
Airport System Planning Practices		◆					
Developing Airport Strategic Plans		◆					
Small Airport Marketing Techniques		◆					
Airport Performance Measurement Systems		◆					
Airport Development and Oil Price Uncertainty		◆	◆				
Airport Airfield Capacity Analysis		◆	◆				
Capital Projects – Best Practices		◆	◆				
Airport Concession Planning		◆	◆				
Airport IT Primer		◆	◆				
Airport Performance Indicators		◆	◆				
Compilation of Airport Benchmarking Data		◆	◆				
Airport Privatization		◆	◆	◆			
Airport Alternative Revenue Strategies		◆	◆	◆			
Asset Management		◆	◆	◆			
GA Business Planning		◆	◆	◆			
Business and Operational Continuity		◆	◆	◆			
Aircraft and Airfield Delay		◆	◆	◆			
Total Budget Authority	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
AIP	**N/A**	**Airport Cooperative Research – Environment**	**$5,000,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes: The objective of the Airport Cooperative Research Program (ACRP) is to carry out applied research on problems that are shared by airport operators and are too difficult for individual airports to solve on their own. Additionally, ACRP studies issues that are not being adequately addressed by existing Federal research programs. ACRP undertakes research in a variety of airport subject areas, including design, construction, environment, maintenance, safety, security, policy, planning, human resources, administration, and operations.

Congress established ACRP through the Vision 100–Century of Aviation Reauthorization Act of 2003 (Vision 100). As called for in Vision 100, a Memorandum of Agreement was developed to provide organizational guidance for the three main entities that fund, administer, and oversee ACRP. The FAA funds the program. The National Academies, acting through its Transportation Research Board (TRB), administers the program. The ACRP Oversight Committee (AOC), an independent governing board comprised of airport managers and other aviation officials appointed by the U.S. Secretary of Transportation, selects all of the program's research projects.

Agency Outputs: The ACRP-Environment program examines the impact an airport has on the surrounding environment and advances the science and technology for creating an environmentally friendly airport system. Projects include the study of airport specific aviation noise and emissions and their environmental impacts, developing strategies and guidance for green airports via reduction in noise and emissions, infrastructure and benefits of alternative aviation fuels at airport facilities, deicing management, and advanced noise and emissions databases.

Research Goals: TRB annually solicits the aviation community for input on future research topics and industry concerns. New research priorities are therefore generated on a yearly basis under the direction of the AOC.

Customer/Stakeholder Involvement: ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, State and local government officials, equipment and service suppliers, airport users, educational institutions, other research organizations, and the general flying public. These stakeholders generate project ideas, guide projects while they are under way, and serve as the ultimate end-users of the final research products.

Representatives from these organizations also serve on the AOC where they help select ACRP research projects. Federal representation on the AOC is comprised of the FAA, along with NASA and the Environmental Protection Agency (EPA). The aviation industry is further represented on the AOC through the participation of the following groups: the Airports Council International (ACI), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA).

R&D Partnerships: ACRP is a cooperative partnership with airports and federal agencies to conduct airport research. The research will be conducted by universities, airports, and companies within the aviation industry.

Accomplishments: Program outputs during the first two years have been focused on low-cost, rapid-response projects on urgent airport problems:

FY09

Clean and Quiet – Baseline Measurement

- Producing a prioritized agenda of research needs associated with aircraft and other airport-related sources of Hazardous Air Pollutants. These needs include, but not be limited to, identifying the types of HAPs being emitted; their sources, detection and measurement; and possible health and other environmental impacts. (ACRP Report 7, formerly 2-03)
- Developing a prioritized agenda of research needs relating to airport sources of PM emissions. The agenda has been developed by (1) conducting a survey of airports regarding PM emissions issues and concerns and

(2) identifying, reviewing, and evaluating past and current research relating to airport sources of PM emissions. (ACRP Report 6, formerly 2-04)

Clean and Quiet – Threshold Levels

- Summarizing, analyzing, and interpreting the scientific data available from the Aircraft Particle Emissions Experiment (APEX) 1-3 and the Unnamed Airport-Unnamed Airline (UNA-UNA) experiment. The results, presented in a comprehensive report, help the airport community and general public understand the data's ability to understand industry data generated on gaseous and particulate emissions and contribute to developing better air quality assessments in the airport environment. (ACRP Report 9, formerly 2-04A)
- Developing a guidebook that can be used to prepare airport source-specific inventories of greenhouse gas (GHG) emissions. The guidebook provides methods to calculate airport GHG emissions inventories in a consistent manner and provides information on considerations that should be taken into account when scoping and preparing such inventories. This guidebook focuses on the following six GHG emissions since they are widely recognized as relevant and quantifiable: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), sulfur hexafluoride (SF6), hydrofluoro compounds (HFC), and perfluorocarbons (PFC). (ACRP Report 11, formerly 2-06)

Clean and Quiet – Reduction Techniques

- Define the present state of the art of aircraft deicing and anti-icing fluids (ADAF) with respect to minimizing their aquatic toxicity and biological oxygen demand (BOD5). The results also identify ADAF components causing aquatic toxicity and BOD5, identify promising alternative ADAF formulations with reduced aquatic toxicity and BOD5, evaluate the performance, efficiency, material compatibility, and environmental, operational, and safety impacts of these alternative ADAF formulations compared with current commercial products, and describe the fate and transport of ADAF and their degradation products. These results inform stakeholders of the operational and environmental benefits of alternative ADAF formulations with reduced aquatic toxicity and BOD5. (ACRP 02-01)
- Developing planning guidelines incorporating an array of best management practices (BMPs) for the practical, cost-effective control of runoff from aircraft and airfield deicing and anti-icing operations. These planning guidelines and BMPs are (1) consistent with the laws and regulations for protecting water quality and ensuring flight safety; (2) provide practical technical guidance to airports and local, state, and federal regulators; and (3) support the U.S. EPA's ongoing efforts to gain better information on how airports manage ADAF-affected stormwater runoff. (ACRP Report 14, formerly 2-02)
- Preparing a handbook that airport operators can use to evaluate the costs and benefits of providing a "drop-in" alternative turbine engine fuel at airports, taking into account that such fuel may also be used for other purposes (e.g., ground vehicles, generators). The cost and benefit analysis includes, at a minimum: infrastructure changes, operational/maintenance impacts, and environmental factors. The handbook also includes templates and illustrative examples of cost and benefit analyses for different sizes of airports and types of fueling facilities. (ACRP 02-07)
- Identifying procedures and technologies that optimize the use of aircraft deicing and anti-icing fluids, thus reducing their environmental impact while assuring safe aircraft operations in deicing and anti-icing conditions. The project produces (1) a description of the application of currently available procedures and technologies to optimize ADAF use, (2) the results of an experiment to validate the effectiveness of promising procedures and technologies, (3) a plan for implementation of these promising procedures and technologies, and (4) recommendations for further study. (ACRP 10-01)

Human-Centered Design

- Developing an informative guidebook about local aircraft noise to inform readers with a direct interest, involvement, or Investment in airports. In addition, this research effort will: develop a toolkit that airport decision makers can use to manage expectations related to aircraft noise within the community; investigate alternative metrics to communicate noise issues to the community; and suggest other improvements that go beyond current practice to ease aircraft-noise issues. For this project, the term "noise issues" involves the socioeconomic, political, operational, safety, environmental, and legal impacts of aircraft noise on an airport; the complaints about aircraft noise from neighbors; the effects that noise has on neighbors; and the communication between the airport and its neighbors. This research also identifies the actual jurisdictional authority over various aspects of the aircraft-noise issue, and the obstacles to airport operations and development because of community perceptions of local aircraft noise. (ACRP 02-05)

FY08

Clean and Quiet – Reduction Techniques

- Conducting an energy-use study of Terminals B and D at Dallas-Fort Worth Airport. This effort provides a model energy report and informational brochure for airport managers that focuses on pro-typical operations, building commissioning, and energy conservation retrofits opportunities. (ACRP Research Results Digest 2, formerly 11-02/T1)
- Producing a report that explores airport sustainability practices across environmental, economic, and social issues. The issue of sustainability is explored, which involves airport facilities and operations, management, and development protocols to ensure economic viability, operational efficiency, natural resource conservation, and social responsibility. Initial aviation industry research and sources validate that sustainability initiatives are implemented and become part of airport management practice in response to the aviation/airport industry's financial pressures, as well as to the expectations or mandates of communities or regulatory agencies. (ACRP Synthesis 10, formerly 11-03 / S02-02)

Clean and Quiet – Baseline Measurement

- Investigating how airports chemically treat their airport pavements to mitigate snow and ice, and the chemicals used, which may impact associated aircraft equipment and airport infrastructure. The areas of pavement deicing product interaction with aircraft brakes and deicing fluids, concrete and asphalt pavements, and airport ground service equipment are explored. (ACRP Synthesis 6, formerly 11-03 / S10-03)

Clean and Quiet – Threshold Levels

- Revising the 1985 FAA publication on Aviation Noise Effects. This document will serve as the new compendium of research concerning the effects of aircraft noise, and function as a centralized location for information that summarizes the findings of new research and conclusions. (ACRP Synthesis 9, formerly 11-03 / S02-01)

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Clean and Quiet – Baseline Measurement

- Designing and implementing a test program to measure gaseous hazardous air pollutant (HAP) emissions from in-production jet engines operating at a range of idle settings and ambient temperatures. The primary research objective of this program encompasses measurements of total hydrocarbons and speciated hydrocarbons, including HAPs, within the exhaust plume at a reasonable proximity of the engine nozzle to capture emissions prior to condensation of volatile gasses. The secondary objective of this project captures measurements at a downstream location where the plume has cooled to near-ambient temperatures. (ACRP 02-03A)
- Gathering data and developing a robust estimate of what potential deicing chemical use may be today and how it may vary by geographic location and or seasonal weather characteristics. In addition, this research effort gathers and summarizes information on the existing Clean Water Act regulatory requirements that directly address the potential discharge of deicing runoff because full implementation of these existing programs sheds important light on the potential effect of related controls and/or potential environmental threats these activities represent. This information is designed to help to direct potential future Estimate of National Use of Aircraft and Airfield Deicing Materials. (ACRP 11-02 / T10)

Clean and Quiet – Threshold Levels

- Providing guidance for airport operators on effective tools and techniques for measuring airport contributions to ambient air quality. This research evaluates existing and potential monitoring strategies and forecasting techniques that airport operators can use to measure airport-related air quality impacts on local jurisdictions that may exceed what is traditionally measured and modeled for National Environmental Policy Act (NEPA) purposes. This research project identifies gaps in existing models and the inputs to those models, future research needed to fill those gaps to improve the predictive capabilities of available models, a set of detailed recommendations for implementing an optimal emissions monitoring and forecasting strategy, and guidance to airport operators on how to select and carry out that strategy. (ACRP 02-08)

Clean and Quiet – Prediction

- Producing a comprehensive Model Development Plan (MDP) that will guide future development of a model to facilitate integrated quantification of multimodal noise and emissions, as well as economic analysis of alternative scenarios. The model that will result from implementing the MDP will consist of an analytical tool or set of tools in the form of a "super" model (i.e., a single, inclusive model designed to address all desired

components) and/or a tool that combines inputs and/or outputs of existing or new models. This research defines the process required to create this model, but does not result in the actual development of the model. The research determines the feasibility of an integrated approach to quantification of multimodal noise and emissions, the form that this model might take, and the process required to create the model. (ACRP 02-09)

- Improving the ability to evaluate noise generated by aircraft ground operations, allowing airport staff, airport planners, and consultants to incorporate taxiway noise modeling in their evaluations systematically when needed. This capability will increase the accuracy of airport noise modeling, thus improving chances that significant noise impacts and incompatible land-uses are properly identified, and that appropriate mitigation strategies are addressed. This research will enable a joint assessment of both noise and air quality, resulting in more balanced and comprehensive decisions in airport planning. (ACRP 11-02 / T8)

FY 2011 PROGRAM REQUEST:
The FAA has requested $15 million for ACRP in FY 2011 as part of the Airport Improvement Program. Of the total amount, $5 million will be provided for each of the 3 ACRP program areas of Safety, Capacity, and Environment.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:
Clean and Quiet – Baseline Measurement

- Developing a departure optimization methodology to (1) quantify potential reductions in fuel burn and source emissions, (2) estimate possible increases in air traffic capacity that can be achieved by optimizing departure procedures while continuing to address noise exposure for communities around airports, and (3) account for existing and future fleet mixes and improvements envisioned under NextGen. In the context of current noise abatement departure procedures, this methodology should estimate environmental and capacity-related benefits associated with the following localized contributors: (a) source noise reduction in future engine/airframe technologies, and (b) realistic alterations to present noise abatement departure procedures to help regulators and airport management make environmentally optimal decisions. (ACRP 2-12)

Clean and Quiet – Threshold Levels

- Defining the current range of factors considered in the development of storage and conveyance systems for the management of winter storm design conditions. Based on these factors, a process will be developed for analyzing key design factors and evaluating design storm or design conditions. This research will focus on evaluation of design storm events as well as design conditions which may consist of multiple small events (ACRP 2-19)

Clean and Quiet – Reduction Techniques

- Developing a guidebook of practices for improving environmental performance at small airports. The objective of this research is to provide managers of small airports with a guidebook (1) promoting environmental awareness, (2) identifying federal environmental compliance requirements, (3) outlining those best management practices that proactively enhance environmental stewardship, and (4) identifying resources/tools that airports can use to be proactive. (ACRP 2-13)
- Evaluating the requirements associated with locating alternative fuel production facilities on or adjacent to airports. This research will address legal requirements, funding opportunities, environmental considerations, public concerns, and logistical considerations associated with locating an alternative fuel production facility adjacent to or at an airport. The research will also identify in detail the potential benefits associated with constructing and operating a facility adjacent to or at an airport. To the extent that projects already have been or are being developed, the project should identify lessons learned during implementation. The research will help evaluate the benefits and identify the hurdles associated with locating an alternative fuel production facility near an airport. The objective of this project is to further the progress toward the widespread use of environmentally friendly alternative fuels in the aviation industry. (ACRP 2-18)
- Evaluation of aviation growth capacity within state implementation plans (SIPs). Given that most SIP emission forecasts for aviation sources differ with the FAA's aviation activity TAF, the objective of this research is to develop recommendations and/or guidance for local and state agencies to better represent future airport emission sources in their SIP forecasts. This research will answer the following questions. What portion(s) of the individual SIP emissions budgets do airport sources represent? What are the forecasted out years of SIP attainment compliance? How were airport emission sources forecasted for these out years? How do the SIP emissions forecasts compare with the FAA's TAF activity forecast? If there is considerable difference between the two, what recommendations can be brought forth to improve the

forecasted growth of airport emissions within the applicable SIP budgets to better align with the FAA TAF? (ACRP 2-21)

- The objective of this project is to develop guidance for evaluating the cost-benefit of incorporating "green" design and engineering practices. This project will also focus on the benefits and challenges of permeable pavements and how it affects Airport Improvement Program (AIP) funding eligibility. (ACRP 2-22)
- Identifying practices, technologies, and procedures to reduce the airport's environmental impacts during construction and long-term operations. This research will develop a collection of sustainable practices that can be implemented during airport construction. The collection will include best practices, methods, procedures, and technologies for all stakeholders involved in the planning, design, and construction of airport development or re-development projects and will be in a format that is easily usable by airports. (ACRP 8-01)
- Identifying implementable actions that result in reducing energy consuming system costs in airport terminals. This research effort will focus on selected opportunities such as those identified in ACRP RRD 2, Model for Improving Energy Use in U.S. Airport Facilities, by describing successful practices that airports have implemented to increase airport energy efficiency and reduce airport operating costs. Because there are many more small airports with fewer discretionary funds, there will be an additional focus on no-cost, low-cost and moderate-cost improvements. The audience for this synthesis of practice is airport managers and their staff that are responsible for these systems and their effect on airport operating budgets (energy, equipment, staff). (ACRP 11-03/S10-04)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	8,000
FY 2010 Enacted	5,000
FY 2011 Request	5,000
Out-Year Planning Levels (FY 2012-2015)	20,000
Total	38,000

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airport Cooperative Research - Environment	0	3,000	5,000	5,000	5,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**3,000**	**5,000**	**5,000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	3,000	5,000	5,000	5,000
Total	**0**	**3,000**	**5,000**	**5,000**	**5,000**

Airport Cooperative Research - Environment Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airport Cooperative Research Program							
Environment-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◇	◇	◇	◇	◇
Hazardous Air Pollutant Emissions from Idling Aircraft		◆					
National Inventory of Deicing Use		◆					
Airport Emissions Impact on Local Air Quality		◆					
Multimodal Noise and Emissions Model		◆					
Enhanced Aircraft Taxiway Noise Model		◆					
Evironmental Optimization of Aircraft Departures		◆	◇				
Evaluation of Stormwater System Design Conditions		◆	◇				
Improving Environmental Performance of Small Airports		◆	◇				
Locating Alternative Fuel Facilities Near Airports		◆	◇				
Aviation Growth Capacity in State Implementation Plans		◆	◇				
Evaluation of Green Engineering Practices		◆	◇				
Reducing Airport Environmental Impact During Construction		◆	◇				
Airport Energy Efficiency and Cost Reduction		◆	◇				
Practices to Reducing an Airport's Carbon Footprint		◆	◇	◇			
Monitoring contaminated Stormwater		◆	◇	◇			
Improving Aircraft Recycling		◆	◇	◇			
Strategies to Reduce Airport Surface Emissions		◆	◇	◇			
Measuring PM Emissions from Ground Support Equipment		◆	◇	◇			
Total Budget Authority	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
AIP	**N/A**	**Airport Cooperative Research – Safety**	**$5,000,000**

GOALS:
The program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes: The objective of the Airport Cooperative Research Program (ACRP) is to carry out applied research on problems that are shared by airport operators and are too difficult for individual airports to solve on their own. Additionally, ACRP studies issues that are not being adequately addressed by existing Federal research programs. ACRP undertakes research in a variety of airport subject areas, including design, construction, environment, maintenance, safety, security, policy, planning, human resources, administration, and operations.

Congress established ACRP through the Vision 100–Century of Aviation Reauthorization Act of 2003 (Vision 100). As called for in Vision 100, a Memorandum of Agreement was developed to provide organizational guidance for the three main entities that fund, administer, and oversee ACRP. The FAA funds the program. The National Academies, acting through its Transportation Research Board (TRB), administers the program. The ACRP Oversight Committee (AOC), an independent governing board comprised of airport managers and other aviation officials appointed by the U.S. Secretary of Transportation, selects all of the program's research projects.

Agency Outputs: The ACRP-Safety program conducts research to prevent and mitigate potential injuries and accidents within the airport operational environment. A fundamental element of this program is to produce results that provide protection of aircraft passengers and airport personnel through improved safety training, airport design, and advanced technology implementation.

Research Goals: TRB annually solicits the aviation community for input on future research topics and industry concerns. New research priorities are therefore generated on a yearly basis under the direction of the AOC.

Customer/Stakeholder Involvement: ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, State and local government officials, equipment and service suppliers, airport users, educational institutions, other research organizations, and the general flying public. These stakeholders generate project ideas, guide projects while they are under way, and serve as the ultimate end-users of the final research products.

Representatives from these organizations also serve on the AOC where they help select ACRP research projects. Federal representation on the AOC is comprised of the FAA, along with NASA and the Environmental Protection Agency (EPA). The aviation industry is further represented on the AOC through the participation of the following groups: the Airports Council International (ACI), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA).

R&D Partnerships: ACRP is a cooperative partnership with airports and federal agencies to conduct airport research. The research will be conducted by universities, airports, and companies within the aviation industry.

Accomplishments: Program outputs during the first two years have been focused on low-cost, rapid-response projects on urgent airport problems:

FY 2009:
Human Protection

- Compilation and analysis of data from aircraft overrun and undershoots on airport runway safety areas (RSAs). This research effort provides a comprehensive database that includes additional variables related to runway overruns and undershoots to allow for more informed RSA design and planning decisions. (ACRP Report 3, formerly 4-01)
- Recommendation of potential improvements to lightning-warning systems for use by airports. This research effort (1) characterizes lightning detection and prediction technologies currently in use by airports and air carriers; (2) evaluates the feasibility of improving operational lightning-warning capabilities; and (3) estimates the reduction in direct and indirect operating costs for airlines and airport operators that would result if the improved lightning-warning capability were implemented. (ACRP Report 8, formerly 4-02)

- Develop a guidebook for airport operators on (1) performing a risk assessment of hazards associated with approach light systems and (2) determining measures that can be taken to mitigate the identified hazards. (ACRP RRD 6, formerly 04-03)
- Creation of a tool for exercising command-level decision making for critical incidents at 14 CFR Part 139 airports. The tool includes methods to measure and evaluate actions and outcomes including compliance with nationally recognized standards and Federal Aviation Administration (FAA) and Department of Homeland Security (DHS) requirements. (ACRP 04-04)
- Developing a resource manual of human-impact considerations and practices for airport and air carrier managers related to human-made accidents or attacks, or natural disaster events. The manual rationalizes the need for airport and air carrier preparedness, and describes critical considerations and steps that can be taken to mitigate employee psychological trauma before, during, and after such distressing events. (ACRP Report 22, formerly 06-01)
- Advancing the development of alternative civil aircraft arresting systems that safely decelerate an aircraft overrunning a runway. This research: (1) identifies and evaluates the most promising alternatives to the existing FAA-approved system; (2) identifies the steps that must be taken to have such promising alternatives approved for use at a civil airport in the United States, and identify barriers that may preclude manufacturers from making the alternative solutions commercially available; and (3) conducts a sensitivity analysis of the FAA's design and performance parameters for civil aircraft arresting systems. (ACRP 07-03)

System Knowledge

- Developing a guidebook for airport Safety Management Systems (SMS). The SMS guidebook describes the associated concepts, methodologies, processes, tools, and safety performance measurements that can be applied by airports based on their level of operations and complexity. The results are applicable to all airports that have certificates issued under 14 Code of Federal Regulations (CFR) Part 139, Certification of Airports. (ACRP Report 1, Vols 1&2, formerly 04-05)

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Human-Centered Design

- Exploration of information on the requirements and training required to obtain driving privileges on airport airfields, and the differences and similarities among the various airports throughout the country. The report also examines information on the types of training programs available to airport employees based on where the employees were authorized to drive. (ACRP Synthesis 15, formerly S04-03)

System Knowledge

- Comparing and evaluating the safety benefits of airport apron management and control programs in countries that regulate airport apron operations under ICAO Annex 14, Paragraph 9.5.1, with those programs and services at similar types of airports in the United States. (ACRP 04-07)

Situational Awareness

- Developing a guidebook that managers of general aviation (GA) airports can use to identify, understand, and mitigate wildlife hazards to aircraft in the airport environs. This guidebook is intended to provide a primer for addressing wildlife hazards but is not intended to fulfill Part 139 certification requirements regarding wildlife. The guidebook is accompanied by a brief reference guide and outreach materials for aircraft/wildlife hazards at GA airports. (ACRP 04-06)
- Developing a handbook for airport operators containing up-to-date wayfinding and signing guidelines for the airport terminal and landside. These research results facilitate the safe and efficient movement of passengers within each airport and from one airport to another through the uniform application of the guidelines. The guidelines address the following areas: (a) terminal including concourses/gates, ticketing/check-in, security checkpoints, federal inspection services, baggage claim; (b) curbside/ground transportation; (c) parking; and (d) on-airport roadways/off-airport access roads. (ACRP 07-06)

FY 2011 PROGRAM REQUEST:

The FAA has requested $15 million for ACRP in FY 2011 as part of the Airport Improvement Program. Of the total amount, $5 million will be provided for each of the 3 ACRP program areas of Safety, Capacity, and Environment.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Human Protection

- Assessing the role of airports and airlines in the spread of vector-borne diseases. This research will result in a better understanding of whether/how vector-borne diseases like malaria are facilitated by air travel. The

resulting report should provide a basis for public health officials to assess the appropriateness and efficacy of current practices such as aircraft disinfection and alternative approaches to preventing introduction of vector-borne diseases in the U.S. (ACRP 2-20)

- Developing guidance for airport management in developing and implementing airport rules and regulations for the use of towbarless tow vehicles (TLTVs) in towing aircraft in airport movement and non-movement areas. The results include a collection of the best practices and/or airport rules and regulations enacted by airports in managing TLTV operations. (ACRP 4-07A)
- Developing a method for assessing the risks associated with non-standard separations at existing constrained airports where standards can not be practicably met and applied nationally. The risk assessment method supports, explains, and justifies requests to modify standards for non-standard separations. Topics studied include: separations standards between taxiways and runways; taxiways/taxilanes and taxiways/taxilanes; and taxiways/taxilanes and fixed or movable objects. (ACRP 4-09)

System Knowledge

- Developing and validating a user-friendly software analysis tool that can be used by airport and industry stakeholders to quantify risk and support planning and engineering decisions when determining RSA requirements to meet an acceptable level of safety for a various types and sizes of airports. This research expands on the research presented in ACRP Report 3, using many variables, not just those referenced in Table 7, page 28, of the report. (ACRP 4-08)
- Determining how proposed firefighting standards would impact airports. These research results: compare the current FAA requirements for ARFF to the proposed NFPA and ICAO standards; provide a financial analysis of the operational costs for airports to comply with the NFPA and ICAO standards to the extent that they differ from the costs associated with the current FAA requirements; and provide a financial analysis of the infrastructure and equipment costs for airports to comply with the NFPA and ICAO standards (ACRP RRD 7, formerly 11-02/T11)
- Analyzing the extent to which NFPA and ICAO ARFF standards beyond FAR Part 139 requirements may be expected to reduce fatalities and/or mitigate serious injuries associated with aircraft accidents on or directly adjacent to airport property. (ACRP 11-02/T17)
- Surveying a statistically meaningful volume of large and medium hub airports to collect data on ramp incidents from both the airport and airlines. This effort is intended to result in a database (Access or Excel) that will be made available to the airport industry. (11-02/T12)
- Conducting a public symposium that features invited presentations on the status of research on or related to the transmission of disease on aircraft and/or in airports. The purpose is to provide an opportunity for the research community to share data, models and methods; discuss findings and preliminary conclusions of ongoing research; and identify gaps to inform future research projects. (11-02/T13)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	20,000
FY 2010 Enacted	5,000
FY 2011 Request	5,000
Out-Year Planning Levels (FY 2012-2015)	20,000
Total	50,000

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airport Cooperative Research - Safety	5,000	5,000	5,000	5,000	5,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	5,000	5,000	5,000	5,000	5,000
Total	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

Airport Cooperative Research - Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airport Cooperative Research Program							
Safety-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◊	◊	◊	◊	◊
Airfield Driving Privilege Requirements		◆					
Airport Signage and Way-finding		◆					
Wildlife Hazard Prevention at Small Airports		◆					
Role of Airports and Airlines in Spread of Diseases		◆	◊				
Improve Ramp Management and Safety		◆	◊				
Improved RSA models		◆	◊				
Assessing Airfield Separation Risk		◆	◊				
ARFF Standard Impacts to Airports		◆	◊				
Total Budget Authority	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
AIP	**N/A**	**Airport Technology Research – Capacity**	**$12,930,000**

GOALS:
This program supports the following FAA *Flight* Plan goals: Increased Safety, Greater Capacity, and International Leadership.

Intended Outcomes: The FAA is enhancing airport system capacity through improved pavement design, construction and maintenance practices, new pavement management systems and better airport design and planning.

