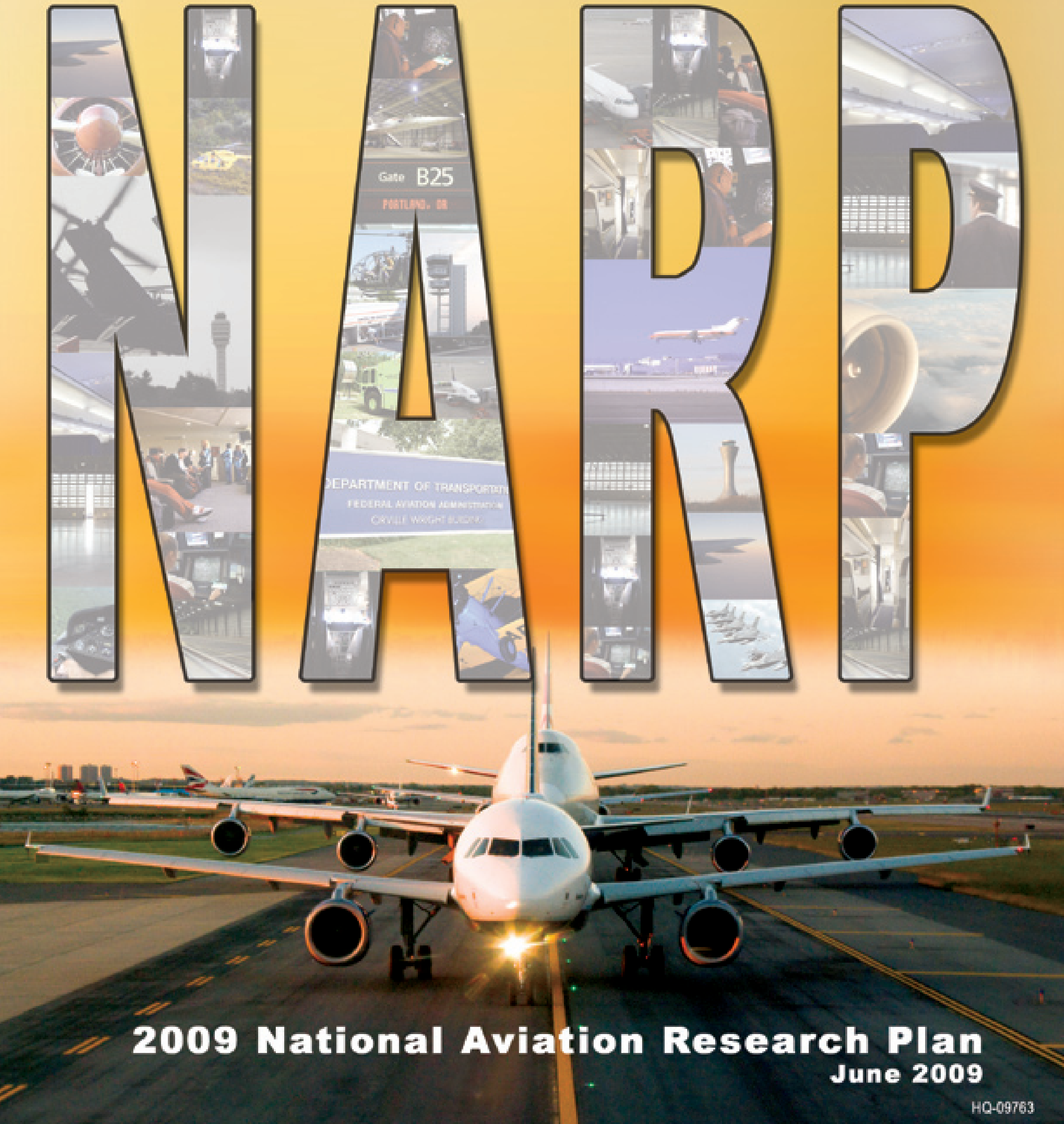
Federal Aviation
Administration

NARP



2009 National Aviation Research Plan

June 2009

HQ-09763

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

2009 *NARP*
June 2009

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* is available on the internet at http://nas-architecture.faa.gov/nas/downloads or http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/nextgen/research_planning/narp.

CONTENTS

EXECUTIVE SUMMARY

The tremendous 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 Flight Plan 2009-2013* 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: A Functional Outline (IWP)* for the year 2025. This approach enables the 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.

The *2009 NARP* presents an established research plan that highlights the results of the research and describes how the FAA R&D programs are progressing toward achieving the R&D targets through 2016. There are no major structural changes in the plan from the *2008 NARP*. It maintains continuity with the previous R&D goals and the milestones supporting those goals. It shows that in fiscal year 2010 the FAA plans to invest a total of $367,817,000 in R&D. This investment spans the four FAA appropriations: $180,000,000 in Research, Engineering, and Development (R,E&D); $150,200,000 in Facilities and Equipment (F&E); $37,472,000 in the Airport Improvement Program (AIP); and $145,000 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 *2009 NARP* highlights 153 key milestones that show the importance of R&D to the goals of the Agency. Of those milestones, 68 support the realization of NextGen. All milestones scheduled to be completed in 2008 were completed.

The FAA's investments in R&D are making a difference. Examples of progress made through R&D in 2008 include the following:

- In 2008, several airports across the United States – from Miami to Atlanta to Los Angeles – were witness to pioneering efforts to reduce aircraft fuel burn, noise, and emissions. Final approaches on certain runways used a new concept called Optimized Profile Descent (OPD) arrivals that allows a pilot to fly the most efficient path and airplane configuration from as far as 50 miles from the airport to touchdown. With OPD, better known as continuous descent arrivals, an airplane flies a smooth path at a near-idle power setting, rather than the typical stair-step approach with varying power levels. OPD is a win-win strategy, having environmental and operational benefits that can reduce noise, emissions, and fuel burn as well as reduce flight time.
- In July 2008, more than a decade's worth of research and innovation reached fruition when the FAA announced the final rulemaking that will significantly enhance fuel tank safety. FAA research led to a low-cost, effective fuel tank inerting system that made this FAA rulemaking activity possible. The rule requires operators and manufacturers of more than 5,000 passenger jets to reduce the flammability levels of fuel tank vapors. The publishing of the rule in the Federal Register came one day before the 12th anniversary of the TWA 800 explosion that killed 230 people, an accident that was attributed to the ignition of fuel vapors in the center fuel tank of the aircraft shortly after taking off from John F. Kennedy International Airport.
- With the mandate from the U.S. Department of Energy for renewable energy sources, wind turbine farms are proliferating across the United States. Lighting these structures, which can be over 400 feet tall, requires a balance between safe flying and the quality of life for surrounding communities. FAA researchers investigated various lighting concepts and concluded that simultaneous flashing lights on select turbines significantly improved the situation awareness of the pilot and, in FY 2008, the FAA issued revised guidance for the new concept. The wind turbine industry has embraced this new guidance material, citing the research results as being less expensive than existing concepts and more readily accepted by the local communities.

The *2009 NARP* describes how the FAA continues to be a good steward of the public's investments in aviation R&D and continues to deliver results that will enhance the safety and capacity of the nation's air transportation system 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[1] and involves research activities funded in four appropriations accounts: Research, Engineering and Development; Facilities and Equipment; Airport Improvement Program; and Operations.

The *NARP* is a portfolio that reflects annual changes to the FAA research and development (R&D) program. The *2005 NARP* aligned the FAA R&D with the near-term goals of the *FAA Flight Plan* and the far-term goals of the *Joint Planning and Development Office (JPDO) Integrated Plan*. The *2006 NARP* strengthened the connection between the near-term and far-term efforts by proposing ten R&D goals with mid-term performance targets. The *2007 NARP* provided a high-level plan for each R&D goal to show how the programs worked together to achieve the R&D targets while supporting both the *FAA Flight Plan* and the next generation air transportation system (NextGen). The *2008 NARP* included more detailed information on how the FAA R&D programs supported both the FAA *Operational Evolution Partnership* (now known as the *FAA's Next Generation Air Transportation System (NextGen) Implementation Plan or NGIP)* and the *JPDO Research and Development Plan for the Next Generation Air Transportation System FY 2009 – FY 2013* (August 31, 2007). The *2008 NARP* also introduced two new appendices: one to report the R&D accomplishments of the past year and the other to map the FAA NextGen R&D activities to the NextGen mid- and far-term operational improvements.

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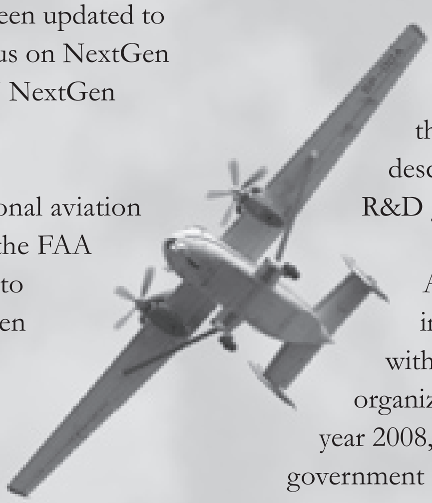
[1] OMB Circular A-11, "Preparation, Submission and Execution of the Budget," June 2006, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

The *2009 NARP* presents an established research plan that highlights the results of the research and describes how the R&D programs are progressing toward achieving the R&D targets. There are no major structural changes in the plan from the *2008 NARP*. It maintains continuity with the previous R&D goals and the milestones supporting those goals, as described in more detail in the budget portfolio provided in Appendix A. New goals and milestones will be added as research is completed and as NextGen planning matures. The completed milestones are noted with a checkmark beside the items and each milestone completed in 2008 is described in progress items at the end of the section for each R&D goal. Chapter 3 has been updated to reflect a restructuring within the FAA to focus on NextGen implementation and monitor the progress of NextGen development and implementation.

Chapter 1 provides an overview of the national aviation system mission, vision, and goals that help the FAA define its R&D needs. It has been updated to reflect changes in the *Flight Plan* and NextGen planning, and it includes a section on mid-term goals to reflect the importance of the *NGIP* and FAA Enterprise Architecture as well as the far-term goals in the *JPDO NextGen Air Transportation System Integrated Work Plan: A Functional Outline (IWP)*.

Chapter 2 includes a master schedule and a high-level plan for each of the ten R&D goals. It integrates the R&D programs with the FAA 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 2008 for each R&D goal.

Chapter 3 describes how the FAA NextGen R&D programs map to the National Airspace System (NAS) Enterprise Architecture, the domains and solution sets in the *NGIP,* and the operational improvements in the *IWP*. The FAA NextGen R&D programs and budget are the relevant subset of information presented in Chapter 2. Appendix E provides additional detail on NextGen program budgets and mapping of program milestones to the relevant elements in the NAS Enterprise Architecture, the *NGIP,* and the *IWP*.



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 2010 and reflects the NextGen R&D programs planned to begin in fiscal year 2009.

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 the descriptions of the accomplishments for the R&D program in fiscal year 2008. It aligns the accomplishments with the programs described in Appendix A and with the ten R&D goals described in Chapter 2.

Appendix C provides the detailed information on FAA partnerships with government, academic, and industry organizations. It lists information for fiscal year 2008, including active agreements with other government agencies, cooperative R&D agreements, patents, and grants. This appendix supports the partnership section in Chapter 4.

Appendix D provides the recommendations of the Research, Engineering, and Development Advisory Committee (REDAC) listed according to the reports produced by the committee in fiscal year 2008. The FAA response to each recommendation is included. This appendix supports the evaluation section in Chapter 4.

Appendix E provides a detailed mapping of the FAA NextGen R&D programs and milestones to the relevant elements in the NAS Enterprise Architecture (near- and mid-term), the *NGIP* (mid-term), and the *JPDO IWP* (far-term). The information is organized by the ten R&D goals described in Chapter 2. Appendix E also provides a summary of the program budgets for the NextGen R&D. This appendix supports both Chapters 2 and 3.

Appendix F provides a list of acronyms and abbreviations for the *2009 NARP* and its appendices.

All appendices are included in a separate volume from the main body of the *2009 NARP*.

CHAPTER 1

national aviation system

Aviation is a vital resource for the United States because of its strategic, economic, and social importance. This 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. 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.

The FAA mission is to provide the safest, most efficient aerospace system in the world.

MISSION

The nation's aviation system, or 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 accommodates many types of aerospace vehicles, airport and airfield configurations, space launch and re-entry sites, and a wide variety of military, civil, and commercial operations. The system consists of three major elements: aerospace vehicles (e.g., commercial and military aircraft, general aviation, space launch and re-entry vehicles, rotorcraft, gliders, hot air balloons); infrastructure (e.g., airports and airfields, air traffic management system, 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.

VISION

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 Federal Aviation Administration (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." [2]

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.

> The FAA R&D vision is to provide the best air transportation system through the conduct of world-class, cutting-edge research, engineering, and development.

The basic challenge posed by this vision is to:

- Increase significantly the capacity of the national aviation system and
- Decrease the time it takes to move people and goods from their origin to destination,

while simultaneously:

- Decreasing fatalities and injuries due to aerospace operations;
- Mitigating the risk of terrorists threats and other hostile actions;
- Reducing the environmental impact of aerospace transportation;
- Decreasing the cost of system operations; and
- Improving the quality of air travel.

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; and
- Retaining U.S. leadership and economic competitiveness in global aviation.

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[2] 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

FAA plans for R&D have three different time horizons: far-term (2015-2025) for the *NextGen Integrated Work Plan: A Functional Outline (IWP)*; mid-term (2012-2018) for the *FAA's NextGen Implementation Plan (NGIP)*; and near-term (2009-2013) for the annual *FAA Flight Plan 2009-2013*. The *NARP* addresses all three horizons, as illustrated in Figure 1.1.

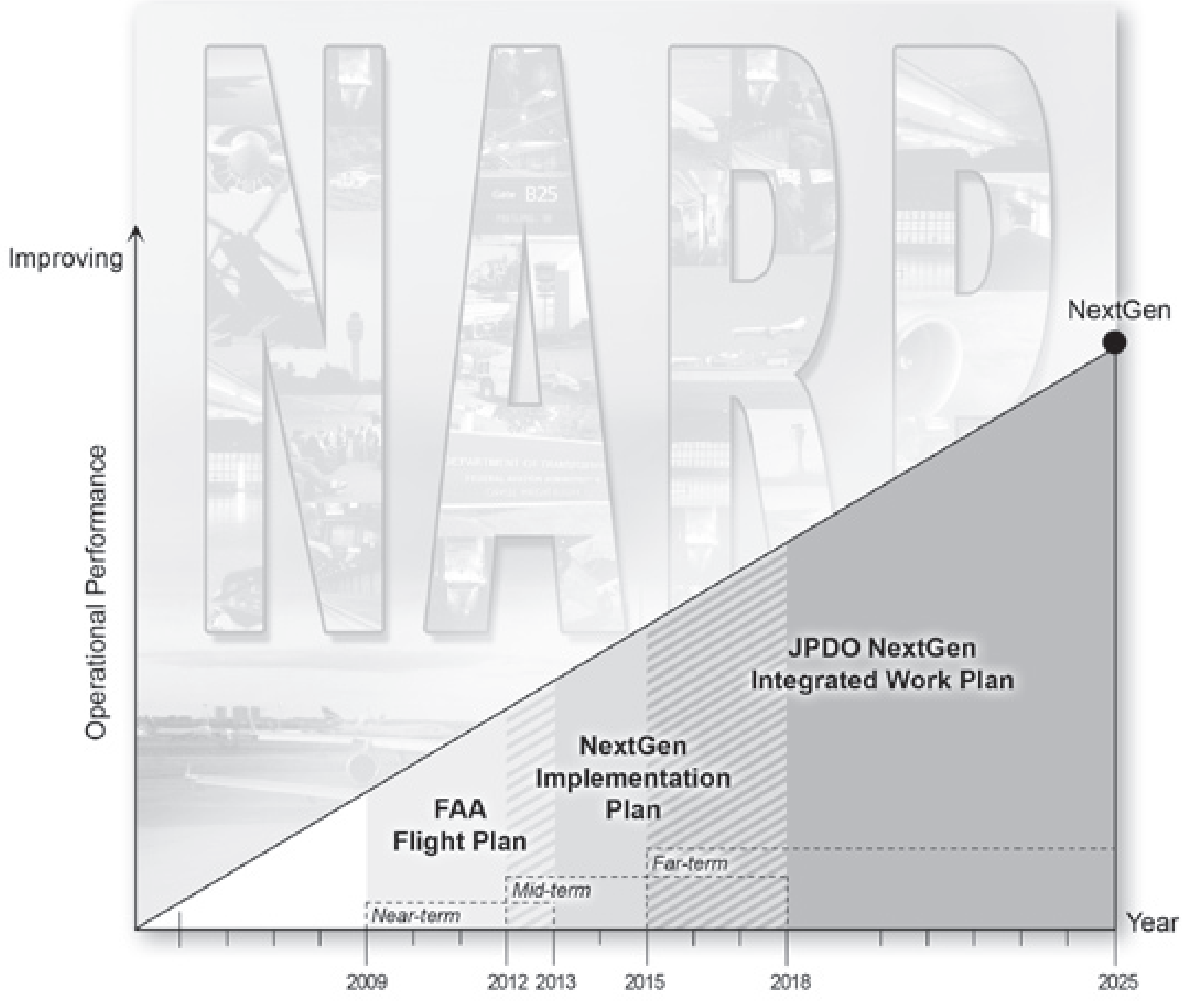

Figure 1.1: The *NARP* Supports FAA Top-Level Plans

JOINT PLANNING AND DEVELOPMENT OFFICE PLANS

In 2003, Congress created the Joint Planning and Development Office (JPDO)[3] to oversee planning related to NextGen. The office reports to a 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 far-term system goals and objectives for NextGen.[4]

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 (up to three times current levels) 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

Based on these goals and objectives, the JPDO has developed top-level policy and planning documents to guide the activities of all participating organizations to achieve the end-state NextGen vision. These include:

- *Concept of Operations for the Next Generation Air Transportation System*, Version 2.0, June 13, 2007
- *Enterprise Architecture V2.0 for the Next Generation Air Transportation System*, June 22, 2007
- *NextGen Air Transportation System Integrated Work Plan: A Functional Outline, (IWP) Version 1.0*, September 30, 2008

These documents can be found at www.jpdo.gov.

To achieve NextGen, the JPDO has identified eight capabilities that are needed to provide a systems approach, support policy and cultural shifts, and address multiple dependencies. They are:

- Network-enabled information access
- Performance-based operations and services
- Weather-assimilated decision-making
- Layered adaptive security
- Broad-area precision navigation
- Aircraft trajectory-based operations
- Equivalent visual operations
- Super-density operations

Detailed explanations of these capabilities can be found in the JPDO NextGen 2005 Progress Report.[5]

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

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

[5] Joint Planning and Development Office, *2005 Progress Report to the Next Generation Air Transportation System Integrated Plan*, March 2006 (http://www.jpdo.gov/library/2005_Progress_Report.pdf).

FAA'S NEXTGEN IMPLEMENTATION PLAN

The *FAA's Next Generation Air Transportation System (NextGen) Implementation Plan (NGIP,* formerly called the *Operational Evolution Partnership* or *OEP*) is the Agency's path to meet NextGen goals and to respond to JPDO strategic direction. The *NGIP* is the FAA's mid-term plan (2012-2018) that addresses proposed system changes and guides them into use. It covers all FAA NextGen-related initiatives, including R&D.

The *NGIP* provides a structured framework for the 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.

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. These capabilities are described further in Chapter 3. Each capability integrates activities from multiple programs in the FAA and in other agencies.

The Airport Development domain focuses on adding airport infrastructure to provide greater capacity and reduce delay. The two solution sets (OEP 35 Airports and OEP Metropolitan Areas) in this domain include activities to relieve pressure on today's most congested airports, including those in New York and Chicago.

The Aircraft and Operator Requirements domain will define 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. As planning matures, this domain will provide 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 EA 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 Enterprise Architecture contains information technology investments and operational changes for Agency business processes including administrative, strategic, and financial planning.

The NAS EA is the set of roadmaps describing how the current NAS will transition to NextGen, the cross-government air transportation vision for the year 2025. 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 *NARP*. The FAA and JPDO are working to align FAA EA planning with the JPDO NextGen Enterprise Architecture and *IWP*.

FAA FLIGHT PLAN

The *FAA Flight Plan 2009-2013* describes the Agency's near-term performance goals and objectives.[6] Since the FAA has the day-to-day responsibility to promote the safe and efficient operation of the current aviation system, its near-term priorities (including research) are driven by the goals and objectives in the *Flight Plan*. 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 the 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
- 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 the 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 2009–2013* (*CIP*) describes the NAS modernization projects and lists the activities FAA intends to complete during that period.[7] It contains projects that modernize existing systems and projects that begin the transformation to NextGen, including R&D activities. It also contains the NAS EA roadmaps that show the timetable for introduction of new technology to achieve the planned NextGen capabilities and capacity increases.

NATIONAL AVIATION RESEARCH PLAN

The *National Aviation Research Plan* (*NARP*) is the FAA's integrated, performance-based R&D plan that supports the FAA's near-, mid- and far-term needs for the NAS. In the past, the *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. Today, in coordination with the *IWP* and the *NGIP*, the *NARP* has become more robust, balanced, and dynamic so it can simultaneously address the critical, near-term needs of the system while defining the research foundation for the next generation system. See Figure 1.1.

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[6] Federal Aviation Administration, *FAA Flight Plan 2009-2013*, October 2008 (http://www.faa.gov/about/plans_reports/media/flight_plan_2009-20013.pdf).

[7] Federal Aviation Administration, *National Airspace System Capital Investment Plan for Fiscal Years 2009-2013*, June 2008 (http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/operations/sysengsaf/cip/files/CIP_FY09-13_Complete.pdf)

FAA RESEARCH AND DEVELOPMENT

The FAA uses R&D to support regulation, certification, and standards development; modernization of the national airspace system; and policy and planning. 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. [8]

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

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

- **Goal driven** – Achieve the mission. The FAA uses R&D as a primary enabler to accomplish its goals and objectives.
- **World class** – Be the best. The FAA delivers world-class R&D results that are high quality, relevant, and improve the performance of the aviation system.
- **Collaborative** – Work together. The 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. The 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. The FAA R&D program delivers quality products and services to the customer quickly and affordably.

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

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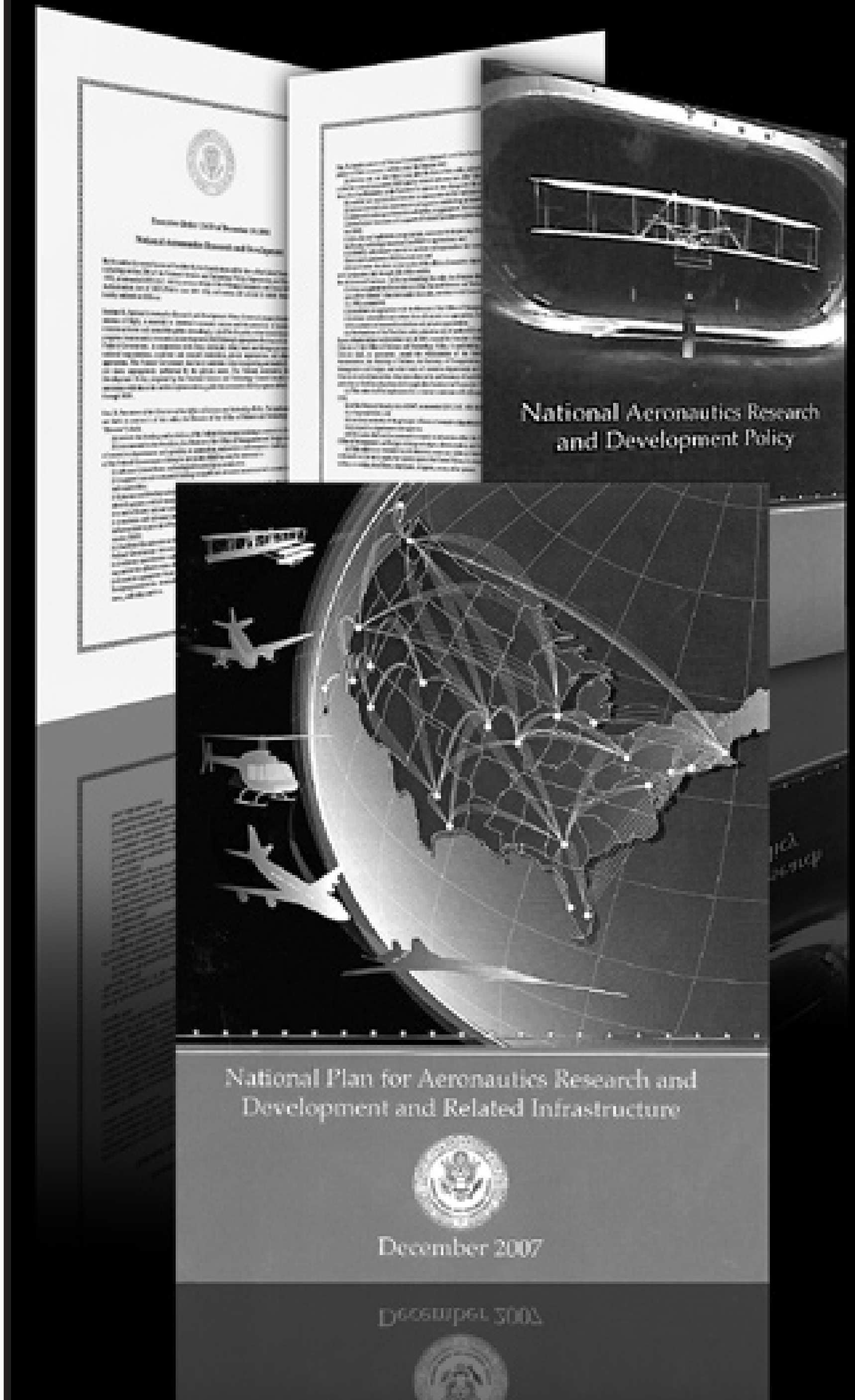
[8] OMB Circular A-11, "Preparation, Submission and Execution of the Budget," June 2006, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

GOALS

The FAA R&D program 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, the 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 and capabilities 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 program 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:

- **Fast, flexible, and efficient** – a system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs
- **Clean and quiet** – a reduction of significant aerospace environmental impacts in absolute terms
- **High quality teams and individuals** – the best qualified and trained workforce in the world
- **Human-centered design** – aerospace systems that adapt to, compensate for, and augment the performance of the human
- **Human protection** – a reduction in fatalities, injuries, and adverse health impacts due to aerospace operations
- **Safe aerospace vehicles** – a reduction in accidents and incidents due to aerospace vehicle design, structure, and subsystems
- **Separation assurance** – a reduction in accidents and incidents due to aerospace vehicle operations in the air and on the ground
- **Situational awareness** – common, accurate, and real-time information on aerospace operations, events, crises, obstacles, and weather
- **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
- **World leadership** – a globally recognized leader in aerospace technology, systems, and operations



National Aeronautics Research and Development Policy and Plan

In December 2006, the President of the United States established the first National Aeronautics Research and Development Policy through Executive order 13419, with the goal of advancing the U.S. technological leadership in aeronautics by fostering a vibrant and dynamic aeronautics R&D community that includes government, industry, and academia.

In accordance with the policy, in December 2007, the National Plan for Aeronautics R&D and Related Infrastructure established aeronautics R&D challenges, priorities, and time-phased objectives, as well as the path forward for developing an aeronautics research, development, test, and evaluation (RDT&E) infrastructure plan. The Plan defines 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.

Table 1.1: Alignment of Goals

			JPDO Integrated Plan	
Flight Plan Goals	FAA R&D Goals	*NextGen Implementation Plan* Domains and Solution Sets	Guiding Principles and Key Capabilities	Goals
Greater Capacity	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	Aircraft trajectory-based operations Broad-area precision navigation Equivalent visual operations Performance-based services Super-density operations Weather assimilated into decision-making	Expand Capacity
	Clean and quiet	Air Traffic Operations Domain -Increase Safety, Security, and Environmental Performance Aircraft and Operator Requirements Domain	Integrated environmental performance	Protect the Environment
Increased Safety	Human-centered design Human protection Safe aerospace vehicles Separation assurance Situational awareness System knowledge		Proactive safety risk management	Ensure Safety
--	--		Layered adaptive security Net-enabled information access	Secure the Nation Ensure our National Defense
International Leadership	World leadership	--	Global harmonization	Retain U.S. Leadership in Global Aviation
Organizational Excellence	High quality teams and individuals	--	User focused	

Table 1.1 shows the primary relationship among the *Flight Plan* goals, the FAA R&D goals, the *NGIP* domains and solution sets, and the far-term goals, guiding principles, and key capabilities 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, High quality teams and individuals is aligned with Organizational Excellence; however, it also supports Increased Safety and Greater Capacity. Similarly, System knowledge and Situational awareness also align with Greater Capacity, in addition to Increased Safety.

CHAPTER 2

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* 2009-2013 and *Capital Investment Plan*, the mid-term needs of the *FAA's NextGen Implementation Plan (NGIP)*, and the far-term needs described in the interagency *JPDO NextGen Integrated Work Plan: A Functional Outline (IWP)*. 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 the accomplishments for each R&D goal. The plan also provides detailed information on how the NextGen R&D programs support the plans of the FAA and the JPDO. This additional information is provided in Chapter 3 and Appendix E.

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* and have been adjusted slightly here to better reflect the current *Flight Plan*.[9] The targets for capacity, from the *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 maintain safety given the assumption that capacity will triple. The specific metrics are defined in Chapter 2, Systems Knowledge, under the section on Safety Evaluation. The targets for organizational excellence are those needed to provide three times capacity without incurring a commensurate increase in cost.

Notional Targets for 2025

(Based on 2004 levels)

- Increased Safety
  - Reduce commercial air carrier fatalities
  - Reduce the rate of GA fatal accidents
  - 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 three times current levels
  - 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 three times current levels
  - Reduce costs and improve productivity
  - Increase Employee Attitude Survey scores
  - Increase Agency scores on the American Customer Satisfaction Index

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[9] The notional target addressing accident reduction in Alaska has been removed.

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 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. 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 the FAA balance its R&D program 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 the 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 IWP*.

Table 2.1 shows how the R&D programs support the R&D goals. The intent is to identify clear responsibilities so that each program focuses on a specific, limited number of R&D goals.

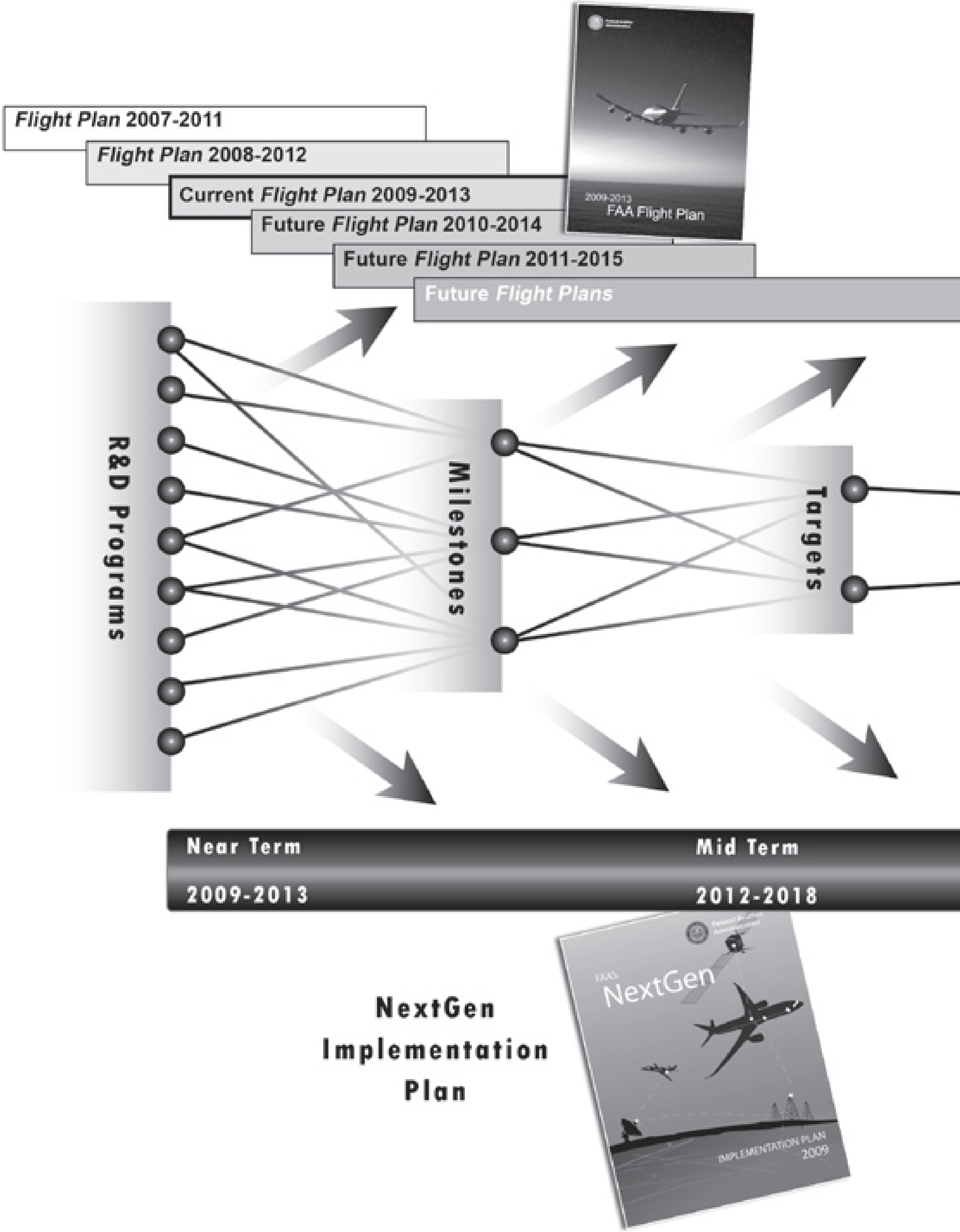


Figure 2.1: Path to Achieving Notional Targets

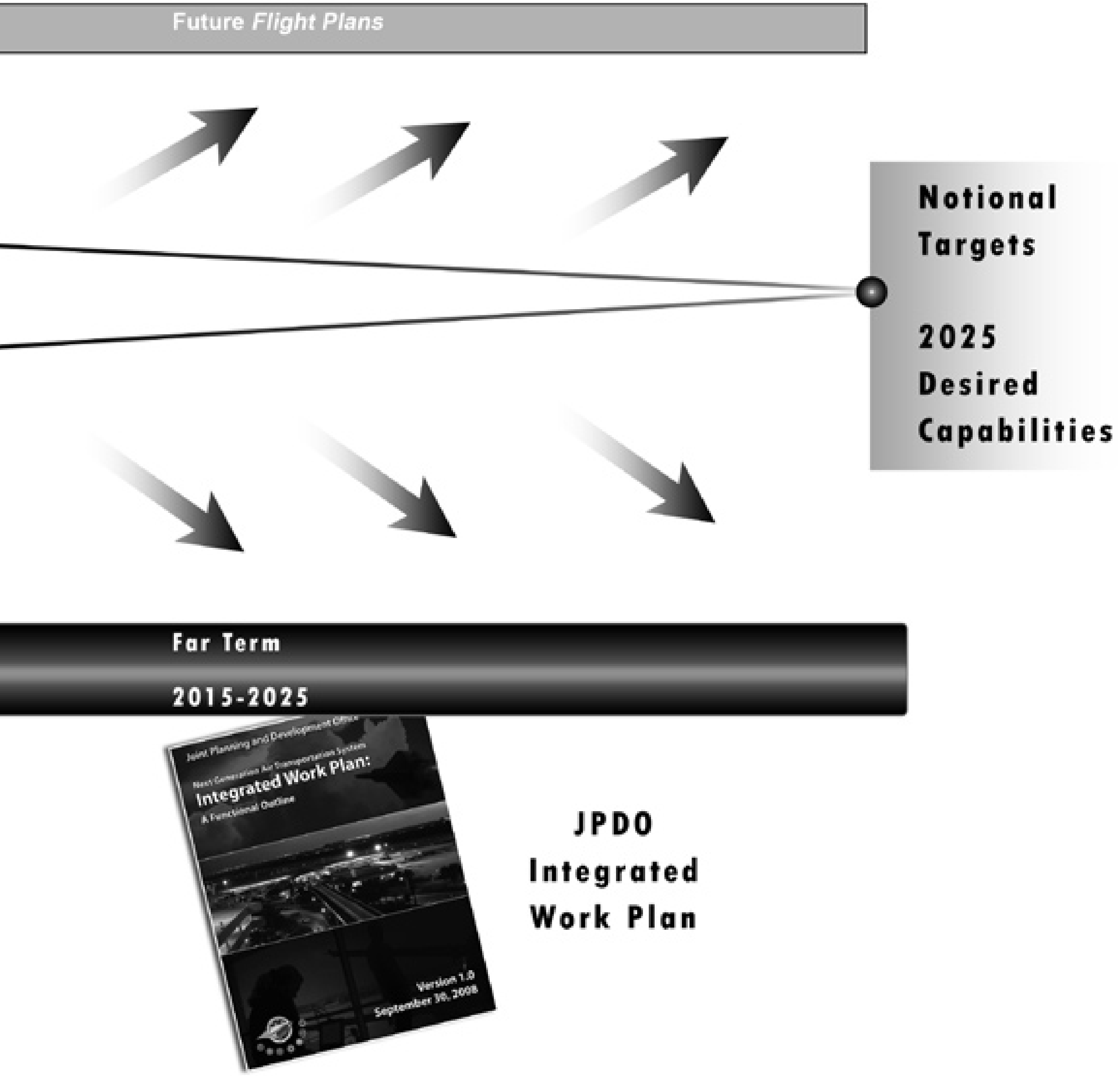

Future Flight Plans
Notional Targets
2025 Desired Capabilities
Far Term
2015-2025
Joint Planning and Development Office
Next Generation Air Transportation System
Integrated Work Plan:
A Functional Outline
Version 1.0
September 30, 2008
JPDO Integrated Work Plan

Table 2.1: Map of R&D Programs in 2010 to R&D Goals

		R&D Goals									
R&D Programs		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									
Airport Cooperative Research - Environment	-		X								Coordinate
Airport Cooperative Research - Safety	-					X			X		
Airport Technology Research - Capacity	-	X									
Airport Technology Research - Safety	-					X			X		
Airspace Management Program	1A01E									X	
Atmospheric Hazards/Digital System Safety	A11.d.					X	X				
Center for Advanced Aviation System Development (CAASD)	4A09A	X		X					X	X	
Commercial Space Transportation Safety	-					X	X				
Continued Airworthiness/Aging Aircraft	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	A12.c.				X						
NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air/Ground Integration	1A08A			X	X						Coordinate
NextGen - Demonstrations and Infrastructure Development	1A07	X							Coordinate		
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									X	
NextGen - Operations Concept Validation - Validation Modeling	1A08C									X	
NextGen - Self Separation	A12.d.							X			Coordinate
NextGen - System Safety Management Transformation	1A08G									X	Coordinate
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/Aviation Safety Risk Analysis	A11.h.				Coordinate					X	
Unmanned Aircraft Systems Research	A11.l.						X			X	
Wake Turbulence	A12.b.	X							X		
Wake Turbulence Research	1A01I	X									
Weather Program	A11.k.	X			Coordinate	X			X		
William J. Hughes Technical Center Laboratory Facility	A14.b.				X						

RUNWAY PROJECTS

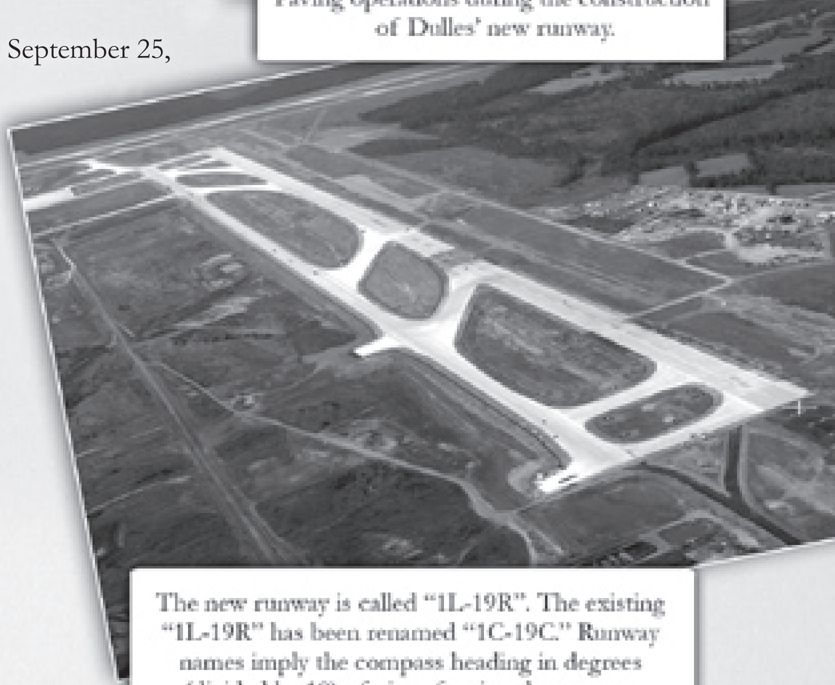
2008-2009 Completed Airfield Projects:

- Seattle
  - Commission 16R/34L (8,500’ runway) November 20, 2008
    - Total Cost $1.1 billion – AIP $301 million
- Washington-Dulles
  - Commission 1L/19R (9,400’ runway) November 20, 2008
    - Total Cost $356 million – AIP $200 million
- Chicago O’Hare
  - Extension (3,000’) to runway 10L/28R completed on September 25, 2008
  - Commission 9L/27R (7,500’ runway) on November 20, 2008
    - Part of the Phase 1 Airfield Reconfiguration: Total cost $1.9 billion – AIP $355 million
- Dallas Ft. Worth
  - First quadrant of Perimeter Taxiway completed December 4, 2008
    - Total cost $67 million - AIP $50 million
- Philadelphia
  - Extension (1,040’) to runway 17/35 completed May 8, 2009
    - Total cost $70 million - AIP $42.5 million

Airfield Projects Under Construction (To be Completed After June 2009)

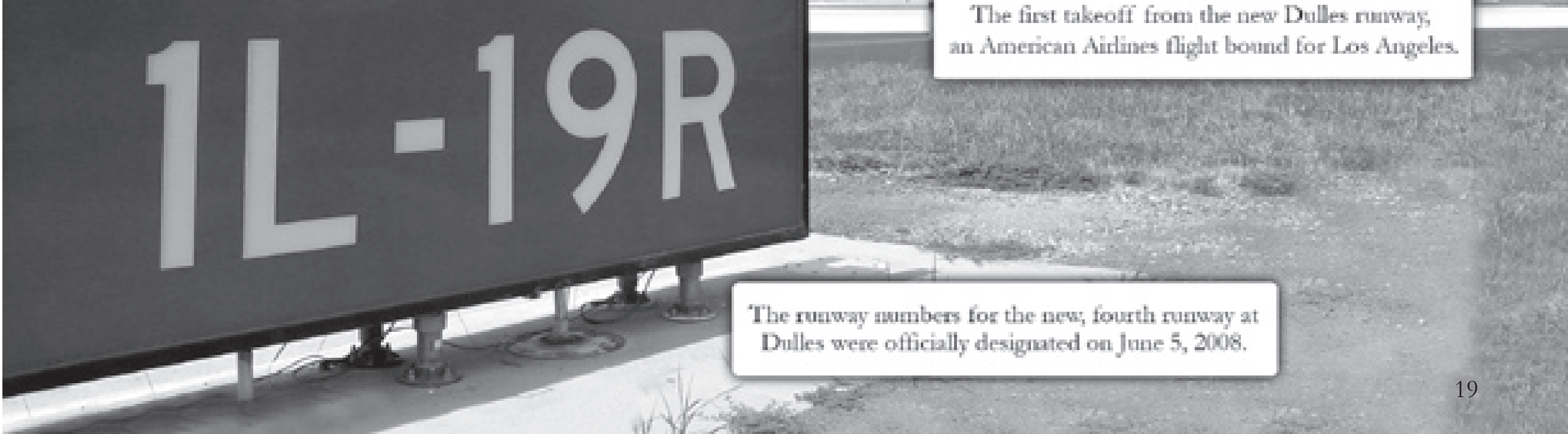
- Boston Logan – centerfield taxiway
  - Total Cost $55 million
  - Estimated Completion: November 2009
- Charlotte – 9,000’ runway (17/35)
  - Total Cost $300 million
  - Estimated Completion: February 2010

Paving operations during the construction of Dulles’ new runway.



The new runway is called “1L-19R”. The existing “1L-19R” has been renamed “1C-19C.” Runway names imply the compass heading in degrees (divided by 10) of aircraft using the runway. Dulles will have three parallel runways designated as left, center, and right.

The first takeoff from the new Dulles runway, an American Airlines flight bound for Los Angeles.



The runway numbers for the new, fourth runway at Dulles were officially designated on June 5, 2008.

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 can handle growth in demand up to three-times current levels[10] and demonstrate that gate-to-gate transit time can be reduced by 30 percent.[11]

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 the system knowledge goal) supports the interim assessment of progress and validation of this target.

MILESTONES

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.
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.

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, see first bullet under Progress in FY 2008]
2009: Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication.
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.
2013: Demonstrate trajectory-based operations in mixed-equipage, high-altitude airspace with actual aircraft and procedures.
2015: Demonstrate auto-negotiations between flight automation and ground automation without human initiation.

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[10] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, http://www.jpdo.gov/library/NGATS_v1_1204r.pdf. A tripled increase in demand is based on the JPDO objective for 2025 to "Satisfy future growth in demand (up to 3 times current levels) and operational diversity."