Agency Outputs: Federal law requires the FAA to develop standards and guidance material for airport design, management, construction, and maintenance. The Airport Technology program provides the technical information needed to support and update these FAA outputs in a timely manner.
The airport Advisory Circulars (AC) related to capacity improvements are the Agency's principal means of communicating with U.S. airport planners, designers, operators, and equipment manufacturers. These ACs apply to airport geometric design, pavement thickness design, pavement management systems and airport planning.
The FAA and its regional offices enforce standards and guiding material when administering the Airport Improvement Program (GIAA).

Research Goals:

Conduct R&D to support the development of standards in the airport system areas to improve pavement thickness design, pavement management, construction methods, and maintenance issues.

- By 2015, improve prediction of pavement service life and provide accurate assessment of aircraft-pavement compatibility.
- By 2015, provide more durable, long-lived airport pavements and reduce downtime due to construction & maintenance activities.

Customer/Stakeholder Involvement: GIAA grants contribute about half of the approximately $2 billion spent each year to provide operationally safe and reliable airport pavements. Projects funded under the GIAA grants must conform to the FAA ACs or designated standards. The remaining costs are borne by state and local governments.

To ensure new pavement standards will be ready to support the safe international operation of next-generation heavy aircraft, the FAA and the Boeing Company have entered into a Cooperative Research and Development Agreement. Together, these partners have built the National Airport Pavement Test Facility (NAPTF), a unique full-scale research vehicle, at the William J. Hughes Technical Center. Along with the International Civil Aviation Organization, the FAA is using data collected at the facility in developing the pavement design standards that airports throughout the world need to accommodate the new large aircraft weighing in excess of 1,000,000 pounds and having high tire pressures.

R&D Partnerships:

- FAA-U.S. Army ERDC[*]
- FAA-U.S. Air Force, Tyndall Air Force Base[1]
- FAA-Center of Excellence for Airport Technology, University of Illinois[2]
- FAA-Boeing Company, Cooperative Research and Development Agreement ($7 million Boeing/$21 million total for the NAPTF)[3]
- FAA-IPRF[4]
- FAA-Auburn University[4]
- FAA-Rowan University[4]

[1] Interagency agreement or Memorandum of Agreement
[2] Partnership through matching funds
[3] Cost Sharing
[4] Cooperative Agreement

- FAA-University of Massachucetts-Dartmouth[4]

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

Accomplishments: The Airport Technology research program has provided products to enhance airport capacity in the United States and around the world. Recent research results are published as FAA reports and ACs and made available to users worldwide. Some major accomplishments are:

FY 2009:

- Completed draft of AC 150/5320-6E, "Airport Pavement Design and Evaluation."
- Finalized the airport pavement thickness design computer program FAARFIELD for release with AC 150/5320-6E.
- Expanded and revised the computer program COMFAA for automatic computation of PCN and assisted in the preparation of Draft AC 150/5335-5B, "Standardized Method of Reporting Airport Pavement Strength – PCN."
- Finalized the airport pavement roughness evaluation computer program ProFAA for release with AC 150/5380-9, "Guidelines and Procedures for Measuring Airfield Pavement Roughness."
- Completed a major upgrade to the NAPTF Test Vehicle, consisting of the addition of four more loading modules, removal and replacement of the load and speed control systems and software, procurement of twelve new rims complete with 52x21.0 R22 radial tires, complete refitting of the control cab, plus numerous other small improvements and repairs.
- Assisted in the evaluation of a runway incursion incident at DFW involving a TLTV towing a Boeing 777. Published a report AR-TN09/44, "Towbarless Towing Vehicle Operations – Evaluation of Braking Action and Vehicle Conspicuity."
- Assisted in an evaluation of new runway grooving at ORD for possible deficiency of construction.

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continue analyzing full-scale data from the NAPTF.
- Improve upon and update the pavement design procedures based on data from the FAARFIELD computer program.
- Continue conducting technical workshops in pavement design using FAARFIELD and COMFAA.
- Revise the ACN-PCN methodology with software program entitled COMFAA 3.0
- Conduct technical workshops in pavement roughness criteria using PROFAA.
- Develop web-based pavement management system called FAA PAVEAIR.
- Conduct full-scale tests on reflective cracking of flexible pavement at the NAPTF.
- Conduct testing of Alkali-Silica Reactive (ASR) concrete pavement under full-scale loading
- Continue development of a web-based application for airport pavement database management system as a suite of FAA analysis tools (PROFAA, FAARFIELD, BAKFAA, LEDFAA)
- Install pavement instrumentation at assorted Airports throughout the Unites States and analyze the recorded data.

FY 2011 PROGRAM REQUEST:

The Airport Technology research program is a collaborative effort among many government organizations, universities, and industry associations. The requested funding will allow this group to continue developing standards and guidelines for maintaining and enhancing our national airport infrastructure.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Purchase a Heavy Vehicle Simulator (HVS) to test different paving materials
- Continue analyzing full-scale data from the NAPTF.
- Continue conducting technical workshops in pavement design using FAARFIELD and COMFAA.
- Conduct technical workshops in pavement roughness criteria using PROFAA.
- Upgrade FAA PAVEAIR with Geographic Information System

- Continue full-scale tests on reflective cracking of flexible pavement at the NAPTF.
- Continue testing of Alkali-Silica Reactive (ASR) concrete pavement under full-scale loading
- Install pavement instrumentation at assorted Airports throughout the Unites States and analyze the recorded data.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	64,103
FY 2010 Enacted	10,596
FY 2011 Request	12,930
Out-Year Planning Levels (FY 2012-2015)	51,720
Total	139,349

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airports Technology Research – Capacity	7,337	7,220	7,536	8,856	10,900
Personnel Costs	1,318	1,535	1,573	1,740	2,030
Other In-house Costs	0	0	0	0	0
Total	**8,655**	**8,755**	**9,109**	**10,596**	**12,930**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	8,655	8,755	9,109	10,596	12,930
Total	**8,655**	**8,755**	**9,109**	**10,596**	**12,930**

Airport Technology Research - Capacity Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airport Technology Research – Capacity Goal							
Airport Technology Research - Capacity	11,190						
Continue full-scale testing at NAPTF		♦	◊	◊	◊	◊	
Continue analysis of full-scale data from NAPTF; maintain equipment, instrumentation, conduct material testing, develop pavement specifications, demolition and reconstruction activities		♦	◊	◊	◊	◊	
Develop advanced airport pavement design procedures; conduct related workshops in development, programming and documentation		♦	◊	◊	◊	◊	
Next phase of rigid pavement design, analysis of slab curling, materials characterization, field instrumentation, and continue support of airport technology center of excellence		♦	◊	◊	◊	◊	
Conduct non-destructive pavement testing		♦	◊	◊	◊	◊	
Support development of a web-based airport pavement management software		♦	◊	◊	◊	◊	
Conduct pavement roughness research		♦	◊	◊			
Operate material testing lab		♦	◊	◊	◊	◊	
Improve paving materials		♦	◊	◊	◊		
In-situ instrumentation and data collection at selected Airports		♦	◊	◊	◊	◊	
Personnel and Other In-House Costs	**1,740**						
Total Budget Authority	**12,930**	**10,596**	**12,930**	**12,930**	**12,930**	**12,930**	**12,930**

♦ - Activities Accomplished ◊ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
AIP	**N/A**	**Airport Technology Research – Safety**	**$14,287,000**

GOALS:
This program supports the following FAA *Flight Plan* goals: Increased Safety, and Greater Capacity.

Intended Outcomes: The FAA conducts safety-related research to improve airport lighting and marking, reduce wildlife hazards, improve airport fire and rescue capability, and reduce surface accidents. The FAA will also develop and maintain standards in airport system areas to:

- Reduce aircraft accidents due to incursions, particularly in low-visibility conditions;
- Reduce aircraft accidents due to slipperiness caused by ice and snow on runways;
- Improve post-crash rescue and firefighting capabilities; and
- Reduce the negative impact of wildlife on airport safety.

Agency Outputs: Federal law requires the FAA to develop and publish standards and guidance material for airport design, construction, and maintenance. The Agency uses the airport AC system as its principal means to communicate this guidance with a user community consisting of U.S. airport planners, designers, operators, and equipment manufacturers.
Achieving the overall FAA goal of reducing accidents requires improvement in airport safety as well as aircraft safety. Outputs of the program include guidance regarding: new technology and techniques that can improve airport lighting and marking to help reduce surface accidents and runway incursions; improve aircraft rescue and fire fighting to address double decked aircraft carrying up to 800 passengers; and modify the habitats of increasing numbers of wildlife on or near airports.
The Airport Improvement Program (GIAA) provides current technical information to support and update ACs covering design of airport safety areas, visual aids, rescue and firefighting, ice and snow control, and wildlife control. The FAA and its regional offices then enforce these standards and guidance materials as part of administering the GIAA.

Research Goals:
Conduct R&D to support the development of standards in the airport system areas to improve safety, improve situational awareness, and reduce accidents.

- By FY 2014, increase post crash passenger survivability and improve current levels of fire fighting effectiveness.
- By FY 2014, improve airport design standards to provide increased levels of safety for airport operations.
- By FY 2015, reduce rate of accidents involving slipperiness and save lives in the event of overruns.
- By FY 2015, reduce wildlife strike risks to aircraft and provide more accurate and timely wildlife strike advisories.
- By FY 2015, reduce pilot disorientation and provide better visual cues to reduce the risk of incursion.

Customer/Stakeholder: Projects funded under the GIAA grants must conform to the FAA ACs or designated standards. GIAA grants contribute about half of the approximately $2 billion spent each year to provide operationally safe and reliable airport pavements. The remaining costs are borne by state and local governments.

R&D Partnerships:

- FAA-U.S. Air Force, Tyndall Air Force Base.
- FAA-U.S. Air Force, Wright Patterson Air Force Base. (aircraft braking performance studies)
- FAA-USDA, National Wildlife Research Center, Sandusky, Ohio.
- FAA-Port Authorities of New York and New Jersey
- FAA-ACRP (for study of alternative arresting systems for civil airports).

Accomplishments: The Airport Technology Research Program has provided products to enhance the safety of airport operations in the United States and around the world. Research results are published as FAA ACs and made available to users worldwide. Recent program accomplishments include the completion of:

FY 2009:

- Studied Next Generation High Reach Extendible Turret.
- Assessed commercial avian radars at Seattle-Tacoma International Airport.
- Deployed commercial avian radars at Chicago O'Hare for multi-year assessment.
- Evaluated alternative runway groove shape on asphalt and concrete runway surfaces.
- Evaluated camera based FOD detection systems at Boston Logan and Chicago O'Hare.
- Evaluated a mobile FOD detection system at Chicago's Midway Airport.
- Evaluated Taxiway Deviation data collection at Manchester, NH and West Palm Beach and Orlando, FL, and Chicago O'Hare.
- Completed phase 1 study of fire fighting agent quantities for NLA.
- Initiated full scale testing of composite fires at NLA Facility, Tyndall AFB, Panama City, FL.
- Completed Report on New Photoluminescent Technology for Visible Surface Markings
- Completed Study of Engineered Material Arresting System cold region freeze-thaw durability
- Completed Testing of Effects of Runway De/Anti-Icing Chemicals on Traction
- Final report on a polyurea alternative marking material;
- Evaluation of a prototype foreign object debris (FOD) detection radar at a large airport;
- Developed AC for Automated FOD Detection Systems.
- Report on installation criteria for taxiway centerline lights;
- Demonstrated use of aircraft lighting to make aircraft on the ground more conspicuous.

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

FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop specifications for a new Visual Guidance Technology Testbed.
- Complete recommendations to improve Heliport Design AC.
- Publish recommendations for airfield LED electrical Infrastructure.
- Update General Aviation "Community Service Airports Lighting Handbook".
- Complete validation testing (phase 2 of study) of firefighting agent quantities for NLA.
- Initiate full scale testing of composite fires at NLA facility, Tyndal AFB, Panama City, FL.
- Complete taxiway deviation data collection for design group III airports, and develop statistical analysis for deviation behavior of aircraft in this group.
- Complete evaluation of second level access vehicle at New Large Aircraft Test Facility.
- Complete report on automated FOD detection system technology.
- Complete report on alternative runway grooving research.
- Initiate Feasibility Study for Dynamic Internal Drum Tire Pavement Test Machine Augmentation
- Complete Report on Deployment of Avian Radars at Civil Airports
- Release new Wildlife Hazards Mitigation Website and Database.
- Complete Draft Advisory Circular for Use of Avian Radar Systems at US Civil Airports.
- Initiate multi-year study on the effects of Fully Enclosed Trash Transfer Facilities on attracting hazardous wildlife.
- Initiate evaluation of other commercial avian radar systems
- Complete Advanced Composite Material Penetration Study (Phase I)
- Complete Phase II of study on The Effects of Fuselage Geometry on Post Crash Fires
- Complete Phase I for Crash Simulation of Transport Aircraft for Predicting Fuel Release
- Complete Phase I of Development of Advanced Fire Fighting Agent Application Model
- Develop Specifications for Low Cost Ground Surveillance System.

FY 2011 PROGRAM REQUEST:
The Airport Technology FY 2011 research program is a collaborative effort among many government organizations, universities, and industry associations. The requested program funding provides the contract support necessary for an integrated, effective research program that delivers the standards and guidelines for maintaining and enhancing airport infrastructure.

KEY FY 2011 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Complete Advanced Composite Material Penetration Study (Phase II - Computer Model Development)
- Complete Phase II for Crash Simulation of Transport Aircraft for Predicting Fuel Release
- Complete Phase II of Development of Advanced Fire Fighting Agent Application Model
- Complete multi-year study of Fully Enclosed Trash Transfer Facilities
- Evaluate non-commercially available, emerging technologies in bird detection and tracking
- Complete Evaluation of Ground Vehicle Navigation Systems
- Complete development of FOD database.
- Initiate collection of taxiway deviation data at design group II airports.
- Initiate visual guidance research utilizing completed Visual Guidance Technology Testbed.

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APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2009)	62,549
FY 2010 Enacted	11,876
FY 2011 Request	14,287
Out-Year Planning Levels (FY 2012-2015)	57,148
Total	145,860

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Airports Technology Research – Safety	7,897	8,312	8,465	10,135	12,546
Personnel Costs	1,318	1,493	1,774	1,741	1,741
Other In-house Costs	0	0	0	0	0
Total	**9,215**	**9,805**	**10,239**	**11,876**	**14,287**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	9,215	9,805	10,239	11,876	12,329
Total	**9,215**	**9,805**	**10,239**	**11,876**	**14,287**

Airport Technology Research - Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Airport Technology Research – Safety Goal							
Airport Technology Research - Safety	**12,546**						
Complete validation testing (phase 2 of study) of firefighting agent quantities for NLA.		♦					
Complete Report on Deployment of Avian Radars at Civil Airports		♦					
Complete evaluation of second level access vehicle at New Large Aircraft Test Facility.							
Complete Report on alternative runway groove shape on asphalt and concrete runway surfaces.		♦					
Complete Report on automated FOD detection system technology.		♦					
Complete taxiway deviation data collection for design group III airports		♦					
Initiate full scale testing of composite fires at NLA facility, Tyndal AFB, Panama City, FL.		♦	◇				
Release new Wildlife Hazards Mitigation Website and Database.		♦					
Complete Draft Advisory Circular for Use of Avian Radar Systems at US Civil Airports.		♦					
Initiate multi-year study on the effects of Fully Enclosed Trash Transfer Facilities on attracting hazardous wildlife.		♦	◇	◇			
Initiate evaluation of other commercial avian radar systems		♦	◇	◇			
Complete recommendations to improve Heliport Design AC.		♦					
Publish recommendations for airfield LED electrical Infrastructure.		♦					
Update General Aviation "Community Service Airports Lighting Handbook".		♦					
Develop specifications for a new Visual Guidance Technology Test bed.		♦					
Complete Advanced Composite Material Penetration Study (Phase I)		♦					
Initiate Feasibility Study for Dynamic Internal Drum Tire Pavement Test Machine Augmentation		♦	◇				
Complete Phase II of study on The Effects of Fuselage Geometry on Post Crash Fires		♦					
Complete Phase I for Crash Simulation of Transport Aircraft for Predicting Fuel Release		♦					
Develop Specifications for Low Cost Ground Surveillance System.		♦					
Personnel and Other In-House Costs	**1,741**						
Total Budget Authority	**14,287**	**11,876**	**14,287**	**14,287**	**14,287**	**14,287**	**14,287**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
Ops	**N/A**	**Commercial Space Transportation Safety**	**$165,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes:

The mission of the Commercial Space Transportation Safety Program is to ensure protection of the public, property, and the national security and foreign policy interests of the United States during commercial launch or re-entry activities, and to encourage, facilitate, and promote U.S. commercial space transportation.

To achieve its mission, the program undertakes research projects intended to:

- Prevent safety incidents (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically Hydrogen Peroxide, H_2O_2, and Nitrous Oxide, N_2O) in commercial space transportation applications.
- Provide information on the capability, limitations, and considerations for GPS implementation in a dynamic environment, such as Space and Air Traffic Control. The results shall include information on topics such as requirements for signal reception, system accuracy, signal processing delay times, and GPS vs. future/alternate technologies.
- Identify operational and technical issues that must be addressed for launching and operating either supersonic or hypersonic point-to-point (PTP) systems in or through the NAS and between transcontinental city pairs.
- Ensure that the safety of the public, crew, and spaceflight participants is well understood by studying the effects of operating in an environment in which composites are used for reusable launch vehicles (RLVs).
- Identify a set of requirements for a black box system and propose a notional design for such a system to be used in expendable launch vehicles (ELVs) and reusable launch vehicles (RLVs).
- Evaluate the adequacy of current rules and polices related to commercial space transportation, implement new rules/policy/advisory materials, and identify barriers to industry caused by unnecessary or conflicting regulations.
- Directly compare present and emerging system safety methods to discern best practices and derive regulatory requirements.

Agency Outputs:

The research program completes or provides inputs for the development of regulations, advisory circulars, and/or guidelines that identify the requirements for the safe operation of expendable, as well as reusable launch vehicles (ELV/RLV). These outputs include:

- Develop clear, written, user-friendly guidelines for transport, processing/loading, usage, and disposal of H2O2 and N2O in commercial space transportation applications. Transmit these guidelines to the commercial space transportation community via an outbrief to COMSTAC, a summary report, and potentially a FAA Advisory Circular containing them.
- Recommendations for standards to consider for GPS implementation in conjunction with licensed activities, for both AST and industry.
- Identify areas related to the PTP study that may require legal, regulatory, or policy changes. Also, provide a prioritized ranking of operational and technical issues, from the most challenging to the least challenging, provide a rationale for each ranking, and provide recommendations for a path forward to resolve each identified issue.
- Guidance for AST and industry use on operational limitations and inspection requirements for suborbital reusable launch vehicles (RLVs) comprised of composite materials. This guidance will be based on and subject to a typical flight profile.
- A requirements document for a black box system for commercial space transportation vehicles, as well as a notional design for use in developing a prototype black box for testing in a future launch.

- A report identifying existing laws beyond those listed in 14 CFR Part 400 which may apply to commercial space transportation, and how they relate may help or hinder industry.
- An assessment conducted by AST on the outputs from two specialized, independent system safety analysis conducted by separate parties to determine the optimal system safety method. The assessment will include the strengths and weaknesses, the hazard analysis depth, the hazard identification thoroughness, and the projected resource utilization.

Research Goals:

- A set of clear written guidelines, in terms of the established conditions and/or technical parameters (concentration, impurities, temperature, pressure, liquid vs. vapor state, shock sensitivity, and incompatible materials), in which H_2O_2 and N_2O may safely be handled and used. These guidelines would also include conditions to avoid. Note: In the (unlikely) event that some of the conditions and/or technical parameters associated with H_2O_2 and N_2O cannot be defined to sufficient granularity to develop clear guidelines, then further research to define specific conditions and/or technical parameters will be recommended.
- To conduct a study on current and near-term capabilities and limitations of GPS user equipment suitable for use in suborbital, ballistic trajectories with emphasis on low cost. The study will capture lessons learned wherever possible.
- To explore possible scenarios to help AST better strategically plan for the future with respect to Air Traffic Interfaces, international relations, and potential vehicle technologies (if applicable).
- To develop effective rules for operations and maintenance (O&M) for use of composite materials, as they apply to commercial space transportation. These rules may also provide potential benefits for rules addressing other systems such as structures and environmental control and life support systems (ECLSSs).
- To provide the ability to access relevant data captured at the time of an anomaly, for determining the root cause(s), potentially enabling faster "return to flight" status.
- Look at various rocket operations and current laws, and apply them to limited areas likely to conduct such operations, to evaluate the current regulatory process. This will assist in providing recommendations for rules and policy and attempt to mitigate barriers to industry.
- To demonstrate the relative performance of different systems safety methods and develop data supporting system safety regulation revisions.

Customer/Stakeholder Involvement:

- A survey of the companies in the aerospace industry (as well as other industries) that use H2O2 and N2O regarding safety incidents they have experienced and lessons learned will be part of the study.
- The study will request inputs from COMSTAC on current plans and challenges for GPS user equipment for commercial vehicles.
- Identify areas related to the PTP study that may require legal, regulatory, or policy changes.
- The study will provide guidance to AST and industry on the use of operational limitations and inspection requirements for suborbital reusable launch vehicles (RLVs) comprised of composite materials.
- To examine the operational environment, determine the number of sensors needed, defining the data recovery process, and provide black box survivability criteria for use in developing requirements for a black box system to be used in commercial space transportation systems (ELVs and RLVs).
- To examine existing laws not included in 14 CFR Part 400 that apply to rocket operations, and asses the adequacy of these rules and policy to identify barriers to industry.
- The results of the assessment will enable AST to have a more accurate system safety method to be used when evaluating applications for launch licenses and permits, to ensure the safety of the public.

R&D Partnerships:

- AST will partner with the Air Force Research Lab, Air Force Space and Missile Center and NASA safety organizations for the research and to establish the guidelines and recommendations related to the use H2O2 and N2O.
- AST will coordinate the goals of the study (and if appropriate) partner with the GPS Joint Program Office (JPO), the Naval Research and Air Force Research Labs, Kennedy and Johnson Spaceflight Centers, and Ames Research Center to determine plans for development or modification of GPS user equipment suitable for use in suborbital, ballistic trajectories, while focusing on low-cost opportunities.

- The Volpe National Transportation System Center has been contracted to conduct the work associated with this research project.
- Partnerships are still being determined.
- Looking into partnership with Volpe National Transportation System Center.
- Looking into partnerships with the academic community or contract with Volpe National Transportation System Center.
- Partnerships are still being determined.

Accomplishments:

FY 2008 was the funding year for the activities known as:

- "Temporal Winds Database Study"*
- "Low Cost ,Field Portable, High Altitude Wind Profiler"*

  *These projects were extended into and completed in FY 2009. Will be included as accomplishments.

FY2009 was the funding year for the activities known as:

- "Lessons Learned in Handling Nontraditional Monopropellants/Oxidizers"
- "Application of GPS to Space Transportation Technologies"
- "Point-To-Point Suborbital Missions"

  *These projects were extended into FY 2010, and thus included in this NARP submission.

FY2010 is the funding year for the activities known as:

- "Effects of Suborbital Flights on Composite Constructed Vehicles and Their Maintainability"
- "Voice/Data Recorder ("Black Box") Requirements and Technology Roadmap for Commercial RLVs and Reentry Vehicles"
- "Research and Identification of Existing Laws and Regulations, Beyond 14 CFR Part 400, Affecting the Commercial Space Transportation Industry"
- "Applicability and Benefits of Alternative System Safety Hazard Analyses Methods"

FY 2010 Major Activities and Anticipated Accomplishments:

- Provided for the following:

  1) Examining existing standards on H2O2 and N2O, from agencies such as DOT, IATA, NFPA, and DoD;

  2) Surveying the aerospace industry and other industries that use H_2O_2 and N_2O;

  3) Develop and deliver briefing to COMSTAC; and

  4) Develop summary report with guidelines and (if needed) recommendations for future research.
- Provided for the following:

  1) Conduct brief survey of RLV users state of the art and plans on GPS user equipment for use in suborbital, ballistic trajectories;

  2) Discuss results of survey of RLV users coordinate the goals of the study (and if appropriate) partner with the GPS Joint Program Office (JPO), the Naval Research and Air Force Research Labs, Kennedy and Johnson Spaceflight Centers, and Ames Research Center to determine their plans for development or modification of GPS user equipment suitable for use in suborbital, ballistic trajectories, while focusing on low-cost opportunities;

  3) Review ongoing state of the art and plans on GPS user equipment in development in national labs and avionics industry suitable for use in suborbital, ballistic trajectories; and

  4) Develop summary report with guidelines and (if needed) recommendations for future research.
- Published a research study with current information on commercial PTP systems identifying legal, regulatory, or policy changes that might be required. Additionally, the publication will identify issues and recommendations to resolve the identified issues.
- Established guidance for AST and industry use on operational limitations and inspection requirements for suborbital RLVs with composite structures to ensure safety of the public, crew, and space flight participants.

This will take into account extreme temperatures, extreme pressure changes, and atomic oxygen environments.

- Developed a set of requirements and a notional design for a black box system for use in space transportation vehicles to assist in early identification and resolution of anomalies.
- Identified existing laws, other than 14 CFR Part 400, that apply to rocket operations in an effort to evaluate the adequacy of existing rules and policy, provide input into new rules and policy, and identify barriers to industry by current rules and policy.
- Compared present and emergent system safety methods to determine best practices for hazard analysis determination used in evaluation for applications for licenses and permits in compliance with the regulatory process.

FY 2011 Program Request:

For all projects, authorized Commercial Space Transportation research is currently included in the Safety and Operations budget.

Key FY 2011 Major Activities and Anticipated Accomplishments:

None identified as yet, although call for topics both internally and externally have been extended. However, as research is conducted during the year, there may be indications of additional research efforts required during FY 2010, with appropriate products and milestones determined at that time.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1983-2009)	473,000
FY 2010 Enacted	145,000
FY 2011 Request	165,000
Out-Year Planning Levels (FY 2012-2015)	660,000
Total	1,443,000

Budget Authority ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Contracts:					
Commercial Space Transporation Safety	125	125	145	145	165
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**125**	**128**	**145**	**145**	**165**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Enacted**	**FY 2011 Request**
Basic	0	0	0	0	0
Applied	38	63	63	73	83
Development (includes prototypes)	38	63	63	73	83
Total	**125**	**128**	**145**	**145**	**165**

Commercial Space Transportation Safety Product and Activities	FY 2011 Request ($000)	Program Schedule					
		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Commercial Space Transportation Safety	**165**						
Lessons Learned in Handling Nontraditional Monopropellants/Oxidizers*							
Guidelines for transport, processing/loading, usage, and disposal of H_2O_2 and N_2O in commercial space transportation applications. These guidelines will be transmitted to the commercial space transportation community via an outbrief to COMSTAC, a summary report, and potentially a FAA Advisory Circular containing them.		♦†					
Application of GPS to Space Transportation Technologies*							
Recommendations for standards to consider for GPS implementation in conjunction with licensed activities, for both AST and industry.		♦†					
Point-To-Point Suborbital Missions*							
Publish a research study with current information on the state of the commercial suborbital transportation industry with a focus on market demand, safety, operability, and international coordination.		♦†					
Effects of Suborbital Flights on Composite Constructed Vehicles and Their Maintainability							
Guidance for AST and industry use on operational limitations and inspection requirements for suborbital reusable launch vehicles (RLVs) comprised of composite materials. This guidance will be based on and subject to a typical flight profile.		♦					
Voice/Data Recorder ("Black Box") Requirements and Technology Roadmap for Commercial RLV and Reentry Vehicles							
A requirements document for a black box system for commercial space transportation vehicles, as well as a notional design for use in developing a prototype black box for testing in a future launch.		♦					
Research and Identification of Existing Laws and Regulations, Beyond 14 CFR Part 400, Affecting the Commercial Space Transportation Industry							
A report identifying existing laws beyond those listed in 14 CFR Part 400 which may apply to commercial space transportation, and how they relate may help or hinder industry.		♦					
Applicability and Benefits of Alternative System Safety Hazard Analyses Methods							
An assessment conducted by AST on the outputs from two specialized, independent system safety analysis conducted by separate parties to determine the optimal system safety method. The assessment will include the strengths and weaknesses, the hazard analysis depth, the hazard identification thoroughness, and the projected resource utilization.		♦					
Total Budget Authority	**165**	**145**	**165**	**165**	**165**	**165**	**165**

♦ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

* ACTIVITIES FUNDED IN FY09 WERE NOT STARTED UNTIL 3Q, FY09, DUE TO CONTINUING RESOLUTION. WORK ON THESE PROJECTS CONTINUED INTO FY10, IN ADDITION TO NEW PROJECTS ADDED AND FUNDED IN FY10. THESE FY09 FUNDED PROJECTS ARE EXPECTED TO COMPLETE IN FY10.

† INDICATES THESE ACTIBVITES ARE FUNDED WITH FY09 FUNDING.

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Introduction

The Federal Aviation Administration (FAA) enhances and expands its research and development (R&D) capabilities by partnering with other government, industry, and academic organizations. Such partnerships help the FAA leverage critical resources and capabilities to ensure that the Agency can achieve its goals and objectives. By reaching out to other government agencies, industry, and the academic community, the FAA gains access to both internal and external innovators, promoting the transfer of technology, personnel, information, intellectual property, facilities, methods, and expertise. These partnerships also foster the transfer of FAA technologies to the private sector for other civil and commercial applications. The Agency uses the following partnership mechanisms to achieve its goals.

1. Working with Government

1.1 Memoranda of Understanding and Agreement

FAA researchers collaborate with their colleagues in government through memoranda of understanding/agreement (MOU/MOA) and other mechanisms, such as interagency agreements (IAs). The National Aeronautics and Space Administration (NASA) is the FAA's closest R&D partner in the federal government. The two agencies cooperate on research through a series of intra-governmental agreements. The FAA also works closely with the Department of Defense (DOD), especially in the environmental area. Table B.1 provides details of the agreements in place in fiscal year (FY) 2009.

Table B.1 – Active MOUs, MOAs, and IAs FY 2009

Active MOUs, MOAs, and IAs in FY 2009		
Agreement Type	Subject	Objective
FAA/NASA MOU	A Partnership to Achieve Goals in Aviation and Space Transportation	Partnering in the pursuit of complementary goals in aviation and space transportation, including safety, airspace system efficiency, environmental compatibility, international leadership, and others.
FAA/NASA MOA	Support of FAA R&D Field Offices at NASA Research Centers	Continuing operation and support of the FAA Field Offices established at NASA Centers.
FAA/NASA MOA	Air Traffic Management Research and Technology Development	Supporting the NASA Aviation Systems Capacity Program and FAA Air Traffic Management with respect to conducting research, development, and technology transfer to FAA.
FAA/NASA MOA	Impact of Aviation Air Emissions on Climate and Global Atmospheric Composition	Establishing programs and plans to determine aviation emissions that have the potential to impact global atmospheric composition, stratospheric ozone and climate.
FAA/NASA MOA	Aeronautical Safety and Human Factors	Establishing a strategic partnership with respect to the conduct of human factors research in commercial air transportation, general aviation, vertical flight, aviation maintenance, flight technologies and procedures, air traffic control and airway facilities, and bioaeronautics.

Active MOUs, MOAs, and IAs in FY 2009		
Agreement Type	Subject	Objective
FAA/NASA MOA	Aviation Safety Reporting System (ASRS)	Describing the basic relationship between the FAA's Aviation Safety Reporting Program and the NASA ASRS, and outlining the roles and responsibilities of each agency.
FAA/DOD MOA	Collaboration on Research and Development to Measure and Mitigate the Environmental Impacts of Aircraft Noise and Aviation Air Emissions	Conducting and coordinating research and development projects and exchanging research and development data, analyses and related information and material concerning the environmental impacts of aircraft noise and aviation emissions.
FAA/DOD Interagency Agreement	Flight Deck Illumination by Unauthorized Lasers DTFACT-05-X-00011	Evaluate laser eye protection during human-in-the-loop simulation studies; develop database models to enhance airmen training; develop and evaluate procedures for flight crew awareness and recovery action.
FAA/DOD Interagency Agreement	Damage Tolerance Methodologies in Rotorcraft Structures and Dynamic components. DTFACT-06-X-00001	Enhance collaboration between FAA and U.S. Army Research, Development, and Engineering Command to support FAA rulemaking and the implementation of damage tolerance (DT) methodology in the design and certification of rotorcraft and dynamic components.
FAA/DOD Interagency Agreement	Aircraft Catastrophic Failure Prevention Program DTFACT-06-X-00005	Provide technical support in these areas: 1. Uncontained Engine Failure Research; 2. Dry Bay Fire Protection; 3. Fuel System Explosion – Protection; 4. Engine Malfunction plus Inappropriate Crew Response; and 5. Engine and Other Aircraft System Impending Failure Diagnostics Research
FAA/DOD Interagency Agreement	Rotorcraft Health Usage Monitoring System (HUMS) DTFACT-06-X-00008	Engineering support for the FAA rotorcraft structural integrity research program.
FAA/NSF Interagency Agreement	Ground Deicing/Anti-icing Program. DTFACT-07-X-00002	Technical participation with and financial support for National Center for Atmospheric Research (NCAR) on ground icing research.
FAA/DOE Interagency Agreement	Continued Airworthiness Assurance DTFACT-07-X-00005	Provide access to DOE/Sandia National Laboratory's independent test and evaluation capabilities for nondestructive inspection systems; structural integrity maintenance & information systems; and aging non-structural systems.
FAA/DOD Interagency Agreement	Rotorcraft Health Usage Monitoring System (HUMS) DTFACT-07-X-00008	Support FAA research efforts in HUMS operational development, commercial HUMS validation, and HUMS Advisory Circular compliance validation and demonstration.
FAA/NASA Interagency Agreement	Wake Turbulence and Associated Reduced Separation Research. DTFAWA-07-X-80026	Building upon and expanding the long-standing research relationship between the FAA and NASA in the areas of wake turbulence and required separation between aircraft to insure flight safety.
FAA/NASA Interagency Agreement	Performance Data Analysis and Reporting System (PDARS) DTFAWA-07-X-00033	To enable continued collaboration in research and development efforts by NASA and the FAA on the utilization and enhancement of the Performance Data Analysis and Reporting System.
FAA/DOD Interagency Agreement	Support substantiation of FAA Advisory Circular AC 29-2C Section MG-15 Airworthiness Approval of HUMS DTFACT-08-X-00002	Obtain technical information related to HUMS AC compliance and validation – flight testing, operational HUMS development, and commercial HUMS validation.

Active MOUs, MOAs, and IAs in FY 2009		
Agreement Type	Subject	Objective
FAA/NASA Interagency Agreement	Software Enhancement, Standardization and Material Database Generation for Damage Tolerance Analysis DTFACT-08-X-00004	Establish a cooperative procedure to enhance the NASA Crack Growth Program (NASGRO) software and generate material database for damage tolerance analysis.
FAA/NASA Interagency Agreement	P-STAR Radar Systems DTFACT-08-X-00005	Establish collaborative research activities on manned and unmanned aircraft systems (UAS), and in particular, on utilization of ground based radar systems to support the FAA UAS safety studies.
FAA/NASA Interagency Agreement	Characterization of High Ice-Water Content Environments. DTFACT-08-X-00007	Collaborative icing research with NASA Glenn Research Center with main, but not exclusive, focus on propulsion icing in high ice water content environments potentially hazardous to engines.
FAA/NASA Interagency Agreements	Support of the FAA R&TD NASA Langley Field Team DTFAWA-08-X-00009	Continuing operation and support of the FAA Field Offices established at NASA Centers and accomplishment of cooperative projects.
FAA/NASA Interagency Agreements	Support of the FAA R&TD NASA Ames Field Team DTFAWA-08-X-80011	Continuing operation and support of the FAA Field Offices established at NASA Centers and accomplishment of cooperative projects.
FAA/NASA Interagency Agreement	Research for Aviation Communications/ Navigation/Surveillance/ Information Systems DTFAWA-08-X-80021	Coordination and cooperation between FAA and NASA to leverage both agencies' strengths to enable the most efficient CNSI research and technology development and implementation of the NextGen vision.
FAA/NASA Interagency Agreement	Human Factors Research DTFAWA-08-X-80023	FAA HFRE and NASA Ames will collaborate on human factors research that support the FAA's goals of greater capacity and increased safety.
FAA/NASA Interagency Agreement	Research and Technology Development DTFAWA-08-X-80031	This agreement between the FAA's Air Traffic Concept Development Group and NASA establishes roles and responsibilities for each organization in a collaborative effort to develop the Next Generation Air Traffic Control System (NextGen).
FAA/NASA Interagency Agreement	Aviation Safety Reporting System (ASRS) DTFAWA-09-X-80016	ASRS is designed to provide information to the FAA and the aviation community to identify and eliminate unsafe conditions to prevent accidents. NASA receives, processes, and analyzes the raw information ensuring confidentiality of the reporter.
FAA/NASA Interagency Agreements	Enhancement of Aeronautical Research and Technology Development DTFAWA-09-A-80018	A framework under which NASA and the FAA can collaborate in aeronautics research and technology
FAA/NASA Interagency Agreement	NextGen Human Factors Air Traffic Control Research DTFAWA-09-X-80020	The FAA and NASA will research, study, analyze, model, test and implement the advanced services and capabilities required for NextGen to be successful.
FAA/NASA Interagency Agreement	Develop methods to define helicopter vibration thresholds IA # SAA3-872	Support validation and demonstration of HUMS operation requirement, technologies, and processes to collect and substantiate structural usage data for maintenance credits.

1.2 Interagency Committees

In addition to MOUs, the FAA partners with other agencies through a variety of inter-agency committees and groups. For example, the FAA and other interested federal agencies established the Federal Interagency Committee on Aviation Noise to encourage debate and agreement over needs for future aviation noise abatement and new research efforts. The committee conducts annual public forums in different geographic regions with the intent to align noise abatement research with local public concerns.

2. Working with Government, Industry, and Academia

The FAA complies with all applicable federal guidelines and legislation concerning the transfer of technology. The FAA's goal is to transfer knowledge, facilities, equipment, and capabilities developed by its laboratories and R&D programs to the private sector. This helps expand the United States technology base and maximize the return on federal R&D investments.

2.1 Cooperative Research and Development Agreements

The Cooperative Research and Development Agreements (CRDAs) allow the FAA and its partners to share facilities, equipment, services, intellectual property, and personnel resources with industry, academia, and state and local governments in collaborative R&D activities. CRDAs are a highly effective way to meet congressionally mandated technology transfer requirements. In fiscal year (FY) 2009, the FAA established 7 new CRDAs, bringing the present total of active agreements to 22. Table B.2 provides details of these CRDAs.

Table B.2 – Active Cooperative Research and Development Agreements, FY 2009

Active CRDAs in FY 2009					
CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completi on Date
1994-A-0065	Airport Technology Research - Safety	Testing of a soft ground arresting system developed to safely stop aircraft that overrun the available length of runway	Engineered Arresting Systems Corp., Logan Township, NJ	09/07/94	09/07/10
1996-A-0097	Airport Technology Research - Capacity	Development of the National Airport Pavement Test Machine	The Boeing Company, Seattle, WA	07/29/96	07/29/11
2001-A-0164	Airport Technology Research - Safety	Use statistical analysis for determining airplane contact risks of varying-span airplanes on taxiways of varying separation	The Boeing Company, Seattle, WA	04/05/02	04/05/11

Active CRDAs in FY 2009					
CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completion Date
2002-A-0171	Capacity and Air Traffic Management Technology	Develop modeling and simulation tools to assist in tech implementation of capacity enhancing capabilities for the National Airspace System	The Boeing Company, McLean, VA	07/17/02	07/17/12
2005-A-0213	Air Traffic Models and Evaluation Tools	Machine-graded aviation English test for pilots for measuring levels of English language proficiency	Ordinate Corporation, Menlo Park, CA	01/17/06	01/17/11
2006-A-0216	Air Traffic Models and Evaluation Tools	Development and improvement of a graphical user interface for the display of recorded air traffic data	Rowan University, Glassboro, NJ	07/25/06	07/25/10
2006-A-0219	Human Factors & Aviation Medicine	Air Traffic Controller Cognitive Modeling	Drexel University, Philadelphia, PA	02/20/07	02/20/10
2006-A-0223	Surface Surveillance	Airport Surface Surveillance	RVision LLC, San Diego, CA	12/13/06	04/13/10
2007-A-0233	Surveillance	Flight testing for ADS-B separation standards	CNS Aviation, Vienna, VA	07/18/07	07/18/11
2007-A-0235	SERC/NextGen	Provide guidance for NetCentric standards and protocols that may be incorporated by the NextGen Program.	Network Centric Operations Industry Consortium Inc., Newport Beach, CA	09/21/07	09/21/10
2007-A-0236	Continued Airworthiness	Composite repair of aircraft structures	The Boeing Company, Huntington Beach, CA	10/30/07	10/30/10
2008-A-0245	Unmanned Aircraft Systems Research	Unmanned aircraft system research	New Mexico State University, Las Cruces, NM	02/19/08	02/19/10
2008-A-0247	Propulsion and Fuel Systems	Full scale engine evaluation and analyses of aviation fuel	Swift Enterprises, West Lafayette, IN	06/30/08	06/30/10
2008-A-0249	Technical Strategies and Integration	Aviation-related research in support of DoD rapid response-third generation activities	HiTec Systems Inc., Egg Harbor Township, NJ	08/5/08	04/5/14
2008-A-0250	Fire Safety	Wind tunnel research in aerodynamics	Absegami High School, Galloway Township, NJ	09/17/08	03/17/10
2008-A-0251	Laboratory Future Development	For the advancement and commercialization of Sun Keyboard System Translator	Diakon Solutions LLC, Cape May Court House, NJ	12/10/08	12/10/13

Active CRDAs in FY 2009					
CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completi on Date
2008-A-0252	Human Factors	Index of cognitive activity and characteristics of the air traffic control task	The Richard Stockton College of New Jersey, Pomona, NJ	01/6/09	01/6/11
2008-A-0255	Weather	Network centric airborne microserver	Center for Network Centric Product Support Research LLC, East Hartford, CT	10/23/08	10/23/11
2009-A-0257	Laboratory Future Development	Aircraft Geometric Height Measurement Element	Diakon Solutions, LLC Cape May Court House, NJ	01/27/09	01/27/14
2009-A-0258	Unmanned Aircraft Systems Research	Modeling and simulation to assess the impact of Unmanned Aircraft Systems	General Atomics Aeronautical Systems, Inc. San Diego, CA	07/15/09	07/15/11
2009-A-0259	Unmanned Aircraft Systems Research	Modeling and simulation to assess the impact of Unmanned Aircraft Systems	AAI Corporation, Hunt Valley, MD	06/26/09	06/26/11
2009-A-0260	Unmanned Aircraft Systems Research	Modeling and simulation to assess the impact of Unmanned Aircraft Systems	GE Aviation Systems LLC, Grand Rapids, MI	06/19/09	06/19/11

3. Working with Industry

3.1 Small Business Innovation Research

Small Business Innovation Research (SBIR) contracts encourage the private sector to invest in long-term research that helps the federal government meet its R&D objectives. Eligible small business contractors compete for Phase I contracts to conduct feasibility-related experimental or theoretical research. A Phase II contract is awarded based on the results of Phase I; Phase II is the actual research phase. Contractors are encouraged to pursue other than SBIR funding sources for Phase III and to attract venture capitalists to commercialize the innovation.

3.2 Patents Issued Through the U.S. Patent and Trademark Office

Inventors are encouraged to patent new technologies through the U.S. Patent and Trademark Office. A patent is a grant of a property right and gives the owner the right to exclude anyone else from making, using, or selling the invention. Inventions patented by FAA inventors are available for commercial licensing with royalty payments shared with the inventor and the agency. Legislation allows for inventors to receive up to $150,000 a year over their salary from royalty payments. The agency's Technology Transfer Program Office promotes the agency's patents for commercialization. Table B.3 lists the current U.S. patents issued to the U.S. Department of Transportation, FAA.

Two licensing agreements are in effect for Patent No. 5,981,290 "Microscale Combustion Calorimeter" and Patent No. 6,464,391 "Heat Release Rate Calorimeter for Milligram Samples."

Under the patent provisions of Government funding agreements, recipients must disclose each subject invention that they make to the Federal agency and may elect to retain title to any patentable subject matter. If the recipient retains title, the Government is granted a broad license to use the invention for Government purposes throughout the world.

The FAA has identified approximately 60 active patents resulting from FAA funded agreements. These patented technologies are available for use by the Government, and its contractors, on a cost-free basis when used for Government purposes. For more information, see http://www.tc.faa.gov/technologytransfer/ttpatentsthru_grant.html.

Table B.3 – Patents Issued for DOT/FAA

Patents Issued for DOT/FAA			
Patent No.	Date of Patent	Title	Description
7,592,816	09/22/09	Localizer cable fault analyzer	An analyzer that memorizes which antenna in a Localizer antenna array caused a fault.
6,812,834	11/02/04	Reference sample for generating smoky atmosphere	A reference sample for testing fire detectors and a method for testing using the reference samples.
6,470,730	10/29/02	Dry transfer method for the preparation of explosives test samples	A method of preparing samples for testing explosives and drug detectors of the type that search for particles in air.
6,467,950	10/22/02	Device and Method to Measure Mass Loss Rate of an Electrically Heated Sample	A device and a method for measuring the mass loss rate of a sample of combustible material placed on a mass-sensitive platform.
6,464,391	10/15/02	Heat Release Rate Calorimeter for Milligram Samples	A calorimeter that measures heat release rates of very small samples (on the order of 1 to 10 milligrams) without the need to separately and simultaneously measure the mass loss rate of the sample and the heat of combustion of the fuel gases produced during the fuel generation process.
6,116,049	09/12/00	Adiabatic Expansion Nozzle	A nozzle for producing a continuous gas/solid or gas/aerosol stream from a liquid having a high room temperature vapor pressure.
5,981,290	11/09/99	Microscale Combustion Calorimeter	A calorimeter for measuring flammability parameters of materials using only milligram sample quantities.

4. Working with Academia

4.1 Joint University Program for Air Transportation Research

The Joint University Program (JUP) is a research partnership of three universities (Ohio University, Massachusetts Institute of Technology, and Princeton) that conducts scientific and engineering research on technical disciplines that contribute to civil aviation, including air traffic control theory, human factors, satellite navigation and communications, aircraft flight dynamics,

avionics, and meteorological hazards. The FAA and NASA benefit directly from the results of the research and, less formally, from valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical expertise in industry, academia, and government. For more information, see http://u2.princeton.edu/~jup/.

4.2 Aviation Grants

The FAA awards research grants to qualifying colleges, universities, and legally incorporated nonprofit research institutions. The evaluation criteria for grant proposals include the potential application of research results to the FAA's long-term goals for civil aviation technology. Table B.4 lists the FAA research grants started in FY 2009. The FAA awarded $9,456,680 in new grants in FY 2009. It also awarded an additional $8,299,661 to grants started in prior fiscal years for a total of $17,756,341 in grant awards in FY 2009.

Table B.4 - FAA Research Grants Starting in FY 2009

FAA Research Grants, FY 2009				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Air Traffic Control/Technical Operations Human Factors	2009-G-001 The Identification of Critical Human Factors Issues for Improving Collaborative Air Traffic Management in the Future Aviation System	The Ohio State University	10/14/2008 8/31/2010	$173,071
Unmanned Aircraft Systems Research	009-G-002 Visual Aircraft Detection and Tracking via Foveal and Peripheral Vision	Board of Trustees of the Leland Stanford Junior University	11/18/2008 11/17/2010	$203,200
Flightdeck/Maintenance/System Integration Human Factors	2009-G-003 Improving Aviation Safety Through Training & Design	George Mason University	2/18/2009 2/17/2010	$450,000
Air Traffic Control/Technical Operations Human Factors	2009-G-004 Data Communication Part-task Simulation: Pilot Performance	Board of Trustees of the University of Illinois	3/3/2009 9/2/2010	$299,523
Runway Incursion Reduction	2009-G-005 Airport Runway Incursion Safety Analysis and Prioritization	The Rector and Visitors of the University of Virginia	7/22/2009 7/21/2011	$160,000

FAA Research Grants, FY 2009				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Airport Technology Research – Safety	2009-G-006 Non Wildlife-attracting Native and Naturalized Turf Species Suitable for Use on Airfields Managed for Wildlife Hazards in the Northeast	The Research Foundation of SUNY for SUNY College at Oneonta	5/21/2009 8/20/2010	$25,487
Weather Program	2009-G-007 Weather Processors Support Task: Right-Sizing NextGen Weather Observation Network	The Board of Regents of the University of Oklahoma	5/27/2009 3/26/2010	$247,500
Air Traffic Control/Technical Operations Human Factors	2009-G-008 Situation Management	Georgia Tech Research Corporation	6/9/2009 6/8/2010	$294,992
Airport Technology Research – Capacity	2009-G-009 Pavement Rehabilitation Strategies for Ramps at Airports with Commercial and Primary Services	University of Massachusetts Dartmouth	6/18/2009 6/17/2010	$43,000
Satellite-based Navigation	Satellite-Based Aircraft Precision Approach and Landing Research	Ohio University	8/3/2009 11/2/2010	$397,533
Airport Technology Research – Safety	2009-G-0011 NSSA Security Work for FY 2000	National Safe Skies Alliance	8/7/2009 8/6/2010	$5,000,000
Flightdeck/Maintenance/ System Integration Human Factors	2009-G-0012 Forecasting the Future of Aviation Maintenance and the Impact on the US Aviation Maintenance Technician	Board of Trustees of the University of Illinois	8/25/2009 8/24/2010	$250,426
Fire Research and Safety	2009-G-0013 Ultra-low Flammability Polymer Materials for Aircraft	University of Massachusetts Amherst	8/7/2009 8/6/2010	$236,747
Continued Airworthiness	2009-G-0014 Flight Loads Analysis of Light Agricultural Aircraft	Wichita State University	8/5/2009 1/4/2011	$245,292

FAA Research Grants, FY 2009				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Continued Airworthiness	2009-G-0015 Damage Tolerance Based Maintenance Planning of Aircraft Structures Subjected to Stochastic Process Random Effects	Wichita State University	8/14/2009 2/17/2011	$180,000
Continued Airworthiness	2009-G-0016 Probabilistic Damage Tolerance-Based Maintenance Planning for Small Airplanes	University of Texas at San Antonio	9/1/2009 8/31/2012	$717,517
Aviation Safety Risk Analysis	2009-G-0017 Statistical Analysis of Contributing Factors in Landing Performance during Commercial Operations	Rutgers, The State University of New Jersey	8/25/2009 8/28/2010	$154,677
Fire Research and Safety	2009-G-0018 Material Flammability: Two-dimensional Burning Model for Aircraft Materials	University of Maryland	9/1/2009 8/31/2010	$139,968
Atmospheric Hazards – Aircraft Icing	2009-G-0019 Plans for Future Pilot Icing Training Materials: Developing New Techniques and Educational Design Methods for Pilot Icing Training Materials	Decision Science Research Institute	8/27/2009 8/26/2010	$50,000
Fire Research and Safety	2009-G-0020 Collaborative Research Supporting FAA Fire Safety Mission through FAA-Rutgers Graduate Assistant Support	Rutgers, the State University of New Jersey	9/2/2009 9/1/2010	$102,116

FAA Research Grants, FY 2009				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Atmospheric Hazards – Aircraft Icing	2009-G-0021 An Investigation of Anti-icing Endurance Times of Aircraft Ground De/Anti-icing Fluids: Snow Pellets, Thermodynamic and Aerodynamic Fluid Failure and Non-glycol Fluids	University of Quebec at Chicoutimi	9/3/2009 9/2/2010	$85,631$
Total of awards originating in FY 2009: $9,456,680				

4.3 Air Transportation Centers of Excellence

The FAA sponsors five air transportation centers of excellence (COEs) with academic institutions throughout the United States. COEs are established through long-term cooperative agreements that encourage collaboration between government, academia, and industry to advance aviation technologies. COE universities match FAA grants by partnering with industry affiliates and state and local governments. The five COEs include:

- COE for Research in the Intermodal Transport Environment (RITE)
- Joint COE for Advanced Materials (JAMS)
- Partnership for Air Transportation Noise and Emission Reduction (PARTNER)
- COE for General Aviation Research (CGAR)
- COE for Airport Technology (CEAT)

A new COE for Commercial Space Transportation is under consideration for FY 2010.

The pages that follow provide a brief description of each of the five centers with a table that identifies the grants awarded in FY 2009 for each COE.

4.3.1 COE for Research in the Intermodal Transport Environment (RITE)

Established as the Center of Excellence for Airliner Cabin Environment in 2004, Harvard University and Purdue University are the technical leads for the renamed COE for Research in the Intermodal Transport Environment (RITE). Auburn University serves as the administrative lead. RITE conducts R&D on cabin air quality and chemical and biological threats. Because of the Phase I evaluation, RITE expanded research activities to include the intermodal transport environment. Other member universities include: Boise State University, Kansas State University, the University of California at Berkeley, and the University of Medicine and Dentistry of New Jersey. For additional information see: http://www.acer-coe.org/.

Table B.5 – Grants Awarded in FY 2009 to COE for Research in the Intermodal Transport Environment (RITE)

RITE Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Pesticide Exposure and Ozone By-Products	University of Medicine and Dentistry of New Jersey	$150,000	C. Ruehle and J. Watson	C. Weisel
Chemical Sensors for Cabin Air Quality	Boise State University	$150,000	C. Ruehle and J. Watson	S. Loo
Ozone and its Volatile Reaction By-Products on Domestic and International Flights	University of California at Berkeley	$150,000	C. Ruehle and J. Watson	W. Nazaroff
Health Effects of Mild Hypoxia During Air Travel - a Study of Physiological Effects and Impact; Evaluation of Triethylene Glycol for Inactivation of Influenza Virus Aerosols	Harvard University	$250,000	C. Ruehle and J. Watson	J. Spengler
Improvements on the Advanced Models for Predicting Contaminant and Infectious Disease Virus Transport in Airliner Cabin Environment	Purdue University	$250,000	C. Ruehle and J. Watson	Q. Chen
Chemical Sensors for Cabin Air Quality	Auburn University	$250,000	C. Ruehle and J. Watson	R. Overfelt
Aircraft Recirculation Filter for Air Quality and Incident Assessment	Kansas State University	$120,000	C. Ruehle and J. Watson	S. Eckels
Total awarded in FY 2009: $1,4000,000				

4.3.2 Joint COE for Advanced Materials (JAMS)

Established in 2003, under the leadership of the University of Washington and Wichita State University, the Joint COE for Advanced Materials conducts R&D on material standardization and shared databases; bonded joints; structural substantiation; damage tolerance and durability; maintenance practices; advanced material forms and processes; cabin safety; life management of materials; and nanotechnology for composite structures. Other member universities include: Edmonds Community College, Northwestern University, Oregon State University, Purdue University, the University of California at Los Angeles, the University of Delaware, Florida International University, the University of Utah, Tuskegee University, and Washington State University. For additional information, see http://www.jams-coe.org/.