[11] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, http://www.jpdo.gov/library/NGATS_v1_1204r.pdf. The thirty percent gate-to-gate time reduction is based on proportional allocation of the JPDO objective for 2025 to "Reduce transit time and increase predictability (domestic curb-to-curb transit time cut by 30%)" based on a 2004 baseline.

Airport capacity

Increase airport capacity while reducing costs.

2008: Increase airport capacity. (Airport Cooperative Research - Capacity) [COMPLETED, see second bullet under Progress in FY 2008]
2012: Develop new standards and guidelines for runway pavement design. (Airports Technology Research - Capacity)

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, see third bullet under Progress in FY 2008]

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)

Aviation weather

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

2010: Develop Continental United States (CONUS) ceiling, visibility, and flight category forecast capability.
2010: Transition Mountain-Wave Turbulence Forecasts for implementation.
2012: Develop consolidated convective weather forecast capability.
2013: Transition turbulence forecast capability for all flight levels for implementation.
2016: Transition Global Turbulence Forecasts for implementation.

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. (Wake Turbulence[NG])
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. (Wake Turbulence[NG])
2012: Finish evaluation of the Wake Turbulence Mitigation for Arrivals air traffic control decision support tool feasibility prototype. (Wake Turbulence Research)
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. (NextGen - Wake Turbulence - Re-categorization)
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)

[NG] The Wake Turbulence Program contains funding for both core research and NextGen research. Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without superscript indicate those funded with the core program resources.

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000	100% of total program
--	Airports Technology Research - Capacity	AIP	9,109	10,596	10,596	10,596	10,596	10,596	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	10,017	10,145	10,145	10,376	10,620	10,864	44% of R&D program in FY 2009
A12.a.	Joint Planning and Development Office	R,E&D	10,126	10,085	10,046	9,950	9,849	9,743	70% of total program
1A07	NextGen Demonstrations and Infrastructure Development	F&E	28,000	33,774	30,000	30,000	30,000	30,000	50% of total program
1A08B	NextGen - New Air Traffic Management Requirements	F&E	5,400	13,200	1,800	31,200	32,000	50,100	100% of total program
1A08E	NextGen - Wake Turbulence Re-categorization	F&E	2,000	2,000	3,000	3,000	3,000	3,000	100% of total program
1A01I	Wake Turbulence Research	F&E	0	1,000	1,000	1,000	1,000	1,000	100% of total program
A12.b.	Wake Turbulence	R,E&D	7,370	7,605	7,740	7,745	7,626	7,661	73% of total program
A11.k.	Weather Program	R,E&D	1,697	1,679	1,658	1,625	1,591	1,555	10% of total program
1A01C	Operations Concept Validation	F&E	0	0	0	0	0	0	coordination only
	Total ($000)		78,719	95,084	80,985	110,492	111,282	129,519	

PROGRESS IN FY 2008: FAST, FLEXIBLE, AND EFFICIENT

- Oceanic Trajectory-Based Operations Proof of Concept Demonstration: Demonstrated that 4-dimensional trajectory-based air traffic management can provide more efficient aircraft-centric oceanic routes and reduce fuel burn and environmental footprint. The initial demonstrations resulted in a savings of approximately 330 gallons of fuel per flight and a reduction of approximately 6,700 pounds of CO_2 emissions per flight. (NextGen Demonstrations and Infrastructure Development)

- Common Use Facilities and Equipment at Airports: Developed a guide for airport operators who are considering the implementation of common use systems in their airport facilities. This research examined many types of common use facilities to determine the best methods and practices that will improve the success of sharing facilities to increase efficiency, lower costs, and improve customer service. Other topics include the advantages and disadvantages of common-use systems, procedures that require modification to implement common-use, and actual experience to date. (Airport Cooperative Research – Capacity)

- Air Traffic Control Change in Applying Wake Separations: Approved a national air traffic control order permitting controllers at specific airports with closely-spaced parallel runways (spaced less than 2,500 feet apart) to use an aircraft separation procedure that mitigates the effects of wake turbulence and allows ten to fifteen additional landings per hour on those runways. The procedure will be used when weather conditions would otherwise force controllers to use a separation procedure equivalent to having all aircraft land on a single runway. (Wake Turbulence)

- Ground Access to Major Airports by Public Transportation: Developed a guide that provides airport managers with user-friendly, concise, and accurate documentation on trends in the area of airport ground access. This research provides both new and updated documentation of the characteristics of ground access based upon products already produced by the Transit Cooperative Research Program. (Airport Cooperative Research – Capacity)

- Controller Aids for Aircraft on Terminal RNAV Routes: Completed development of two prototype aids that could help controllers manage traffic in the area navigation environment by providing additional information on their radar situation displays. The first aid shows the relative position of converging traffic that will help controllers coordinate merging area navigation arrivals. The second aid is an automated visual alert that provides controllers early warning of aircraft deviation from assigned area navigation routing and altitude constraints. (Center for Advanced Aviation System Development (CAASD))

- Equivalent Visual Operations for the NAS: Developed and evaluated an advanced version of a concept for improving arrival capacity on single runways in low visibility conditions called IMC CAVS-S (Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation for single runway approaches in Instrument Meteorological Conditions (IMC)). The concept includes tools that allow flight crews to assess and avoid the potential for wake encounters. The evaluation showed that the concept was easy for flight crews to use and may improve airport capacity significantly when weather conditions deteriorate below visual approach minima. (CAASD)

- Integrated Departure Route Planning: Developed an integrated departure management decision capability that integrates traffic, weather, and airspace resource information into a common test bed and laboratory prototype. Initial experiments show that an integrated departure route planning capability could significantly improve system performance by reducing the time needed to coordinate, implement, and revise traffic management initiatives and departure management plans as weather and traffic situations change dynamically. (CAASD)

- Optimized Profile Descent Procedures: Completed over twenty full and partial continuous descent arrival (CDA) demonstrations using RNAV and RNP arrivals with optimized vertical profiles at Atlanta and Miami International Airports. The initial analysis showed fuel savings with reduced noise and emissions per arrival. (NextGen Demonstrations and Infrastructure Development)

- NextGen Wake Separation Standards, Processes, and Decision Support Tools: Completed a cost/benefit analysis on a concept for an air traffic control wake turbulence mitigation decision support tool that would allow more landings on closely spaced parallel runways when weather conditions require the use of instrument approach procedures. Further work will focus on developing other concepts that could capture additional capacity benefits. (Wake Turbulence Research)

- Wind-Dependent Wake Turbulence Mitigation for Departures Decision Support Tool: The number of models the FAA uses to determine the operational benefits of the Wake Turbulence Mitigation for Departures (WTMD) decision support tool was expanded at ten candidate NextGen/OEP airports, enabling greater departure capacity for closely-spaced parallel runways. Algorithm validation tools were developed to evaluate the reliability of the WTMD cross-wind predictions and data-based wake encounter models were enhanced. Additionally, the model was modified to evaluate the safety risk of WTMD based air traffic control departure procedures. (Wake Turbulence Research)

- Convective Weather: Conducted a demonstration of an advanced storm prediction forecast capability that will provide probabilistic forecasts and weather avoidance fields beyond six hours. The demonstration included a 0-2 hour national scale nowcast/forecast capability as well as a 2-6 hour northeastern corridor forecast capability. When implemented, this forecast capability will provide a valuable input into air traffic management decision making, enhancing NAS efficiency and capacity. (Weather Program)

- Airport Traffic Control Tower Simulation Infrastructure Development: Created a full-scale air traffic control tower simulator, including a set of simulation pilot commands. The simulator will be used for the systematic evaluation of NextGen tower concepts. Prior to this, FAA did not own a research simulator, severely limiting its ability to evaluate future concepts. (Air Traffic Control/Technical Operations Human Factors)

CLEAN AND QUIET

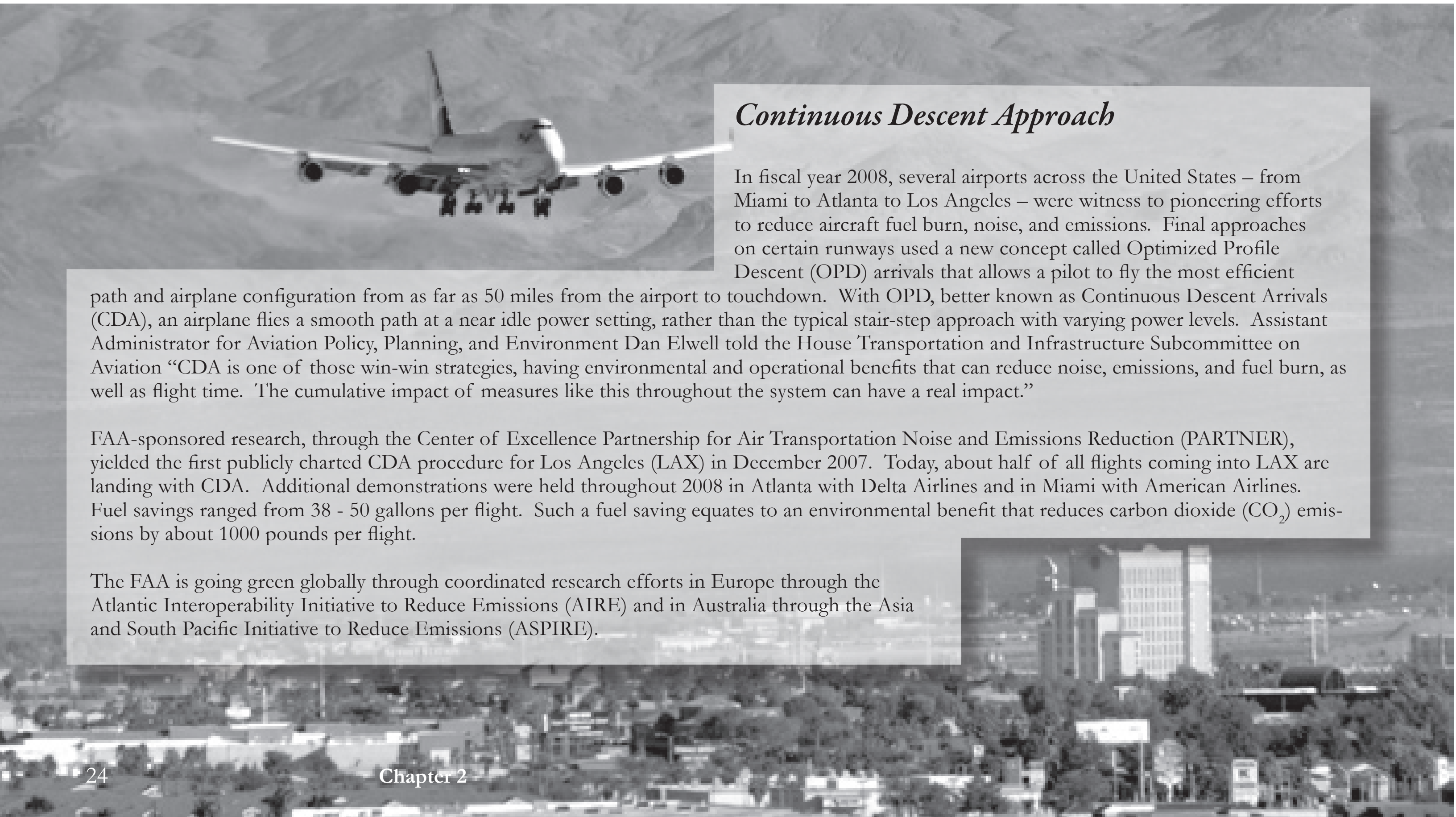
A reduction of significant aerospace environmental impacts in absolute terms

R&D TARGET

By 2016, demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (to enable three times capacity) 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 four 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, and develop reduction techniques and assess their cost-benefit. Validation of the R&D target will include modeling, physical demonstrations, prototypes, full-scale tests, and software beta tests. The environmental evaluation (under the System knowledge goal) supports the interim assessment of progress and validation of this target.



Continuous Descent Approach

In fiscal year 2008, several airports across the United States – from Miami to Atlanta to Los Angeles – were witness to pioneering efforts to reduce aircraft fuel burn, noise, and emissions. Final approaches on certain runways used a new concept called Optimized Profile Descent (OPD) arrivals that allows a pilot to fly the most efficient path and airplane configuration from as far as 50 miles from the airport to touchdown. With OPD, better known as Continuous Descent Arrivals (CDA), an airplane flies a smooth path at a near idle power setting, rather than the typical stair-step approach with varying power levels. Assistant Administrator for Aviation Policy, Planning, and Environment Dan Elwell told the House Transportation and Infrastructure Subcommittee on Aviation “CDA is one of those win-win strategies, having environmental and operational benefits that can reduce noise, emissions, and fuel burn, as well as flight time. The cumulative impact of measures like this throughout the system can have a real impact.”

FAA-sponsored research, through the Center of Excellence Partnership for Air Transportation Noise and Emissions Reduction (PARTNER), yielded the first publicly charted CDA procedure for Los Angeles (LAX) in December 2007. Today, about half of all flights coming into LAX are landing with CDA. Additional demonstrations were held throughout 2008 in Atlanta with Delta Airlines and in Miami with American Airlines. Fuel savings ranged from 38 - 50 gallons per flight. Such a fuel saving equates to an environmental benefit that reduces carbon dioxide (CO_2) emissions by about 1000 pounds per flight.

The FAA is going green globally through coordinated research efforts in Europe through the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) and in Australia through the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE).

MILESTONES

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 (HAPs). (Environment and Energy, Airport Cooperative Research - Environment)

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

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

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, 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. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics, Airport Cooperative Research - Environment)

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, see first bullet under Progress in FY 2008]

2010: Develop a preliminary planning version of an Aviation Environmental Design Tool 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. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2013: Update environmental assessments models to incorporate new noise metrics. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2014: Complete development and field a fully validated suite of tools, including the Aviation Environmental Design and Aviation Environmental Portfolio Management tools, which will allow cost/benefit analyses. (Environment and Energy, Airport Cooperative Research - Environment)

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, see Continuous Descent Approach description on page 24]

2010: Develop algorithms to optimize ground and airspace operations by leveraging communication, navigation, and surveillance technology in the near- to mid-term to optimize aircraft sequencing and timing on the surface and in the terminal area. (NextGen Environment and Energy Environmental Management Systems and Noise and Emissions Reduction)

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

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: 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, Airport Cooperative Research - Environment)

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 Systems and Noise and Emissions Reduction)

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	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	15,608	15,522	15,440	15,264	15,079	14,886	100% of total program
A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	16,050	19,470	20,510	20,858	21,207	21,219	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
1A08D	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	F&E	2,500	7,000	18,000	18,000	18,000	18,000	100% of total program
		Total ($000)	39,158	46,992	58,950	59,122	59,286	59,105	

PROGRESS IN FY 2008: CLEAN AND QUIET

- Aviation Environmental Portfolio Management Tool: Applied the tool to determine potential environmental benefits from technology and operational innovations proposed in the *NGIP*. Results showed possible savings of 3.3 billion gallons of fuel (about $10 billion in current costs) in the high-density case by 2025. It also showed the potential to decrease health risks for a savings of up to $3 billion and to reduce noise and climate impacts saving tens of billions in associated costs. (Environment and Energy)

- Airport Particulate Matter Emissions: Produced a prioritized research agenda to study airport sources of particulate matter emissions. The agenda was developed by conducting a survey of airports regarding particulate matter emissions issues and identifying, reviewing, and evaluating past and current research relating to airport sources of these emissions. The agenda recommends focus areas such as: source apportionment, modeling, measurement methods, and the effects of fuel composition on particulate matter emissions. (Airport Cooperative Research – Environment)

- Energy Use at U.S. Airports: Completed research that provides airport managers, operators, and their operations and maintenance contractors with a guidebook for improving energy use at our nation's airports. Airports are faced with rising energy prices and the need to reduce the environmental impacts of airport operations. (Airport Cooperative Research – Environment)

- Hazardous Air Pollutants: Produced a prioritized agenda of research needs associated with aircraft and other airport-related sources of hazardous air pollutants (HAPs). The agenda is based on pollutant types being emitted and their source, detection and measurement, and possible health and environmental impacts. This is needed to produce a strategy to mitigate the impacts of these pollutants in a cost-beneficial manner. The agenda has already resulted in a new project on measurement of gaseous HAP emissions from idling aircraft as a function of engine and ambient conditions, which will begin by the end of 2009. (Airport Cooperative Research – Environment)

- Impact of Airport Pavement Deicing Products on Aircraft and Airfield Infrastructure: Examined how airports deice their airfield pavements, what chemicals are commonly used, the amounts applied, and the existence of associated corrosion or degradation of aircraft and airfield infrastructure. These results will help federal authorities institute appropriate regulatory requirements and help airport operators and airlines perform more efficiently during winter operations. (Airport Cooperative Research – Environment)

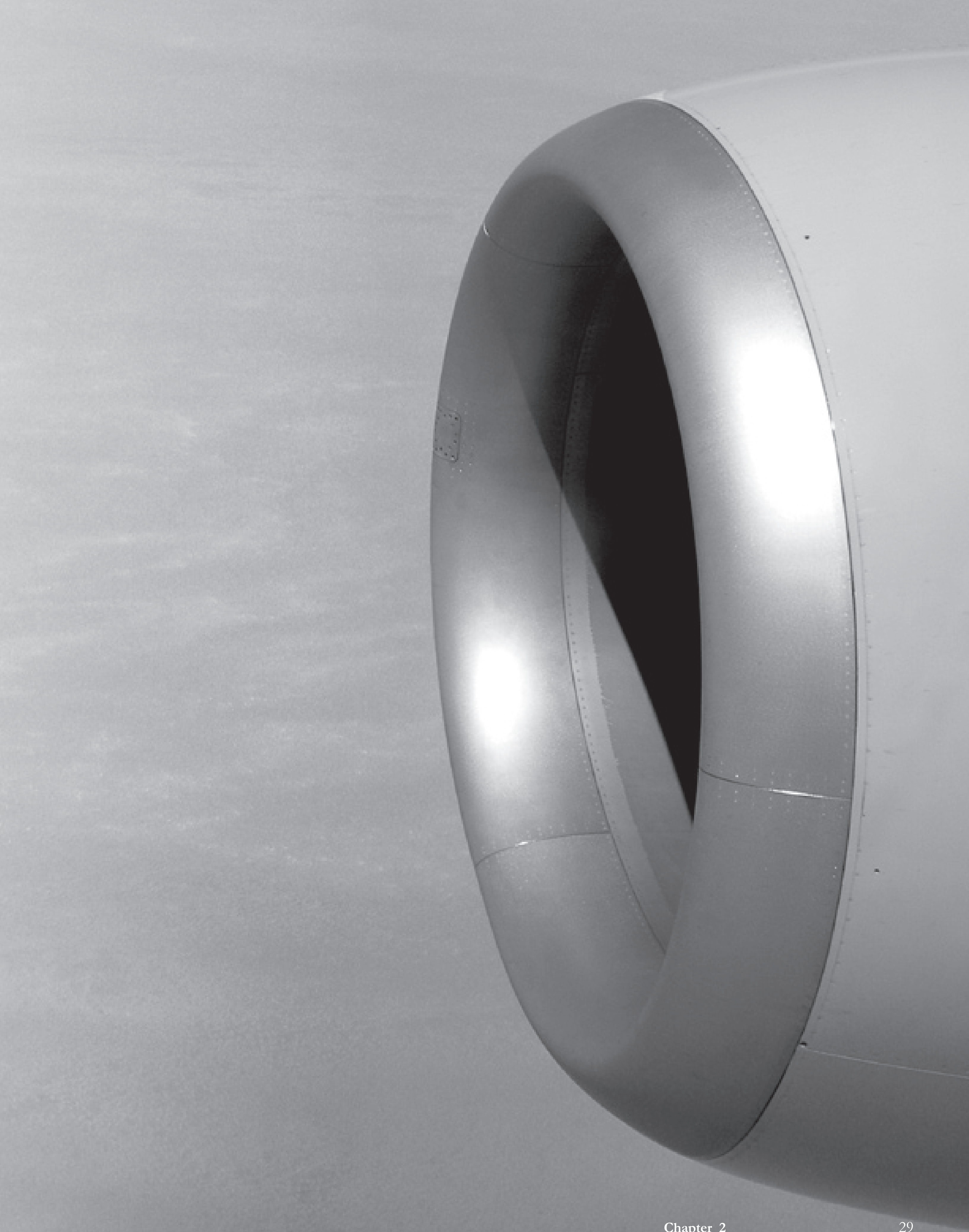
- Aircraft Emissions Inventories: Developed hydrocarbon emissions profiles for aircraft equipped with turbofan, turbojet, and turboprop engines. This is the first time that aircraft hydrocarbon emissions have been characterized based on commercial engines. Developed a Recommended Best Practice document and incorporated the new data into the Emissions and Dispersion Model System (EDMS) version 5.1, to support requirements for the aircraft emission inventories required under the National Environmental Policy Act. This will streamline and improve airport environmental assessments and compliance activities, savings millions of dollars and reducing the time it takes to implement capacity enhancements. (Environment and Energy)

- Aviation Alternative Fuels Initiative: Measured the emissions characteristics of a commonly used in-service jet engine using alternative fuels. The results showed that the significant emissions reductions observed in older military engines operating on alternative fuels are also possible in modern commercial engines. (Environment and Energy)

- Aviation Climate Change Research Initiative: Completed a comprehensive report that will inform the U.S. position on aviation emissions within the International Civil Aviation Organization (ICAO) Group on International Aviation and Climate Change, which is charged with crafting an aviation emission strategy by 2010. (Environment and Energy)

- Environmental Benefits through Optimizing En Route Operations: Developed a prototype optimization algorithm that will allow optimization of en route operations. Computational studies were completed that demonstrated significant fuel and cost savings of the proposed algorithms using traffic through Cleveland Air Route Traffic Control Center, one of the most congested airspaces in the United States. This will enable FAA to plan and conduct flight demonstrations at the Center. (Environment and Energy)

- Predicting Aircraft Environmental Performance Scenarios: Completed validations of current technology 300-passenger, twin-aisle aircraft and 150-passenger, single-aisle aircraft, which cover a significant portion of the commercial fleet, using the Environment Design System (EDS) tool. The EDS tool estimates source noise, exhaust emissions, performance, and economic parameters for aircraft designs under different technological, policy, and market scenarios. The use of the EDS tool will lead to more effective regulations to reduce aviation environmental impacts within the ICAO Committee on Aviation Environmental Protection and help focus industry and research and development efforts on the most cost-beneficial technologies. (Environment and Energy)



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 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 en route and pursuit of new knowledge and results that produce efficiency gains in terminal and tower. 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 the human-centered design goal.

MILESTONES

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, see first bullet under Progress in FY 2008]
2008: Conduct initial simulation to determine what weather information is required by en route and tower controllers to improve efficiency. [COMPLETED, see second bullet under Progress in FY 2008]

Demonstrate improvements in air navigation service provider (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 ANSP 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: Redefine ANSP roles in a strategic air traffic environment for en route and terminal domains.
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: 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.
2016: Redefine the ANSP role in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur.