Table B.6 – Grants Awarded in FY 2009 to the Joint COE in Advanced Materials (JAMS)

JAMS Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Fluid Ingression Damage Mechanisms in Composite Sandwich Structures	Wichita State University	$50,000	D. Westlund	J. Tomblin
Development and Safety Management of Composite Certification Guidance	Wichita State University	$51,500	C. Davies	J. Tomblin
Improving Adhesive Bonding of Composites through Surface Characterization	University of Washington	$70,000	C. Davies	B. Flinn
Certification of Discontinuous Composite Material Forms for Aircraft Structures	University of Washington	$65,000	C. Davies	M. Tuttle
Standardization of Analytical and Experimental Methods for Crashworthiness Energy Absorption of Composite Materials	University of Washington	$34,044	A. Abramowitz	P. Feraboli
Combined Global/Local Variability and Uncertainty in Integrated Aeroservoelasticity of Composite Aircraft	University of Washington	$34,000	L. Pham	E. Livne
Development of Reliability-Based Damage Tolerant Structural Design Methodology	University of Washington	$34,000	L. Pham	E. Livne
Administration of the FAA Center on Advanced Materials in Transport Aircraft Structures (AMTAS)	University of Washington	$74,531	C. Davies	M. Tuttle
Identification and Validation of Analytical Chemistry Methods for Detecting Composite Surface Contamination and Moisture	Florida International University	$34,000	D. Westlund	D. McDaniel
Development and Evaluation of Fracture Mechanics Test Methods for Sandwich Composites	University of Utah	$34,000	C. Davies	D. Adams
Certification by Analysis	Wichita State University	$150,000	A. Abramowitz	G. Olivares
Environmental Factor Influence on Composite Design and Certification	Wichita State University	$225,000	D. Westlund	J. Tomblin
Inverse/Optimal Thermal Repair of Composites	University of Washington	$58,761	C. Davies	A. Emery
Improving Adhesive Bonding of Composites Through Surface Characterization	University of Washington	$34,000	C. Davies	B. Flinn
Impact Damage Formation on Composite Aircraft Structures	University of California at Los Angeles	$162,500	C. Davies	T. Hahn/H. Kim

JAMS Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Training Strategy Development - Composite Materials Education for Aircraft Practitioners	Edmonds Community College	$38,640	C. Davies	C. Seaton
Training Strategy Development – Composite Materials Education for Aircraft Practitioners	Edmonds Community College	$25,000	D. Westlund	C. Shaeffer
Failure of Notched Laminates Under Out-of-plane Bending	Oregon State University	$30,000	L. Pham	J. Parmigiani
Development and Safety Management of Composite Certification Guidance	Wichita State University	$75,000	C. Davies	J. Tomblin
Evaluation of Friction Stir Weld Process and Properties for Aircraft Application	Wichita State University	$200,000	L. Pham	D. Burford
Failure of Notched Laminates Under Out of Plane Bending	Oregon State University	$64,650	L. Pham	T. Kennedy
Damage Tolerance Testing and Analysis Protocols for Full-Scale Composite Airframe Structures under Repeated Loading	Wichita State University	$275,000	C. Davies	J. Tomblin
Administration of the Center of Excellence for Composites and Advanced Materials (CECAM) at Wichita State University	Wichita State University	$75,000	C. Davies	J. Tomblin
Production Control Effect on Composite Material Quality and Stability	Wichita State University	$125,000	C. Davies	J. Tomblin
Total awarded in FY 2009: $2,019,626				

4.3.3 COE Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER)

Selected by the Administrator in 2003, the COE Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) is co-sponsored by NASA and Transport Canada with FAA and led by the Massachusetts Institute of Technology. PARTNER conducts R&D to identify, understand, measure, and mitigate the impacts of aircraft noise and aviation emissions. PARTNER seeks to reduce uncertainty in issues dealing with climate impact and the health and welfare effects of emissions to actionable levels. Other member universities include: Pennsylvania State University, Purdue University, Stanford University, the University of Missouri-Rolla, the University of North Carolina – Chapel Hill, and Georgia Institute of Technology. For additional information, see http://www.partner.aero.

Table B.7 – Grants Awarded in FY 2009 to the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER)

PARTNER Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Noise Exposure-Response: Annoyance	Pennsylvania State University	$25,000	M. Marsan	V. Sparrow
Environmental Design Space Tool Development	Georgia Institute of Technology	$100,000	J. DiPardo	D. Mavris
Program Management for Aircraft Noise and Aviation Emissions Mitigation Center of Excellence	Massachusetts Institute of Technology	$100,000	L. Maurice	I. Waitz
Noise Exposure Response - Sleep Disturbance	Purdue University	$25,000	L. Fisher	P. Davies
Emissions Characteristics of Alternative Aviation	Missouri University of Science and Technology	$150,000	C. Ma	P. Whitefield
Environmental Cost-Benefit Analysis of Ultra Low Sulfur Jet Fuels	Massachusetts Institute of Technology	$174,000	M. Gupta	I. Waitz
EDS Capability Demonstration for Assessing the CLEEN Program	Georgia Institute of Technology	$100,000	J. DiPardo	D. Mavris
Implementation of Enhanced Network Restructuring Algorithms and Scenarios for Improved ATO Forecasts	Purdue University	$75,000	J. Post	D. DeLaurentis
Economic and Environmental Effects of the Introduction of a Cap and Trade Policy in Aviation	Massachusetts Institute of Technology	$400,000	T. Cuddy	I. Waitz
SAE E31 Methodology Development and Associated PM and HAP Emissions Characteristics for a High-Bypass Turbofan Engine	Missouri University of Science and Technology	$450,000	C. Ma	P. Whitefield
Use of Near-Term Operational Changes to Mitigate Environmental Impacts of Aviation	Purdue University	$104,515	L. Wedande	K. Marais
Development of a Research Roadmap for Sound Structural Transmission	Purdue University	$25,000	B. Hua	K. Ming
CDA Implementation in Low-through High Density Traffic	Georgia Institute of Technology	$250,000	S. Liu	J-P Clarke
NextGen En Route Traffic Optimization to Reduce Fuel Burn and Emissions	Georgia Institute of Technology	$989,197	L. Windhoffer	J-P Clarke
Noise Characterization and Improved Metrics to Assess Open Rotor Engine Architectures and Noise Impact to Airport Communities	Georgia Institute of Technology	$75,000	B. He	D. Mavris

PARTNER Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Monitoring of Enroute and Open Rotor Noise	Pennsylvania State University	$75,000	Hua	V. Sparrow
Program C. Management for Aircraft Noise and Aviation Emissions Center of Excellence	C. Massachusetts Institute of Technology	$295,000	L. Maurice	I. Waitz
Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring	Georgia Institute of Technology	$225,000	L. Windhoffer	D. Mavris
Outreach	Pennsylvania State University	$60,000	L. Fisher	V. Sparrow
Sonic Boom Mitigation	Pennsylvania State University	$167,658	L. Fisher	V. Sparrow
Source Emission and Propagation	Pennsylvania State University	$58,000	B. Hua	V. Sparrow
Studying the Effects of Aircraft Exhaust on Global and Regional Climate	Stanford University	$420,000	M. Gupta	M. Jacobson
Multi-Scale Modeling Assessment of the Impacts of Aviation Emissions on Air Quality	University of North Carolina	$274,999	M. Gupta	S. Arunachalam
Health Impacts of Aviation-Related Air Pollutants	Harvard University	$200,000	M. Gupta	J. Levy
SAE E31 Methodology Development and Associated PM Emissions Characteristics of Aircraft APUs and Alternative Aviation Fuels	Missouri University of Science and Technology	$60,000	C. Ma	P. Whitefield
Use of Isotopic Measurement and Analysis Approach to Uniquely Relate Aircraft Emissions to Changes in Ambient Air Quality	Missouri University of Science and Technology	$96,063	M. Gupta	P. Whitefield
Sonic Boom Mitigation	Purdue University	$10,000	L. Fisher	P. Davies
Environmental Design Space Tool Development	Georgia Institute of Technology	$799,999	J. DePardo	D. Mavris
Use of Near-Term Operational Changes to Mitigate Environmental Impacts of Aviation	Massachusetts Institute of Technology	$153,000	L. Wedande	J. Hansman
Emissions Characteristics of Alternative Aviation Fuels	Missouri University of Science and Technology	$384,000	C. Ma	P. Whitefield
Environmental Cost-Benefit Analysis of Alternative Jet Fuels	Massachusetts Institute of Technology	$300,000	W. Gillette	I. Waitz
Noise Exposure Response – Sleep Disturbance	Purdue University	$45,000	L. Fisher	P. Davies
Total awarded in FY 2009: $6,666,431				

4.3.4 COE for General Aviation Research (CGAR)

Established in 2001, Embry-Riddle Aeronautical University serves as the lead member for the Center of Excellence for General Aviation Research. This COE conducts safety-related R&D with application to non-commercial aviation. Core university members include: Wichita State University, the University of North Dakota, and the University of Alaska - Fairbanks and Anchorage. For additional information, see http://www.cgar.org.

Table B.8– Grants Awarded in FY 2009 to COE for General Aviation Research (CGAR)

CGAR Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Pilot Awareness of Current and LED Elevated Runway Guard Lighting	Embry-Riddle Aeronautical University	$52,804	D. Gallagher	J. French
General Aviation Systems Safety Management Research	Embry-Riddle Aeronautical University	$49,369	T. Tessitore	A. Stolzer
General Aviation Systems Safety Management Research	University of Alaska - Anchorage	$25,000	T. Tessitore	L. Kirk
General Aviation Systems Safety Management Research	University of North Dakota	$45,000	T. Tessitore	G. Ullrich
Flight Data Monitoring: General Aviation Safety Information Analysis & Sharing	Embry-Riddle Aeronautical University	$23,492	T. Tessitore	D. Esser
General Aviation Systems Safety Management Research	University of North Dakota	$10,000	T. Tessitore	G. Ullrich
General Aviation Systems Safety Management Research	University of Alaska – Anchorage	$10,000	T. Tessitore	L. Kirk
Data Communications Human Factor Air Traffic Control Implications on Preferential Treatment Service-for-Equipage Scenarios Across the NAS	Embry-Riddle Aeronautical University	$35,157	L. Ileri	E. Blickensderfer
Weather in the Cockpit (WITC) - Concept of Operations	University of Alaska - Anchorage	$150,126	I. Johnson	L. Kirk
A Database Management System for General Aviation Safety	Embry-Riddle Aeronautical University	$58,972	V. Kolli	M Bazargan
Year Nine, Management & Administrative Support - General Aviation Center of Excellence	Embry-Riddle Aeronautical University	$221,446	P. Sparacino	S. Hampton
Weather Technology in the Cockpit - User Needs Segment	University of North Dakota	$176,679	I. Johnson	J. Vacek
Load Spectrum Development for Unmanned Aerial Systems Airworthiness	Wichita State University	$100,000	T. Vu	J. Tomblin

CGAR Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Development of a 3-Dimensional Radar Based Airspace Monitoring Surveillance Instrument	University of Alaska - Fairbanks	$22,139	J. Zvanya	G. Walker
Development of a Three-Dimensional Radar Based Airspace Monitoring and Surveillance Instrument	University of Alaska - Fairbanks	$88,883	J. Zvanya	G. Walker
Subject Matter Expert Support for FAA UAS Simulator Workstation	University of North Dakota	$100,000	Lee/ Buondonno	D. Marshall
Remote Airfield Lighting Systems	Embry-Riddle Aeronautical University	$109,848	D. Gallagher	C. Grant
Weather Technology in the Cockpit - Pilot Training	Embry-Riddle Aeronautical University	$77,364	I. Johnson	J. Lanicci
General Aviation Systems Safety Management Research	Embry-Riddle Aeronautical University	$10,000	T. Tessitore	S. Hampton
Helicopter Lighting System	University of North Dakota	$192,941	D. Gallagher	T. Zeidlik
Total awarded in FY 2009: $1,559,220				

4.3.5 COE for Airport Technology (CEAT)

Established in 1995, the Center of Excellence for Airport Pavement Research focused primarily on pavement issues. The Center expanded its scope to include R&D on wildlife hazard mitigation, lighting, and related topics and changed its name to the Center of Excellence for Airport Technology. The University of Illinois at Urbana-Champaign remains the lead university. Other member universities include: Northwestern University, Georgia Institute of Technology, and Rensselaer Polytechnic Institute. For further information, see http://www.ceat.uiuc.edu/.

Table B.9 – Grants Awarded in FY 2009 to COE for Airport Technology (CEAT)

CEAT Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Field Evaluation of Runway Guard Lights	Rensselaer Polytechnic Institute	$125,000	D. Gallagher	N. Narendran
GIS, Hazard Assessment, Hazard Visualization, and CONOPS as Components of Wildlife Management Programs at Airports	University of Illinois - Urbana-Champaign	$451,476	R. King	E. Herricks
Metrics Research	Rensselaer Polytechnic Institute	$150,000	D. Gallagher	N. Narendran

CEAT Awards in FY 2009				
Title	Recipient University	Amount	FAA POC	University POC
Deployment and Operation of FOD Detection Systems at Airports with Runway Grove Testing	University of Illinois - Urbana-Champaign	$405,626	J. Patterson	E. Herricks
Phosphor LEDs	Rensselaer Polytechnic Institute	$75,000	D. Gallagher	N. Narendran
Center of Excellence for Airport Technology (CEAT) Work Program FY 2010	University of Illinois - Urbana-Champaign	$408,000	D. Brill	D. Lange
Deployment and Evaluation of Avian Radars	University of Illinois - Urbana-Champaign	$996,296	R. King	E. Herricks
Color Boundaries for Color Deficient Observers	Rensselaer Polytechnic Institute	$125,000	D. Gallagher	N. Narendran
Total awarded in FY 2009: $2,736,398				

APPENDIX C: Research, Engineering and Development Advisory Committee

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Introduction

The Federal Aviation Administration (FAA) values the ongoing involvement of the Research, Engineering and Development Advisory Committee in reviewing its current and planned research and development programs. FAA has established a formal process for the agency to reply to Committee recommendations. This document summarizes the Committee recommendations made during fiscal year (FY) 2009, and includes FAA responses as follows:

1. FAA Response to REDAC Guidance on Fiscal Year 2011 R&D Portfolio
2. FAA Response to REDAC Recommendations on Fiscal Year 2011 R&D Budget.

In FY 2010, FAA expects to receive the Committee's recommendations on FAA's planned research and development investments for FY 2012, including detailed recommendations from the standing subcommittees.

1. FAA Response to REDAC Guidance on Fiscal Year 2011 R&D Portfolio.

Dr. John Hansman (Committee Chair) submitted REDAC's R&D guidance for FY 2011 to the Administrator on Oct. 17, 2008. The agency provided the following response to the recommendations.

General Observations

FAA Response: In response to your general observation about the multiple shared objectives of the Next Generation Air Transportation System (NextGen), the FAA recognizes the need to fully integrate the shared objectives of NextGen (e.g., Capacity, Efficiency, Emissions, Noise, Safety, Security) in both the near-term and long-term plans. The integrated benefits story related to the shared objectives is discussed in the NextGen Implementation Plan that the Agency released in January. Specific metrics that can be tracked to reflect progress towards the shared objectives are also in development.

Subcommittee on Environment and Energy

As a general observation, the REDAC has been encouraged by the efforts to develop a structured approach to integrate near term and longer term (NextGen) objectives as well as the beginning of a research requirements flow down process driven by NextGen. The REDAC is concerned, however, that the multiple shared objectives of NextGen (e.g. Capacity, Efficiency, Emissions, Noise, Safety, Security) are somewhat piecemeal and need to be more fully integrated in both near term and long term plans. It is also important that the NextGen planning processes remain dynamic and able to adapt to emergent factors such as fuel, emissions and financial concerns which may shift the relative importance of competing NextGen objectives.

Recommendation (1): The Agency must continue to focus its environmental research on both activities to support NextGen and the traditional research necessary to ensure that United States leadership in the international process (ICAO) remains constant. It is therefore recommended that additional resources be made available, at least at the levels envisioned by the National Aviation Research Plan (NARP).

FAA Response (1): We fully agree that environmental research to support the activities of both the Next Generation Air Transportation System (NextGen) and the International Civil Aviation Organization (ICAO) is important and should continue. We will strive to support these activities in 2011 at least at the levels envisioned in the 2008 NARP.

Recommendation (2): With respect to NextGen, it is recommended that:

Recommendation (2a): Concentration on applied solutions should continue, especially with respect to the ongoing research on potential alternative fuels. Indeed, to highlight the importance of alternative fuels, the Subcommittee recommends that funding for Alternative Fuels research be broken out as a separate line item in future FAA budgets.

FAA Response (2a): We agree that focusing on applied solutions to mitigate environmental impacts is critical. We will separately highlight Alternative Fuels research investments in the future. However, please note that we cannot initiate robust efforts on applied solutions unless Congress appropriates the Fiscal Year 2009 President's Budget request and ultimately reauthorizes the Agency's activities.

Recommendation (2b): Airspace redesigns have generated an entirely new class of aircraft noise complaints, with citizens miles from airports now voicing concerns. It is recommended that sufficient funds be made available for a thorough reassessment of the noise issue to ensure that the goals of NextGen are not derailed by environmental concerns based on noise.

FAA Response (2b): We agree it is important to assess aircraft noise impacts within the context of airspace redesign. We are in the process of developing a new comprehensive noise research strategy and identifying partners and resources to carry it out.

Recommendation (2c): Similarly, with NextGen considering a shift to underutilized or new airports to relieve future congestion, the environmental challenges inherent in such a paradigm shift, both in terms of noise and emissions, must be considered. Sufficient funding to conduct such research should be provided.

FAA Response (2c): We agree that we must carefully assess and effectively address the environmental challenges inherent to shifting activities to underutilized airports. We will work this important effort, but it is dependent on Congress appropriating our Fiscal Year 2009 President's Budget request for Environment and Energy research and development.

Recommendation (2d): In order to foster continued communication and cooperation between the Office of Environment and Energy and the Air Traffic Organization (ATO), the subcommittee recommends that ATO establish one point of contact for work with the environmental community. Such communication is necessary to ensure that environmental metrics are included in the ATO NextGen decision-making process so that the environmental impacts on air traffic decisions are adequately considered.

FAA Response (2d): The Office of Environment and Energy (AEE) serves as FAA's single point of contact with respect to the external environmental community. Environmental issues that impact NextGen span broad constituencies, such as airports, aircraft, and air traffic control infrastructure and procedures. As a result of the broad impact, the FAA has not assigned a single individual point of contact with ATO. However, the NextGen Integration and Implementation Office is serving as the coordinating office on NextGen environmental issues within ATO. Furthermore, AEE is an active member of the NextGen Review Board and is represented on cross-FAA integration teams, including the NextGen benefits integration team.

Recommendation (2e): With respect to longer term considerations, the subcommittee recommends that FAA environmental research also concentrate on the environmental benefits of new aircraft development and specifically that work in conjunction with NASA on such issues continue.

FAA Response (2e): We agree that concentrating on the environmental benefits of new aircraft is critical to achieving NextGen environmental goals. We are working with the National Aeronautics and Space Administration (NASA) to implement the Continuous Low Energy, Emissions and Noise (CLEEN) program, which will concentrate on developing new clean and quiet aircraft technology. We will consider CLEEN a top priority as we build our Fiscal Year 2011 Budget Request. However, as noted previously, our ability to initiate this critical research is dependent on Congress appropriating the Fiscal Year 2009 President's Budget request and ultimately reauthorizing the Agency's activities.

Recommendation (2f): Finally, with global climate change an increasing environmental concern, the subcommittee recommends that the FAA work to bring together all relevant agencies to support the Aviation Climate Change Research Initiative (ACCRI).

FAA Response (2f): We agree that the climate impact of aviation is a topic of increasing environmental concern. Understanding climate impacts of aviation is an issue of high priority for the FAA, and we are addressing it through the Aviation Climate Change Research Initiative (ACCRI). We are engaging various federal agencies including NASA, the National Oceanic and Atmospheric Administration, Department of Energy, Environmental Protection Agency, and National Science Foundation that are participants in the U.S. Climate Change Science Program. We are working on developing approaches to implement the next phases of ACCRI.

Recommendation (3): With respect to the ICAO standard setting process:

Recommendation (3a): The development of tools and metrics to support international standard setting should continue. In order to support these objectives, funding for the PARTNER program and the tool to assess the costs and benefits of various environmental initiatives (APMT) must continue.

FAA Response (3a): We agree that development of tools and metrics to support international standard setting is an important and high priority activity for the agency. We will strive to continue funding the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence and all efforts for the development of tools such as the Aviation environmental Portfolio Management Tool (APMT) in coming years.

Recommendation (3b): With ICAO having established a new process to assess the issue of global climate change (GIACC), the subcommittee recommends that sufficient funding and personnel resources be made available to support this activity.

FAA Response (3b): The activities of the ICAO Group on International Aviation and Climate Change (GIACC) are critical. We have already allocated new funds in Fiscal Year 2008 to support GIACC activities. We will continue monitoring the requirement and support GIACC as necessary**.**

NAS Operations Subcommittee

Finding: Neither the July workshop nor the September briefings presented adequate information to determine if, or how, critically important (if very difficult) R&D with system-wide NextGen design implications is being conducted. Specific areas of concern are an apparent lack of R&D devoted to (1) separation responsibility--including the air-ground split, the human-automation split, and the impact of failures or aircraft nonconformance; (2) the impact of new classes of vehicles (UAS, VLJ, CESTOL, etc) on the NextGen design and operation; (3) the development of risk assessment methods and safety analyses for the NextGen ConOps; and (4) the design of NextGen and operations in it to optimally minimize adverse environmental effects.

Recommendation (1): Use a taxonomy based upon research devoted to these areas to assess the FY 09 and FY10 R&D projects to ascertain whether a re-binning and an increase in funding for FY11 for R&D in these difficult areas is required. If so (and NASOPS believes it is so), consider re-allocating additional resources from other target areas to NASOPS.

FAA Response (1): NextGen R&D addresses these and other important areas through programs that coordinate with the NextGen Integration and Implementation Office (AJP-A) to ensure alignment of activities and priorities across FAA lines of business. In addition, the Agency's NextGen and core R&D programs are mapped into the National Airspace System Enterprise Architecture (NASEA) infrastructure roadmaps, which provide additional checks for time-phasing of program priorities. R&D program priorities are approved by the NextGen Review Board.

Fiscal Year 2011 involves a proposed current services budget that is based on the Fiscal Year 2010 proposed current services budget and is subject to change from policy decisions stemming from the new Presidential Administration.

In Fiscal Year 2011 NextGen R&D addresses separation responsibility including allocation of function between the human and automation as well as delegation of separation responsibility between air and ground through several NextGen budget line items. Based on the Fiscal Year 2011 proposed current services budget, this includes NextGen Self-Separation funded at $8.661 million as well as NextGen ATC/Technical Operations Human Factors – Controller Efficiency funded at $6.7 million. Also, the FAA partners with NASA to leverage its R&D investments in safety and airspace management.

Research is addressing new classes of vehicles with a multi-year Unmanned Aircraft Systems (UAS) project in the NextGen Demonstration budget line item funded in the Fiscal Year 2009 proposed budget at $5.7 million and the Fiscal Year 2010 proposed current services budget at $3.8 million. In addition, there is an ongoing UAS safety research program in the RE&D appropriation funded in the Fiscal year 2011 proposed current services budget at $1.97 million. The FAA models the introduction of UAS, Very Light Jets (VLJ), NASA's Cruise Efficient Short Takeoff and Landing (CESTOL) subsonic transport system, and other new classes of vehicles into the National Airspace System (NAS) to assess impacts from their operational characteristics.

Research is addressing NextGen and safety including through the System Safety Management Transformation budget line item funded in the Fiscal Year 2011 proposed current services budget at $16.3 million. This includes R&D components on Safety Management Systems, Safety Risk Management, System Safety Assessments, and Operational Safety Assessments. As each NextGen concept of operation matures, the Acquisition Management System requires completion of safety analysis reported in a Safety Risk Management Document, which is funded through the NextGen Operations Concept Validation – Validation Modeling budget line item. Safety analysis methods are reviewed with EUROCONTROL through Action Plan 15, Safety.

Research is addressing environmental modeling through the NextGen Environment and Energy – Advanced Noise and Emission Reduction and Validation Modeling budget line item funded in the Fiscal Year 2011 proposed current services budget at $7 million.

Finding: Although there was mention that a plan to establish an avionics roadmap has been drafted. The FAA appears to have no avionics roadmap yet for aircraft equipage, nor incentive to the industry to equip in an integrated fashion. Briefings on the airborne requirements for ATM are not linked to specific performance requirements. Since equipage is a major cost and complexity driver for airlines, this lack needs to be remediated immediately.

Recommendation (2): NASOPS subcommittee offers to work with the Aircraft Working Group of the JPDO to establish an airborne avionics road-map and FY11 funding requirements for airborne ATM R&D and lead-in re-prioritization of FY10 funding.

FAA Response (2): The FAA welcomes the interest and the offer of assistance by the NASOPS subcommittee regarding the NextGen Avionics Roadmap, and how this can be used to improve the NextGen-related R&D plans and the associated funding priorities for long-term avionics needs.

Recommendation (3): Continue to fund the EA at an appropriate level, but ensure that it develops into a straightforward tool to map and assess requirements and R&D.

FAA Response (3): The FAA appreciates the support of the REDAC in our efforts to develop, maintain, and evolve the Enterprise Architecture (EA) to facilitate sound enterprise level planning and decisionmaking and to support the evolution of the NAS towards NextGen. The FAA agrees with the suggestion to continue to fund and support the Agency's EA development and maintenance efforts at current funding levels. We also agree with the suggestion to align, map, and integrate R&D activities and requirements into the EA. We anticipated the second recommendation and have already made this a part of the annual EA update process for this year. The next version of the NAS roadmaps was published in January. These roadmaps will depict linkages and a mapping of existing and planned research and development activities to the main program/project activities planned for NextGen. This work, in conjunction with the development of new EA roadmaps for this year (i.e., Human System Integration, Security, etc.), will provide a more complete picture of the key relationships that must exist between critical R&D efforts and the NextGen portfolio of systems and programs. We anticipate that this EA enhancement will not only allow enhanced visibility into linkages between existing research and the NextGen portfolio, but will also identify potential areas where additional R&D efforts may address gaps or

reduce risk for NextGen. We are currently working within the ATO to coordinate acquisition planning with the R&D planning efforts using these new alignment artifacts as a basis for the coordination.

Recommendation (4): Re-establish funding at $15M/year for 2025 ConOps development, and develop a less risk averse NextGen Board ranking criterion.

FAA Response (4): The 2025 ConOps development is a Joint Planning Development Office (JPDO) function and they remain funded to complete the work. The NextGen Review Board is focused on near- and mid-term implementation and uses portfolio ranking criteria to prioritize funding on an annual basis.

Recommendation (5): Re-examine lower priority work currently funded with the goal of ending it. A specific recommendation is to stop Common Data and Structure Data (CSSD) work. Another is to re-examine the funding requirement for Common Automation Platform.

FAA Response (5): The FAA applies prioritization criteria to each activity to assess its continuation and the appropriate funding levels. The FAA is continuously reviewing activities and their results and any activity that does not warrant receiving continued funding will have the funding removed.

In response to the CSSD and Common Automation Platform recommendations specifically, the CSSD is not part of the RE&D portfolio as it is in the pre-implementation stage. It was identified as a critical shortfall as far back as the Target System Description and the introduction of Architecture Version 6. The CSSD activity is critical to moving towards a SWIM environment. This capability will be subject to a full investment analysis before it moves into development.

As envisioned, the common automation platform, or automation convergence, will enable significant cost savings. As the elements of the common automation platform are in our pre-implementation process, the FAA continues to examine aspects including common infrastructure, common software, common human and machine interactions and identical systems.

Partnerships

Finding: The NextGen design appears to be based on intuition and consensus, rather than modeling, analysis, simulation, and demonstration or testing. The implication from the July workshop is that the FAA intends to start a whole new activity in modeling and simulation, heavily infrastructure based, which was not ready to be briefed to NASOPS in September. This is not the correct approach. Additionally, the demonstration activities (e.g. Florida) need to be explicitly a part of the analysis, simulation, and learning process, and there is no evidence that they are.

Recommendation (6): Leverage the work of NASA and other government partners, and particularly the considerable investment of the JPDO and its industry partners in the work

accomplished by its System Modeling and Design Division, to form the basis from which to start this activity. Re-examine funding plans to develop entirely new simulation capabilities.

FAA Response (6): The ATO-P NextGen Modeling and Simulation Directorate is responsible for the development and coordination of FAA's NextGen Simulation capabilities. They presently have modeling and simulation capability in-house and make extensive use of the capabilities resident in the following organizations:

- Performance Strategy and Analysis Directorate;
- NextGen Integration and Implementation;
- Research and Technology Development;
- Aviation Weather;
- Technical Center's Test and Evaluation organization;
- FAA Airports;
- NASA;
- MITRE;
- University Partners; and
- National Center of Excellence for Aviation Operations Research (NEXTOR).

FAA uses this modeling and simulation expertise to integrate NextGen planning and benefits across the Agency. In 2009, FAA is launching a task force with industry through RTCA to focus on maximizing NextGen benefits, deployments, and business case understanding for industry. We are continually looking to advance our capabilities. We have recently completed a lab gap analysis to identify the expertise and laboratory needs for the near-term and future NextGen R&D and test and evaluation (T&E) activities and to describe the gaps between those needs and what is available at the William J. Hughes Technical Center and the Civil Aeromedical Institute (CAMI). This analysis can be used to identify future simulation capabilities that will be needed and provide input on funding priorities.

Recommendation (7): Establish criteria for demonstration projects that link them to specific research questions and on-going analysis and simulation to provide validated answers. Provide exit criteria for, and lessons-learned from, each demonstration project. Establish clear funding stream for proof-of-concept tests or demonstrations.

FAA Response (7): We agree with the characterization in the recommendation, which is consistent with the processes being established for managing demonstration projects. This includes defining the research issues being addressed by the project, and outputs expected at the end.

Demonstrations are selected based on opportunities identified from the National Airspace System Enterprise Architecture and in conjunction with key public interest.

Exit criteria correspond to the purpose of the demonstration. Near-term demonstrations conclude following validation of requirements, which are then allocated to systems for investment

decisions. Longer-term demonstrations accommodate additional validation exercises in order to further assess NextGen concepts such as involving new scenarios and technologies.

Funding for demonstration projects and tests are included in all NextGen budget lines including the NextGen Technology Demonstration and Infrastructure Development budget line, pre-investment activities contained in the NextGen solution sets, and in the R&D portfolio.

Subcommittee on Airports

Recommendation (1): The Subcommittee is pleased with the Airport Technology Research budget allocation for FY 10/FY 11, and with the task statements and recommends the personnel increase of two persons that the budget supports.

FAA Response (1): We concur. The FAA recognizes the need for additional staff in the Airport R&D Branch to keep pace with the significant funding increase in the Airport Technology Program. We have been successful in obtaining additional staff in Fiscal Year 2008 and Fiscal Year 2009. We will carefully consider the staffing levels required as we develop the Fiscal Year 2010 and Fiscal Year 2011 Administration budget requests.

Recommendation (2): The Subcommittee recommends closer coordination between the Airport Cooperative Research Program (ACRP) and the FAA's own Airports Technology Research Program based at the FAA Technical Center. This is especially important given the maturation of the ACRP after a several year start-up period. These two research programs should be, and largely are, complimentary and are both vital to supporting the airport progress needed in the years ahead. While they target different types of airport issues, only a continuous awareness by each program of the other's activities can assure that the goal of complementary programs will be achieved.

FAA Response (2): We concur. The FAA will continue close coordination between ACRP and the Airports Technology Research Program to ensure they remain complementary and are not duplicative. The Deputy Associate Administrator for Airports is on the ACRP Board of Governors. The Airport Subcommittee designated Federal official, James White, also supports the ACRP and is on the ACRP workgroup that screens all ACRP topics before they are considered by the ACRP Board. The active participation in both airport research programs by senior FAA personnel in the Office of Airports ensures that the programs will operate efficiently and without duplicative research.

Recommendation (3): There has been talk of moving the Airport Technology Research Branch (AJP) from ATO to AAS, which is the primary sponsor for the Airport Technology research. The subcommittee supports this realignment.

FAA Response (3): The Office of Airports has a Memorandum of Agreement with the Air Traffic Organization that specifies the roles of each organization in the oversight of the Airport R&D Branch. We believe it is working well and do not plan to make significant changes.

Recommendation (4): The subcommittee recognizes the good work that has come out of the large aircraft fire mock-up at Tyndall AFB in Panama City, Florida, and recommends the transition of this work to a draft training document as soon as possible to support fire crews across the nation at airports wherever the A380 might operate. An emphasis on composite fire fighting is also strongly supported.

FAA Response (4): We concur. We will include composites in our fire fighting research.

Recommendation (5): The subcommittee supports the pavement area research and the construction of a laboratory to support this research area. There is one topic that the Airport Subcommittee recommends adding to the pavement area research and that would be an effort to investigate the use of warm-mix asphalt for air carrier airport pavements, which reportedly deliver environmental benefits to paving operations.

FAA Response (5): We concur. We will add warm-mix asphalt research to the pavement research program.

Recommendation (6): The subcommittee recommends an increase for FY 2011 of $1,375,000 for visual aids, which increases this item to a total of $3,200,000. The increase is required to start work on the development of a visual aids test. For visual guidance, FAA will start a multiyear initiative to develop a state-of-the-art visual guidance technology test bed. This will enable visual guidance engineers an opportunity to design, install, test, monitor, and report on what it will take to create a visual guidance infrastructure that will take full advantage of state of the art technologies in Signs, Lighting and Markings. This will provide a more efficient infrastructure and the best visual cues to the airport user. Major advances in visual guidance technology have brought forth new, brighter, more efficient and more conspicuous lighting devices, enhanced paint material that lasts longer than traditional paint, and airport signage that is easier to read from greater distances. This new technology, when compared with the current state of visual guidance systems, warrants that the FAA undertake a major research effort to enhance these essential systems, making improvements that will best serve the future of our nation’s aviation system. The FAA's conceptual "NextGen" program talks about levels of air traffic increasing to three times what it is today, bringing thousands and thousands of aircraft to smaller airports that have historically seen very little traffic. The demand for the visual guidance infrastructure at these airports will increase significantly, bringing with it higher levels of usage, higher performance requirements, and higher costs to maintain. Energy use and energy costs are becoming an important consideration for all airports in their efforts to become more sustainable and ”green“. Today’s General Aviation community is already indicating that there is a need to enhance their visual aids, citing examples of aging power cables, antiquated fixtures, and high energy costs as major problems that they are experiencing now.

FAA Response (6): We concur. Funding for the Visual Aids Laboratory was in the President’s Fiscal Year 2009 budget request. That funding is uncertain because we are operating under a continuing resolution. If it is not included in the final Fiscal Year 2009 appropriations, we will consider it in future budgets.

Recommendation (7): The Subcommittee recommends that at some point in the future to carry out a study that would validate (or refute) the findings on taxiway deviation at JFK, now that NLA operations have begun. While not necessarily the only study that could be considered for validation, it would be timely to do this, once the numbers of daily operations increase to a suitable level.

FAA Response (7): We concur. We will continue to work with the Subcommittee and start this research at the appropriate time.

Recommendation (8): The Airport Subcommittee sees an overarching need for the NextGen program to more thoroughly consider airport issues in its plans. The NextGen Program should decide what a future airport might possess in order to make it fully NextGen ready, and then articulate the attributes that airports will need to build to, in order to achieve consistency with that vision.

FAA Response (8): Development of future airports capabilities is an integral part of NextGen and the FAA's Airports organization is integrally tied into NextGen planning and implementation. This is illustrated by both the July 2008 and January 2009 releases of the NextGen Implementation Plan which highlight a number of recent and planned improvements to a number of airports. Improvements included the installation of surface movement technology, improved routes and procedures in and out of airports, and the reduction of landing visibility minimums. The FAA is also actively pursuing research and other activities that will lead to improvements in the utilization of closely spaced parallel runways. The FAA will continue to work closely with the airport community to improve understanding of NextGen plans and benefits as they relate to airports and to receive improved feedback on those plans.

Subcommittee on Human Factors

Observations

Recommendation (1): The committee noted the strong cooperation/collaboration between ATO-P and AVS human factors (HF) personnel. The committee believes that a continued level of close cooperation will be critical to achieving success in development and fielding of NextGen concepts.

FAA Response (1): The Human Factors Research and Engineering Group intends to continue and strengthen the link to human factors personnel in the Aviation Safety organization. We feel that a high level of coordination is necessary to address common human factors issues as we move forward to implement NextGen.

Recommendation (2): The Personnel Roadmap is an extremely valuable tool to ensure recognition and visibility for human-related issues in NextGen. The committee strongly supports this effort and feels it will be a valuable component of the NextGen development process.

FAA Response (2): We agree about the importance of fully incorporating human considerations in the development of NextGen and the NAS Enterprise Architecture. The Personnel Roadmap,

now revised to the "Human System Integration (HSI) Roadmap" as suggested during discussions with the Subcommittee on Human Factors, provides a means to link system developments with the impacts on human role changes and safety as well as changes in staffing, training, and personnel selection requirements. We intend to use the HSI Roadmap as a focal point for our research and development activities and for coordination with other elements of the FAA associated with new automation, safety, staffing, training, and personnel selection.

Recommendation (3): It is important that NextGen planning and implementation continue to leverage common resources across industry, government and academia.

FAA Response (3): Our NextGen planning will make full use of laboratories, personnel, and other resources on a national level. We have engaged NASA and Volpe in discussions to leverage their resources through tasking agreements and will continue to cooperate with academia as we have in our core human factors research program. We anticipate making extensive use of contracting to industry to perform analyses, modeling, and other activities.

Findings and Recommendations

Finding (1) - Focus on Equipment at Expense of Human Issues: Current FAA NextGen planning in the solution set framework focuses primarily on equipment acquisition and insufficiently addresses human-related issues and needs. Greater emphasis on human systems integration in NextGen is required.

Recommendation (1a): Edit and revise NextGen planning documents, enterprise architecture, etc. to address human systems integration issues related to NextGen implementation. Continued development and integration of the Personnel Roadmap should facilitate this process.

FAA Response (1a): The FAA agrees. The next version of the NAS enterprise architecture includes a HSI roadmap. The FAA is continuing to assess related threads through the other enterprise architecture roadmaps. Examples include Optimized Profile Descent (OPD) and Low Visibility Operations. Furthermore, the FAA added a Chief System Engineer for Human Factors to its Chief System Engineers Group in the NextGen Integration and Implementation Office.

Recommendation (1b): Change term "Human Factors" in FAA job titles and organizational names to "Human Systems Integration." This may facilitate a broader role and understanding of the human component in the systems engineering approach.

FAA Response (1b): We will consider changing "Human Factors" in FAA job titles and organizational names to "Human Systems Integration" as suggested, but we have several concerns. While HSI may facilitate a broader role and understanding of the human component in systems engineering and acquisition, it is not typically used in civil aviation operations, either in air traffic or aviation safety. As such, it may be less useful in effectively communicating within and between FAA lines of business as well as with ICAO where "human factors" is currently used. We also need to better understand the potential impact on changing job titles while operating within the framework and job listings developed and managed by the Office of Personnel Management

Finding (2) - Human Factors Resource Limitations. Human factors resources in ATO-P and AVS are insufficient to carry out the range of activities required to adequately support NextGen development and implementation.

Recommendation (2): Increase AVS and ATO-P HF staffing and ATO-P HF research funding to support NextGen. In case of an extended Continuing Resolution for FY09 that will maintain Human Factors funding at the FY08 level, the FAA should augment human factors research funding so that critical NextGen human factors activities can be initiated. The Human Factors subcommittee notes that for FY08, the NextGen human factors budget line items were among the few that did not receive funding to perform substantive work. An additional delay in funding will jeopardize human system integration for NextGen.

FAA Response (2): We agree that human factors staffing is insufficient. Both Aviation Safety and the Air Traffic Organization have posted Human Factors professional vacancy announcements. We have selected two individuals from the list of candidates to fill positions in the Human Factors Research and Engineering Group. This Group has two additional vacancies to fill and will continue to review applications as they are received. We will continue to monitor the status of human factors specialist staffing in order to ensure that this critical component is adequately resourced. Our vacancy announcements will continue to cycle until we have recruited and hired sufficient staff. We are using various means to ensure that the human factors community of practice is aware of the vacancies to cast our recruiting net as wide as possible.

We are exploring avenues with other Air Traffic Organization service units to ensure that human factors work in NextGen reflects the needs of the people in the NAS as we introduce new technology and change roles and responsibilities. We will fund high priority cross-cutting NextGen human factors work to a limited degree from our traditional RE&D funding lines.

Finding (3) - Lessons Learned Not Well Integrated. The Post Implementation Review (PIR) process for the Advanced Technologies and Oceanic Procedures program resulted in a number of significant human factors findings, but there is not a clear process to ensure these findings are fed forward to benefit other NextGen programs.

Recommendation (3): Develop a process to formalize a human factors component to Post Implementation Reviews and establish processes to ensure lessons learned are available to other NextGen programs.

FAA Response (3): As we continue to assess and improve all aspects of the Post Implementation Review (PIR) process, we will look for further opportunities to enhance the incorporation of human factors as an essential component of this evaluation tool. The PIR policy requires that lessons learned be identified when PIRs are conducted. In early Fiscal Year 2009, an analysis of all lessons learned from PIRs conducted in Fiscal Year 2008 will be performed. The lessons learned are to be categorized by subject area (e.g., contracting, human factors, performance goals, cost and schedule baseline management, etc.) and used to identify any necessary changes in AMS policy or guidance including those related to human factors. The lessons learned will be available to all Acquisition process stakeholders in the agency.

Finding (4) - Crosscutting NextGen HF Issues Are Not Adequately Addressed. Due to the management structure of NextGen (individual program managers, solution set managers, etc.), it is not clear how crosscutting human factors issues will be recognized and addressed.

Recommendation (4): Develop management structure to address cross cutting human systems integration issues. Consider sharing REDAC subcommittee members or joint REDAC subcommittee meetings.

FAA Response (4): The FAA has applied a significant amount of research to human factors. We believe we have an operational and management structure that appropriately applies this research in addressing human factors issues in NextGen development. It is the responsibility of the solution set coordinators and the Chief System Engineer (CSE) for Human Factors to ensure human factors issues are being addressed in a consistent manner. The FAA is taking an integrated approach and recognizes it is a priority. The REDAC Subcommittee Chairs have received all meetings dates and will attend as schedule permits.

Subcommittee on Aircraft Safety

Key program observations and recommendations are listed below:

Observation (1): The Subcommittee on Aircraft Safety is encouraged by the FY2011 AVS Strategic Guidance provided by the Associate Administrator to the research planning community. The guidance created two new TCRGs, one focused on Weather in the Cockpit and the other on Self Separation & Air-Ground Integration. Additionally, emphasis was placed on the importance of program metrics, milestones & project phases in planning research projects, all positive additions intended to guide the right project management planning & execution.

Recommendation (1): Item tracking database put in place. Assures subcommittee input is addressed.

FAA Response (1): The FAA thanks the subcommittee for its positive observation. The FAA will continue to update the item tracking database and effectively follow-up on subcommittee recommendations.

Observation (2): The Subcommittee on Aircraft Safety reiterates its past recommendation that R, E & D requirements definition for NextGen must be expedited. Failure to define the research needs supportive of the envisioned cutting edge technologies that NextGen is counting on will result in less capable, in hand, solutions having to be implemented with NextGen performance suffering as a result. Given that the NextGen mid-term implementation target dates are 2012-2018 or just 3 to 9 years from now, R&D should already be well underway on any new capabilities envisioned for these time frames. Without roadmaps in place, some capabilities currently being envisioned for NextGen may already be overtaken by time.

Currently only about 10% of the R,E&D efforts are aligned explicitly with NextGen needs based on a SAS requested Solution Set, Domain & Roadmap alignment assessment. While waiting for top down requirements;

Recommendation (2): The Subcommittee recommends AVS R,E&D management extend the assessment approach, on a proactive basis, to uncover potential research requirements by reviewing Roadmaps, Integrated Work Plans, ConOps and Operational Improvements (as well as any other lower level plans that might exist) and discuss the findings with the Solution Set coordinators for validation.

FAA Response (2): During the September 2008 meeting, the subcommittee was briefed on an initial assessment of the alignment of FAA aircraft safety R&D projects with NextGen needs. As noted, this assessment indicates that about 10 percent of the base aircraft safety research program is aligned with NextGen. The subcommittee recommended, and the FAA concurs, that the assessment be continued. In the next step, NextGen solution set managers will review their respective solution sets with AVS to identify all NextGen Air Traffic Operations needs that potentially require supporting aircraft safety research. The FAA will complete this next step and present the results of this assessment at the next SAS meeting in the spring of 2009.

Observation (3): As was discussed at the July 2008 REDAC workshop on NextGen, there is currently no overarching System Safety Analysis model for NextGen. This model could be used to assess the impact of the large number of proposed NextGen system & subsystem elements and enable proper trades & capability requirements to be defined.

Recommendation (3): The Subcommittee recommends a System Safety Model be developed to permit an integrated, quantitative assessment of NextGen.

FAA Response (3): The FAA uses a Safety Management System (SMS) approach to all changes to the NAS. Due to the number and scope of the changes that are envisioned in NextGen implementation, the FAA is taking an integrated approach to assessing NextGen capabilities and that these are addressed in a consistent manner under the SMS framework.

Observation (4): Aviation Weather research is a very complex topic with the dual goals of improving both safety and capacity. The Subcommittee appreciated the review provided by Ken Leonard and the team. A strategic plan is needed to show how the products developed under the research program will be transitioned to meet the needs of the flying community.

Recommendation (4): Recommend the FAA engage the user community for both safety and capacity improvements validation.

FAA Response (4): FAA concurs with the recommendation and is pursuing it on multiple fronts. First, the ATO NextGen and Operations Planning Integration and Implementation Office is developing an overall NextGen strategy composed of seven solution sets. The Aviation Weather Office is responsible for the development and execution of a solution set called the Reduced Weather Impact (RWI), a NextGen transformational program called NNEW, and supporting research for both.

Second, the Aviation Weather Office is developing plans to transition each weather research area, such as convection, icing, ceiling and visibility, to operational use. Each plan will incorporate requirements from the NextGen ConOps, the NextGen Weather Functional Requirements, the FAA Weather Performance Requirements, the FAA NextGen Reduced Weather Impact solution set and other users input.

Third, the Aviation Weather Office will launch a program in Fiscal Year 2009 to validate the Weather Functional Requirements and the Weather Performance Requirements with users in the pilot, dispatch, and controller communities. The validation effort will utilize user workshops, user surveys, and, extending beyond Fiscal Year 2009, simulations and demonstrations.

Observation (5): ASIAS has indeed come a long way. However, there is still much work to do in R,E&D to accomplish ASIAS objectives as envisioned. Tools are still needed to effectively process, integrate, and mine the large amounts of disparate data that will be entered into ASIAS as more data sources come on line. Thus need to have clear roadmaps with roles and responsibilities of what new capabilities are needed and how they will be inserted into ASIAS. Also, it was noted that a Continuing Resolution (CR) in FY09 will impact new starts planned for ASIAS. SAS did not hear a mitigation strategy if CR should go past March, which is indeed possible in an election year.

Recommendation (5): Subcommittee strongly recommends FAA create mitigation plans, in the event the CR goes for an extended period. (note: this concern is not unique to ASIAS)

FAA Response (5): The FAA agrees and has developed and begun to implement a mitigation plan. Tasks for the initial six months of the fiscal year have been prioritized and funding has been secured which will allow ASIAS R,E&D work to continue to operate at the current staffing level until the end of March 2009.

Observation (6): FAA should continue to contribute to instrumentation development for NASA High Ice Water Content Atmospheric Characterizations effort. There is a need for fundamental physics research on accretion of ice crystals inside an engine – partial funding of this work is be contemplated by the FAA. This basic research is needed for future engine development and certification as well as resolving in-service issues of engine power loss. This research has applications beyond the engine, to any inlet with a heated surface, as well as probes which can be corrupted by ice crystals.

Recommendation (6): Subcommittee recommends finding a way to enable the Weather program to provide “pop-up” support of the upcoming flight test effort to maximize the efficiency of the test program.

FAA Response (6): The FAA concurs with the recommendation and is rebalancing its Fiscal Year 2009 activities to support the upcoming flight test effort via the Aviation Weather Office's Aviation Weather Research Program (AWRP). The AWRP’s In-Flight Icing Research Team will support the NASA High Ice Water Content effort by working closely with the FAA Aircraft Icing Group and NASA to provide scientific analyses of cloud environments with high ice

crystal concentrations. Forecasts will then be provided for those regions during instrumented flight tests.

Observation (7): The influx of new Unmanned Aircraft Systems (UAS) requirements from the user community is not waiting for or being driven by NextGen. The FAA needs to address current requirements that are ready for operational implementation, and also have a strategic plan to ensure NextGen can accommodate emerging and future UAS requirements.

Recommendation (7): Subcommittee recommends the FAA take a proactive education approach aimed at the "newcomers" to this rapidly expanding aviation sector as well as accelerating rulemaking-supporting research.

FAA Response (7): The FAA agrees with the recommendations. Education was identified early on as one of the most important issues regarding unmanned aircraft. Since 2004, the FAA has had a coordinated effort working closely with hobby groups, professional organizations, manufacturers, state and local law enforcement, and Federal agencies to develop a shared understanding of the issues. Throughout this time, the FAA has participated or hosted numerous conferences and meetings to better understand the users' needs and educate them on relevant aviation policy, regulations, and procedures. Since it is not unusual for 'newcomers' to have little or no aviation experience or knowledge, our education efforts often include a wide range of topics from basic aviation theory to advanced R&D initiatives. Building upon this interaction, the FAA has created a UAS Modeling and Simulation Lab where current and emerging needs can be evaluated against the NAS, as it is today and as it will be under NextGen. Numerous manufacturers and users groups are already participating in the development of this R&D effort.

Based on what we learned in these gatherings, the FAA initiated in mid 2007 a Special Federal Aviation Rulemaking effort to enable small unmanned aircraft to operate routinely in the NAS by late 2011. This regulatory effort, largely based on a "non-traditional" approach toward airworthiness and personnel certification, will rely heavily on validation through our Safety Management System and supporting research conducted along the way to ensure safety of the NAS is maintained. After this rule is enacted, resulting operations will provide valuable data that will be used in the many ongoing and new R&D efforts, including the UAS Lab, to promote the development of further regulation and the expanded integration of UAS into the NAS.

Observation (8): Research is planned to: "Develop minimum standards for augmented manual control Fly By Wire (FBW) designs". The Subcommittee is surprised that the current certification approach apparently relies heavily on program specific Special Conditions instead of up to date, comprehensive regulations. The Subcommittee is equally surprised the current regulations apparently do not adequately cover the >15 year old Fly by Wire technology.

Recommendation (8a): The Subcommittee recommends the FAA closely examine all areas of aircraft & engine certification for repeated use of Special Conditions as an indicator of areas where the regulations have not actually kept pace with the "advancing" technology.

FAA Response (8a): The SAS recommendation is related to policies regarding the methods of managing type certification and the updating of regulations and standards. FAA requests

additional time to evaluate the recommendation concerning the use of special conditions and will respond to the SAS prior to the spring 2009 meeting date.

Observation (8b): Airframe Icing - NASA and the FAA Technical Center have been involved with other organizations in a multi-year SLD technology roadmap to define the SLD environment and to develop engineering tools (codes, icing tunnels) with which airplane manufacturers can predict SLD ice shapes. This capability is critical to the airplane design, flight test, and certification processes. The FAA advisory group is currently conducting a status review of the available SLD engineering tools prior to the rulemaking proposal being issued for public comment. Although there is an "interim" capability for developing SLD ice shapes for freezing drizzle conditions the available tools are inadequate for freezing rain conditions. It is essential that FAA & NASA provide adequate priority and funding to enable completion of the key remaining SLD technology roadmap tasks prior to the regulation being implemented.

FAA Response (8b): The FAA Aircraft Icing research plans that were developed for Fiscal Years 2009 and 2010 did include projects for supercooled large droplet (SLD) engineering tools development. However, due to the priority of engine ice crystal ingestion research, available aircraft icing research resources have been concentrated on this issue. There are insufficient resources for the concurrent support of SLD and engine ice crystal ingestion research. The Aircraft Safety Research Program is currently prioritizing requirements for 2011 and will carefully evaluate aircraft icing research requirements.

Observation (9): Halon Replacement - Industry is still committed to working with the FAA to define an acceptable Halon-1301 replacement for engine/APU applications. This requires continued work with the nacelle fire simulator located at the William J. Hughes Technical Center. In addition to further testing using the FAA/industry-reviewed protocol Minimum Performance Standard - Engines (MPSe) Rev03, it will be necessary to define Rev04 of the MPSe to account for next generation fire extinguishing agents (e.g., higher boiling points, non-gaseous). Lack of support for these initiatives will make it difficult or even impossible to eliminate Halon-1301 from the propulsion fire extinguishing system on future airplanes.

FAA Response (9): The FAA supports industry development of extinguishing technologies for aircraft engine and auxiliary power unit applications, including alternatives for replacement of Halon 1301. FAA aircraft safety research resources are not currently budgeted specifically to extinguishing agent projects; however, the FAA will monitor continuing activities in this area and evaluate future priorities as appropriate.

2. FAA Response to REDAC Recommendations on Fiscal Year 2011 R&D Budget.

Dr. John Hansman (Committee Chair) submitted REDAC's recommendations to the fiscal year 2011 R&D budget to the Administrator on May 18, 2009. The agency provided the following response to the recommendations.

General Observations

Observation 1: As a general observation, the REDAC has been encouraged by the efforts to develop a structured approach for NextGen implementation. The REDAC does have concerns that the NextGen scope is so broad it is difficult to identify the most critical research requirements and determine if the appropriate research is in place to support NextGen. The 2018 focus of current implementation efforts seems appropriate for initial FAA implementation but it will be important to retain a longer national focus for the full NextGen effort.

FAA Response: As mentioned, the FAA's focus is NextGen's near- and mid-term implementation. However, the FAA does coordinate extensively with the Joint Planning and Development Office (JPDO) to ensure consistency between mid-term implementation and the long-term vision. The Enterprise Architecture (EA) lays the framework for NextGen beyond 2018 and into the 2025 timeframe from a high level, and the FAA has worked to ensure there are links within the EA from the mid-term through the long-term. The NextGen Implementation Plan provides additional detail on the activities (including research activities) to achieve the desired near- and mid-term operational improvements. While most of the research activities currently in the FAA's R&D portfolio are focused on mid-term implementation, the FAA is continuously evaluating research needs. In addition, the FAA along with the National Aeronautics and Space Administration (NASA), is working with the JPDO on four Research Transition Teams (RTT) to better coordinate between agencies the evolution of research into operational improvements and new capabilities. These efforts expand the full NextGen timeline through the long-term vision. The FAA values the insights we receive from REDAC and welcomes further recommendations on specific longer-term research requirements.