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

Funding Requirements

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,469	10,302	10,505	10,686	10,876	11,075	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	7,003	7,093	7,093	7,255	7,425	7,596	31% of R&D program in FY 2009
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	F&E	3,800	0	0	0	0	0	100% of total program
1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency and Air Ground Integration	F&E	0	5,700	5,700	5,700	5,700	5,700	55% of total program
A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	0	0	0	0	0	0	coordination only
Total ($000)			21,272	23,095	23,298	23,641	24,001	24,371	

Progress in FY 2008: High Quality Teams and Individuals

- Future En Route Workstation II Human-in-the-Loop Simulation: Collected data to compare air traffic controller performance, workload, and capacity as a function of using an emulation of the current Display System Replacement workstation, the En Route Automation Modernization (ERAM) workstation currently in development, and the Future En Route Workstation (FEWS) workstation, which is ERAM with more automation capabilities integrated according to best human factors principles. The workstations were compared with and without data communications and with staffing of either one or two controllers per sector. Controller performance was best with the FEWS in the two-person configuration with data communications. The results of this simulation and a previous FEWS I simulation show the potential for an increase in control efficiency of at least 130 percent over current levels. (Air Traffic Control/Technical Operations Human Factors)

- Controller Displays for Severe Weather Avoidance: Developed display concepts for air traffic controller workstations that will enable controllers to ensure pilots, particularly general aviation (GA) pilots, remain clear of hazardous weather conditions. An automated support tool called AIRWOLF was developed also that alerts controllers to potential conflicts between aircraft and severe weather. These new capabilities have the potential to increase controller weather situational awareness and increase the safety of GA in adverse weather conditions. This is particularly important since two-thirds of all GA accidents that occur in IMC are fatal. (Air Traffic Control/Technical Operations Human Factors)

- Air Traffic Control Safety Risk Assessment Analysis: Conducted a study to assess the probability that an air traffic control operational error (OE) will occur by taking into account the amount of time spent on position during normal operations. Without other variables, the overall cumulative probability of an OE was found to be very low (0.05 percent). This means that for any two-hour period, the chance for an OE to occur during a position change is 5 out of 10,000. This highlights the rarity of a controller experiencing an OE. The probability is so low that it is difficult to design a human-centered approach to eliminate the possibility of an OE. As a result, greater attention should be paid to managing the most severe OEs once they do occur, using automation and/or procedures that provide multiple backups in case the human system fails. (Air Traffic Control/Technical Operations Human Factors).

- Air Traffic Control Selection Instruments: Conducted an assessment to validate the Air Traffic Selection and Training tests that will be used to select ANSP personnel for the NextGen system. The tests were shown to predict outcomes for 74 percent of the trainees. (Air Traffic Control/Technical Operations Human Factors)

- Cockpit Task Demands: Published a book, titled *Multitasking in Real World Operations: Myths and Realities* that summarizes the results of a multi-year ethnographic study of cockpit tasks and crew performance in normal flight operations. The study found that the dynamic and concurrent nature of task demands in today's airliner was a major source of inadvertent failures to perform intended actions. It identifies situations in which pilots may forget to perform intended actions and discusses potential reasons why even very experienced pilots are vulnerable to error. The book contains detailed guidance on countermeasures individuals and organizations can take to reduce vulnerability to error in these common situations. (Flightdeck/Maintenance/ Systems Integration Human Factors)

- Methods to Assess Applicant Temperament and Emotional Stability: Replaced the 16 Personality Factor (16 PF) test with the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) test to psychologically screen ATC Specialists. Such screening is mandated by FAA Order 3930.3A. The MMPI-2 was found to be a more sensitive indicator of potential psychopathology than the 16PF. Now candidates who are flagged with the MMPI-2 test will be offered secondary screening. The assessment process has also moved from a paper-and-pencil task requiring 2 hours to administer and a week to score, to an on-line experience requiring only 35 minutes to administer with near-instantaneous scoring. Using the MMPI-2 and the improved secondary screening process, the FAA is now more likely to identify applicants with medically disqualifying conditions as early in the application process as possible. (Air Traffic Control/Technical Operations Human Factors)

- Weather-related Training and Testing for GA Pilots: Developed advanced flight simulation scenarios to train and evaluate GA pilot use of basic weather knowledge and decision-making skills when using visual flight rules and flying into IMC. The scenarios provide a tool to improve pilot decision-making and reduce fatal GA accidents. (Flightdeck/ Maintenance/System Integration Human Factors, Weather Program)

- Understanding Human Performance in Aviation: Produced two reports that address barriers to effective airline pilot and dispatcher performance resulting from temporary changes to either the Notices to Airman (NOTAM) system or the data regarding the condition of aircraft operating surfaces at airports (field condition, or FICON reports). The reports were: NOTAM System Modernization: The Pilots' Perspective. Report Summarizing Input from the Pilot Input to NOTAM System Modernization Working Group, and Field Conditions Data: The Airline Dispatchers' Perspective. Report Summarizing Input from the Dispatch Aviation Safety Action Program (ASAP) Field Conditions (FICON) Working Group. (Flightdeck/Maintenance/System Integration Human Factors)

- Advanced Systems for Air Traffic Workforce Training: Used an en route trainer prototype to develop functional requirements and specifications for an automated simulation pilot capability and aviation-specific speech recognition algorithm for the En Route Automation Modernization. An advanced technology terminal trainer prototype that includes voice synthesis, game technology, simulation, and interactive design was developed. The prototype was approved for field evaluation in 2009. Its use will strengthen air traffic controller training and reduce the time and resources required to provide instruction. (CAASD)

- Air Traffic Control Specialist Biographical Data and Interview Selection Procedures: Developed a structured interview process for Air Traffic Control (ATC) Specialist applicants. The interview is used to make a placement decision, based on past experience, and assess candidate suitability for the job. (Air Traffic Control/Technical Operations Human Factors)

- Color Vision Tests for ATC Specialist Applicants: Developed a new color vision test for selecting air traffic controllers to ensure that they have adequate color vision to operate the color displays in ATC facilities. (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.

MILESTONES

Roles and responsibilities

Define the changes in roles and responsibilities, between pilots and controllers and between humans and automation, required to implement NextGen. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficency and Air Ground Integration)

2011: Develop initial taxonomy describing the relationship between human pilots and controllers with associated automated systems.
2012: Complete initial research to evaluate and recommend procedures for negotiations and shared decision-making between pilots and controllers.
2016: Complete research to enable safe and effective changes to pilot and controller roles and responsibilities for NextGen procedures.

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

Error management

Develop and apply error management strategies, mitigate risk factors, and reduce automation-related errors. (NextGen - Air Ground Integration, 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.

Integrated demonstrations

Conduct incremental and full-mission demonstrations to increase the likelihood of successful implementation of research results. (NextGen - Air Ground Integration, 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.

Funding Requirements

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
A11.h.	System Safety Management/ Aviation Safety Risk Analysis	R,E&D	0	0	0	0	0	0	coordination only
A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,465	7,128	7,208	7,264	7,323	7,384	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	coordination only
A12.d.	NextGen - Air Ground Integration	R,E&D	2,554	5,688	11,355	11,536	11,716	11,701	100% of total program
	NextGen - ATC/Tech Ops Human Factors (Air Ground Integration)	F&E	2,900	0	0	0	0	0	100% of total program
1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency and Air Ground Integration	F&E	0	4,700	4,700	4,700	4,700	4,700	45% of total program
1A08E	NextGen - Wake Turbulence Re-categorization	F&E	0	0	0	0	0	0	coordination only
A12.f.	NextGen - Weather Technology in the Cockpit	R,E&D	0	0	0	0	0	0	coordination only
A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,536	3,614	3,728	3,841	3,959	4,084	100% of total program
A11.k.	Weather Program	R,E&D	0	0	0	0	0	0	coordination only
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	coordination only
Total ($000)			16,455	21,130	26,991	27,341	27,698	27,869	

Progress in FY 2008: Human-Centered Design

- Separation Management Project: Conducted a cognitive walkthrough with a panel of subject matter experts to identify information requirements for separation management in different air traffic control situations. Based on the results of the initial walkthrough, researchers selected several separation management concepts for future implementation in the laboratory air traffic control simulator. (Air Traffic Control/Technical Operations Human Factors)
- Airport Ground Access Mode Choice Models: Documented the state of practice for airport ground access and egress mode choice models. This project addresses the issues needed to develop and use these models in airport planning and management and to provide guidance on their use and development. The results will help focus research and development efforts to improve the state of the art for modeling airport ground access mode choice. (Airport Cooperative Research – Capacity)

- En Route Information Display System Analyses: Collected data on the usage and benefits of the En Route Information Display System (ERIDS) as compared to usage before it was implemented. It is an interactive, real-time electronic information display system developed to replace the current, paper-based air traffic control information system. Results were mixed. Data maintenance for system required fewer labor hours, but there were a number of human factors issues and potential solutions identified that could improve system usability. (Air Traffic Control/ Technical Operations Human Factors)

- Color Vision Requirements for Pilots: Completed a color vision/hypoxia study that examined the effects of mild hypoxia on normal and color-deficient pilots' color discrimination. The study measured the colors used in modern glass cockpit displays, including a Boeing 777, an MD-80, and several military aircraft. The chromaticity of airport lighting systems, including the Precision Approach Path Indicator, Visual Approach Slope Indicator, taxiway, and runway lights, were measured at 20 airports. This research will determine whether current color vision screening tests are adequate, given the increased use of color in the cockpit. (Flightdeck/ Maintenance/System Integration Human Factors)

- Air Traffic Control Display Standard - Terminal Color: Developed human factors standards that are specific to terminal ATC primary situation displays, providing very detailed guidance for the most important display elements. Measured colors currently used by ATC primary situation displays on different monitors and applied current human factors standards to develop specific color values for specific display elements. This project produced a standard terminal color palette for primary situation displays that: 1) follows human factors guidelines and best practices, 2) considers the operational, procedural, and environmental factors of terminal ATC, 3) is specific with regard to display elements and color values, and 4) provides standards that can be directly implemented by system developers. (Air Traffic Control/ Technical Operations Human Factors)

- Pilot Training and Experience with Transport Category Rudder Control Systems: Conducted a pilot survey to understand the factors associated with inadvertent, erroneous, and unsafe rudder usage; determined the influence of rudder design on pilot input/response; and recommended what types of design requirements and training procedures may prevent accidents. More than half of the pilots responded that more training in transport airplane rudder usage would be beneficial and over three-quarters indicated that recurrent training would be beneficial. (Flightdeck/Maintenance/System Integration Human Factors)

- Human Factors Analysis and Classification System Database: Published a technical report that classifies GA accident causal factors by Human Factors Analysis and Classification System (HFACS) categories and traditional demographic data. HFACS is a tool for investigating and analyzing human error associated with accidents. The HFACS database contains nearly 34,000 U.S. accidents for the period 1990-2006 across all types of operations. Over 28,500 have been coded for human error as identified by the National Transportation Safety Board (NTSB). Accident data coding and analyses have been completed. Discussions were held with the Aviation Safety Information Analysis and Sharing (ASIAS) program office about transitioning the on-line database to their network server to foster the sharing and centralizing data among the FAA workforce. ASIAS has agreed to assume the database in coming years. (Flightdeck/Maintenance/System Integration Human Factors)

- GA Data Collection: Explored whether safety data could be captured for GA, enabling more proactive approaches to risk management. Twenty-one pilots were interviewed regarding their experiences during a flight assist, emergency, or weather encounter. These interviews enhanced the data in the Human Factors Analysis and Classification System and analyses of weather accidents for general aviation. (Flightdeck/Maintenance/ System Integration Human Factors, Weather Program)

- Future Terminal Workstation: Identified the requirements for the future terminal workstation platform that will serve as the basis for future human-in-the-loop simulations. The prototype workstation will be used to conduct human factors research on NextGen operational concepts and procedures to determine their effect on controller performance, decision-making, and workload, and how the information needed by NextGen in the terminal domain can be best presented and integrated onto the controller workstation. (Air Traffic Control/Technical Operations Human Factors)

- Operational Voice Communications between Native and Foreign Airline Pilots and Controllers during Oceanic Operations: Completed research on the effect of ATC message length and complexity on en route pilot read-back performance, and pilot English language proficiency and the prevalence of communication problems. The ICAO has mandated an English language proficiency requirement, and the FAA lacks baseline data to gauge its effect on NAS operations and safety. This research will enable the FAA to measure how the English language proficiency requirements will affect ATC operations and safety. (Flightdeck/ Maintenance/System Integration 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. [12]

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 the safe aerospace vehicle goal will contribute to the interim and final measurements of the reduction. The safety evaluation (under the System knowledge goal) 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.

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)

Turbulence

Prevent injuries and fatalities due to turbulence.

2011: Transition convectively induced turbulence forecast capability for implementation. (Weather Program)

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/Digital System Safety)

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[12] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, http://www.jpdo.gov/library/NGATS_v1_1204r.pdf. The two thirds reduction in the rate of aviation fatalities and injuries is based on the JPDO objective for 2025 of three times increase in capacity using a 2004 baseline. The target for this goal is to demonstrate in 2015 that it is possible to achieve operationally the fatality and injury rate reduction of two thirds by 2025.

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)

Airports

Prevent injuries and fatalities due to aircraft overrun.

2011: Evaluate new formulations for soft ground arrestor systems. (Airport Technology Research - Safety, Airport Cooperative Research - Safety)
2011: Complete evaluation of new airport runway pavement groove shape to reduce risk of overrun due to hydroplaning. (Airport Technology Research - Safety)

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.

✓ 2008: Conduct a study to provide a basic understanding of what is necessary in an Informed Consent form for commercial space flight participants. (Commercial Space Transportation Safety) [COMPLETED, see first bullet under Progress in FY 2008]
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. (Commercial Space Transportation Safety)

Human aeromedical safety and health risk management

Identify and manage human aeromedical safety and health risks. (Aeromedical Research)

2015: Incorporate aerospace medical issues in the development of safety strategies concerning upset recovery, controlled flight into terrain, and other forms of loss of aircraft control. As adaptive-control techniques are developed, assess pilot performance relative to aeromedical considerations.
2015: Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks.
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.
2015: Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors.

FUNDING REQUIREMENTS

The funding levels listed for FY 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

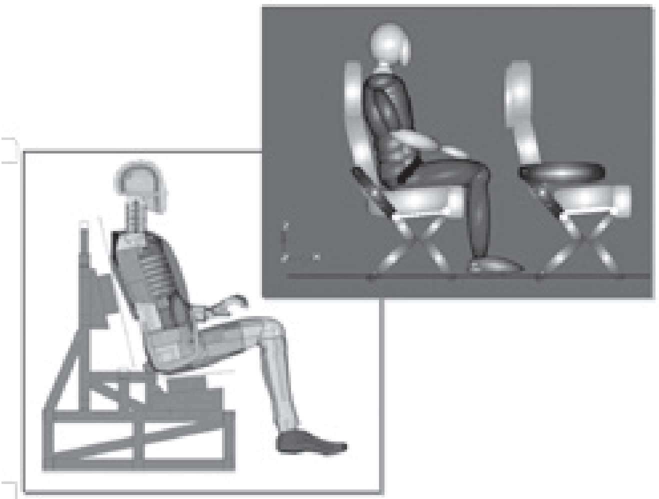
			2009	2010	2011	2012	2013	2014	Notes
A11.c.	Advanced Materials/Structural Safety	R,E&D	0	0	0	0	0	0	coordination only
A11.j.	Aeromedical Research	R,E&D	8,395	10,378	10,621	10,848	11,086	11,334	100% of total program
--	Airport Cooperative Research – Safety	AIP	3,000	3,000	3,000	3,000	3,000	3,000	60% of total program
--	Airport Technology Research – Safety	AIP	3,584	4,157	4,157	4,157	4,192	4,157	35% of total program
A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	1,451	1,345	1,356	1,364	1,370	1,378	30% of total program
--	Commercial Space Transportation Safety	Ops	73	73	73	73	73	0	50% of total program
A11.a.	Fire Research and Safety	R,E&D	5,586	6,551	6,670	6,775	6,885	7,000	84% of total program
A11.k.	Weather Program	R,E&D	1,527	1,511	1,492	1,463	1,432	1,399	9% of total program
Total ($000)			23,616	27,015	27,369	27,680	28,038	28,268	

Progress in FY 2008: Human Protection

- Informed Consent: Released a report that provides background on the origin of informed consent, describes its place in traditional legal framework, discusses how much information should be given to a space flight participant based on past cases, and recommends what a space flight participant should be told about the possible effects of space flight on the human body. The report enables the government to make an informed decision on "informed consent" as required by the Commercial Space Launch Amendments Act of 2004 and provides commercial space flight operators information on what they need to do to satisfy the regulatory requirements of 14 CFR Part 460, specifically at § 460.45(a)(1). This section requires a launch operator to inform space flight participants of each known hazard and risk that could result in a serious injury, death, disability, or total or partial loss of physical and mental function. (Commercial Space Transportation Safety)

- Biomarkers: Initiated several studies to assess the effect of alcohol and fatigue on gene expression. Initial results show that, for men in their early 20's, approximately 400 genes change expression level at some point between blood alcohol levels of 0.00 percent and 0.08 percent, the legal limit for automobile operations in most states. The results also showed that over 150 genes alter expression levels in subjects exposed to a thirty-six hour sleepless period. Validation of these results is in progress as well as the analysis of data on the affect of altitude on biomarkers. (Aeromedical Research)

- Side-Facing Seat Safety Criteria: Completed a study of the injury potential of side-facing seats using a specialized anthropomorphic test dummy. The study developed safety criteria for side-facing seat designs and determined the benefits of inflatable shoulder restraints (airbags) in crash survival. (Aeromedical Research)



- Aircraft Overrun and Undershoot Analysis: Collected and analyzed historical data related to both overrun and undershoot occurrences to assist airport operators evaluate runway safety areas. Data studied include accident and incident characteristics, such as aircraft type, occupancy, exit speed, overrun/undershoot distance, weather, elevation, pavement condition, and other characteristics pertinent to the occurrences. (Airport Cooperative Research – Safety)

- Comprehension of Safety Material and Signs: Completed an evaluation to determine the comprehension of airliner exit signs and the effectiveness of passenger safety briefing materials. Findings from nearly 800 subjects, including cabin safety professionals, showed the use of the word "EXIT," as required by current regulations to designate emergency doors, was more effective than symbolic exit signs. (Aeromedical Research)

- Evacuation Models: Developed and demonstrated a computer simulation of airliner emergency evacuation for both narrow and wide body aircraft. The simulation includes aircraft seat and door configurations in normal and damaged modes, passenger behavior, crew actions, and other features that impact emergency evacuation. The simulation is being used to assess the potential value of emergency egress assist devices relative to evacuation time. (Aeromedical Research)

- Alternative Pavement Grooving Evaluation: Installed and evaluated an alternative pavement grooving technique, called trapezoidal grooving, at Chicago O'Hare Airport and Quantico Marine Corp Facility. The new shaped groove was found to resist damage from sweeping, snow plowing, and aircraft traffic. The standard (rectangular) groove has been susceptible to damage and is typically replaced after a few years. (Airport Technology Research - Safety)

- Evaluation and Mitigation of Aircraft Slide Evacuation Injuries: Identified challenges associated with the use of aircraft evacuation slides at airports, focusing on causes of injuries and ways to reduce them. A report was produced that includes: a literature review of known incidents where aircraft evacuations occurred via the slides and identified causes of known injuries; a survey/interview of airport operators and emergency responders involved in those incidents, slide manufacturers, and aircraft manufacturers, as appropriate; a review of tools relative to aircraft slide evacuations available to first responders; and recommended guidance for airport operators and emergency personnel to prepare for aircraft slide evacuations that includes best practices for minimizing injury rates. (Airport Cooperative Research - Safety)

- Acute Human Exposure Limits for Gaseous Halocarbon Extinguishing Agents: Developed acute human exposure limits for FAA-approved halon replacement agents in hand-held extinguishers in ventilated aircraft. The guidance material will appear in a proposed Advisory Circular (AC) and is expected to allay concerns related to harmful halon replacement agent exposure in small aircraft and compartments. (Fire Research and Safety)

- Engineered Material Arresting Systems: Completed full-scale, arctic testing of the system with the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory. Additional test were conducted on individual components of the system that are designed to provide protection from harsh environments. This research supports the formulation of existing systems and provides a baseline for further testing of new soft ground arrestor system concepts. (Airport Technology Research - Safety)

- Next Generation High-Reach Extendable Turret: Completed testing of the non-fire portion of the next generation turret. This testing brings the aviation community a step closer to providing a technology that can pierce both the first- and second-level passenger cabin in a post-crash fire situation. It will allow fire fighters to pierce the fuselage skin, apply fire fighting agents into the cabin, and extinguish an interior fire as well as knock down the heat and toxic smoke. This will make the conditions in the cabin more survivable, increasing the chances for safe evacuation of passengers. (Airport Technology Research - Safety)

- Burning Behavior of Cabin Materials: Developed a one-dimensional computational model of the burning behavior of a material. The model is a product of far-term research to improve our understanding of how a material burns and attempt to predict the burning behavior under more complex conditions. (Fire Research and Safety)

- Operation of New Large Aircraft – Second Level Fire Fighting Evaluation: Partnered with the U.S. Air Force Research Lab at Tyndall Air Force Base to construct a mockup of a full-scale section of a new large aircraft that will enable researchers to address issues concerning what kinds of specialized tools, training, strategies, and agents will be required to handle a large-scale fire. This will enable the FAA to update Aircraft Rescue and Fire Fighting service standards and recommended practices to improve passenger survivability in post-crash fires in new large aircraft. (Airport Technology Research - Safety)

- Powered Air Purifying Respirator Feasibility Study: Measured the impact of wearing powered air purifying respirators (PAPRs) on task performance, including speech intelligibility, visual acuity, visual detection, ability to perform physical tasks, and subjective comfort. The most profound impact was found on speech intelligibility, particularly in face-to-face communication, with error levels exceeding minimally acceptable levels. Determining the impact of PAPRs on the performance of ATC and maintainer tasks will help to develop an effective overall crisis contingency plan. (Air Traffic Control/Technical Operations Human Factors)