Observation 2: The REDAC also notes that the existing environmental and safety approval processes are not well structured to deal with the magnitude of system changes expected from NextGen. The challenges of the New York airspace redesign illustrate the difficulty of making even modest changes which clearly improve the environmental performance of the system. Innovative technical and policy approaches to these processes will be necessary for successful modernization.

FAA Response: The FAA remains committed to environmental stewardship and recognizes there are significant technical and political challenges to addressing environmental issues. The National Environmental Policy Act (NEPA) places stringent mandates on the FAA for how we assess changes in the environmental performance of the system and timely NEPA reviews are a critical element of NextGen implementation. NEPA requires Federal agencies to consider the environmental impacts of proposed Federal projects which could significantly affect the environment. While this requirement can be time consuming, the FAA continually looks for opportunities to improve the process. The FAA has taken steps to ensure the NextGen changes

and the resulting assessments are integrated appropriately. The FAA has recently formed a cross organizational team to ensure we map environmental reviews into NextGen project timelines. We are also conducting research to ensure we understand the longer term NEPA implications of NextGen. The FAA operates under a Safety Management System (SMS) that requires the assessment of all changes before they become operational. In addition, environmental impacts and safety integration are among the topics that are actively discussed by FAA leadership at the NextGen Management Board (NMB) meetings.

Observation 3: Finally, the REDAC has a continuing concern regarding the FAA's technical workforce in several emerging technology areas. In particular, the REDAC has repeatedly identified critical software and digital systems as an area where the agency has unique responsibility and exposure to technical risk in both air traffic and flight safety. The progress has been disappointing and will require a significant effort in the hiring and training of core technical staff as well as a research investment to stimulate national competency in these areas.

FAA Response: The FAA agrees with the REDAC's observation regarding the FAA's technical workforce in the critical software and digital systems area. The Software and Digital Systems (SDS) Technical Community Representative Group is developing a comprehensive and integrated research plan that identifies SDS-related research requirements for automation, communications, navigation, surveillance, and security as they relate to NextGen evolution. This plan, due December 30, 2009, should help focus new hiring requirements for SDS. To date, the Aircraft Certification Service (AIR) has hired two digital systems engineers in 2008 and a third vacancy is being filled presently. Also, we are actively recruiting to fill the Chief Scientific and Technical Advisory positions for both Aircraft Computer Software and Advanced Avionics.

Also, our Airports and Aircraft Safety Group has budgeted for an additional senior system engineer and computer scientist to supplement the staff. We are seeking individuals who have knowledge of integrated and complex aircraft digital systems and have conducted safety assessments of civil airborne systems and equipment.

Subcommittee on Airports

Recommendation 1: The Subcommittee recommends the FAA expedite completion of the research to identify if more firefighting agent is required at airports. This research is for the new large aircraft (group 6 aircraft) such as the A-380. These aircraft carry much more fuel than the group 5 aircraft such as the B-747.

FAA Response: The FAA agrees with this recommendation. Air carriers are purchasing and operating the Design Group 6 aircraft and several airports are making preparations to accept these aircraft. We will continue to focus on the completion of the fire testing underway to determine if changes to the appropriate advisory circulars are necessary.

Recommendation 2: The Subcommittee recommends the FAA continue to focus on wildlife research. This should be maintained at the highest levels to assure further progress in reducing wildlife hazards to aviation around airports.

FAA Response: The Office of Airports has a longstanding research program aimed at mitigating wildlife hazards, and we intend to continue these efforts. This includes research on habitat modification, harassment techniques, and the assessment of portable radars capable of detecting and tracking birds on or near airports.

Recommendation 3: The Subcommittee recommends that staffing be increased by one engineer within the Airport R&D Branch at the William J. Hughes Technical Center. The position will support the increased funding and research projects underway.

FAA Response: The FAA agrees with this recommendation. The President's Fiscal Year (FY) 2010 Airports Improvement Program (AIP) budget includes one engineer for the Airport R&D Branch. We anticipate requesting another engineer in the FY 2011 AIP request.

Recommendation 4: The Subcommittee recommends the FAA include $2,300,000 for Phase II of the visual aid test bed, and $2,400,000 for the high tire pressure testing initiative in the FY 2011 program request.

FAA Response: The FAA agrees with this recommendation. We support the initiatives to continue with Phase 2 of the visual test bed in FY 2011 and to start the high tire pressure testing in FY 2011. We anticipate including both these items in our FY 2011 AIP request.

Subcommittee on Environment and Energy

Recommendation 1: The Subcommittee finds that the FAA Office of Environment and Energy is significantly underfunded and understaffed, especially in view of the additional responsibilities (global climate change issues and a refocusing on noise research) that continue to be imposed on it. While the Subcommittee recognizes that the FAA is captive to the congressional appropriations process, action is necessary to ensure that appropriate research activities are initiated and sustained. In particular:

a. The Subcommittee recommends that the Agency fully fund an additional position in the Operations and Policy Division as soon as possible.

FAA Response 1(a): The FAA agrees with the Subcommittee that we need to augment staff in the Office of Environment and Energy to address the environment and energy issues associated with NextGen. In FY 2009, we have filled or are in the process of filling three vacancies and have added eight new positions to the Office of Environment and Energy. This includes filling two vacancies and adding three new positions to the Operations and Policy Division.

b. The Subcommittee recommends the Agency should, as quickly as possible, restore the contract support that was recently removed.

FAA Response 1(b): The FAA agrees that maintaining contract support to ensure the Agency's environment and energy research priorities are coordinated with the JPDO is important. We have asked JPDO to reevaluate this support and, in the mean time, have added an on-site contractor to provide support to the Environmental Working Group led by the Office of Environment and Energy.

c. The Subcommittee recommends that appropriate funding should be provided to continue the research review of aviation noise metrics and policy.

FAA Response 1(c): The FAA agrees with this recommendation. The Office of Environment and Energy is creating a research plan to review aviation noise metrics and policy with the assistance of a panel and the engagement of experts. We have begun work on what we consider the low-hanging-fruit tasks related to the effort. Constructive work is being done prior to the draft and final research roadmaps; however, the bulk of the effort will take place after the final research roadmap as this roadmap is needed to ensure a systematic approach to conducting the research. We will weigh allocation of resources for this effort against other research priorities when we finalize the research roadmap. At the conclusion of the research, there will be a recommendation on an aircraft noise metric (or metrics) and noise impact criteria.

d. The Subcommittee recommends that support of, and leadership in, the international processes of the International Civil Aviation Organization (ICAO) be continued. Specifically, funds should be available to support the activities of ICAO's Group on International Aviation and Climate Change (GIACC). GIACC is working to establish international standards on global climate change.

FAA Response 1(d): The FAA agrees that the work of the GIACC is critical. Funding was made available to support this activity in the past. At present there is no need for additional research to support the GIACC process. However, the environment and energy research program will support the action plan the GIACC has recommended to mitigate the impacts of international aviation emissions.

Recommendation 2: The Subcommittee continues to be concerned that environmental issues have not been given appropriate attention in the NextGen effort. In order to ensure proper environmental consideration, it is recommended that an Environmental Management System (EMS) be established for the NextGen initiative. This EMS would be used to provide information on the environmental impacts of modernization actions and would facilitate the implementation of environmental research efforts.

FAA Response: The FAA views addressing environmental issues as critical to the success of NextGen. Furthermore, the FAA agrees with the Subcommittee's observations about the importance of EMS and its recommendation to establish the NextGen EMS. We are presently scoping out the EMS framework for NextGen and will convene the first workshop on this important issue later this year to seek input from all stakeholders. The Office of Environment and Energy and the Air Traffic Organization are working together to address the operational aspects to be included in the NextGen EMS.

Recommendation 3: In order to support environmental research efforts, the Subcommittee recommends funding for the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) program is continued.

FAA Response: The FAA agrees with this recommendation. PARTNER plays a vital role in FAA's environment and energy RE&D program. We are in the process of completing the Phase-3 renewal of PARTNER and will continue to fund its valuable research activities at current or higher levels, depending on congressional appropriation levels.

Subcommittee on Human Factors

Finding 1: As a whole, the NextGen research work plans proposed by both Air Traffic Control and Technical Operations (NextGen Controller Efficiency) and Flight Deck (NextGen Self Separation and NextGen Air Ground Integration) domains were well crafted and reflect a good allocation of budget. The Subcommittee was pleased to see the efforts within NextGen Self Separation and NextGen Air Ground Integration focused on flight deck automation and human-automation function allocations. However, after reviewing the material provided (NARP, NextGen Implementation Plan), we were unable to judge the extent to which human factors was adequately addressed beyond the efforts of The FAA Human Factors Office (AJP-61) across NextGen elements. Numerous reviews by GAO, National Research Council and so forth have highlighted the lack of a NextGen strategy for ensuring that concerns with human performance, human system integration and effective use of automation are being systematically and thoroughly addressed at all stages of design and implementation.

Recommendation: The FAA, perhaps through the NextGen Integration and Implementation Office, should ensure that all organizations responsible for design and implementation of NextGen contribute to and act upon the following:

(a): A thorough review should be made and reported in a single document (e.g., *Human Factors Requirements of NextGen*) of the key issues with human performance, human systems integration and effective use of automation inherent to NextGen Operational Improvements (OIs) and enablers. Particular attention should be devoted to highlighting potential solutions and mitigations to likely issues.

(b): This document should be finalized in a multi-disciplinary workshop. The workshop organized outside of AJP-61 should include key decision makers in NextGen design and implementation. It should include the Chief Scientist for Architecture, the NextGen Development and the Director of the NextGen Integration and Implementation Office. This workshop should also address a strategy for pervasively, comprehensively, and systematically accounting for issues with human performance, human systems integration, and effective use of automation, and building in solutions and mitigations to identified concerns early in design. The document should have concurrence with the Chief Scientist for Architecture and NextGen Development and by the Director of the NextGen Integration and Implementation Office at the conclusion of the workshop and made available for public dissemination.

(c): The Subcommittee recommends that the agency should require all organizations in the FAA to periodically report how they are addressing the human factors requirements as documented in the areas of NextGen design and implementation for which they are responsible.

FAA Response: We appreciate the positive comments in the Finding regarding three NextGen human factors research work plans addressing Controller Efficiency, Self Separation, and Air-Ground Integration. The FAA agrees that the human element is a critical factor in successfully implementing NextGen and it remains a large focus for the Agency. However, the FAA does not believe that a stand-alone plan for human factors requirements is in the best interest of NextGen because it introduces opportunities for confusion and lack of integration. The FAA believes it is in our best interest to fully integrate human factor issues into our existing planning and execution. Integrated planning efforts are ongoing across the FAA to avoid the inconsistencies that might be raised as a result of developing independent, stand-alone plans. The FAA uses results from human factors research and studies in setting requirements as well as for validation of processes and systems. This is designed to provide the required level of integration and traceability.

These efforts have resulted in the development of an architecture roadmap for human system integration. In addition, there is extensive engagement occurring across the solution sets to address human performance and human system integration issues, solutions, and mitigations in NextGen. The Human Factors Research and Engineering office (AJP-61) works closely with the NextGen Integration and Implementation office (AJP-A) and other performing organizations to address critical human factors issues within the solution sets and transformational programs.

Finding 2: Many programs within and outside NextGen call out issues that have direct human factors implications but may not fall within the purview of AJP-61. Examples are weather products, safety, System-Wide Information Management (SWIM), and the repeated articulation of supporting situational awareness across many NextGen elements. We are concerned that critical human factors issues within these elements may not be addressed.

Recommendation: The Subcommittee recommends that the FAA develop a consistent process that addresses critical human factors issues within the seven NextGen Solution Sets. One approach would be to hire a human factors professional within the solution sets comprising the developmental areas of NextGen. AJP-61 could help coordinate and facilitate these developmental human factors activities.

FAA Response: A strong framework is in place to address human factors within the seven solutions sets as a result of substantial coordinated efforts. There has been and will continue to be significant discussion regarding human performance and human system integration challenges. The Human Factors Research and Engineering office (AJP-61) works closely with the NextGen Integration and Implementation Office (AJP-A) to address critical human factors issues in the solution sets. In addition, considerable effort was expended to develop an architecture roadmap for human system integration.

From a resource perspective, the NextGen Integration and Implementation Office added a Chief System Engineer for Human Factors within the last year to help provide the required consistency. AJP-61 supports NextGen efforts conducted by the ATO service units. AJP-61 is also coordinating with Flight Standards and Aircraft Certification office in Aviation Safety (AVS) regarding human factors research requirements supporting AVS NextGen regulatory matters.

Finding 3: The Subcommittee views the new NextGen positions allotted to AJP-61 and one more position as important steps to addressing the resource shortfall. However, filling the remaining positions is an immediate need for managing programs and contracts. Challenges external to the FAA include a shortage of both qualified applied researchers who understand the flight-deck, ATO domains, human factors engineering, and qualified human-in-the-loop simulation facilities. Compounding this problem is the lack of rapid and effective mechanisms for letting contracts to bring external researchers into the program.

Recommendation: The Subcommittee recommends that the FAA begin now to prepare human factors researchers for the NextGen tasks. This should include bringing in top talent in human factors and providing rapid but comprehensive exposure to the flight-deck and ATO domains. The FAA should explore ways to engage researchers in countries with similar ATO traditions (e.g., Canada, Europe, and Australia). Qualifying simulation facilities needs to be explored and the specialized programming skills required for this work obtained. The NextGen program is of long enough duration that a concerted effort to train the necessary researchers is still feasible, if it starts immediately. Other funding mechanisms need to be explored to allow qualified researchers to participate effectively, e.g., contracts, inter-agency agreements, broad agreements with umbrella groups (e.g., National Institute of Aerospace) and temporary assignments of researchers to FAA for specific time periods.

We also recommend that efforts be made to increase the pool of qualified applicants for future positions. This may be addressed by supporting the education of aviation human factors specialists at universities through contracts and grants. Within the FAA, short courses may be offered in aviation human factors for acquisition and regulatory personnel.

FAA Response 3: The FAA, led by the Human Factors Research and Engineering group (AJP-61), is pursuing several approaches for building a stronger base of specialized aviation human factors expertise enabling continued research for NextGen in the years ahead.

We are investigating new mechanisms to access aviation human factors expertise in academia and non-profit aviation organizations broadly. FAA continues to improve and expand air traffic control and flight deck simulation capabilities at the William J. Hughes Technical Center and the Civil Aerospace Medical Institute, including specialized programming expertise in relation to NextGen capabilities.

We are building and expanding research relationships with NASA, including use of its simulation facilities. By leveraging the expertise of the highly experienced human factors professionals at NASA and by ensuring that NASA's basic research is aligned with FAA NextGen goals, we are developing a cohesive human factors program. FAA collaborates with EUROCONTROL and its international research partners in air traffic management safety and human reliability assessment.

Education of aviation human factors students promotes a steady supply of professionals for positions in the public and private sectors. To this end, FAA has developed a Web-based short course on human factors.

Finding 4: The Human Factors office (AJP-61) has had rapid turnover in leadership with a series of temporary appointments. This may provide human factors with less influence on NextGen policies and decisions than would be the case if there was long-term continuity in the office.

Recommendation: The Subcommittee recommends that permanent leadership be appointed as rapidly as possible. This person should have sufficient authority to ensure effective, coordinated human factors activities across the organizational lines spanned by human factors.

FAA Response: AJP-61 is under the management of an experienced supervisor, with human factors expertise, who is actively taking steps to build the group's business practices, practices that are crucial in implementing the NextGen human factors portfolio. It is recognized that Human Factors Group management has changed in recent years, mostly due to individual career choice but also due to corporate needs. The Acting Director has the full support of the Director of Research and Technology Development (R&TD) and is empowered to make leadership decisions for AJP-61. The current Senior Executive leading AJP-61 is on a temporary detail to the Department of Transportation.

Finding 5: The Subcommittee is encouraged by the identification of human factors lessons learned in acquisition such as those expressed in the AJA Report *Cross Post-Implementation Review Analysis Lessons Learned*, dated December 30, 2008. However, in order for the FAA to take full advantage of the opportunities identified, a follow-on activity is needed to address each of these lessons as an appropriate change to acquisition policy, standards, guidance, or processes.

Recommendation: The Subcommittee recommends a process be developed that establishes how to transition human factors lessons learned into substantive follow-on activities. This will improve system implementation and acquisition policy, standards, guidance, and processes.

FAA Response: We agree with this recommendation. As our base of experience grows we need to capture what was learned, what changes resulted from these experiences, and how to transition improvements to acquisition policy, standards, guidance, and processes into the Acquisition Management System. The Human Factors Research and Engineering Office will monitor and coordinate with Air Traffic Organization service units to identify opportunities and mechanisms for gathering lessons learned throughout the system life cycle.

NAS Operations Subcommittee

Finding 1: The majority of the research presented was oriented at developing a mid-term capability in 2018 for the NAS or by implementing incremental changes to the existing system to increase controller productivity. The general construct for the research is therefore one of evolution from the current system, rather than a transformation of the system. The Subcommittee understands that it is important for the FAA to provide as many benefits to the NAS users in the near term as possible; the evolutionary focus is consistent with that requirement. However, the Subcommittee is very concerned that this emphasis will not provide the technologies, policies, and procedures required for the transformation to the long-term vision of the NAS, because it is a push from current operations rather than a pull from the future. To have research oriented to both 2018 and the long term may require more resources than those needed for either vision alone.

Recommendation (a): The Subcommittee recommends that the FAA conduct an assessment of the extent to which the planned mid-term improvements to the NAS for 2018 are consistent with the requirements for the transformed long term NAS. Research conducted for the 2018 goal should be scalable to the transformations most needed for the long-term vision.

FAA Response: There are ongoing efforts to ensure alignment between the mid-term improvements and the long-term vision. The FAA and JPDO expend considerable effort to ensure consistency between FAA's mid-term implementation and the long term vision. This is clearly illustrated by the significant efforts to ensure consistency between the FAA's National Airspace System Enterprise Architecture (NAS EA) and the JPDO's longer term, cross-agency EA.

The FAA's focus is on near-and mid-term NextGen implementation. However, part of the FAA's process for managing NextGen is to execute current mid-term activities while continually assessing future requirements. The FAA does not view the mid-term (i.e., 2018) as a stopping

point. However, the long-term is extremely visionary and exploratory and, therefore, by its very nature does not have well defined requirements. The ongoing mid-term activities set the foundation for building future requirements. In building the requirements for individual operational improvements for the mid-term, the FAA develops plans for evolving the operational improvement beyond the mid-term. As pointed out, there must be a focus on research activities that support both the mid-term and long-term need. The ongoing RTTs will help provide the foundation for moving forward. The RTTs are designed to coordinate the development of key research requirements and to better coordinate the evolution of research into operational improvements and new capabilities. Efforts like this help ensure that research being conducted in the midterm will meet the long-term vision. It also allows for the identification of any additional research resources that might be required.

Recommendation (b): If the research supporting the 2018 capability does not scale to the longer-term vision, the FAA should undertake to identify additional research resources that may be required for the longer-term vision and clarify the approach for obtaining them.

FAA Response: The FAA's implementation focus on the near- and mid-term is not exclusive and must have a research focus that extends beyond the mid-term to the long-term. The FAA works in partnership with the JPDO, who maintains the long-term vision, and collaborates closely with them on identifying long-term needs. The FAA believes that there is a strong role for the FAA, NASA, and JPDO to define coordinated research to explore and mature long-term concepts. The FAA, along with NASA, is working with JPDO on four RTT that provide the foundation for the way forward.

Finding 2: The Subcommittee heard a briefing on the Avionics roadmap, which provides a good start to providing an understanding of the requirements for the air-side contribution to the NextGen infrastructure, but much work remains to be done. Performance metrics must be established and systems requirements must be defined. This is particularly true for the aircraft contribution to the 2018 architecture, because no research was described which addresses what the airspace users have to do to enable NextGen. Additionally, none of the research we have seen has addressed the aircraft avionics reliability impact on the 2018 or the long-term ConOps.

Recommendation: The Subcommittee recommends that the FAA accelerate developing airborne avionics and ground-based automation requirements that permit achievement of the stated 2018 goals so that users will know what they need to do. Consideration of reliability requirements should be part of this development. The roadmaps should include necessary stakeholder decisions, actions, and implied costs.

FAA Response: The NextGen mid-term is focused on building on proven capabilities. All involved with the NextGen avionics roadmap believe it was a good start, and that it points to how much remains to be done to ensure fleet avionics equipage. The January 2009 NextGen Implementation Plan provides a view on mid-term avionics planning in terms of user equipage. This work has continued as the avionics roadmap has been completely integrated in FAA planning in the NASEA Aircraft roadmap. This roadmap indicates the aircraft contribution to every one of the planned NAS Operational Improvements and outlines the infrastructure that will continue to be built on in the long-term. The standards that will be in place for the mid-term are

outlined in the 2009 NextGen Implementation Plan. In addition, there are a number of initiatives within the NextGen portfolio, both F&E and RE&D, that are geared towards solidifying requirements and the FAA is continuing with other concept and development work that directly impacts requirements. All research and development funded by the FAA whether in the Navigation Services, Data Communications, or Surveillance and Broadcast Services, explicitly considers avionics reliability in terms of failure effects and resultant certification level expected in the equipment approval. Examples of ongoing work include closely spaced parallel runways, weather in the cockpit, human-in-the-loop simulations for Datacomm, and the "Texas T" 4-D Trajectory demo. Furthermore, we have integration activities underway that look at overarching reliability and maintenance strategies for NextGen.

The RTCA NextGen Implementation Task Force is working in part to identify strategies to enable and encourage avionics equipage as well as defining the means for maximizing benefits, both for operators and the FAA.

Finding 3: The Subcommittee was given a briefing of the Air Traffic Control/Technical Operations Core and the NextGen Controller Efficiency human factors research programs. The Subcommittee has mixed opinions concerning this work and the level of funding it is receiving. On the one hand, these two programs each are requesting plus-ups near $6 million for FY 2011, which are substantial increases when overall ConOps, and technical issues such as human-automation or air-ground roles-responsibilities, have not yet been determined. On the other hand, it is clear that controller roles will in some sense be switching from tactical control to management of traffic, even for the mid-term implementation, and it should be relatively straightforward to develop hypotheses regarding the change in required skill sets and start developing selection and training programs for new hires.

Recommendation: The Subcommittee recommends that the FAA task REDAC to put together a joint NASOPS-Human Factors Working Group to provide an external assessment of the best way to accelerate appropriate ATM human factors research in support of the 2018 mid-term capability. A key aspect should be the definition of accelerated activities required to develop new controller selection and training criteria.

FAA Response: The planned budgets for the two programs you mentioned are only increasing slightly from FY 2010 to FY 2011. The FAA has made, and continues to make, process changes to ensure NextGen related research is clearly aligned to NextGen needs and decisions. We agree new controller selection and training criteria will be needed for NextGen and research to address this need is underway. Specifically, research on the NextGen Strategic Job Analysis is assessing changes to criteria for screening applicants for controller positions. The NextGen Strategic Training Analysis, starting in FY 2009, will assess changes to training needs associated with NextGen capabilities. Thus, we do not believe there is a need to establish a REDAC Working Group at this time as suggested.

Finding 4: In the presentations given to the Subcommittee, there is frequently a lack of connection of the research to desired increments in NextGen capability, a lack of any sense of the magnitude of the problem being addressed, a lack of any real technical detail of the work being performed, a lack of any measure of the extent to which performing the research and

implementing the results will provide an efficiency or capacity increase for NextGen, and a lack of an overall sense of relative priority among research elements. The resulting lack of clarity makes the research (1) very difficult to place in context, and (2) very difficult to ascertain in value.

Recommendation: The Subcommittee recommends that the FAA should conduct (or complete, if it is underway) a gap analysis which clearly identifies projected benefits, in quantitative terms, to capacity, efficiency, and/or safety of proposed implementations in the solution sets, the priorities among them, and the research required to provide them, and develop research portfolios which have clear milestone completion requirements, exit criteria, defined funding lines, and clear lines of authority.

FAA Response: The FAA recognizes it has not done an effective job of communicating and providing clarity on our NextGen R&D efforts during briefings and will improve on that aspect. However, all items the subcommittee recommends are active elements of the existing NextGen planning and execution processes and many efforts are already underway to better define the processes.

Quantitative benefits based on preliminary modeling of a series of NextGen capabilities were published in the 2009 NextGen Implementation Plan. The FAA will continue to refine these projections as additional information is made available. In addition, clear entrance and exit criteria for decisions are included in the enterprise architecture. Also, this is being augmented by the development of a stage gate process both to advance mature technologies and to identify and eliminate research activities that should not receive continued funding. The FAA has initiated a cross-agency team that will establish the Research and Systems Analysis (RSA) guidelines to support portfolio management of pre-concept requirements definition (CRD) investment activities (pre-CRD phase of AMS), optimize research and development investments, and standardize decisionmaking. The FAA is pursuing RSA to ensure there is a consistent and disciplined approach to advancing promising research concepts and technologies while eliminating less promising work.

To ensure continuity and consistency, all RE&D FY 2012 targets for the NextGen mid-term capabilities will be formulated and managed using the solution set process that is in place for the NextGen F&E budget.

Finding 5: Public-private partnerships hold substantial, and largely untapped, potential for many of the activities underway for engaging the private and state sectors in NextGen technology maturation and the related required innovations. Such partnerships are particularly effective when they emphasize pre-competitive, industry-wide design guidelines, industry standards for systems and architectures, and means of compliance for certification of new technologies. Additionally, industry methods for managing R&D may provide various accelerations to the FAA approach. Even with the slowly rebuilding NASA/FAA partnership, current FAA NextGen implementation strategies make scarce, insufficient use of partnerships.

Recommendation: The Subcommittee recommends that the FAA should consider developing a public-private partnership for the execution of NextGen. The FAA should use past models for

lessons learned, and build the partnership around pre-competitive focus, shared governance, cost sharing, and appropriate IP protections. An approach would be to engage the National Council for Public Private Partnerships (NCPPP) as a forum to facilitate the design exercise, and engage the roles of small and large businesses (OEMs and suppliers), the states and municipalities, the operators, academia, and the Federal sector.

FAA Response: The subcommittee may be unaware that the FAA already has extensive public-private partnerships through a number of cooperative agreements currently in place and will continue to develop partnerships as NextGen matures. All told, the FAA has over two dozen cooperative agreements in place with aviation partners. For example, we are partnering with several of the nation's air carriers for trials and demonstrations and we are working with a wide range of government, university, and industry partners to evaluate NextGen technologies. The most visible example is the NextGen Test Bed where concepts, procedures, technologies, and capabilities are demonstrated through a laboratory operated by Embry-Riddle Aeronautical University and an industry consortium at Daytona Beach International Airport.

In addition, in December 2008 the FAA announced that we have entered into a lease agreement and signed a memorandum of understanding with the South Jersey Economic Development District to build an aviation research and technology park adjacent to the William J. Hughes Technical Center near Atlantic City, N. J. The FAA transferred 55 acres of property to the district to build the research park, which will be a high-technology, integrated, and dynamic aviation facility that will provide the infrastructure for National and international leadership in aviation technologies. The park will offer a central location for the FAA's partners to perform research, development, testing, integration, and verification of the technologies, concepts, and procedures required by NextGen.

Finding 6: The described FAA approach to assessing the environmental impacts of operational changes focuses on deleterious effects but does not allow credit for offsetting reductions in environmental impact. This imbalance was particularly evident in the discussion of the Required Navigation Performance (RNP) approaches that remove noise impacts over much of a possible approach or departure area by concentrating all flight tracks in narrow corridors.

Recommendation: The Subcommittee recommends that the FAA should task REDAC to develop a NAS Operation/Environment & Energy Working Group to propose new assessment approaches for environmental impact.

FAA Response: The FAA agrees that assessing environmental impacts of our operations is critical and recognize, the need to continue looking for further opportunities to enhance the process. The FAA has significant work underway to advance techniques to assess environmental impacts. Our demonstrations and studies clearly illustrate that NextGen capabilities provide positive environmental benefits. We will brief the NAS Operations and Environmental and Energy REDAC subcommittees on these efforts as appropriate. However, we do not believe there is a need to charter a REDAC Working Group to do this.

Subcommittee on Aircraft Safety

Finding 1: The Subcommittee has considered the roles played by several activities and laboratories – especially the Tech Center Fire laboratory, the Fuels laboratory and, importantly, CAMI. FAA has made major contributions to knowledge in these areas. The laboratories and their work are world renowned and add important luster to FAA. There is a need to document the various capabilities and the justification for the care and feeding of these facilities, so as to permit an FAA-wide examination of the need for, modernization of, and the funding of existing facilities. This examination should ensure that adequate ATC/Cockpit/pilot/controller simulation and modeling capabilities are available to support studies related to NextGen, self-separation, human factors, reduction of spacing between parallel runways, RNP, etc.

Recommendation: The Subcommittee recommends that, even in difficult budget periods, the work and funding of these laboratories be addressed from not only a program perspective, but from an Agency and national perspective as well. The full motion flight simulators at CAMI supporting research in Terminal Area Safety is a case in point.

FAA Response: FAA shares the Subcommittee's views on the value of the FAA's unique research laboratories to the entire FAA and the aviation community. A case in point is the fire test facilities complex, which is unprecedented in the world, enabling FAA to be the clear international leader in aircraft fire safety R&D and the recognized source of knowledge relative to aircraft fire safety. Although the greatest majority of fire safety R&D is sponsored by AVS, important work has also been performed for the FAA's Office of Hazardous Materials and agencies outside FAA such as the National Transportation Safety Board and the Pipeline and Hazardous Materials Safety Administration. We have completed an independent review of the FAA Aviation Engine and Fuels Test facility. The Independent Review Team recommended that the FAA conclude the search for a replacement fuel for 100 LC and develop a program plan to address alternative fuel research for General Aviation aircraft. In addition, we are completing a gap analysis of the modeling and simulation capabilities of the Agency. We will continue to evaluate the requirements and capabilities from both an Agency and national perspective. These FAA laboratories, simulators, and modeling capabilities are critical to accomplishing our mission and achieving the NextGen vision and they will be modified, closed, or supplemented as necessary. Thus, we believe these actions are addressing the current recommendation.

Finding 2: Several research topics presented plans that were stated to be in support of the Next Gen initiative. Detailed NextGen research needs appear to be elusive and still need to be clearly defined in most areas. It was mentioned that the I&I office is working diligently on this requirements definition process.

Recommendation: As stated in the last several Subcommittee meeting reports, the Subcommittee recommends that this must be accelerated to assure research is done in a manner consistent with NextGen deployment timing. In the interim the FAA research sponsors must use their best judgment to anticipate the NextGen research needs until such requirements become better defined. In addition as requirements evolve, the sponsors must be aware of research that has already been done. For example, much work has been done to evaluate closely spaced parallel runway limitations for today's infrastructure. Much of this work may be applicable to

support Next Gen objectives for assessing self-separation capabilities on closely spaced parallel runways.

FAA Response: The FAA recognizes the need to continually improve the clarity of its R&D program requirements for NextGen. Last year for the first time, the FAA included clear linkages between architectural decision points to the research activities that support those decisions. Moving to 2012, NextGen research will be driven using the same process currently being used for the enabling activities in the Capital Investment Programs. Once in place, research activities will unambiguously drive future requirements definition. As the Subcommittee notes, we have made significant progress over the recent years. The highlighted closely spaced parallel runway operations project is an important NextGen activity designed to produce a safe reduction in separation standards targeted for the midterm. Significant work is underway at the Aeronautical Center in Oklahoma City targeting safe standards reduction for closely spaced parallel runway operations relying on today's systems and equipment.

Finding 3: Consistent with the Strategic Guidance provided, the Subcommittee expects to see detailed plans with measurable milestones & deliverables for the FY 2011 research activity. It is noted that excellent results need several key ingredients – complete planning, diligent execution & skilled people.

Recommendation: The Subcommittee recommends that the FY11 plans be defined, be clear & explicit to the point of being trackable on a monthly basis – not just the budget expenditure but the actual results vs. the plan. This timely understanding of execution issues enables midcourse corrections to be considered & implemented early for maximum benefit. Additional focus on execution excellence will yield more & better research per dollar spent. Earned Value Measurement techniques are available to help here and can be very simple to implement in their most basic form.

FAA Response: The FAA does not believe Earned Value Measurement (EVM) techniques are appropriate for research activities and have no plans to pursue EVM in this area. However, the FAA agrees with the Subcommittee that having detailed plans with measurable milestones and deliverables for the planned research activities is critical to the success of the research. The Office of Research and Technology Development (AJP-6) has begun an effort in July 2009 to do exactly that in a uniform manner across the R&D portfolio. As noted in Recommendation 2009-3-4, Project Level Agreements (PLAs) are being used in some research programs, those that are NextGen funded. Other programs use similar mechanisms, but there has not been a consistent approach across the FAA's R&D programs. We plan to develop a consistent status reporting and feedback process that will use the information currently gathered by the existing tools, such as PLAs, to minimize workload on the program offices. This process will also include information on the implementation of the research results. As suggested by the Subcommittee on Aircraft Safety (SAS) in Recommendation 2009-3-3, we are beginning with several of the research activities reviewed by the SAS. We will be able to brief the Subcommittee on the progress at their March 2010 meeting.

Finding 4: The Subcommittee understands that FAA now uses Project Level Agreements as a management tool to make judgments about appropriate NextGen research levels – as opposed to

the former use of Program Plans. Program Plans have been valuable as a mechanism to gather user and stakeholder support and input. Weather Plan and Human Factor Plan are good examples. (The Weather research program, for example. continues to deliver high quality capability improvements. This consistent delivery may be due, in part to a consistently high level of research funding for which multi-year detailed plans are created & executed). This approach could be duplicated for strategically critical programs in other areas. These efforts have helped FAA to achieve support, consistency, and effective monitoring on the research initiatives.

Recommendation: The Subcommittee recommends that the Project Level Agreement mechanism be used actively to document the core research efforts and to capture industry and stakeholder input.

FAA Response: Finding and Recommendation 4 has been addressed in combination with the response to Finding and Recommendation 3.

Finding 5: The Subcommittee also recognizes that Weather requirements cut across both safety and capacity mission objectives of the FAA. Consequently there are inherent institutional complexities for managing and sponsoring the Weather research.

Recommendation: The Subcommittee recommends that FAA ensure it has enough qualified people to manage the broad and complex Weather related programs that support multiple mission needs.

FAA Response: FAA agrees; the Aviation Weather Group has recently added two new positions for the Weather Technology in the Cockpit (WTIC) program, and one new position in Aviation Weather Research Program (AWRP).

Finding 6: There is more funding proposed for Unmanned Air System (UAS) activities than for software /digital systems work. We have been informed that all the internal requests for research have been fully funded, but this situation may be evidence of the previously identified difficulty of FAA acquiring talented software/digital system experts. Next Gen based research requirements for Software Digital Systems are largely missing & must be defined. The continued lack of requirements is actually quite surprising since all of Next Gen is dependent on advanced avionics.

Recommendation: In light of the growing and crucial importance of software/digital systems, the Subcommittee recommends that this work be given additional emphasis and funding, as well as renewed efforts to hire software and digital systems experts.

FAA Response: There is a considerable amount of ongoing work being done with automation to solidify NextGen based research requirements. These efforts and FAA's plans going forward are outlined in the 2009 NextGen Implementation Plan and the NAS Enterprise Architecture. In addition, the Stevens Institute of Technology is currently conducting a study to provide recommendations on revising and refining competency models for the FAA systems engineering, systems integration and software engineering workforce, with a specific consideration of the impact of NextGen. The FAA anticipates receiving the recommendations in late August 2009.

In reference to renewing the hiring efforts, the NextGen I&I Office already has in place a Chief System Engineer (CSE) for this domain. AIR continues to increase its staffing levels for software and digital systems policy development. AIR-100 hired two digital systems engineers in 2008. Applicants are currently being interviewed to fill another similar position in 2009. AIR is also actively recruiting to fill the Chief Scientist and Technical Advisor positions for both Aircraft Computer Software and Advanced Avionics.

In addition, at the direction of the AVS Management Team, the Software and Digital Systems (SDS) Technical Community Representative Group (TCRG) is developing a comprehensive and integrated research plan that identifies SDS-related research requirements for automation, communications, navigation, surveillance, and security. This SDS Plan is due to the Associate Administrator for Aviation Safety by December 30, 2009. The SDS TCRG made significant progress in 2008 by identifying sources of reference for research requirements. This resulted in identification of both people and documents for future collaboration and research.

Finding 7: Unmanned Air System (UAS) research requirements are fuzzy at best and lack a coherent plan that provides a clear path to certification and operation of UAS in the NAS. It appears the possible solution set is overly constrained by multiple conflicting operational requirements to the point where it may well be a null set making research either irrelevant or misdirected.

Recommendation: The Subcommittee recommends that significant system level thinking be applied to the development of the optimal operational construct and to the definition of the research (if any) needed to permit guidance material & regulations to be developed. The Subcommittee recommends that a Program Plan be developed with milestones, metrics and funding requirements.

FAA Response: The FAA has applied system level thinking towards developing a framework for defining research requirements and using research results to develop policies, standards, and guidelines for safe integration of UASs into the NAS. We presented a detailed UAS program review to the Subcommittee at the 2008 Fall meeting. That program review, including an overview of the 2011 research, engineering and development requirements, was favorably received by the Subcommittee.

The FAA will continue to engage the UAS community in the development of standards through the RTCA and the research program is integral to this process. The UAS Program Office will review its program and ensure the research requirements are clearly defined and linked to standards and policy development plans. Additional emphasis will be placed upon development of critical research and implantation milestones and performance metrics for the 2012 requirements and this information will be presented to the Subcommittee at the Spring 2010 meeting. We feel that we are addressing this recommendation.

Finding 8: The Subcommittee notes that based on what was presented, the FAA planned activities for icing research are relevant, appear to be on track, and are well integrated with other organizations doing icing research such as NASA.

Finding 9: The Small Airplane Directorate has a very tough task ahead to assure Continued Operational Safety (COS) for the >150,000 general aviation aircraft in the US. The issue of aging aircraft (one that has been worked tirelessly for many years on large commercial aircraft with great success) has barely had an impact in the General Aviation (GA) fleet. There remains significant work to do here. The approach proposed to develop guidance material for GA airplane structural fatigue assessment is good but insufficient. The efforts of the Directorate to educate pilots, mechanics & owners are commendable & are very slowly increasing awareness of the issue, but this too is insufficient. There needs to be a large scale, mandatory reporting system implemented to permit the FAA to gather the aging aircraft structural cracking data it needs to support an adequate, data based, reliable approach to COS for this fleet. This is unpopular & difficult. Absent a program such as this, the GA fleet will expose the structural fatigue issues, event by event, death by death. It will happen, what will be the human cost before the FAA is called to react to the systemic issue of aging GA aircraft?

Recommendation: The Subcommittee recommends that FAA develop a more efficient and timely reporting system for the general aviation fleet as a means of gathering factual data on the aging GA fleet to proactively prevent in-flight catastrophic structural failures by enabling timely, appropriately focused, data based, high priority GA R&D activities leading to improved structural assessment guidance material and potentially Airworthiness Directives. This is directly aligned with the FAA mandate to assure Continued Operational Safety as well as complimentary to the ongoing Small Airplane Directorate Part 23 Certification Process Study.

FAA Response: This finding and the associated recommendation address a Small Airplane Directorate research project. The FAA appreciates the REDAC's support for the Small Airplane Directorate's research project to develop guidance material for general aviation (GA) airplane structural fatigue assessments and risk assessment tools. The FAA agrees with the Subcommittee's finding 9, that a mandatory service difficulty reporting (SDR) system for GA would provide the FAA with better data to assess and manage risk of continued operational safety concerns proactively.

As the recommendation states, the need for a mandatory SDR system has also been identified by the Part 23 Small Airplane Certification Process Study (CPS) currently in progress. The FAA and industry representatives with vested interest in GA safety have undertaken the CPS to develop recommendations for future actions, including rule changes. One of those recommendations will be to require SDRs for GA airplanes, which would require a Part 91 rule change. The CPS report was released to the public at AIR Venture in Oshkosh on July 30, 2009.

The CPS recommendation on SDRs is part of a larger effort by AVS to implement a safety management system (SMS) philosophy to improve processes related to safety. The FAA will consider all CPS recommendations and determine how best to move forward. The FAA will process the CPS recommendation regarding SDRs through appropriate channels and that action will provide the response to this recommendation. The FAA will brief the Subcommittee on the result at a future meeting once the CPS recommendations have been processed.

Finding 10: The Subcommittee was asked to review a Volcanic Ash Risk Assessment paper that was provided at the meeting. Although the risk assessment was very limited and there have been no accidents to date due to Volcanic Ash encounters, the Subcommittee recognizes there is legitimate concern within the transport pilot community about the potential hazards of volcanic ash. The subcommittee concludes that these concerns probably warrant further research.

Recommendation: The Subcommittee recommends that research be limited to a very focused approach on how to detect and avoid a volcanic ash encounter. The Subcommittee does not believe the research related to the development of onboard technologies to detect or harden an aircraft against volcanic ash is warranted. The Subcommittee recommends that the research be limited to the development of procedures for getting tactical information to flight crews so they can effectively avoid the hazardous areas. Finally the Subcommittee believes that even this limited scope for research is relatively low in the broad research portfolio.

FAA Response: The FAA agrees that research on onboard technologies to detect or harden an aircraft against volcanic ash is not needed. The FAA will, however, continue to focus our volcanic ash research efforts on predicting the movement and location of the ash plume and communicating that information to flight planners and to flight crews so the aircraft can effectively avoid the hazardous areas.

APPENDIX D: Changes in NARP Chapter 2 Milestones

The 2010 NARP presents an established research plan that describes how the FAA R&D programs are progressing toward achieving the R&D targets through 2016. The plan maintains continuity with the previous R&D goals and the milestones supporting those goals. To enhance the visibility of this continuity, we have added "Appendix D - Changes in 2010 Chapter 2 Milestones."

Appendix D summarizes all the changes to the milestones in Chapter 2 (as compared with the Chapter 2 milestones from the 2009 NARP) and provides an explanation for each change. Only milestones that change or were added are listed. This is intended to help the reader see the how the program milestones are changing from year to year and to understand the rationale for all changes. After all, these are research efforts and it is expected that there will be changes given the nature of research and the reality of government budget processes.

R&D Goal 1 - Fast, Flexible, and Efficient

1. NextGen demonstrations
Develop and demonstrate NextGen technologies and concepts.

1.1 Demonstrate super-density operations.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen Demonstrations and Infrastructure Development	2010: Demonstrate greater throughput in congested, domestic, en route airspace using point-in-space metering linked to required navigation (RNAV)/required navigation performance (RNP) routes.	Not in 2010 NARP	Program no longer considered R&D after FY 2009, will be included in FAA Capital Investment Plan (CIP)

1.2 Demonstrate trajectory-based operations.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen Demonstrations and Infrastructure Development	2011: Demonstrate trajectory-based operations in transitional airspace, between oceanic and domestic en route, using oceanic data link and Advanced Technologies and Oceanic Procedures (ATOP) automation.	Not in 2010 NARP	Program no longer considered R&D after FY 2009, will be included in CIP
NextGen Demonstrations and Infrastructure Development	2013: Demonstrate trajectory-based operations in mixed-equipage, high-altitude airspace with actual aircraft and procedures.	Not in 2010 NARP	Program no longer considered R&D after FY 2009, will be included in CIP
NextGen Demonstrations and Infrastructure Development	2015: Demonstrate auto-negotiations between flight automation and ground automation without human initiation.	Not in 2010 NARP	Program no longer considered R&D after FY 2009, will be included in CIP

2. Airport capacity
Increase airport capacity while reducing costs.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Airport Cooperative Research - Capacity		2011: Develop guidebook to assist airport planners with airfield and airspace capacity evaluation.	NEW Milestone

3. Separation standards

3.1 - Reduce separation with procedures only.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Wake Turbulence		2013: Modify procedures as requested to allow use of closely spaced parallel runways for arrival operations during non-visual conditions.	NEW Milestone

3.2 - Develop new performance-based separation standards.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Wake Turbulence - Re-categorization	Under subheading of "Demonstrate wake turbulence avoidance technologies" and procedures in 2009 NARP, see section 4. below.	2013: Determine how best to incorporate the leader/follower based wake separation standards into the en-route and terminal automation platforms.	Same research activity, revised wording for clarity

4. Wake turbulence

Demonstrate wake turbulence avoidance technologies and procedures.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Wake Turbulence Research	2012: Finish evaluation of the Wake Turbulence Mitigation for Arrivals air traffic control decision support tool feasibility prototype.	Not in 2010 NARP	Program ends in FY 2010; combined with another F&E program after FY 2010
NextGen - Wake Turbulence - Re-categorization	2013: Develop additional, static, wake-based set of categories and separation minima to optimize capacity for a set of airport-specific fleet mixes and define the automation requirement to support those modifications.	Moved to different subsection of Goal 1 (Develop new performance-based separation standards) and wording revised, see section 3.2 above.	Fit the category of "Develop new performance-based separation standards" better

5. Aviation weather

Reduce weather-related delays to increase on-time arrival rate and reduce transit time.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Weather Program	2010: Develop Continental United States (CONUS) ceiling, visibility, and flight category forecast capability.	Moved to Situational Awareness in FY 2010 NARP	Activity fit better there
Weather Program	2012: Develop consolidated convective weather forecast capability.	2010: Develop 0-6 hour advanced storm prediction algorithm. 2011: Demonstrate 0-6 hour advanced storm prediction algorithm.	Wording changes to make milestone more specific, same activity

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Weather Program		2010: Transition Rapid Refresh Weather Forecast Model for implementation at NOAA NCEP.	NEW milestone
Weather Program	2010: Transition Mountain-Wave Turbulence Forecasts for implementation.	Moved to Human Protection Goal in FY 2010 NARP	Activity fit better there
Weather Program	2012: Develop consolidated convective weather forecast capability.	2013: Transition 0-6 hour advanced storm prediction algorithm for implementation.	Wording changed
Weather Program	2013: Transition turbulence forecast capability for all flight levels for implementation.	Moved to Human Protection Goal in FY 2010 NARP	Activity fit better there
Weather Program	2016: Transition Global Turbulence Forecasts for implementation.	Moved to Human Protection Goal in FY 2010 NARP	Activity fit better there
Weather Program		2013: Transition in-flight icing Alaska forecast and analysis capability for implementation.	NEW milestone

R&D Goal 2 - Clean and Quiet

1. Baseline measurements
   Measure current levels of aviation related noise and emissions.

No Changes from 2009 NARP to 2010 NARP

2. Threshold levels
   Determine acceptable levels of noise and emissions.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Environment and Energy		2011: Investigate feasibility of new standards for aircraft noise and emissions certification.	NEW milestone

3. Prediction
   Develop models to predict the impact and benefits of changes.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Operational Assessments		2011: Enhance regional analysis capability in aviation environmental analysis tools.	NEW milestone
NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction		2014: Assess NAS-wide benefits of environmental mitigation solutions comprised of new technologies, alternative fuels, advanced operational procedures, market measures, and options for policy and noise/emissions standards.	NEW milestone

4. Reduction techniques
Develop noise and emission reduction methods.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics		2011: Complete detailed feasibility study, including economic and, environmental impacts and an assessment of potential of renewable alternative fuels for gas turbine engines.	NEW milestone
NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics		2013: Complete significant demonstration of "drop-in" alternative turbine engine fuels.	NEW milestone
NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics		2014: Complete assessment of renewable alternative turbine engine fuels.	NEW milestone

5. Environmental Management (**NEW subcategory in this goal**)
Develop environmental management systems for the NAS.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction		2011: Complete detailed feasibility study, including economic and, environmental impacts and an assessment of potential of renewable alternative fuels for gas turbine engines.	NEW milestone
NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction		2013: Complete significant demonstration of "drop-in" alternative turbine engine fuels.	NEW milestone

R&D Goal 3 - High Quality Teams and Individuals

1. Increase to 130 percent
   Demonstrate 130 percent controller efficiency.

No Changes from 2009 NARP to 2010 NARP

2. Demonstrate improvements in ANSP efficiency
   Demonstrate improvements in ANSP efficiency achieved by implementation of NextGen ground automation capabilities and aircraft equipage, use of data communications, and implementation of new decision support tools and automation.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2010: Define anticipated ANSP workload reductions due to implementation of data communications.	2010: Define anticipated controller workload reductions due to implementation of data communications.	Returning to controller terminology back from ANSP (service provider) terminology
NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2010: Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area.	2010: Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area.	Returning to controller terminology back from ANSP (service provider) terminology; extra wording added for clarity
NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2013: Redefine ANSP roles in a strategic air traffic environment for en route and terminal domains.	2013: Analyze controller roles in a strategic air traffic environment for en route and terminal domains for the impact on personnel selection and training.	Returning to controller terminology back from ANSP (service provider) terminology
NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2016: Increase efficiency given the need to manage multiple airport streams for the terminal phases of flight in large metropolitan areas given a mixed-equipage environment.	Not in 2010 NARP	Milestone linked to preliminary JPDO planning. As NextGen research requirements matured, Human Factors office determined the milestone was no longer valid. Should have been deleted previously from 2009 NARP

3. Selection criteria
   Ensure ANSPs have the aptitude and capability required to manage air traffic in the future system.

No Changes from 2009 NARP to 2010 NARP

R&D Goal 4 - Human-Centered Design

1. Roles and responsibilities
   Define the changes in roles and responsibilities, between pilots and controllers and between humans and automation, required to implement NextGen.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Airport Cooperative Research - Capacity		2011: Document ramp operational and safety techniques and how airport operators implement pavement maintenance programs.	New milestone
NextGen - Air Ground Integration Human Factors and NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2011: Develop initial taxonomy describing the relationship between human pilots/ATC and associated automated systems.	2011: Develop initial mid-term analysis describing the relationship between human pilots and controllers with associated automated systems.	Changed to emphasize the mid-term focus of the research and reworded pilots and controllers versus pilots/ATC.
NextGen - Air Ground Integration Human Factors and NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2012: Complete initial research to evaluate and recommend pilot-ATC procedures for negotiations and shared decision-making NextGen activities.	2012: Complete initial research to evaluate and recommend procedures for negotiations and shared decision-making between pilots and controllers.	Reworded to improve clarity
NextGen - Air Ground Integration Human Factors and NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2016: Complete research to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures.	2016: Complete research to enable safe and effective changes to pilot and controller roles and responsibilities for NextGen procedures.	Reworded to improve clarity

2. Human system integration
   Define human and system performance requirements for design and operation of aircraft and air traffic management systems.

No Changes from 2009 NARP to 2010 NARP

3. Error management
   Develop and apply error management strategies, mitigate risk factors, and reduce automation-related errors.

No Changes from 2009 NARP to 2010 NARP

4. Integrated demonstrations
   Conduct incremental and full-mission demonstrations to increase the likelihood of successful implementation of research results.

No Changes from 2009 NARP to 2010 NARP

R&D Goal 5 - Human Protection

1. Safe evacuation
   Prevent injuries or fatalities during evacuations.

No Changes from 2009 NARP to 2010 NARP

2. Turbulence
   Prevent injuries and fatalities due to turbulence.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Weather Program	2011: Transition convectively induced turbulence forecast capability for implementation.	2013: Transition convectively-induced turbulence forecast capability for implementation.	Due to changes in research priorities, milestone due date was slipped
Weather Program		2012: Transition mountain-wave turbulence forecast capability for implementation.	NEW milestone
Weather Program		2013: Transition convectively-induced turbulence forecast capability for implementation.	NEW milestone
Weather Program		2016: Transition global turbulence forecast capability for implementation.	NEW milestone

3. Hazardous weather
   Prevent injuries and fatalities due to hazardous weather.

No Changes from 2009 NARP to 2010 NARP

4. Occupant restraint
   Improve occupant restraint systems to reduce injuries and fatalities.

No Changes from 2009 NARP to 2010 NARP

5. Airports
   Prevent injuries and fatalities due to aircraft overrun.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Airport Technology Research - Safety, Airport Cooperative Research - Safety	2011: Evaluate new formulations for soft ground arrestor systems.	Not in 2010 NARP	This milestone was deleted based on results of the initial evaluation of alternative material documented in ACRP Report 29. Research task will be re-evaluated.

6. Cabin air quality
Reduce health risk to aircrew and passengers due to cabin environmental threats.

No Changes from 2009 NARP to 2010 NARP

7. Commercial space.
Identify the requirements for safe commercial space transportation operations.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Commercial Space Transportation Safety	2009: Conduct a study to determine the need to develop a temporal wind database to support the launch of wind-weighted, unguided, suborbital rockets launched from nonfederal launch sites.	Moved to Situational Awareness Goal in FY 2010 NARP	Activity fit better under that Goal

8. Human aeromedical safety and health risk management
Identify and manage human aeromedical safety and health risks.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Airport Cooperative Research - Safety		2011: Assess role of airports and airlines in the spread of vector-borne diseases.	NEW milestone

R&D Goal 6 - Safe Aerospace Vehicles

1. Engines
   Prevent engine failures.

No Changes from 2009 NARP to 2010 NARP

2. Structures

Prevent accidents due to structural failures or fire.

No Changes from 2009 NARP to 2010 NARP

3. Systems
   Prevent accidents due to system failures.

No Changes from 2009 NARP to 2010 NARP

4. Unmanned aircraft
   Integrate unmanned aircraft systems (UAS) into the civil airspace.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Unmanned Aircraft Systems Research		2012: Analyze data on the safety implications of system performance impediments to UAS command, control, and communication (C3) in different classes of airspaces and operational environments.	NEW milestone
Unmanned Aircraft Systems Research		2013: Develop and conduct system-level proof-of-concept regulatory-based causal factor framework (RCFF) by applying Safety Management System (SMS) principles to support integration of UAS civil/commercial operations in the NAS.	NEW milestone
Unmanned Aircraft Systems Research		2012: Determine performance characteristics and operational requirements for UAS detect, sense and avoid technologies (DSA).	NEW milestone

5. General aviation (GA)
Reduce GA accidents.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Continued Airworthiness	2012: Complete developing methods and data for damage tolerance analysis of rotorcraft.	2012: Complete development of methods and data for damage tolerance analysis of rotorcraft structure.	Revised wording for clarity
NextGen - Alternative Fuels for General Aviation		2015: Evaluate and characterize all candidate replacement formulations for 100LL.	NEW milestone

6. Commercial space
Identify the requirements for safe commercial space transportation vehicles.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Commercial Space Transportation Safety	2009: Conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of radar wind profiler to obtain winds to greater altitudes than currently available.	Moved to Situational Awareness goal in FY 2010 NARP	Activity fit better under that goal
Commercial Space Transportation Safety		2010: Conduct a study to provide information on the capability, limitations, and considerations for GPS implementation in space launch and reentry environments, such as Space and Air Traffic Control, which will be used to help determine requirements for GPS usage and future technologies.	NEW milestone
Commercial Space Transportation Safety		2010: Conduct a study to identify means of preventing hazards (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically hydrogen peroxide, H_2O_2, and nitrous oxide, N_2O) used in propulsion systems in commercial space applications.	NEW milestone

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Commercial Space Transportation Safety		2010: Conduct a study to provide guidance to AST and industry on the use of operational limitations and inspection requirements for suborbital reusable launch vehicles (RLVs) comprised of composite materials. The results of this study will help to develop effective rules for operations and maintenance (O&M) for use of composite materials, as they apply to commercial space transportation.	NEW milestone
Commercial Space Transportation Safety		2010: Conduct a study to examine the operational environment, determine the number of sensors needed, defining the data recovery process, and provide black box survivability criteria for use in developing requirements for a black box system to be used in commercial space transportation systems (ELVs and RLVs).	NEW milestone
Commercial Space Transportation Safety		2010: Conduct an assessment on the outputs from two specialized, independent system safety analysis conducted by separate parties to determine the optimal system safety method. The assessment will include the strengths and weaknesses, the hazard analysis depth, the hazard identification thoroughness, and the projected resource utilization.	NEW milestone

R&D Goal 7 - Separation Assurance

1. Surface/runway operations awareness
   Support procedures, equipage, training and design to enable enhanced aircraft spacing for surface movements.