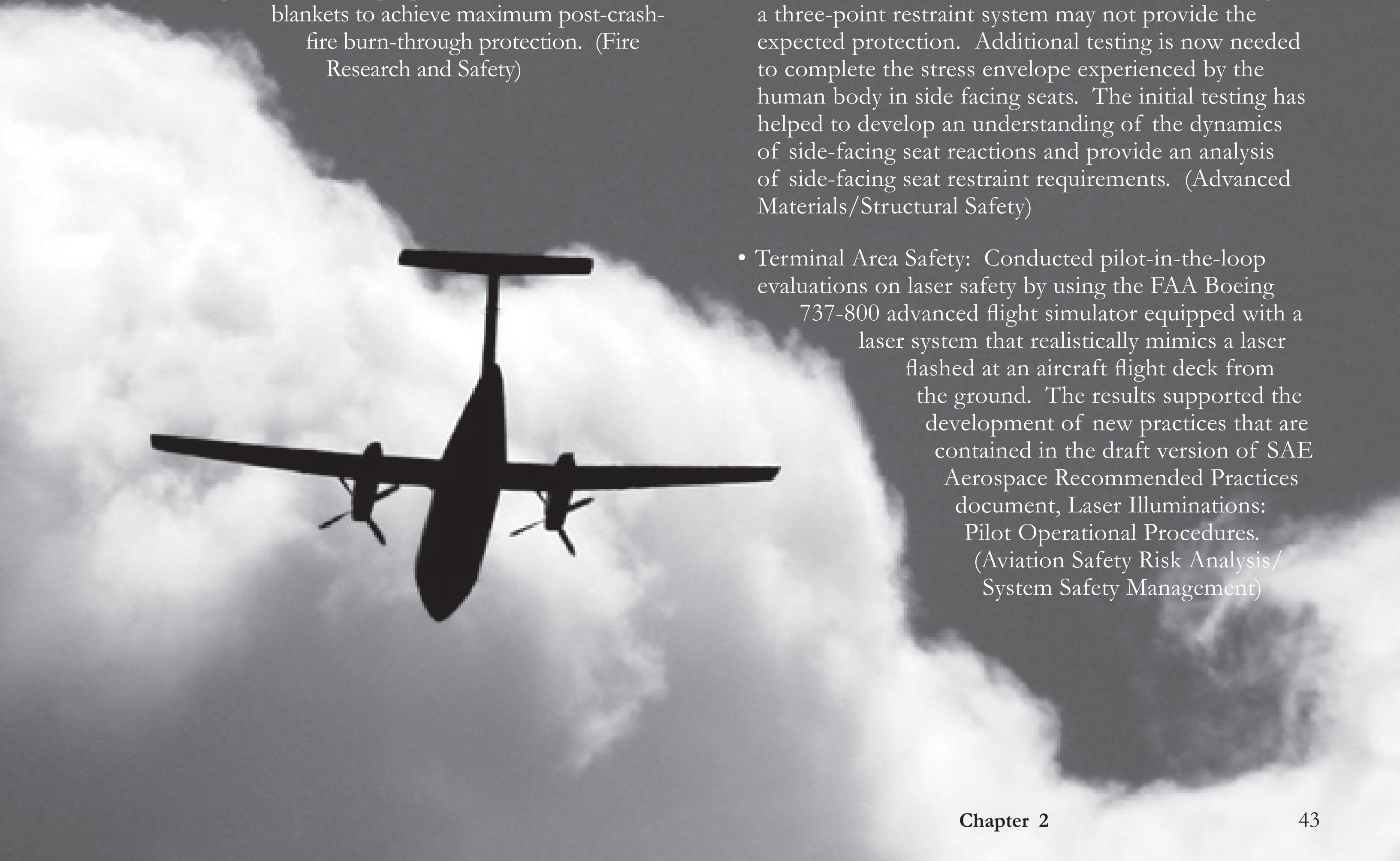
- Thermal Acoustic Insulation Burn-through Resistance Certification and Installation Guidance Material: Developed significant technical input to update AC 25.856-2A on thermal acoustic insulation burn-through resistance. The AC documents a new fire test burner for showing compliance with FAA fire safety regulations and contains guidance on the proper installation of insulation blankets to achieve maximum post-crash-fire burn-through protection. (Fire Research and Safety)

- Icing Forecasting: Completed development of the Forecast Icing Product-Severity. This product will alert users to areas of forecasted in-flight icing by graphically displaying the probability that icing will occur along their planned flight path. These capabilities will allow users to plan more effective flight routes that will avoid hazardous icing areas. In-flight icing causes more than 25 accidents annually, with over half of these resulting in fatalities and destroyed aircraft. This equates to $100 million in injuries, fatalities, and aircraft damage per year. (Weather Program)

- Turbulence: Deployed the NEXRAD Turbulence Detection Algorithm on all U.S. NEXRADs as part of the Open Radar Build 10 software. This data will be used to produce a three-dimensional in-cloud turbulence map that will be integrated into other turbulence products, including the Graphical Turbulence Guidance Nowcast. The algorithm provides a valuable tool for identifying potentially hazardous regions of in-cloud turbulence and will allow users to plan more effective and safer routes of flight that will avoid hazardous turbulence areas. (Weather Program)

- Side-Facing Seat Crash Dynamics: Completed cadaver testing and obtained data to develop neck injury criteria for side-facing seats. The testing determined the ability of the human neck to handle tension and moment loading from a deceleration during a crash. The results were compared to analytical models for the prediction of stresses and strains associated with side impact and revealed that the conventional wisdom of using a three-point restraint system may not provide the expected protection. Additional testing is now needed to complete the stress envelope experienced by the human body in side facing seats. The initial testing has helped to develop an understanding of the dynamics of side-facing seat reactions and provide an analysis of side-facing seat restraint requirements. (Advanced Materials/Structural Safety)

- Terminal Area Safety: Conducted pilot-in-the-loop evaluations on laser safety by using the FAA Boeing 737-800 advanced flight simulator equipped with a laser system that realistically mimics a laser flashed at an aircraft flight deck from the ground. The results supported the development of new practices that are contained in the draft version of SAE Aerospace Recommended Practices document, Laser Illuminations: Pilot Operational Procedures. (Aviation Safety Risk Analysis/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 vehicle 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 into the NAS; and addressing safety problems specific to GA. 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 the human protection goal.

Rulemaking on Fuel Tank Inerting

On July 16, 2008, acting FAA Administrator Robert Sturgell announced rulemaking that "will close the book on fuel tank explosions." The FAA's final rule on fuel tank inerting requires installation of flammability reduction means (FRM) as a retrofit in vulnerable transport airplanes and in certain new production airplanes.

Eliminating flammable fuel/air vapors in fuel tanks has been the focus of intense scrutiny since the loss of flight TWA 800 in 1996. Experts from around the world considered a then-widely-used military solution for inerting fuel tanks impractical for use in commercial airplanes. Yet over the course of seven years, a team of FAA researchers at the William J. Hughes Technical Center designed, built, and tested a practical, low cost, and effective fuel tank inerting system. Close cooperation with the FAA Transport Airplane Directorate, NASA, Boeing, and Airbus lead to a series of successful flight tests that demonstrated the ability to continuously generate nitrogen that replaced air and fuel vapors in a fuel tank. This landmark R&D effort made the FAA rulemaking action possible.

In August 2008, only one month after the FAA rule, new Boeing 737s were being equipped with nitrogen generation systems based on the FAA system for center fuel tanks. Similar systems were installed in Boeing 777s beginning in the fourth quarter of 2008 and in Boeing 747-8's in 2009.

MILESTONES

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/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/Aging Aircraft)
- 2012: Complete a certification tool [13] 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)

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/Aging Aircraft)
- 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.

- 2015: Conduct field evaluation of detect, sense, and avoid (DSA) technology; command, control, and communications (C3) technologies; and flight termination procedures. (Unmanned Aircraft Systems Research)

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/Digital System Safety)

Flight controls
- 2010: Complete the study in usage, design, and training issues for rudder control systems in transport aircraft. (Continued Airworthiness/Aging Aircraft)

General aviation

Reduce GA accidents.

- 2012: Complete development of methods and data for damage tolerance analysis of rotorcraft structure. (Continued Airworthiness/Aging Aircraft)
- 2013: Develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems (HUMS) for usage credits. (Continued Airworthiness/Aging Aircraft)

Commercial space

Identify the requirements for safe commercial space transportation vehicles.

- 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. (Commercial Space Transportation Safety)

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[13] Design Assessment Reliability and Inspection (DARWIN)

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

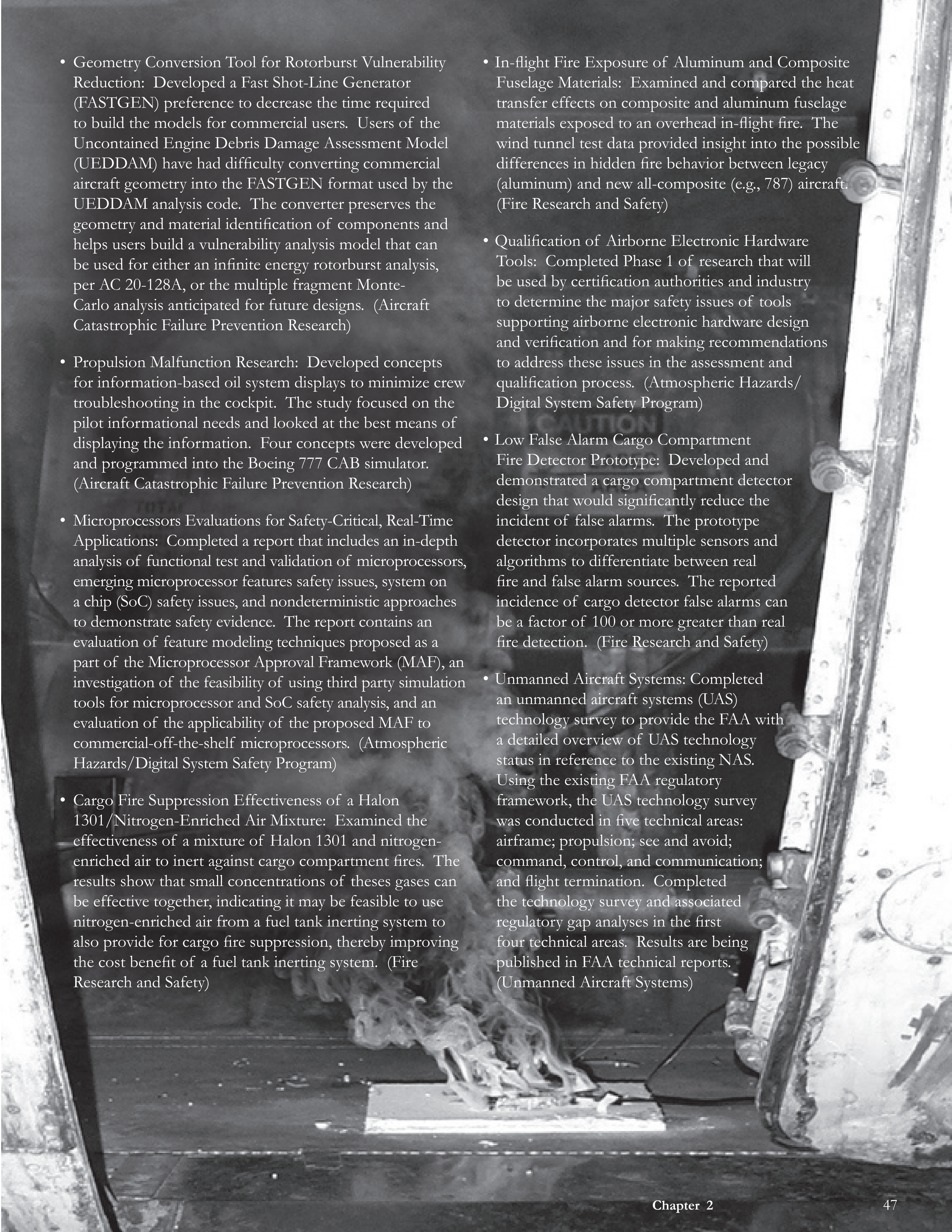
			2009	2010	2011	2012	2013	2014	Notes
A11.c.	Advanced Materials/Structural Safety	R,E&D	2,920	2,448	2,476	2,495	2,515	2,537	100% of total program
A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	14,005	10,506	10,581	10,615	10,648	10,684	96% of total program
A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	436	1,545	1,557	1,564	1,570	1,577	100% of total program
A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	3,387	3,137	3,165	3,182	3,198	3,214	70% of total program
--	Commercial Space Transportation Safety	Ops	73	73	73	73	73	73	50% of total program
A11.a.	Fire Research and Safety	R,E&D	1,064	1,248	1,271	1,290	1,311	1,333	16% of total program
A11.b.	Propulsion and Fuel Systems	R,E&D	3,669	3,105	3,150	3,186	3,224	3,264	100% of total program
A11.l.	Unmanned Aircraft Systems Research	R,E&D	1,576	2,912	2,922	2,920	2,916	2,913	84% of total program
Total ($000)			27,130	24,974	25,195	25,325	25,455	25,595	

PROGRESS IN FY 2008: SAFE AEROSPACE VEHICLES

- Friction Stir Welded Aviation Structures Design Criteria: Determined that many of the parameters initially thought critical to friction stir welded aviation structure design do not change the structural performance of the weld. A standard joint configuration can be described that is path-independent (processing parameters do not effect the outcome) and an in-situ rivet process can be repeated without proprietary processing information. These two findings will be the basis for standardizing the process to develop joint values that can be compared from location to location to understand the manufacturer's process control and to develop preliminary design capabilities that can be used to evaluate the potential of the process in new applications. Efforts were initiated to adopt these methodologies in standard practice and material allowable handbooks such as Metallic Materials Properties Development and Standardization. (Advanced Materials/Structural Safety)

- Surface Condition Determination for Reliable Processing for Bonded Structures and Repair: Identified the surface contaminants that cause degradation; documented technologies that identify surface contaminants; and evaluated equipment that can assess surfaces for those contaminants. This work will allow applicants and operators to provide repair procedures that incorporate reliable methods for accurate determination of surface suitability for durable structural bonds. This will enable the use of more bonded structures in future aircraft while providing expected level of safety. (Advanced Materials/Structural Safety)

- Integrated Modular Avionics Research: Completed research on real-time operating systems and component integration considerations in Integrated Modular Avionics (IMA) systems. Research results will be used by certification authorities and industry for integrating real-time operating systems into IMA systems. (Atmospheric Hazards/Digital System Safety)



- Geometry Conversion Tool for Rotorburst Vulnerability Reduction: Developed a Fast Shot-Line Generator (FASTGEN) preference to decrease the time required to build the models for commercial users. Users of the Uncontained Engine Debris Damage Assessment Model (UEDDAM) have had difficulty converting commercial aircraft geometry into the FASTGEN format used by the UEDDAM analysis code. The converter preserves the geometry and material identification of components and helps users build a vulnerability analysis model that can be used for either an infinite energy rotorburst analysis, per AC 20-128A, or the multiple fragment Monte-Carlo analysis anticipated for future designs. (Aircraft Catastrophic Failure Prevention Research)

- Propulsion Malfunction Research: Developed concepts for information-based oil system displays to minimize crew troubleshooting in the cockpit. The study focused on the pilot informational needs and looked at the best means of displaying the information. Four concepts were developed and programmed into the Boeing 777 CAB simulator. (Aircraft Catastrophic Failure Prevention Research)

- Microprocessors Evaluations for Safety-Critical, Real-Time Applications: Completed a report that includes an in-depth analysis of functional test and validation of microprocessors, emerging microprocessor features safety issues, system on a chip (SoC) safety issues, and nondeterministic approaches to demonstrate safety evidence. The report contains an evaluation of feature modeling techniques proposed as a part of the Microprocessor Approval Framework (MAF), an investigation of the feasibility of using third party simulation tools for microprocessor and SoC safety analysis, and an evaluation of the applicability of the proposed MAF to commercial-off-the-shelf microprocessors. (Atmospheric Hazards/Digital System Safety Program)

- Cargo Fire Suppression Effectiveness of a Halon 1301/Nitrogen-Enriched Air Mixture: Examined the effectiveness of a mixture of Halon 1301 and nitrogen-enriched air to inert against cargo compartment fires. The results show that small concentrations of theses gases can be effective together, indicating it may be feasible to use nitrogen-enriched air from a fuel tank inerting system to also provide for cargo fire suppression, thereby improving the cost benefit of a fuel tank inerting system. (Fire Research and Safety)

- In-flight Fire Exposure of Aluminum and Composite Fuselage Materials: Examined and compared the heat transfer effects on composite and aluminum fuselage materials exposed to an overhead in-flight fire. The wind tunnel test data provided insight into the possible differences in hidden fire behavior between legacy (aluminum) and new all-composite (e.g., 787) aircraft. (Fire Research and Safety)

- Qualification of Airborne Electronic Hardware Tools: Completed Phase 1 of research that will be used by certification authorities and industry to determine the major safety issues of tools supporting airborne electronic hardware design and verification and for making recommendations to address these issues in the assessment and qualification process. (Atmospheric Hazards/Digital System Safety Program)

- Low False Alarm Cargo Compartment Fire Detector Prototype: Developed and demonstrated a cargo compartment detector design that would significantly reduce the incident of false alarms. The prototype detector incorporates multiple sensors and algorithms to differentiate between real fire and false alarm sources. The reported incidence of cargo detector false alarms can be a factor of 100 or more greater than real fire detection. (Fire Research and Safety)

- Unmanned Aircraft Systems: Completed an unmanned aircraft systems (UAS) technology survey to provide the FAA with a detailed overview of UAS technology status in reference to the existing NAS. Using the existing FAA regulatory framework, the UAS technology survey was conducted in five technical areas: airframe; propulsion; see and avoid; command, control, and communication; and flight termination. Completed the technology survey and associated regulatory gap analyses in the first four technical areas. Results are being published in FAA technical reports. (Unmanned Aircraft Systems)

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 the JPDO plan for self-separation.

MILESTONES

Surface/runway operations awareness (NextGen - Self Separation)

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.

Reduced separation (NextGen - Self Separation)

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 (NextGen - Self Separation)

2011: Complete 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.

Funding Requirements

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	coordination only
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
A12.e.	NextGen - Self Separation	R,E&D	8,025	8,247	10,076	10,243	10,411	10,410	100% of total program
1A08E	NextGen - Wake Turbulence Re-categorization	F&E	0	0	0	0	0	0	coordination only
Total ($000)			8,025	8,247	10,076	10,243	10,411	10,410	

Progress in FY 2008: Separation Assurance

Funding of programs associated with this goal starts in FY 2009.

SITUATIONAL AWARENESS

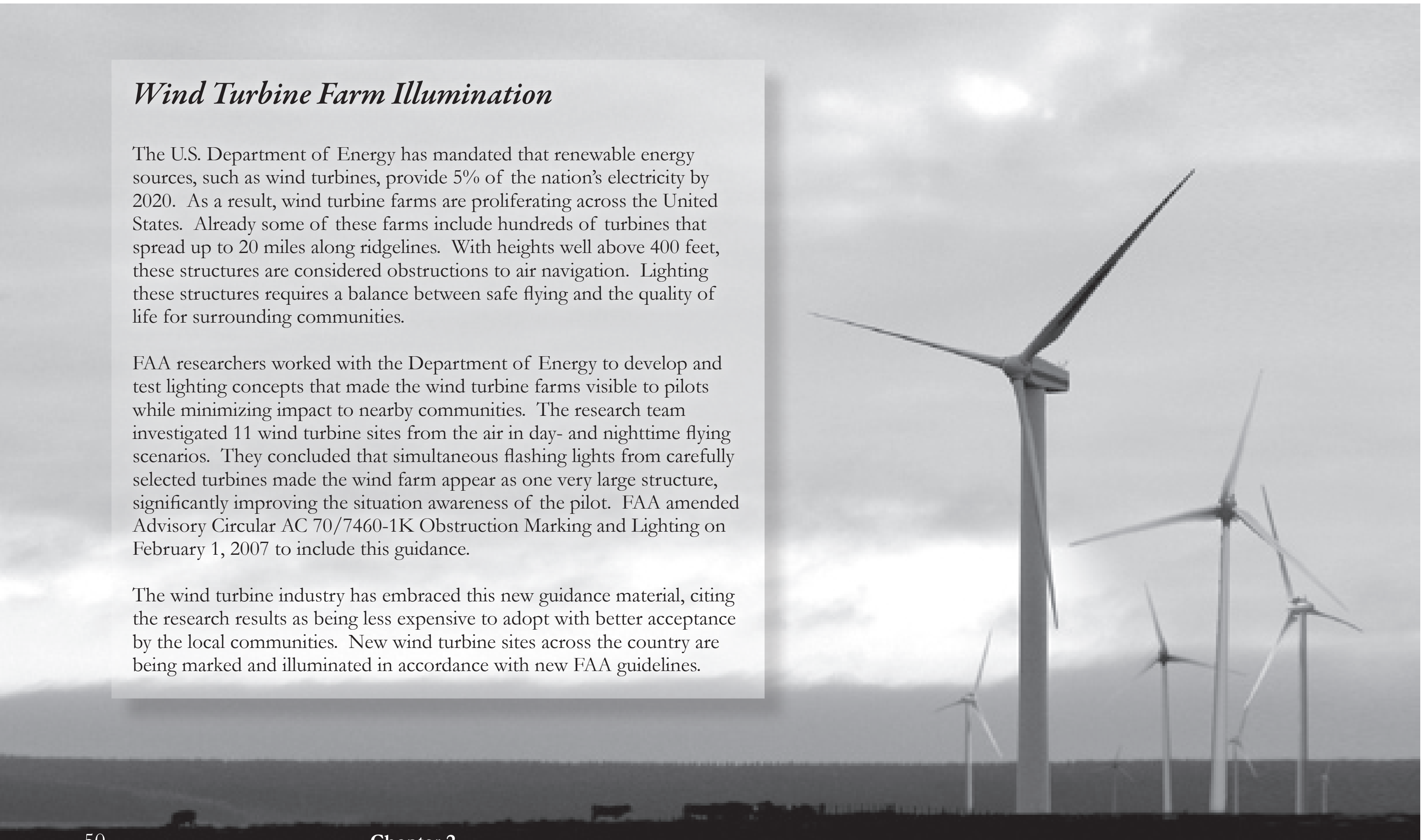
Common, accurate, and real-time information of aerospace operations, events, crises, obstacles, and weather

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.



Wind Turbine Farm Illumination

The U.S. Department of Energy has mandated that renewable energy sources, such as wind turbines, provide 5% of the nation's electricity by 2020. As a result, wind turbine farms are proliferating across the United States. Already some of these farms include hundreds of turbines that spread up to 20 miles along ridgelines. With heights well above 400 feet, these structures are considered obstructions to air navigation. Lighting these structures requires a balance between safe flying and the quality of life for surrounding communities.

FAA researchers worked with the Department of Energy to develop and test lighting concepts that made the wind turbine farms visible to pilots while minimizing impact to nearby communities. The research team investigated 11 wind turbine sites from the air in day- and nighttime flying scenarios. They concluded that simultaneous flashing lights from carefully selected turbines made the wind farm appear as one very large structure, significantly improving the situation awareness of the pilot. FAA amended Advisory Circular AC 70/7460-1K Obstruction Marking and Lighting on February 1, 2007 to include this guidance.

The wind turbine industry has embraced this new guidance material, citing the research results as being less expensive to adopt with better acceptance by the local communities. New wind turbine sites across the country are being marked and illuminated in accordance with new FAA guidelines.

MILESTONES

Weather situational awareness

Develop common situational awareness for weather.

Weather Information Improvements (Weather Program)

- 2009: Transition for operational readiness the National Ceiling and Visibility forecast for CONUS.
- 2011: Transition in-flight icing Alaska forecast for implementation.
- 2013: Transition the volcanic ash forecast for operational readiness.