No Changes from 2009 NARP to 2010 NARP

2. Reduced separation
   Support procedures, equipage, training and design to enable reduced separation.

No Changes from 2009 NARP to 2010 NARP

3. Delegated separation
   Support procedures, equipage, training and cockpit design to enable delegated separation.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Self-Separation Human Factors	2011: Complete research to evaluate and recommend procedures, equipage, and training to safely conduct oceanic and en route pair-wise delegated separation.	2013: Complete initial research to evaluate and recommend procedures, equipage, and training to safely conduct oceanic and en route pair-wise delegated separation.	Start of task was delayed due late receipt of the FY 2009 budget and the en route component is not as mature as expected so will need more time to properly assess and address procedures, equipage, and training

R&D Goal 8 - Situational Awareness

1. Weather situational awareness
   Develop common situational awareness for weather.

1.1 Weather Information Improvements

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Weather Program	2009: Transition for operational readiness the National Ceiling and Visibility forecast for CONUS.	2010: Develop CONUS ceiling, visibility and flight category forecast capability.	Wording revised for clarity; year slipped due to change in priority
Weather Program		2012: Demonstrate 1-3 hour CONUS ceiling, visibility, and flight category forecast capability.	NEW milestone
Weather Program		2014: Demonstrate 1-12 hour CONUS ceiling, visibility, and flight category forecast capability.	NEW milestone
Weather Program		2016: Transition 1-12 hour CONUS ceiling, visibility, and flight category forecast capability for implementation.	NEW milestone
Weather Program	2012: Transition in-flight icing Alaska forecast for implementation.	2013: Transition in-flight icing Alaska forecast for implementation.	Aviation Weather is still supporting this activity due FY 2013. Year slipped due to change in priority
Weather Program	2013: Transition the volcanic ash forecast for operational readiness.	Not in 2010 NARP	In light of REDAC recommendation to limit research to a very focused approach on how to detect and avoid a volcanic ash encounter, research is temporarily halted pending the results of gap analysis.

1.2 Weather Technology in the Cockpit (WTIC)

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen – Weather Technology in the Cockpit		2010: Assess bandwidth demand of graphical icing products (Current Icing Product and Forecast Icing Product) and graphical turbulence products (Graphical Turbulence Guidance) for potential delivery via existing and planned FAA data link services.	NEW milestone
NextGen – Weather Technology in the Cockpit	2010: Simulate and evaluate available cockpit weather technologies.	2012: Simulate and evaluate available cockpit weather technologies.	Date change, explanation pending

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen – Weather Technology in the Cockpit		2011: Identify, validate, and document datalink system attributes that may affect use of weather in the cockpit.	NEW milestone

2. Airports
   Ensure safe airport operations.

No Changes from 2009 NARP to 2010 NARP

3. Commercial space (**NEW subcategory in this goal**)
   Develop situational awareness for commercial space transportation.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Commercial Space Transportation Safety	Located under Human Protection Goal in FY2009 NARP	2009: Conduct a study to determine the need to develop a temporal wind database to support the launch of wind-weighted, unguided, suborbital rockets launched from nonfederal launch sites.	Moved to this goal in FY 2010, activity fit better within this goal
Commercial Space Transportation Safety	Located under Safe Aerospace Vehicles Goal in FY2009 NARP	2009: Conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of radar wind profiler to obtain winds to greater altitudes than currently available.	Moved to this goal in FY 2010, activity fit better within this goal
Commercial Space Transportation Safety		2009: Review integrated operations of reusable launch vehicles (RLVs) from spaceports, joint use airport and spaceports, as well as the airspace surrounding those facilities and provide recommendations on how to safely integrate and conduct routine RLV operations.	NEW milestone

R&D Goal 9 - System Knowledge

1. Information analysis and sharing

No Changes from 2009 NARP to 2010 NARP

2. Capacity and efficiency evaluation
   Develop methods, metrics, and models to demonstrate that the modernized system can handle anticipated increases in capacity.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Operations Concept Validation	2008: Demonstrate capacity increase to 130% current levels	2008: Demonstrate capacity increase to 130% of baseline levels.	Wording changes made to clarify the definition of the baseline as set in 2004
Operations Concept Validation	2011: Demonstrate capacity increase to 166% current levels	2011: Demonstrate capacity and efficiency increase to 166% of baseline levels.	Wording changes made to clarify the definition of the baseline as set in 2004
Airport Cooperative Research - Capacity		2011: Develop a guidebook for airport operators and air cargo industry stakeholders that provides tools and techniques for measuring economic impact of air cargo activities at the national, regional, and local level.	NEW milestone
Operations Concept Validation	2013: Demonstrate capacity increase to 230% current levels	2013: Demonstrate capacity and efficiency increase to 230% of baseline levels.	Wording changes made to clarify the definition of the baseline as set in 2004
Operations Concept Validation	2016: Demonstrate capacity increase to 300% current levels	2016: Demonstrate capacity and efficiency increase to 300% of baseline levels.	Wording changes made to clarify the definition of the baseline as set in 2004

3. Safety management system
   Produce guidelines for developing processes and technologies to implement a safety management system.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Airport Cooperative Research - Safety		2011: Develop and validate a software tool to quantify risk and support engineering decision-making safety area requirement.	NEW milestone

4. Commercial space
Develop understanding of commercial space transportation system operations.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
Commercial Space Transportation Safety		2010: Conduct a study with current information related to the state of the commercial suborbital transportation industry with a focus on market demand, safety, operability, and international coordination.	NEW milestone
Commercial Space Transportation Safety		2010: Conduct a study to evaluate the adequacy of current rules and polices related to commercial space transportation, implement new rules, policy, and advisory materials, and identify barriers to industry caused by unnecessary or conflicting regulations.	NEW milestone

5. Safety evaluation
Develop methods and metrics to measure progress in reducing the rate of fatalities and significant injuries by two-thirds.

No Changes from 2009 NARP to 2010 NARP.

6. Environmental evaluation
Develop methods, metrics, and models to demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms to enable the air traffic system to handle growth in demand up to three times current levels.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Environment and Energy - Validation Modeling	2009: Demonstrate no environmental constraints at 130% capacity.	Not in 2010 NARP	New milestones listed below for this section are the current research activities that will lead to defining the appropriate metrics for FAA environmental research
NextGen - Environment and Energy - Validation Modeling	2011: Demonstrate no environmental constraints at 166% capacity.	Not in 2010 NARP	New milestones listed below for this section are the current research activities that will lead to defining the appropriate metrics for FAA environmental research. FY 2009 was the final year for this program, new milestones below will be funded by NextGen Operational Assessment Program

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen - Environment and Energy - Validation Modeling	2013: Demonstrate no environmental constraints at 230% capacity.	Not in 2010 NARP	New milestones listed below for this section are the current research activities that will lead to defining the appropriate metrics for FAA environmental research. FY 2009 was the final year for this program, new milestones below will be funded by NextGen Operational Assessment Program
NextGen - Environment and Energy - Validation Modeling	2016: Demonstrate no environmental constraints at 300% capacity.	Not in 2010 NARP	New milestones listed below for this section are the current research activities that will lead to defining the appropriate metrics for FAA environmental research. FY 2009 was the final year for this program, new milestones below will be funded by NextGen Operational Assessment Program
NextGen - Environment and Energy - Validation Modeling		2009: Develop and implement NAS-wide regional environmental analysis capability within Aviation Environmental Design Tool (AEDT).	NEW milestone
NextGen Operational Assessment		2010: Implement weather effects in AEDT environmental analyses.	NEW milestone
NextGen Operational Assessment		2012: Develop and implement NAS-wide cost-benefit environmental analysis capability with Aviation Portfolio Management Tool (APMT).	NEW milestone
NextGen Operational Assessment		2013: Explore options to integrate environmental assessment capability with NextGen NAS models.	NEW milestone
NextGen Operational Assessment		2016: Employ AEDT and APMT for NAS-wide environmental analyses.	NEW milestone

R&D Goal 10 - World Leadership

1. Management
   Manage ongoing research.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
System Planning and Resource Management	2008: Manage R&D portfolio, conduct advisory committee reviews of R&D, and publish the NARP	2008: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2008-2013 FAA R&D plan.	Reworded to better describe activities of program, and split into multi-year steps to better show schedule.
		2009: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2009-2014 FAA R&D plan.	Reworded to better describe activities of program, and split into multi-year steps to better show schedule.
		2010: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the R,E&D Advisory Committee, and contains the FY 2010-2015 FAA R&D plan.	Reworded to better describe activities of program, and split into multi-year steps to better show schedule.
System Planning and Resource Management	2010: Determine measures for the exchange of research information	2010: Determine criteria for assessing the benefits of the international research collaboration.	Reworded for clarity.

Leverage international research collaboration.

No Changes from 2009 NARP to 2010 NARP

2. Products
   Leverage research results.

Program Name	2009 NARP Ch. 2 Milestone	2010 NARP Ch. 2 Milestone	Explanation for Change
NextGen – Wake Turbulence – Re-categorization	2013: Complete development of ANSP wake separation standards that better use aircraft flight characteristics and information concerning surrounding weather conditions.	Not in 2010 NARP	This milestone was deleted based on a change in the program's direction.

Acronym	Definition
0-9	
100LL	100 Low Lead
4D	Four-Dimensional
4DT	Four-Dimensional Trajectories
A	
AA	ASIAS Architecture
AAAE	American Association of Airport Executives
AAFEX	Alternative Aviation Fuel Experiment
AAIADS	Aerospace Accident Injury and Autopsy Data System
AAM	FAA Office of Aviation Medicine
AAWU	Alaska Aviation Weather Unit
AC	Advisory Circular
ACCRI	Aviation Climate Change Research Initiative
ACER	Airliner Cabin Environment Research
ACES	Airspace Conflict Evaluation Simulator
ACI	Airports Council International
ACI-NA	Airports Council International-North America
ACO	Aircraft Certification Office
ACOSM	Air Carrier Operations Systems Model
ACRP	Airport Cooperative Research Program
ADAF	Airfield Deicing and Anti-Icing Fluids
ADS-B	Automatic Dependent Surveillance-Broadcast
AEC	Aviation Emissions Characterization
AEDT	Aviation Environmental Design Tool
AEE	FAA Office of Environment and Energy
AEP	FAA Office of Aviation Policy, Planning, and Environment
AFETF	Aviation Fuel and Engine Test Facility
AFRL	Air Force Research Lab
AGHME	Aircraft Geometric Height Measurement Element
AIA	Aerospace Industries Association
AIP	Airport Improvement Program Appropriation
AIR	Aircraft Certification Service
AJP-6	FAA Office of Research and Technology Development Directorate
AJP-61	FAA Human Factors Research and Engineering Group
AJP-A	FAA NextGen Integration and Implementation Directorate
ALE	Airfield Lighting Equipment
AMS	Aerospace Materials Specifications
AMTAS	Advanced Materials in Transport Aircraft Structures

Acronym	Definition
ANSI	American National Standards Institute
ANSP	Air Navigation Service Provider
AOC	ACRP Oversight Committee
AOC	Airline/Aviation/Aircraft Operations Center
APEX	Aircraft Particle Emissions Experiment
APM	Automated People Mover
APMT	Aviation Environmental Portfolio Management Tool
APU	Auxiliary Power Unit
AQP	Advanced Qualification Program
ARAC	Aviation Rulemaking Advisory Committee
ARFF	Aqueous Film-Forming Foam
ARP	Aerospace Recommended Practice
ARTS	Automated Radar Terminal System
AS	Aerospace Standard
ASAP	Aviation Safety Action Program
ASIAS	Aviation Safety Information Analysis and Sharing
ASPIRE	Asia and South Pacific Initiative to Reduce Emissions
ASR	Alkali-Silica Reactive
ASRS	Aviation Safety Reporting System
ASTM	ASTM International (formerly the American Society for Testing and Materials)
ATA	Air Transport Association
ATC	Air Traffic Control/Controllers
ATC/TO	Air Traffic Control/Technical Operations
ATCOV	Air Traffic Control Color Vision Test
ATCS	Air Traffic Controller Station/Specialist
ATD	Anthropomorphic Test Device/Dummy
ATM	Air Traffic Management
ATO	FAA Air Traffic Organization
ATOP	Advanced Technologies and Oceanic Procedures
AUVSI	Association of Unmanned Vehicle Systems International
Avgas	Aviation Gasoline
AVS	FAA Office of Aviation Safety
AVSI	Aerospace Vehicle Systems Institute
AWRP	Aviation Weather Research Program

Acronym	Definition
B	
BMP	Best Management Practice
BOD_5	Biological Oxygen Demand
BOM	Australian Bureau of Meteorology
C	
C3	Command, Control, and Communication
CA	Constant Amplitude
CAAFI	Commercial Aviation Alternative Fuel Initiative
CAASD	Center for Advanced Aviation System Development
CAD	Color Assessment and Diagnostics
CAEP	Committee on Aviation Environmental Protection
CAMI	Civil Aerospace Medical Institute
CAMS	Critical Area Management System
CANSO	Civil Air Navigation Services Organization
CAST	Certification Authorities Software Team
CAST	Commercial Aircraft Safety Team
CATM	Collaborative Air Traffic Management
CAVS	CDTI-assisted visual separation
CCSP	Climate Change Science Program
CDA	Continuous Descent Arrival
CDTI	Cockpit Display of Traffic Information
CEAT	COE for Airport Technology
CECAM	Center of Excellence for Composites and Advanced Materials
CESTOL	Cruise Efficient Short Takeoff and Landing
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulations
CGAR	COE for General Aviation Research
CH_4	Methane
CIP	Capital Investment Plan
CLEEN	Continuous Lower Energy, Emissions, and Noise
CNS	Communication/Navigation/Surveillance
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COA	Continental Airlines
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
ConOps	Concept of Operations

Acronym	Definition
CONUS	Continental United States
COS	Continued Operational Safety
COTS	Commercial-Off-The-Shelf
CP	Compression Precracking
CPCA	Compression Precracking Constant-Amplitude
CPS	Certification Process Study
CR	Continuing Resolution
CRC	Coordinating Research Council
CRD	Concept Requirements Definition
CRDA	Cooperative Research and Development Agreement
CSAHWG	CDTI Symbology Ad Hoc Working Group
CSE	Chief System Engineer
CSF	Cockpit Simulation Facility
CSPR	Closely Space Parallel Runways
CSSD	Common Data and Structure Data
CVN	Color Vision Normal
D	
DAH	Design Approval Holder
DARWIN	Design Assessment Of Reliability With INspection
Data Comm	Data Communications
DFW	Dallas/Fort Worth International Airport
DHS	U.S. Department of Homeland Security
DIWS	Data Imaging and Workflow System
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DoDAF	DoD Architecture Framework
DOT	U.S. Department of Transportation
D-RVSM	Domestic Reduced Vertical Separation Minimum
DRWP	Doppler Radar Wind Profilers
DSA	Detect, Sense, and Avoid
DST	Decision Support Tools
DT	Damage Tolerance
E	
E&E	Environment and Energy
EA	Enterprise Architecture
EA	Environmental Assessment
ECLSS	Environmental Control and Life Support System
EDMS	Emissions and Dispersion Modeling System

Acronym	Definition
EDS	Environmental Design Space
eFAROS	Final Approach Runway Occupancy Signal
EFB	Electronic Flight Bag
EFG	Economic and Financial Group
EFVS	Enhanced Flight Vision Systems
E-IPT	Environmental Integrated Product Team (now Environmental Working Group, or EWG)
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicle
EMS	Environmental Management System
EOP	Executive Office of the President
EPA	U.S. Environmental Protection Agency
ERDC	En Route Data Communications
ETA	Estimated Time of Arrival
ETBE	Ethyl Tertiary Butyl Ether
EUOCONTROL	European Organization for the Safety of Air Navigation
EVM	Earned Value Measurement
EVO	Equivalent Visual Operations
EWG	Environmental Working Group (formerly the Environmental Integrated Product Team, or E-IPT)
EWIS	Electrical Wiring Interconnect Systems
F	
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FACT	Future Airport Capacity Team/Task
FAR	Federal Aviation Regulation
FASTER	Full-Scale Aircraft Structural Test Evaluation and Research
FBW	Fly-By-Wire
FEA	Federal Enterprise Architecture
FEIS	Final Environmental Impact Statement
FEWS	Future En Route Workstation
FFRDC	Federally Funded Research and Development Center
FICAN	Federal Interagency Committee on Aviation Noise
FIP-AK	Forecast Icing Product - Alaska
FLM	Front Line Manager
FMS	Flight Management Systems
FOD	Foreign Object Debris
FOQA	Flight Operations Quality Assurance
FPI	Fluorescent Penetrant Inspection

Acronym	Definition
FT	Fischer-Tropsch
FTWS	Future Terminal Workstation
FY	Fiscal Year
G	
GA	General Aviation
GAMA FAST	General Aviation Manufacturers Association Future Avgas Strategy and Transition Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GEOSS	Global Earth Observation System of Systems
GGUAS	Global Gridded Upper Air Station
GHG	Greenhouse Gas
GIAA	Grant-In-Aid-to-Airports
GIACC	Group on International Aviation and Climate Change
GOES	Geostationary Operational Environmental Satellites
GPS	Global Positioning Satellites/System
GRC	NASA Glenn Research Center
GUI	Graphical User Interface
H	
HAATS	Houston Area Air Traffic System
HAP	Hazardous Air Pollutant
HCAS	Hazard Categorization and Analysis System
HEPA	High Efficiency Particulate Air
HESRA	Human Error Safety Risk Assessment
HF	Human Factors
HFD	Hydrofluoro Compounds
HIS	Human System Integration
HITL	Human-In-The-Loop
HIWC	High Ice-Water Content
HRET	High-Reach Extendable Turrets
HUD	Head-Up Display
HUMS	Health and Usage Monitoring Systems
HVS	Heavy Vehicle Simulator
I	
I&I	FAA NextGen Integration and Implementation Office
IA	Interagency Agreement
IAP	Instrument Approach Procedure
IC4D	Interactive Correction in Four Dimensions
ICAO	International Civil Aviation Organization

Acronym	Definition
ICAO/CAEP	International Civil Aviation Organization Committee on Aviation Environmental protection
IFR	Instrument Flight Rule
ILS	Instrument Landing System
IMA	Integrated Modular Avionics
INM	Integrated Noise Model
IOSA	International Aviation Transportation Association Operational Safety Audit
IRT	Icing Research Tunnel
ISU	Iowa State University
IT	Information Technology
ITS	Intelligent Training Systems
ITWS	Integrated Terminal Weather System
IWP	Integrated Work Plan
J	
JAIdB	Job Analysis Information Database
JAMS	Joint COE for Advanced Materials and Structures
JPDO	Joint Planning and Development Office
JPE	Joint Planning Environment
JPO	Joint Program Office
JRC	Joint Resources Council
JTA	Job Task Analysis
JUP	Joint University Program
L	
LAAS	Local Area Augmentation System
LCA	Life Cycle Analysis
LCGS	Low Cost Ground Surveillance System
LIDAR	Light Detection And Ranging
LOS	Level-Of-Service
LOSA	Line Operations Safety Audit
LR	Load-Reduction
LTO	Landing and Take-Off
M	
M&S	Merging and Spacing
MAGENTA	Model for Assessing Global Exposure to the Noise of Transport Aircraft
MDP	Model Development Plan
MMIR	Maintenance Malfunction Information Reporting
MMPDS	Metallic Materials Properties Development and Standardization
MOA	Memorandum of Agreement
MOA/U	Memorandums of Understanding/Agreement

Acronym	Definition
MOC	Memorandum of Cooperation
MOPS	Minimum Operational Performance Standards
MOU	Memorandum of Understanding
MPSe	Minimum Performance Standard - Engines
MSP	Multi-Sector Planner
N	
N_2O	Nitrous Oxide
N47	FAA's Bombardier Global 5000 Test Aircraft
NAPTF	National Airport Pavement Test Facility
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NASEA	National Airspace System Enterprise Architecture
NASGRO	NASA Crack Growth Program
NAT	North Atlantic
NATO	North Atlantic Treaty Organization
NATPRO	National Air Traffic Professionalism Program
NAWC	Naval Air Warfare Center
NCAR	National Center for Atmospheric Research
NCP	National Airspace System Change Proposal
NCPPP	National Council for Public Private Partnerships
NDI	Nondestructive Inspection
NDT	Nondestructive Test
NEIS	Net Enabled Information Sharing
NEO	Net Enabled Operations
NEPA	National Environmental Policy Act
NEVS	Network-Enabled Verification System
NextGen	Next Generation Air Transportation System
Nextor	National Center of Excellence for Aviation Operations Research
NGIP	FAA's NextGen Implementation Plan
NIEC	NextGen Integration & Evaluation Capability
NMB	NextGen Management Board
NNEW	NextGen Network Enabled Weather
NOAA	U.S. National Oceanic and Atmospheric Administration
NOSS	Normal Operations Safety System
NOx	Nitrogen Oxide

Acronym	Definition
NPARDRI	National Plan for Aeronautics Research and Development and Related Infrastructure
NPRM	Notice of Proposed Rulemaking
NRC	National Research Council
NSS	NAS Strategy Simulator
NT	NextGen Towers
NTSB	National Transportation Safety Board
NUC	National University of Colombia
NWEC	NextGen Weather Evaluation Capability
NWS	National Weather Service
O	
O&M	Operations and Maintenance
OE	Operational Error
OI	Operational Improvement
OMB	Office of Management and Budget
ONERA	Office of National d'Etudes et de Recherches Aerospatiales
OOT	Object-Oriented Technology
OPD	Optimized Profile Descent
Ops	Operations Appropriation
OSED	Operational Suitability and Environmental Description
OST	Office of Science & Technology Policy
OSTP	Office of Science and Technology Policy
P	
PAPI	Precision Approach Path Indicator
PARC	Performance-Based Operations Aviation Rule-Making Committee
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PDARS	Performance Data Analysis and Reporting System
PFC	Perfluorocarbon
PHA	Preliminary Hazards Assessment
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIR	Post Implementation Review
PLA	Project Level Agreement
PM	Particulate Matter
ppm	Parts-Per-Million
PRA	Probabilistic Risk Assessment
PTP	Point-To-Point
Q	
q-PCR	Quantitative Polymerase Chain Reaction

Acronym	Definition
R	
R&D	Research and Development
R&TD	Research and Technology Development
R,E&D	Research, Engineering and Development Appropriation
RA	Radioactive
RAMs	Repairs, Alterations, and Modifications
RAPT	Route Availability Planning Tool
RARM	risk assessment and risk management
RCFF	Regulatory-Based Causal Factors Framework
RDHFL	Research Development & Human Factors Laboratory
REB	Research and Development Executive Board
REDAC	Research, Engineering, and Development Advisory Committee
RF	Radius-to-Fix
RILs	Runway Intersection Lights
RIRP	Runway Incursion Reduction Program
RITA	Research and Innovative Technology Administration
RITE	FAA National Air Transportation COE for Research in the Intermodal Transportation Environment
RLV	Reusable Launch Vehicle
RNA	Ribonucleic Acid
RNAV	Area Navigation
RNP	Required Navigation Performance
ROD	Record of Decision
ROGIDS	Remote Onboard Ground Ice Detection System
RSA	Research and Systems Analysis
RSA	Runway Safety Area
RTCA	Radio Technical Commission for Aeronautics
RVSM	Reduced Vertical Separation Minima
RWI	Reduce Weather Impact
RWSL	Runway Status Light
S	
SAE	Society of Automotive Engineers
SAFO	Safety Alert for Operators
SAGE	System for Assessing Aviation's Global Emissions
SAS	Single Authoritative Source
SAS	Subcommittee on Aircraft Safety
SBIR	Small Business Innovation Research
SBS	Surveillance and Broadcast Services

Acronym	Definition
SC	Special Committee
SCPI	System Capacity, Planning and Improvement
SDP	Service Delivery Point
SDR	Service Difficulty Reporting
SDS	Software and Digital Systems
SEMP	Systems Engineering Management Plan
SF_6	Sulfur Hexafluoride
SFO	San Francisco International Airport
SHM	Structural Health Monitoring
SIF	Stress Intensity Factor
SIMMOD	FAA's Airspace and Airport Simulation Model
SIP	State Implementation Plan
SIS	Scientific Information System
SJA	Strategic Job Analysis
SLD	Supercooled Large Droplet
SMS	Safety Management System
SNT	Staffed NextGen Towers
SRA	Solar Radiation Alert
SRM	Safety Risk Management
SRMP	Safety Risk Management Plan
SS II	SpaceShipTwo
SSA	System Safety Assessment
SSE	Safety, Security, and Environment Solution Set
SSM	Safety Systems Management
SSRI	Selective Serotonin Reuptake Inhibitor
STARS	Standard Terminal Automation Replacement System
STARS+	STARS plus DataComm
STL	St. Louis International Airport
SUA	Special Use Airspace
SVS	Synthetic Vision Systems
SWIM	System-Wide Information Management
SwRI	Southwest Research Institute
T&E	Test and Evaluation
T	
TA	Tailored Arrivals
TBO	Trajectory-Based Operation
TCAS	Traffic Alert and Collision Avoidance System
TCP	Tricresyl Phosphate

Acronym	Definition
TCRG	Technical Community Representative Group
TERPS	Terminal Instrumentation Procedures
TFM	Traffic Flow Management
TGF	Target Generator Facility
THC	Delta-9-Tetrahydrocannbinol
ThermaKin	FAA Thermal-Kinetic Burning Model
TLTV	Towbarless Tow Vehicle
TMA	Traffic Management Advisor
TO	Technical Operations
TODDS	Tower Operations Digital Data System
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TRL	Technology Readiness Levels
U	
U.S.	United States
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UEDDAM	Uncontained Engine Debris Damage Assessment Model
UI	User Interface
UIUC	University of Illinois at Urbana-Champaign
USAF	U.S. Air Force
V	
VFR	Visual Flight Rules
Vision 100	Vision 100–Century of Aviation Reauthorization Act of 2003
VLJ	Very Light Jet
VOC	Volatile Organic Compound
VRR	Voice Recognition and Response
W	
WAAS	Wide Area Augmentation System
WAFS	World Area Forecast Services
Wake Re-Cat	Wake Turbulence – Re-Categorization Program
WFD	Widespread Fatigue Damage
WIFS	WAFS File Service
WJHTC	William J. Hughes Technical Center
WK II	WhiteKnightTwo
WRF	Weather Research and Forecast
WRR	Weather Radar Replacement
WTIC	Weather Technology in the Cockpit

Acronym	Definition
WTMA	Wake Turbulence Mitigation for Arrivals
Z	
ZOA	Northern California Redesign