Weather Technology in the Cockpit (WTIC)[14] (NextGen-Weather Technology in the Cockpit)

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

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, Airport Cooperative Research - Safety)
- 2011: Develop a radar-based, national bird strike advisory system for airports and their vicinity. (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, Airport Cooperative Research - Safety)

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

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
--	Airport Cooperative Research – Safety	AIP	2,000	2,000	2,000	2,000	2,000	2,000	40% of total program
--	Airport Technology Research – Safety	AIP	6,655	7,719	7,719	7,719	7,784	7,719	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	2,649	2,683	2,683	2,744	2,808	2,873	12% of total program
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	1,000	3,300	3,400	100% of total program
1A08	NextGen Demonstrations andInfrastructure Development	F&E	0	0	0	0	0	0	coordination only
A12.f.	NextGen - Weather Technology in the Cockpit	R,E&D	8,049	9,570	10,320	10,497	10,674	10,681	100% of total program
1A01A	Runway Incursion Reduction	F&E	12,000	10,000	5,000	3,000	3,000	3,000	100% of total program
A12.b.	Wake Turbulence	R,E&D	2,762	3,026	3,010	3,097	3,306	3,230	27% of total program
A11.k.	Weather Program	R,E&D	13,744	13,599	13,430	13,163	12,884	12,592	81% of total program
A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	0	0	0	0	0	0	coordination only
		Total ($000)	48,859	49,597	45,162	43,220	45,756	45,495	

PROGRESS IN FY 2008: SITUATIONAL AWARENESS

- Weather in the Cockpit Baseline Assessment: Documented current and projected weather information needs and assessed gaps in current and projected weather-information products. An assessment of weather information use in Airline Operations Centers was started. This research begins to establish criteria for the organization and presentation of weather information in the cockpit to allow pilots to more safely and efficiently reach their intended destination without encountering significant weather hazards. (Weather Program)
- Vision Model to Predict Target Detection and Recognition: Conducted controlled laboratory experiments to measure visibility of a range of aircraft for a set of human observers. The data were used to validate a new general model that can be used in a broad range of aviation human factors applications. (Air Traffic Control/Technical Operations Human Factors)

- Quarantine Facilities for Arriving Air Travelers: Developed guidance for airport operators to identify potential quarantine facilities on or off the airport and for continuity of airport operations. The guidance is based on evaluation of requirements and constraints, including such factors as: physical needs of individuals, non-airport resources available, structural requirements for such facilities, potential existing facilities at airports or in community, operational and financial impacts of identifying on-airport facilities, and planning guidelines for expected maximum number of individuals to be quarantined. (Airport Cooperative Research – Safety)

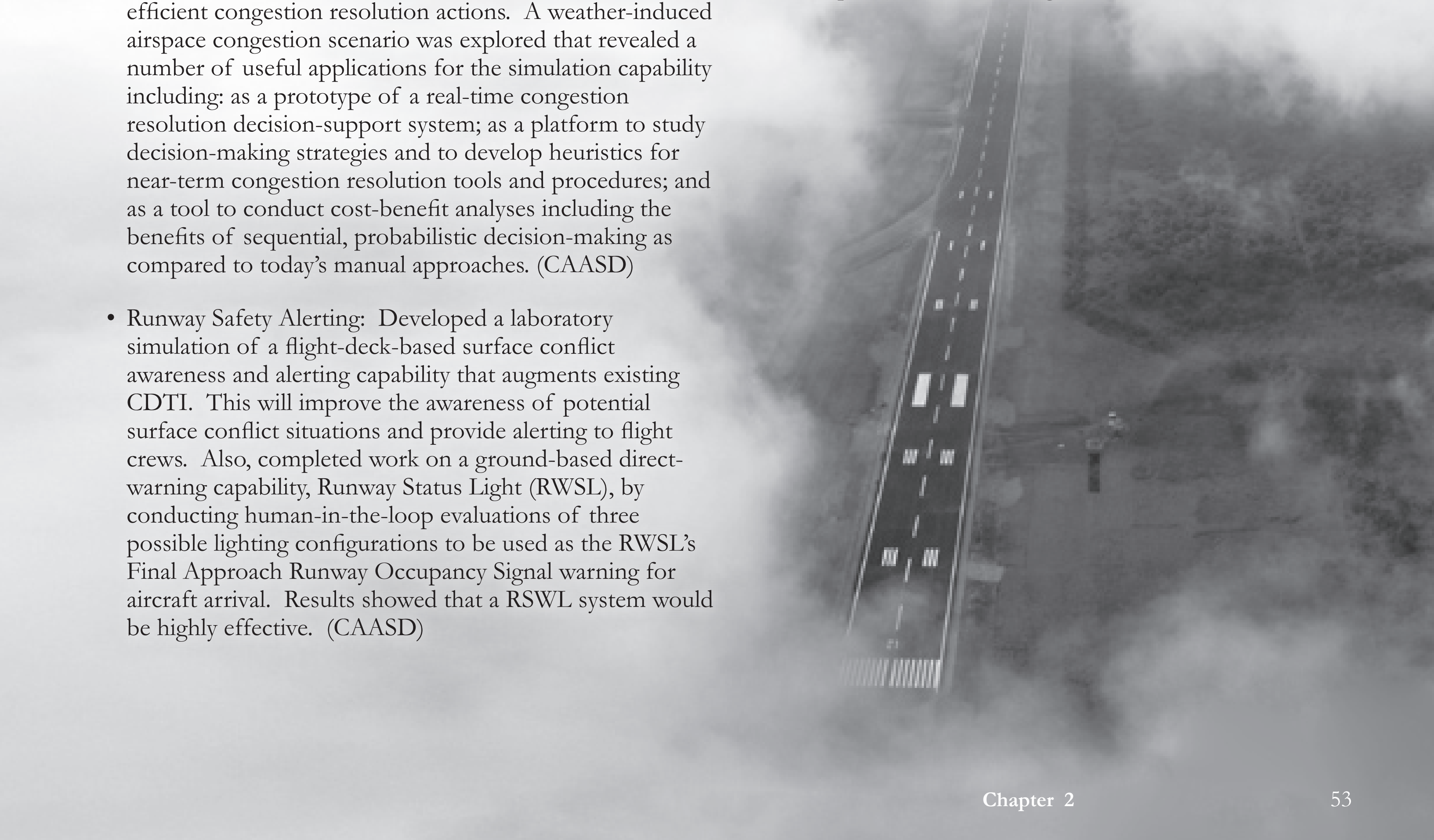
- Automated Foreign Object Debris Detection System Evaluation: Completed the evaluation of the millimeter-wave radar Foreign Object Debris (FOD) system at the T. F. Green Airport in Providence, Rhode Island. The evaluation is based on data collected over 12 months by 2 seperate units, with particular attention to data collected over winter months. The results will be used to create a national standard for FOD detection. These systems can find very small items on the surface of the runway, and automatically report them to the airport operator. Further testing of additional FOD detection systems, including a hybrid system that uses both millimeter-wave radar and high-powered cameras, an intellegent vision system, and a mobile detection system, are taking place at trial airports like Boston Logan International Airport and Chicago O'Hare. (Airport Technology Research - Capacity)

- Application of Sequential Decision-making to Traffic Flow Management: Developed a sequential decision-making simulation capability in which traffic and weather forecast prediction uncertainty is quantified and used to develop efficient congestion resolution actions. A weather-induced airspace congestion scenario was explored that revealed a number of useful applications for the simulation capability including: as a prototype of a real-time congestion resolution decision-support system; as a platform to study decision-making strategies and to develop heuristics for near-term congestion resolution tools and procedures; and as a tool to conduct cost-benefit analyses including the benefits of sequential, probabilistic decision-making as compared to today's manual approaches. (CAASD)

- Runway Safety Alerting: Developed a laboratory simulation of a flight-deck-based surface conflict awareness and alerting capability that augments existing CDTI. This will improve the awareness of potential surface conflict situations and provide alerting to flight crews. Also, completed work on a ground-based direct-warning capability, Runway Status Light (RWSL), by conducting human-in-the-loop evaluations of three possible lighting configurations to be used as the RWSL's Final Approach Runway Occupancy Signal warning for aircraft arrival. Results showed that a RSWL system would be highly effective. (CAASD)

- Sensory Deficiencies in the Operation of Unmanned Aircraft Systems: Completed a technical report on the integration of unmanned aircraft systems (UAS) into the NAS. The report includes a comparison of manned sensory information to sensory information available to the unmanned aircraft pilot, a review of remediation for sensory deficiencies from the current UAS inventory, a review of human factors research related to enhancing sensory information available to the UAS pilot, and a review of current FAA regulations related to sensory information requirements. Analyses demonstrated that pilots of UAS receive less and fewer types of sensory information compared to pilots of manned aircraft. One consequence is that UAS pilots have more difficulty recognizing and diagnosing anomalous flight events that could endanger flight safety. One way to resolve this is to incorporate multi-sensory alert and warning systems into UAS control stations. (Flightdeck/ Maintenance/System Integration Human Factors)

- Model Development and Enhancement: Implemented the experimental rapid refresh Weather Research and Forecasting modeling system at the National Oceanic and Atmospheric Administration (NOAA). The system provides an hourly update across North America, including Alaska, for aviation hazards including icing, convection, turbulence, and ceiling and visibility. This will provide the capability to conduct a real-time demonstration and ensure that the system meets all National Weather Service operational requirements prior to operational implementation in FY 2010. Full operational implementation will provide enhanced forecasts of aviation hazards, enhancing both NAS safety and capacity. (Weather Program)



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, and environmental goals. Validation of the R&D target will include analysis, modeling, prototypes, and demonstrations. The evaluation efforts under this goal support the interim assessment of progress and validation of the R&D targets under the human protection; clean and quiet; and fast, flexible, and efficient goals.

MILESTONES

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.
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/Aviation Safety Risk Analysis)

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.

Capacity evaluation

Develop methods, metrics, and models to demonstrate that the system can handle growth in demand up to three times current levels.[15] (Operations Concept Validation, NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning, and Improvement; Airspace Management Laboratory; Airspace Management Program)

✓ 2008: Demonstrate capacity increase to 130% current levels. [COMPLETED, see first bullet under Progress in FY 2008]
2011: Demonstrate capacity increase to 166% current levels.
2013: Demonstrate capacity increase to 230% current levels.

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

Safety evaluation[16]

Develop methods and metrics to measure progress in reducing the rate of fatalities and significant injuries by two-thirds[17]. (System Safety Management/Aviation Safety Risk Analysis)

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[18].
2016: Demonstrate capacity increase to 300% current levels.

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[15] This supports demonstration of the R&D target under the fast, flexible, and efficient goal.

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

[17] This supports demonstration of the R&D target under the human protection goal.

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

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.[19] (NextGen – Operational Assessments)

2009: Demonstrate no environmental constraints at 130% capacity.[20]
2011: Demonstrate no environmental constraints at 166% capacity.
2013: Demonstrate no environmental constraints at 230% capacity.
2016: Demonstrate no environmental constraints at 300% capacity.

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	584	438	441	442	444	445	4% of total program
	Airspace Management Lab[21]	F&E	4,000	0	0	0	0	0	100% of total program
1A01E	Airspace Management Program	F&E	3,000	3,000	5,000	5,000	5,000	5,000	100% of total program
A11.h.	System Safety Management/ Aviation Safety Risk Analysis	R,E&D	12,488	12,698	12,668	12,566	12,460	12,350	100% of total program
4A09A	Center for Advanced Aviation System Development	F&E	3,263	3,305	3,305	3,380	3,460	3,539	14% of R&D program in FY 2009
	NextGen - Environment and Energy (Validation Modeling)	F&E	4,500	0	0	0	0	0	100% of total program
1A08F	NextGen – Operational Assessments (Environment and Energy)	F&E	0	3,000	3,000	3,000	3,000	3,000	40% of total program
1A08F	NextGen – Operational Assessments (Capacity and Safety)	F&E	0	4,500	7,000	7,000	7,000	7,000	60% of total program
A12.a.	Joint Planning and Development Office	R,E&D	4,340	4,322	4,306	4,264	4,221	4,176	30% of total program
1A08C	NextGen - Operations Concept Development Validation Modeling	F&E	4,000	10,000	10,000	10,000	10,000	10,000	100% of total program
1A08G	NextGen - System Safety Management Transformation	F&E	16,300	16,300	18,000	18,000	18,000	18,000	100% of total program
1A01C	Operations Concept Validation	F&E	7,400	8,000	8,000	8,000	6,000	6,000	100% of total program
1A01B	System Capacity, Planning, and Improvement	F&E	6,500	4,100	6,500	6,500	6,500	6,500	100% of total program
A11.l.	Unmanned Aircraft Systems Research	R,E&D	300	555	557	556	556	555	16% of total program
A11.j.	Aeromedical Research	R,E&D	0	0	0	0	0	0	coordination only
Total ($000)			66,675	70,218	78,777	78,708	76,641	76,565	

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[19] This supports demonstration of the R&D target under the clean and quiet goal.

[20] In FY 2009 this program was funded by NextGen – Environment and Energy (Validation Modeling); starting in FY 2010, this program will be funded by NextGen – Operational Assessments.

[21] By FY 2010, this program will have matured beyond research activities and be functioning on a day-to-day operational basis.

PROGRESS IN FY 2008: SYSTEM KNOWLEDGE

- NextGen Towers: Developed a concept of operations for both staffed and automated NextGen towers that will improve operational efficiency and enable cost-effective expansion of air traffic services to a significantly larger number of airports than would be possible with traditional methods of service delivery. Completed a technology assessment for staffed towers and alternatives. (Operations Concept Validation)

- Airport Economic Impact Methods and Models: Examined how airports determine the economic impact of an airport today, which is quite different from the traditional convention of incremental economic cost/benefit analysis of investing in an airport project. The project focused on the methods and models used to: define and identify, evaluate and measure, and communicate the different facets of economic impact that local airports are having on communities and regions. (Airport Cooperative Research – Capacity)

- Aviation Medical Examiner Survey: Collected survey data from aviation medical examiners about their satisfaction with the aeromedical certification services provided by the FAA. Overall, domestic, non-military examiners reported being satisfied with the personnel who provide certification services, but fewer were satisfied with the technological tools used for medical certification applications. Examiners identified specific areas for improvement, including the standards and guidelines for deferrals, training, digital ECG system, AMC Internet Subsystem, and the FAA's OAM website. The survey results will be used by senior managers to: 1) evaluate the degree of customer satisfaction with aerospace medical certification services, 2) identify areas in which improvements in service delivery can be made, and 3) assess change in customer satisfaction as a result of those improvements. (Flightdeck/Maintenance/Systems Integration Human Factors)

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 and conducting analyses. The research results listed under the subheading of Products are generated by 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 result.

MILESTONES

Products

Leverage research results[22].

✓ 2008: Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions. (Wake Turbulence) [COMPLETED, see third bullet under Fast, Flexible, and Efficient Progress in FY 2008]
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. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics, Airport Cooperative Research - Environment)
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. (NextGen - System Safety Management Transformation)
2013: Complete development of ANSP wake separation standards that better use aircraft flight characteristics and information concerning surrounding weather conditions. (NextGen - Wake Turbulence - Re-categorization)
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)
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)

Management

Manage ongoing research. (System Planning and Resource Management)

✓ 2008: Manage R&D portfolio, conduct advisory committee reviews of R&D, and publish the *NARP*. [COMPLETED, see bullet under Progress in FY 2008]

Manage research collaborations. (System Planning and Resource Management)

2010: Determine measures for the exchange of research information.
2011: Develop a strategic mapping for international collaboration.
2011: Identify a process to measure quality, timeliness, and value of collaboration.
2016: Determine final value of collaboration.

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[22] These milestones were selected from the other nine goals to show international collaboration.

FUNDING REQUIREMENTS

The funding levels listed for years 2011 to 2014 are estimates and subject to change. Programs with zero funding listed supply only coordinated FAA staff resources towards the R&D goal.

			2009	2010	2011	2012	2013	2014	Notes
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.a.	Environment and Energy	R,E&D	0	0	0	0	0	0	coordination only
A12.f.	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	1,817	1,766	1,741	1,702	1,664	1,620	100% total program
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
--	Airport Cooperative Research –Environment	AIP	0	0	0	0	0	0	coordination only
A12.e.	NextGen - Self Separation	R,E&D	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
Total ($000)			1,817	1,766	1,741	1,702	1,664	1,620	

PROGRESS IN FY 2008: WORLD LEADERSHIP

- Portfolio Management: The Research, Engineering, and Development Advisory Committee (REDAC) provided guidance on the FAA FY 2010 R&D portfolio on October 3, 2007. The 2008 *National Aviation Research Plan* (*NARP*) was submitted to Congress on February 4, 2008. The R&D Executive Board (REB) developed the proposed FY 2010 R&D portfolio between November 2007 and February 2008. The five REDAC subcommittees reviewed the portfolio in February 2008, and the REDAC provided its final review of the FY 2010 R&D portfolio to the FAA on March 5, 2008. The NextGen Review Board approved the NextGen portion of the FY 2010 R&D portfolio on May 19, 2008. The FAA Executive Council approved the FY 2010 R,E&D budget on May 27, 2008, and the Joint Resources Council approved it on June 4, 2008. The FAA FY 2010 R,E&D budget was submitted to the Office of the Secretary of Transportation on July 30 and August 15, 2008, and to Office of Management and Budget on September 8, 2008.


WORLD AERONAUTICAL CHART
CE-15
SCALE 1:1,000,000
Lambert Conformal Conic Projection Standard Parallels 49°20' and 54°40'
Horizontal Datum: North American Datum of 1983 (World Geodetic System
EDITION May 15, 2008
Includes airspace amendments effective May 1
all other aeronautical data received by
Consult appropriate NOTAMs and
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FORT LAUDERDALE
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V-157-511-599
282
Pumping station
17

CHAPTER 3

nextgen alignment

Over the past year, the Federal Aviation Administration (FAA) has refined its approach to implement the next generation air transportation system (NextGen). The newly created position of Senior Vice President of NextGen and Operations Planning (ATO-P) within the Air Traffic Organization (ATO) provides the needed focus on NextGen, enhancing the synergy with the Joint Planning and Development Office (JPDO) that was reorganized under the ATO-P.

The *FAA's NextGen Implementation Plan (NGIP)*, released in June 2008 and updated in January 2009, reflects an intensive effort to focus the FAA and the aviation community on making firm commitments to implement new operational improvements (OIs) in a coordinated, timely fashion. The OIs identified in the *NGIP* are identical to the operational improvements displayed in the National Airspace System (NAS) Enterprise Architecture's service roadmaps. Within the FAA, NextGen implementation requires planning and execution across all lines of business. Three key management structures are responsible for NextGen decision-making and progress monitoring: the NextGen Management Board, the NextGen Review Board, and the Senior Vice President for NextGen and Operations Planning. The roles and responsibilities of the two boards are provided in Chapter 4 under the Evaluation section.

The FAA NextGen R&D programs, which began in fiscal year 2009, will contribute to the R&D needs identified by the *NGIP* and the *JPDO NextGen Integrated Work Plan (IWP)*. This chapter describes how the FAA R&D goals and activities listed in Chapter 2 map to the mid-term OIs in the *NGIP*. Other linkages to the IWP are described in Appendix E.

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 the FAA NextGen R&D programs align with the OIs identified in the *NGIP*. The fourth section presents the 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 are adapted from the *NGIP*.

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

This solution set focuses primarily on en route cruise operations and specific aircraft requirements, such as that equipment needed for required navigation performance (RNP). Air traffic control will shift from voice and clearance-based control to trajectory-based control negotiated between the pilot and the air traffic manager. The pilot will fly a predetermined preferred route characterized by three-dimensional position and time achieved at certain periods of flight. Sectors will be managed automatically. Aircraft separation will be variable, based on wake turbulence and aircraft capabilities.

Increase Arrivals/Departures in High-Density Airports

This solution set focuses on increasing capacity at the busiest airports (the Operational Evolution Partnership (OEP) 35 airports) and in the busiest airspace to achieve and maintain greater throughput. Requirements include the same capabilities of flexible terminals and airspace as well as integrated tactical and strategic flow capabilities. Additional requirements include higher performance navigation and communications capabilities, more efficient airport surface movements, reduced spacing and separation requirements, and improved overall traffic flow management.

Increase Flexibility in the Terminal Environment

This solution set focuses on expanding use of secondary and reliever airports to meet higher traffic levels. Requirements consist of more reliable access to non-hub airports in low-visibility conditions; improved pilot and controller situational awareness; and more flexible use of terminal airspace, including required navigation (RNAV)/RNP routings, continuous-descent approaches, dynamic terminal airspace, and other performance-based procedures.

Improve Collaborative Air Traffic Management

This solution set strives to adjust airspace and other assets to satisfy forecast demand, rather than constraining demand to match available assets. If constraints are required because of capacity, safety, security, or environmental concerns, collaborative decision-making will maximize the operators' opportunities to resolve those constraints based on the operators' preferences.

Reduce Weather Impact

This 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

Inherent in all evolving aspects of NAS operations and protocol are the three areas of safety, security, and the environment. This solution set is composed of three subsets.

- **Safety**
  This subset involves sharing and proactively analyzing aviation safety information to assess and manage risks before incidents occur. Additionally, the sharing and analysis of aviation safety information will support safety assessments at the system level. With the projected increase in operations, it is not sufficient to maintain the current low accident rate. Therefore, safety must improve to ensure the number of accidents does not increase. This will require a transition to safety management systems (SMS), a formal, systematic, business-like approach to managing safety risk.
- **Security**
  This subset involves airspace security capabilities. Information security is integral to the baseline of each NAS program. NAS institutional information security processes and protocols deliver robust information security. As information security technology and best practices advance, NAS-based information security will be upgraded accordingly.
- **Environment**
  This subset involves activities that relate directly to improvements of aviation energy efficiency and reducing environmental impacts. The primary environmental constraints on the capacity and flexibility of NextGen will likely be noise, emissions, local air quality, global climate changes, water quality, and energy production and consumption.

Transform Facilities

This solution set involves all activities related to the establishment or removal of NAS facilities, and the transition to the NextGen facility concept. This includes the optimized allocation of staffing and facilities to provide enhanced services, the use of more cost-effective and flexible information sharing, general management and training of human assets, and removal of unneeded systems.

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 population and economic growth through 2025. 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.

AIRCRAFT AND OPERATOR REQUIREMENTS DOMAIN

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

NEXTGEN PORTFOLIO MANAGEMENT PROCESS

To enhance FAA performance and management control, the FAA NextGen Integration and Implementation (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. That office is also responsible for all NextGen-related decision-making processes and accountability across the Agency.

FAA NEXTGEN RESEARCH REQUIREMENTS

The FAA NextGen R&D programs are a subset of the FAA R&D goals, targets, and milestones listed in Chapter 2. Table 3.1 links the NextGen R&D to the mid- and far-term OIs in the *NGIP*. A NextGen R&D program may support more than one *NGIP* OI. Appendix E provides a more detailed description of the linkage to the mid- and far-term OIs in the *NGIP* and to the far-term OIs in the *JPDO IWP*. There are fewer linkages in the mid-term, since the bulk of NextGen R&D funding is planned to start in FY 2009 and a substantial lead time is typically required between the completion of R&D activities and their contribution to implementation.

Table 3.1: Mapping of FAA NextGen R&D Programs to the 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	New Air Traffic Management Requirements (1A08B)	NextGen - Air Ground Integration (A12.d.)	NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency & Air Ground Integration (1A08A)	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08D)	NextGen - Operational Concept Development - Validation Modeling (1A08C)	NextGen - Self Separation (A12.e.)	NextGen - System Safety Management Transformation (1A08G)	NextGen - Weather Technology in the Cockpit (A12.f.)	NextGen - Wake Turbulence - Re-categorization (1A08E)	NextGen Demonstrations and Infrastructure Development (1A07)	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b.)	Wake Turbulence (A12.b.)
Trajectory Based Operations	101103	Provide Interactive Flight Planning from Anywhere												
	102108	Oceanic In-trail Climb and Descent									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
	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												
	104121	Tactical Trajectory Management	X	X	X									
	108206	Flexible Airspace Management			X									
	108209	Increase Capacity and Efficiency using RNAV and RNP	X											
High Density Arrivals/Departures	102139	Use Aircraft-provided Intent Data to Improve Flow and Conflict Resolution						X						
	--	Delegated Responsibility for Horizontal Separation												
	102141	Improved Operations to Closely-Spaced Parallel Runways	X				X				X			X
	102142	Wake Vortex Incorporated into Flow					X			X	X			X
	104117	Optimize Runway Assignments			X									
	104122	Integrated Arrival/Departure Airspace Management			X									
	104123	Time Based Metering using RNAV and RNP Route Assignments					X					X		
	104206	Full Surface Traffic Management with Conformance Monitoring		X	X			X						
	104208	Use Data Messaging to Provide Flow and Taxi Assignments		X	X									
	104209	Initial Surface Traffic Management												
Flexible Terminal Environment	102138	ADS-B Services to Secondary Airports												
	102140	WTMD: Wind Based Wake Procedures												
	103406	Provide Full Surface Situation Information	X											
	103409	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												
	107107	GBAS Precision Approaches												
Collaborative Air Traffic Management	101102	Provide Full Flight Plan Constraint Evaluation with Feedback												
	101202	Trajectory Flight Data Management												
	102302	Manage Airspace as Trajectories			X						X			
	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												

Air Traffic Operations Domain

Solutions Sets			FAA NextGen R&D Budget Lines											
	OI#	Operational Improvements	New Air Traffic Management Requirements (1A08B)	NextGen - Air Ground Integration (A12.d.)	NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency & Air Ground Integration (1A09A)	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08D)	NextGen - Operational Concept Development - Validation Modeling (1A08C)	NextGen - Self Separation (A12.e.)	NextGen - System Safety Management Transformation (1A08G)	NextGen - Weather Technology in the Cockpit (A12.f.)	NextGen - Wake Turbulence - Re-categorization (1A08E)	NextGen Demonstrations and Infrastructure Development (1A07)	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b.)	Wake Turbulence (A12.b.)
Reduce Weather Impact	103116	Turbulence and Icing Available on Meteorological Data Collection and Reporting System												
	103117	Automatic Hazardous Weather Alert Notification								X				
	103119	Trajectory Based Weather Impact Evaluation												
	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*													
	–	National Standards for Safety Management							X					
	–	Safety Management Enterprise Services												
	–	Fully Institutionalized National Aviation Safety Policy and Continuous Safety Improvement Culture							X					
	–	Data Fusion Demonstration												
	–	Data Fusion from All Sources Enabled												
	–	Initial System-wide Integrated Assessments							X					
	–	Aviation Safety Information Analysis and Sharing							X					
	–	Safety Management System							X					
	ENVIRONMENT													
	–	Establish Metrics and Formulate Policy											X	
	–	Integrated Models Assess Trade-offs between Environment and Capacity												
	–	NGATS Operational Initiatives Implemented that Reduce Environmental Impacts				X							X	
	–	National EMS Supports Integrated Environmental Performance											X	
	–	Explore Environmental Control Algorithms for Operational Procedures				X								
	–	Establish the Impacts of New Aircraft Technologies and Alternative Fuels				X								
	SECURITY													
	–	Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk-Based Assessment												
	–	SSA and Information System Security Integrated Incident Detection and Response												
	–	Information on System Security and Surveillance Integration/Protection												
	–	Full Integrated Surveillance and Information SSA Operational Security												
Transform Facilities	108104	NAS-wide Sector Demand Prediction and Resource Planning												
	109402	Net-Centric Virtual Facility												
	109403	NextGen Facilities												
	–	Integration, Development, and Operations Analysis Capability												

– Does not have OI#

x Supporting NextGen R&D Activities

☐ Mid-term OI

▨ Far-term OI

BUDGET

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

Table 3.2: NextGen R&D Funding Levels in F&E[23]

Details of R&D NextGen Programs in F&E		2009 ($000)	2010 ($000)	2011 ($000)	2012 ($000)	2013 ($000)	2014 ($000)	R&D Goal
1A07	NextGen Demonstrations and Infrastructure Development	28,000	33,774	30,000	30,000	30,000	30,000	1
	NextGen - ATC/Tech Ops Human Factors (Air Ground Integration)	2,900	0	0	0	0	0	4
	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	3,800	0	0	0	0	0	3
1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency/Air Ground Integration	0	10,000	10,000	10,000	10,000	10,000	3
1A08B	NextGen - New ATM Requirements	5,400	13,200	1,800	31,200	32,000	50,100	1
1A08C	NextGen - Operations Concept Development Validation Modeling	4,000	10,000	10,000	10,000	10,000	10,000	9
	NextGen - Environment and Energy - (Validation Modeling)	4,500	0	0	0	0	0	9
	NextGen - Environment and Energy – Advanced Noise and Emissions Reduction & Validation Modeling	2,500	0	0	0	0	0	2
1A08D	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	0	7,000	18,000	18,000	18,000	18,000	2
1A08E	NextGen - Wake Turbulence Re-categorization	2,000	2,000	3,000	3,000	3,000	3,000	1
1A08F	NextGen - Operational Assessments	0	7,500	10,000	10,000	10,000	10,000	9
1A08G	NextGen - System Safety Management Transformation	16,300	16,300	18,000	18,000	18,000	18,000	9
1A08H	NextGen - Initial Operation Test & Evaluation	0	100	0	0	0	0	9
1A08	Subtotal NextGen - System Development (1A08A-1A08H)	41,400	66,100	70,800	100,200	101,000	119,100	
		69,400	**99,874**	**100,800**	**130,200**	**131,000**	**149,100**	

Key:

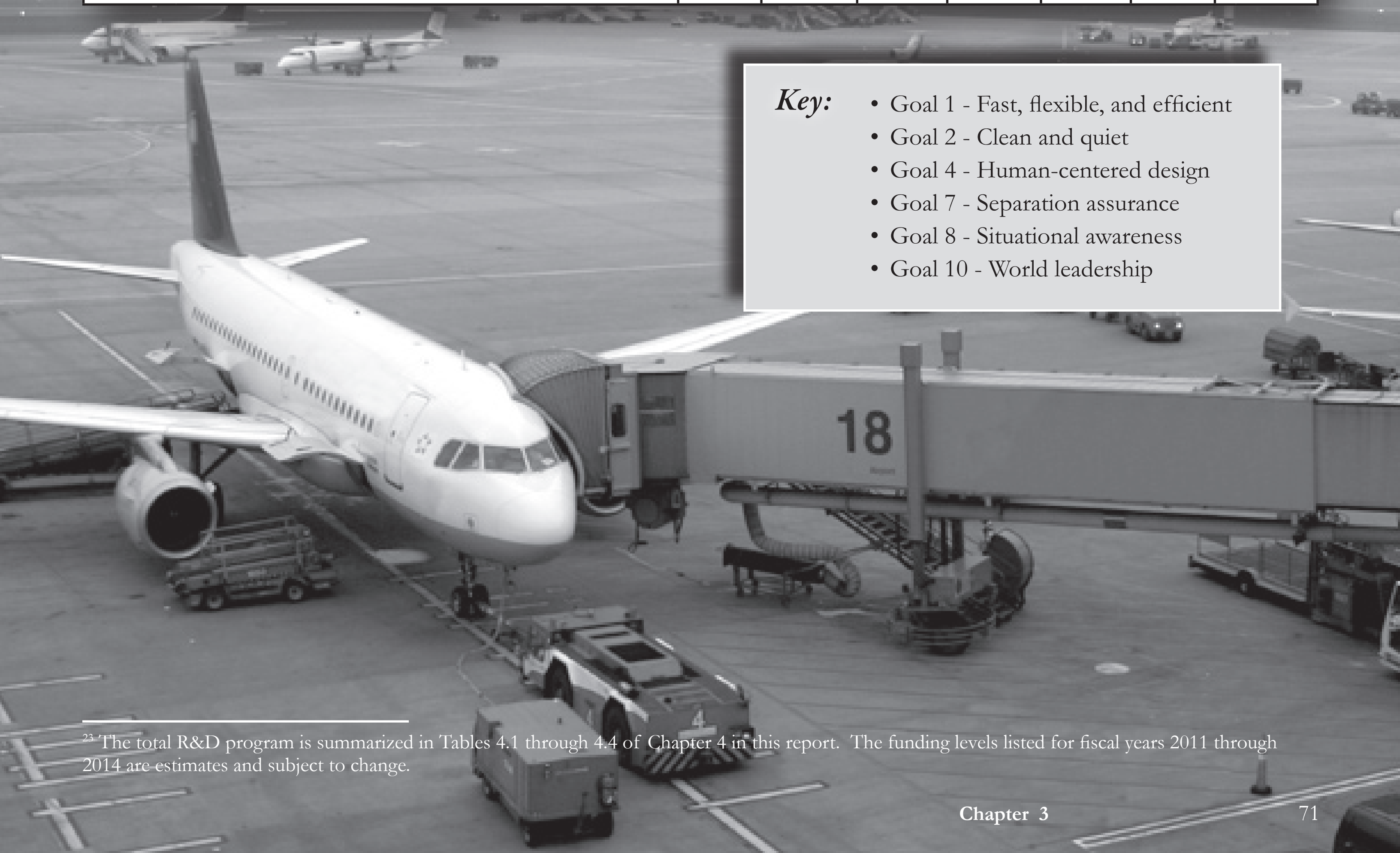
- Goal 1 - Fast, flexible, and efficient
- Goal 2 - Clean and quiet
- Goal 3 - High quality teams and individuals
- Goal 4 - Human-centered design
- Goal 9 - System knowledge

Table 3.3: NextGen R&D Funding Levels in R,E&D[23]

Details of R&D NextGen Programs in R,E&D		2009 ($000)	2010 ($000)	2011 ($000)	2012 ($000)	2013 ($000)	2014 ($000)	R&D Goal
A12.a.	Joint Planning and Development Office	14,466	14,407	14,352	14,214	14,070	13,919	10
A12.b.	NextGen Wake Turbulence	7,370	7,605	7,740	7,745	7,626	7,661	1
A12.d.	NextGen - Air Ground Integration	2,554	5,688	11,355	11,536	11,716	11,701	4
A12.e.	NextGen - Self Separation	8,025	8,247	10,076	10,243	10,411	10,410	7
A12.f.	NextGen - Weather Technology in the Cockpit	8,049	9,570	10,320	10,497	10,674	10,681	8
A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	16,050	19,470	20,510	20,858	21,207	21,219	2
		56,514	**64,987**	**74,353**	**75,093**	**75,704**	**75,591**	

Key:

- Goal 1 - Fast, flexible, and efficient
- Goal 2 - Clean and quiet
- Goal 4 - Human-centered design
- Goal 7 - Separation assurance
- Goal 8 - Situational awareness
- Goal 10 - World leadership



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[23] The total R&D program is summarized in Tables 4.1 through 4.4 of Chapter 4 in this report. The funding levels listed for fiscal years 2011 through 2014 are estimates and subject to change.

CHAPTER 4

research management

This chapter summarizes the Federal Aviation Administration (FAA) research and development (R&D) program according to its FY 2010 budget submission. The chapter explains what the 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

The FAA R&D program supports regulation, certification, and standards development; modernization of the national airspace system (NAS); and policy and planning. To support the 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 program 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.[24] 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.[25] It also funds administrative and technical support costs to support airport programs. The commercial space transportation program's R&D operating expenses are funded under the Ops account.

The programs in the FY 2010 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.

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[24] FAA Order 2500.8A, Funding Criteria for Operations, Facilities and Equipment (F&E), and Research, Engineering and Development (R,E&D) Accounts, dated April 9, 1993.

[25] 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.

Fire Research and Safety (A11.a.)

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, fuels, 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/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/Aging Aircraft (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, 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/Aviation Safety Risk Analysis (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, which 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 technologies to provide weather observations, warnings, and forecasts that are accurate, accessible, and efficient. These efforts will reduce the impacts of adverse weather on the operational capacity of the NAS and will enhance flight safety.

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.

Joint Planning and Development Office (JPDO) (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.

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 (A12.d.)

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 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 (A12.e.)

The program addresses human performance and coordination requirements for pilots and air navigation service providers 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.f.)

The program ensures the integration of cockpit, ground, and communication technologies, practices, and procedures to provide pilots with shared and consistent weather information to enhance common situational awareness. It will do this by providing airborne 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 policy 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 policy, standards, and guidance, including training, procedures, and error management.

Environment and Energy (A13.a.)

The program develops and validates methodologies, models, metrics, and tools to assess and mitigate the effect of aircraft noise and aviation emissions. It analyzes and balances the interrelationships between noise and emissions, considers local and 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 addresses the NextGen goal to increase capacity three-fold while reducing significant environmental impacts in absolute terms. The program is focused on reducing current levels of aircraft noise; investigating local air quality, greenhouse gas emissions, and energy use; and advancing alternative fuels for aviation use. 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 the FAA programs, and foster acceptance of U.S. standards and technology to meet global aviation needs.

William J. Hughes Technical Center Laboratory Facility (WJHTC) (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.

FACILITIES AND EQUIPMENT (F&E) APPROPRIATION

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 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 ATO to increase operational predictability 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 ATO.

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.

Wake Turbulence Research (1A01I)

The program evaluates air traffic control wake turbulence mitigation decision support tool prototypes as possible enablers to meet NextGen, projected demand for increased capacity in the nation's airspace and airports. It evaluates technology research and development and new wake separation concept modeling and simulation efforts for application to NextGen.

NextGen Demonstrations and Infrastructure Development (1A07)

The program demonstrates and tests concepts related to NextGen, including trajectory-based operations and super density operations to mature technologies, support investment decisions, and deploy new capabilities. It identifies early implementation opportunities, refines longer-term objectives, and may eliminate certain concepts from further consideration if results dictate.

NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Inegration (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 air navigation service provider personnel. It examines how air navigation service provider 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 Requirement (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 - Oprations 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 identifies advances in communication, navigation, and surveillance or satellite technologies and demonstrates how to leverage their capabilities to increase capacity while reducing noise, fuel burn, and emissions through the use of procedures, sequencing, and timing that optimize en route, arrival, departure, and surface operations. The program also develops 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. It measures the improvements provided by the products from the other components of the Environment and Energy program.

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.

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 the FAA's far-term requirements.

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.

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-related hazardous air pollutants, airport impact on climate change, alternative aviation fuels, and advanced noise and emissions models.

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.

BUDGET

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 2010. The funding levels listed for FYs 2011 to 2014 are estimates and subject to change.

Appropriation account – Table 4.1 shows the FAA R&D budget planned for FY 2010, including the five-year plan through FY 2014, grouped by appropriation account. The previous section listed the programs for the four appropriation types. The F&E budget in Table 4.1 includes four main line items: Advanced Technology Development and Prototyping (ATD&P), line item 1A01; NextGen Demonstrations and Infrastructure Development, 1A08; NextGen System Development, 1A07; and the CAASD, 4A08. 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 2010, including the five-year plan through FY 2014, 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 – The FAA research includes both applied research and development as defined by the Office of Management and Budget (OMB) Circular A-11.[26] Table 4.3 shows the FAA R&D program according to these categories with the percent of applied research and development for FY 2010 through 2014.

Performance goal – Table 4.4 shows the FAA R&D budget by performance goal as defined in Exhibit II of the FAA budget request for FY 2010. The R&D programs apply to three performance goals – safety, mobility, and environment. 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 2010.

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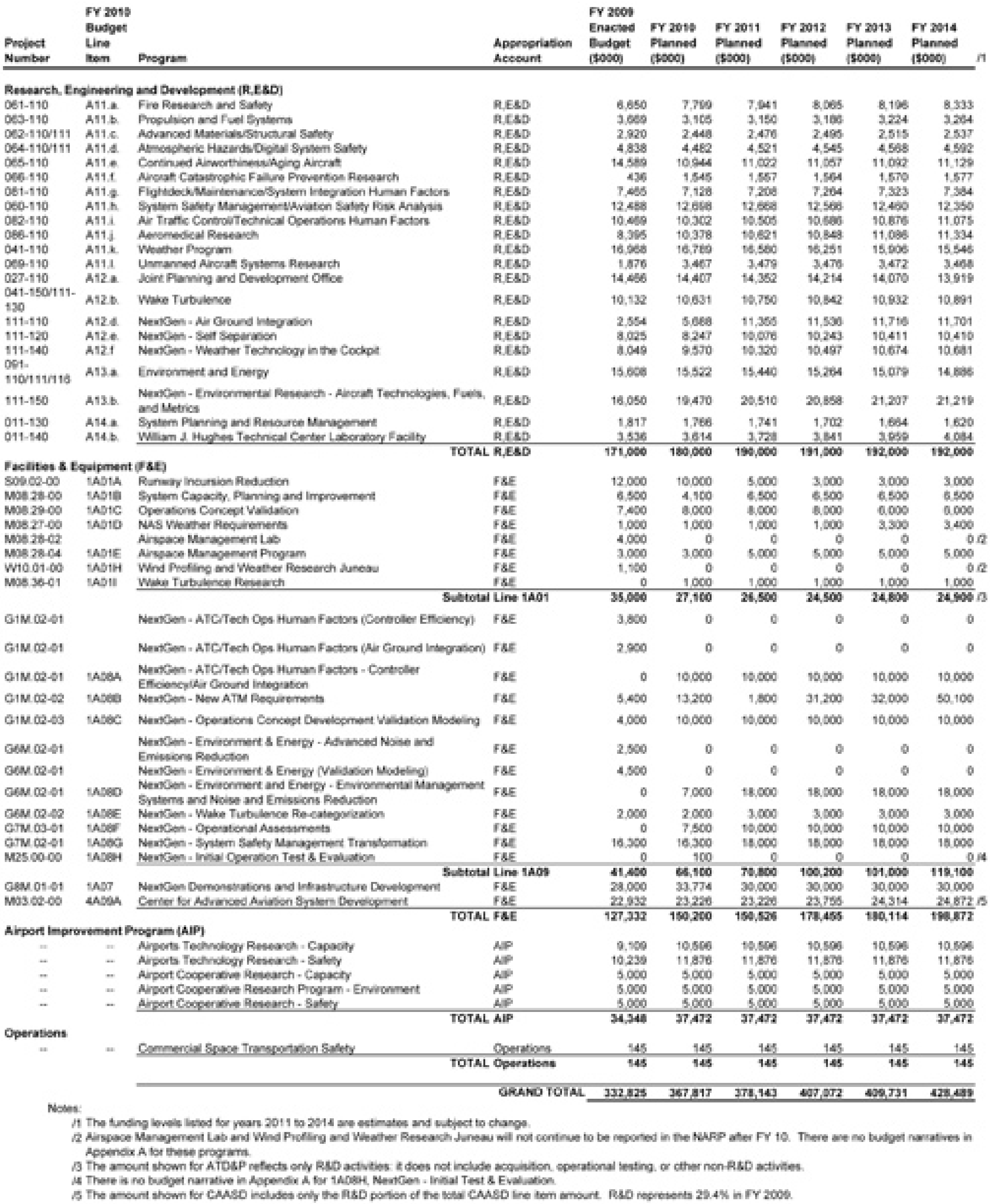
[26] OMB Circular A-11, "Preparation, Submission and Execution of the Budget," June 2006, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

Table 4.1: Planned R&D Budget by Appropriation Account



Project Number	FY 2010 Budget Line Item	Program	Appropriation Account	FY 2009 Enacted Budget ($000)	FY 2010 Planned ($000)	FY 2011 Planned ($000)	FY 2012 Planned ($000)	FY 2013 Planned ($000)	FY 2014 Planned ($000)	/1
Research, Engineering and Development (R,E&D)										
061-110	A11.a.	Fire Research and Safety	R,E&D	6,650	7,799	7,941	8,065	8,196	8,333	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	3,669	3,105	3,150	3,186	3,224	3,264	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	2,920	2,448	2,476	2,495	2,515	2,537	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,838	4,482	4,521	4,545	4,568	4,592	
065-110	A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	14,589	10,944	11,022	11,057	11,092	11,129	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	436	1,545	1,557	1,564	1,570	1,577	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,465	7,128	7,208	7,264	7,323	7,384	
060-110	A11.h.	System Safety Management/Aviation Safety Risk Analysis	R,E&D	12,488	12,698	12,668	12,566	12,460	12,350	
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,469	10,302	10,505	10,686	10,876	11,075	
086-110	A11.j.	Aeromedical Research	R,E&D	8,395	10,378	10,621	10,848	11,096	11,334	
041-110	A11.k.	Weather Program	R,E&D	16,968	16,789	16,580	16,251	15,906	15,546	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	1,876	3,467	3,479	3,476	3,472	3,468	
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,466	14,407	14,352	14,214	14,070	13,919	
041-150/111-130	A12.b.	Wake Turbulence	R,E&D	10,132	10,631	10,750	10,842	10,932	10,891	
111-110	A12.d.	NextGen - Air Ground Integration	R,E&D	2,554	5,688	11,355	11,536	11,716	11,701	
111-120	A12.e.	NextGen - Self Separation	R,E&D	8,025	8,247	10,076	10,243	10,411	10,410	
111-140	A12.f	NextGen - Weather Technology in the Cockpit	R,E&D	8,049	9,570	10,320	10,497	10,674	10,681	
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,608	15,522	15,440	15,264	15,079	14,886	
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	16,050	19,470	20,510	20,858	21,207	21,219	
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,817	1,766	1,741	1,702	1,664	1,620	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,536	3,614	3,728	3,841	3,959	4,084	
		TOTAL	**R,E&D**	**171,000**	**180,000**	**190,000**	**191,000**	**192,000**	**192,000**	
Facilities & Equipment (F&E)										
S09.02-00	1A01A	Runway Incursion Reduction	F&E	12,000	10,000	5,000	3,000	3,000	3,000	
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	6,500	4,100	6,500	6,500	6,500	6,500	
M08.29-00	1A01C	Operations Concept Validation	F&E	7,400	8,000	8,000	8,000	6,000	6,000	
M08.27-00	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	1,000	3,300	3,400	
M08.28-02		Airspace Management Lab	F&E	4,000	0	0	0	0	0	/2
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	3,000	5,000	5,000	5,000	5,000	
W10.01-00	1A01H	Wind Profiling and Weather Research Juneau	F&E	1,100	0	0	0	0	0	/2
M08.36-01	1A01I	Wake Turbulence Research	F&E	0	1,000	1,000	1,000	1,000	1,000	
		Subtotal	**Line 1A01**	**35,000**	**27,100**	**26,500**	**24,500**	**24,800**	**24,900**	/3
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	F&E	3,800	0	0	0	0	0	
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Air Ground Integration)	F&E	2,900	0	0	0	0	0	
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency/Air Ground Integration	F&E	0	10,000	10,000	10,000	10,000	10,000	
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	5,400	13,200	1,800	31,200	32,000	50,100	
G1M.02-03	1A08C	NextGen - Operations Concept Development Validation Modeling	F&E	4,000	10,000	10,000	10,000	10,000	10,000	
G6M.02-01		NextGen - Environment & Energy - Advanced Noise and Emissions Reduction	F&E	2,500	0	0	0	0	0	
G6M.02-01		NextGen - Environment & Energy (Validation Modeling)	F&E	4,500	0	0	0	0	0	
G6M.02-01	1A08D	NextGen - Environment and Energy - Environmental Management Systems and Noise and Emissions Reduction	F&E	0	7,000	18,000	18,000	18,000	18,000	
G6M.02-02	1A08E	NextGen - Wake Turbulence Re-categorization	F&E	2,000	2,000	3,000	3,000	3,000	3,000	
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	0	7,500	10,000	10,000	10,000	10,000	
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	16,300	18,000	18,000	18,000	18,000	
M25.00-00	1A08H	NextGen - Initial Operation Test & Evaluation	F&E	0	100	0	0	0	0	/4
		Subtotal	**Line 1A09**	**41,400**	**66,100**	**70,800**	**100,200**	**101,000**	**119,100**	
G8M.01-01	1A07	NextGen Demonstrations and Infrastructure Development	F&E	28,000	33,774	30,000	30,000	30,000	30,000	
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	22,932	23,226	23,226	23,755	24,314	24,872	/5
		TOTAL	**F&E**	**127,332**	**150,200**	**150,526**	**178,455**	**180,114**	**198,872**	
Airport Improvement Program (AIP)										
--	--	Airports Technology Research - Capacity	AIP	9,109	10,596	10,596	10,596	10,596	10,596	
--	--	Airports Technology Research - Safety	AIP	10,239	11,876	11,876	11,876	11,876	11,876	
--	--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000	
--	--	Airport Cooperative Research Program - 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**	**34,348**	**37,472**	**37,472**	**37,472**	**37,472**	**37,472**	
Operations										
--	--	Commercial Space Transportation Safety	Operations	145	145	145	145	145	145	
		TOTAL	**Operations**	**145**	**145**	**145**	**145**	**145**	**145**	
			GRAND TOTAL	**332,825**	**367,817**	**378,143**	**407,072**	**409,731**	**428,489**	

Notes:

/1 The funding levels listed for years 2011 to 2014 are estimates and subject to change.

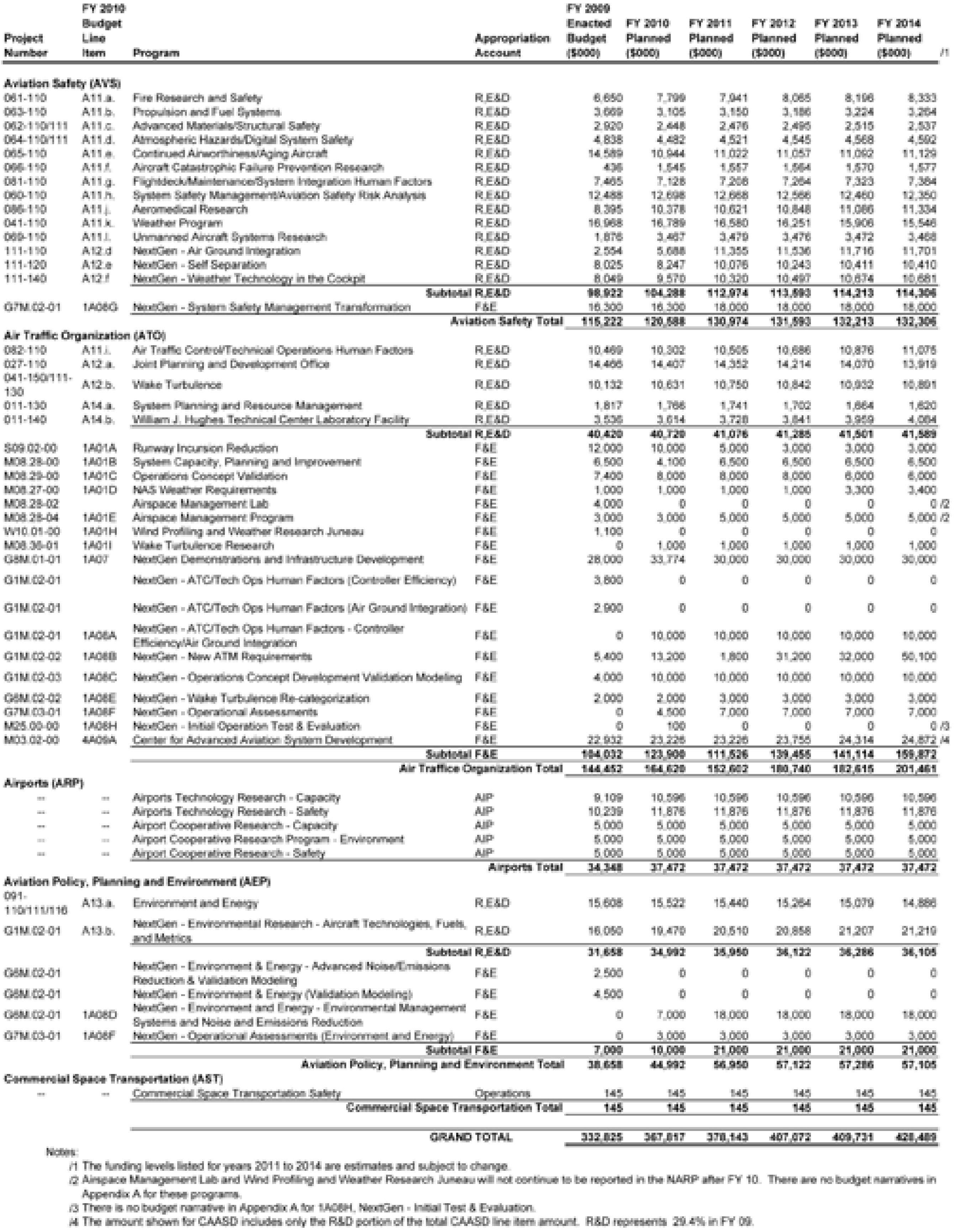
/2 Airspace Management Lab and Wind Profiling and Weather Research Juneau will not continue to be reported in the NARP after FY 10. There are no budget narratives in Appendix A for these programs.

/3 The amount shown for ATD&P reflects only R&D activities: it does not include acquisition, operational testing, or other non-R&D activities.

/4 There is no budget narrative in Appendix A for 1A08H, NextGen - Initial Test & Evaluation.

/5 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 29.4% in FY 2009.

Table 4.2: Planned R&D Budget by Sponsoring Organization



Project Number	FY 2010 Budget Line Item	Program	Appropriation Account	FY 2009 Enacted Budget ($000)	FY 2010 Planned ($000)	FY 2011 Planned ($000)	FY 2012 Planned ($000)	FY 2013 Planned ($000)	FY 2014 Planned ($000) /1
Aviation Safety (AVS)									
061-110	A11.a.	Fire Research and Safety	R,E&D	6,650	7,799	7,941	8,065	8,196	8,333
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	3,669	3,105	3,150	3,186	3,224	3,264
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	2,920	2,448	2,476	2,495	2,515	2,537
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,838	4,482	4,521	4,545	4,568	4,592
065-110	A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	14,589	10,944	11,022	11,057	11,092	11,129
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	436	1,545	1,557	1,564	1,570	1,577
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,465	7,128	7,208	7,264	7,323	7,384
060-110	A11.h.	System Safety Management/Aviation Safety Risk Analysis	R,E&D	12,488	12,698	12,668	12,566	12,460	12,350
086-110	A11.j.	Aeromedical Research	R,E&D	8,395	10,378	10,621	10,848	11,086	11,334
041-110	A11.k.	Weather Program	R,E&D	16,968	16,789	16,580	16,251	15,906	15,546
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	1,876	3,467	3,479	3,476	3,472	3,468
111-110	A12.d	NextGen - Air Ground Integration	R,E&D	2,554	5,688	11,355	11,536	11,716	11,701
111-120	A12.e	NextGen - Self Separation	R,E&D	8,025	8,247	10,076	10,243	10,411	10,410
111-140	A12.f	NextGen - Weather Technology in the Cockpit	R,E&D	8,049	9,570	10,320	10,497	10,674	10,681
		Subtotal	**R,E&D**	**98,922**	**104,288**	**112,974**	**113,593**	**114,213**	**114,306**
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	16,300	18,000	18,000	18,000	18,000
		Aviation Safety Total		**115,222**	**120,588**	**130,974**	**131,593**	**132,213**	**132,306**
Air Traffic Organization (ATO)									
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,469	10,302	10,505	10,686	10,876	11,075
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,466	14,407	14,352	14,214	14,070	13,919
041-150/111-130	A12.b.	Wake Turbulence	R,E&D	10,132	10,631	10,750	10,842	10,932	10,891
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,817	1,766	1,741	1,702	1,664	1,620
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,536	3,614	3,728	3,841	3,959	4,084
		Subtotal	**R,E&D**	**40,420**	**40,720**	**41,076**	**41,285**	**41,501**	**41,589**
S09.02-00	1A01A	Runway Incursion Reduction	F&E	12,000	10,000	5,000	3,000	3,000	3,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	6,500	4,100	6,500	6,500	6,500	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	7,400	8,000	8,000	8,000	6,000	6,000
M08.27-00	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	1,000	3,300	3,400
M08.28-02		Airspace Management Lab	F&E	4,000	0	0	0	0	0 /2
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	3,000	5,000	5,000	5,000	5,000 /2
W10.01-00	1A01H	Wind Profiling and Weather Research Juneau	F&E	1,100	0	0	0	0	0
M08.36-01	1A01I	Wake Turbulence Research	F&E	0	1,000	1,000	1,000	1,000	1,000
G8M.01-01	1A07	NextGen Demonstrations and Infrastructure Development	F&E	28,000	33,774	30,000	30,000	30,000	30,000
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	F&E	3,800	0	0	0	0	0
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Air Ground Integration)	F&E	2,900	0	0	0	0	0
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency/Air Ground Integration	F&E	0	10,000	10,000	10,000	10,000	10,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	5,400	13,200	1,800	31,200	32,000	50,100
G1M.02-03	1A08C	NextGen - Operations Concept Development Validation Modeling	F&E	4,000	10,000	10,000	10,000	10,000	10,000
G6M.02-02	1A08E	NextGen - Wake Turbulence Re-categorization	F&E	2,000	2,000	3,000	3,000	3,000	3,000
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	0	4,500	7,000	7,000	7,000	7,000
M25.00-00	1A08H	NextGen - Initial Operation Test & Evaluation	F&E	0	100	0	0	0	0 /3
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	22,932	23,226	23,226	23,755	24,314	24,872 /4
		Subtotal	**F&E**	**104,032**	**123,900**	**111,526**	**139,455**	**141,114**	**159,872**
		Air Traffice Organization Total		**144,452**	**164,620**	**152,602**	**180,740**	**182,615**	**201,461**
Airports (ARP)									
--	--	Airports Technology Research - Capacity	AIP	9,109	10,596	10,596	10,596	10,596	10,596
--	--	Airports Technology Research - Safety	AIP	10,239	11,876	11,876	11,876	11,876	11,876
--	--	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research Program - 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		**34,348**	**37,472**	**37,472**	**37,472**	**37,472**	**37,472**
Aviation Policy, Planning and Environment (AEP)									
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,608	15,522	15,440	15,264	15,079	14,886
G1M.02-01	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	16,050	19,470	20,510	20,858	21,207	21,219
		Subtotal	**R,E&D**	**31,658**	**34,992**	**35,950**	**36,122**	**36,286**	**36,105**
G6M.02-01		NextGen - Environment & Energy - Advanced Noise/Emissions Reduction & Validation Modeling	F&E	2,500	0	0	0	0	0
G6M.02-01		NextGen - Environment & Energy (Validation Modeling)	F&E	4,500	0	0	0	0	0
G6M.02-01	1A08D	NextGen - Environment and Energy - Environmental Management Systems and Noise and Emissions Reduction	F&E	0	7,000	18,000	18,000	18,000	18,000
G7M.03-01	1A08F	NextGen - Operational Assessments (Environment and Energy)	F&E	0	3,000	3,000	3,000	3,000	3,000
		Subtotal	**F&E**	**7,000**	**10,000**	**21,000**	**21,000**	**21,000**	**21,000**
		Aviation Policy, Planning and Environment Total		**38,658**	**44,992**	**56,950**	**57,122**	**57,286**	**57,105**
Commercial Space Transportation (AST)									
--	--	Commercial Space Transportation Safety	Operations	145	145	145	145	145	145
		Commercial Space Transportation Total		**145**	**145**	**145**	**145**	**145**	**145**
		GRAND TOTAL		**332,825**	**367,817**	**378,143**	**407,072**	**409,731**	**428,489**

Notes:

/1 The funding levels listed for years 2011 to 2014 are estimates and subject to change.

/2 Airspace Management Lab and Wind Profiling and Weather Research Juneau will not continue to be reported in the NARP after FY 10. There are no budget narratives in Appendix A for these programs.

/3 There is no budget narrative in Appendix A for 1A08H, NextGen - Initial Test & Evaluation.

/4 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 29.4% in FY 09.

Table 4.3: Planned R&D Budget by Research Category

Project Number	FY 2010 Budget Line Item	Program	Appropriation Account	FY 2009 Enacted Budget ($000)	FY 2010 Planned ($000)	FY 2011 Planned ($000)	FY 2012 Planned ($000)	FY 2013 Planned ($000)	FY 2014 Planned ($000) /1
Applied Research									
061-110	A11.a.	Fire Research and Safety	R,E&D	6,650	7,799	7,941	8,065	8,196	8,333
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	3,669	3,105	3,150	3,186	3,224	3,264
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	2,920	2,448	2,470	2,495	2,515	2,537
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,838	4,482	4,521	4,545	4,568	4,592
065-110	A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	14,589	10,944	11,022	11,057	11,092	11,129
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	436	1,545	1,557	1,564	1,570	1,577
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	7,465	7,128	7,208	7,264	7,323	7,384
060-110	A11.h.	System Safety Management/Aviation Safety Risk Analysis	R,E&D	12,488	12,698	12,668	12,566	12,460	12,350
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,469	10,302	10,505	10,686	10,876	11,075
086-110	A11.j.	Aeromedical Research	R,E&D	8,395	10,378	10,621	10,848	11,088	11,334
041-110	A11.k.	Weather Program	R,E&D	16,968	16,789	16,580	16,251	15,906	15,546
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	1,876	3,467	3,479	3,470	3,472	3,468
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,466	14,407	14,352	14,214	14,070	13,919
041-150/111-130	A12.b.	Wake Turbulence	R,E&D	10,132	10,631	10,750	10,842	10,932	10,891
111-110	A12.d	NextGen - Air Ground Integration	R,E&D	2,554	5,688	11,355	11,536	11,716	11,701
111-120	A12.e	NextGen - Self Separation	R,E&D	8,025	8,247	10,076	10,243	10,411	10,410
111-140	A12.f	NextGen - Weather Technology in the Cockpit	R,E&D	8,049	9,570	10,320	10,497	10,674	10,681
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,608	15,522	15,440	15,264	15,079	14,886
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	16,050	19,470	20,510	20,858	21,207	21,219
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,817	1,766	1,741	1,702	1,664	1,620
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,536	3,614	3,728	3,841	3,959	4,084
		Subtotal R,E&D		**171,000**	**180,000**	**190,000**	**191,000**	**192,000**	**192,000**
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	22,932	23,226	23,226	23,755	24,314	24,872 /2
		Subtotal F&E		**22,932**	**23,226**	**23,226**	**23,755**	**24,314**	**24,872**
–	–	Airport Cooperative Research - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
–	–	Airport Cooperative Research Program - 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	Operations	73	73	73	73	73	73
		Subtotal Operations		**73**	**73**	**73**	**73**	**73**	**73**
		Applied Research Total		**209,005**	**218,299**	**228,299**	**229,828**	**231,386**	**231,945**
		Percent Applied Research		**62.8%**	**59.3%**	**60.4%**	**56.5%**	**56.5%**	**54.1%**
Development									
S09.02-00	1A01A	Runway Incursion Reduction	F&E	12,000	10,000	5,000	3,000	3,000	3,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	6,500	4,100	6,500	6,500	6,500	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	7,400	8,000	8,000	8,000	6,000	6,000
M08.27-00	1A01D	NAS Weather Requirements	F&E	1,000	1,000	1,000	1,000	3,300	3,400
M08.28-02	–	Airspace Management Lab	F&E	4,000	0	0	0	0	0 /3
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	3,000	5,000	5,000	5,000	5,000
W10.01-00	1A01H	Wind Profiling and Weather Research Juneau	F&E	1,100	0	0	0	0	0 /3
M08.36-01	1A01I	Wake Turbulence Research	F&E	0	1,000	1,000	1,000	1,000	1,000
G8M.01-01	1A07	NextGen Demonstrations and Infrastructure Development	F&E	28,000	33,774	30,000	30,000	30,000	30,000
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	F&E	3,800	0	0	0	0	0
G1M.02-01		NextGen - ATC/Tech Ops Human Factors (Air Ground Integration)	F&E	2,900	0	0	0	0	0
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency/Air Ground Integration	F&E	0	10,000	10,000	10,000	10,000	10,000
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	5,400	13,200	1,800	31,200	32,000	50,100
G1M.02-03	1A08C	NextGen - Operations Concept Development Validation Modeling	F&E	4,000	10,000	10,000	10,000	10,000	10,000
G6M.02-01		NextGen - Environment & Energy - Advanced Noise/Emissions Reduction & Validation Modeling	F&E	2,500	0	0	0	0	0
G6M.02-01		NextGen - Environment & Energy (Validation Modeling)	F&E	4,500	0	0	0	0	0
G6M.02-01	1A08D	NextGen - Environment and Energy - Environmental Management Systems and Noise and Emissions Reduction	F&E	0	7,000	18,000	18,000	18,000	18,000
G6M.02-02	1A08E	NextGen - Wake Turbulence Re-categorization	F&E	2,000	2,000	3,000	3,000	3,000	3,000
G6M.03-01	1A08F	NextGen - Operational Assessments	F&E	0	7,500	10,000	10,000	10,000	10,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	16,300	18,000	18,000	18,000	18,000
M25.00-00	1A08H	NextGen - Initial Operation Test & Evaluation	F&E	0	100	0	0	0	0 /4
		Subtotal F&E		**104,400**	**126,974**	**127,300**	**154,700**	**155,800**	**174,000**
–	–	Airports Technology Research - Capacity	AIP	9,109	10,596	10,596	10,596	10,596	10,596
–	–	Airports Technology Research - Safety	AIP	10,239	11,876	11,876	11,876	11,876	11,876
		Subtotal AIP		**19,348**	**22,472**	**22,472**	**22,472**	**22,472**	**22,472**
–	–	Commercial Space Transportation Safety	Operations	73	73	73	73	73	73 /5
		Subtotal Operations		**73**	**73**	**73**	**73**	**73**	**73**
		Development Total		**123,821**	**149,518**	**149,845**	**177,245**	**178,445**	**196,545**
		Percent Development		**37.2%**	**40.7%**	**39.6%**	**43.5%**	**43.5%**	**45.9%**
		GRAND TOTAL		**332,826**	**367,817**	**378,143**	**407,072**	**409,731**	**428,489**

Notes:

/1 The funding levels listed for years 2011 to 2014 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 29.4% in FY 09.

/3 Airspace Management Lab and Wind Profiling and Weather Research Juneau will not continue to be reported in the NARP after FY 10. There are no budget narratives in Appendix A for these programs.

/4 There is no budget narrative in Appendix A for 1A08H, NextGen - Initial Test & Evaluation.

/5 The Commercial Space Transportation Program is 50 percent applied research and 50 percent development, which is $72.5K rounded to $73K for FY 2010 and beyond.

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

Project Number	FY 2010 Budget Line Item	Program	Appropriation Account	FY 2010 Contract Costs ($000)	FY 2010 Personnel Costs ($000)	FY 2010 Other In-House Costs ($000)	FY 2010 Total Planned ($000)	/1
1. SAFETY								
a. Reduce the Commercial Air Carrier Fatality Accident Rate								
061-110	A11.a.	Fire Research and Safety	R,E&D	3,496	3,940	363	7,799	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	1,579	1,400	126	3,105	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	1,368	1,004	76	2,448	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	2,684	1,660	138	4,482	
065-110	A11.e.	Continued Airworthiness/Aging Aircraft	R,E&D	6,847	3,831	266	10,944	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	947	555	43	1,545	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	3,995	2,919	214	7,128	
060-110	A11.h.	System Safety Management/Aviation Safety Risk Analysis	R,E&D	9,879	2,531	288	12,698	
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	4,389	5,617	296	10,302	
086-110	A11.j.	Aeromedical Research	R,E&D	3,811	6,342	225	10,378	
041-110	A11.k.	Weather Program	R,E&D	15,750	862	177	16,789	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	2,368	1,024	75	3,467	
011-130	A14.a.	System Planning and Resource Management	R,E&D	867	22	8	898	/2
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	437	1,359	41	1,837	/2
		Subtotal	**R,E&D**	**58,417**	**33,067**	**2,336**	**93,820**	/3
S09.02-00	1A01A	Runway Incursion Reduction	F&E	10,000	0	0	0	
		Subtotal	**F&E**	**10,000**	**0**	**0**	**0**	
--	--	Airports Technology Research - Safety	AIP	9,735	1,741	0	11,476	/4
--	--	Airport Cooperative Research - Safety	AIP	3,750	1,250	0	5,000	
		Subtotal	**AIP**	**13,485**	**2,991**	**0**	**16,476**	
		Reduce the Commercial Air Carrier Fatality Accident Rate		**81,902**	**36,058**	**2,336**	**120,296**	
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	Operations	114	31	0	145	
		Maintain Zero Commercial Space Transportation Accidents		**114**	**31**	**0**	**145**	
			TOTAL SAFETY	**82,416**	**36,089**	**2,336**	**120,841**	
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	11,528	2,622	257	14,407	
041-150/111-130	A12.b.	Wake Turbulence	R,E&D	2,491	425	110	3,026	
111-130	A12.b.	NextGen Wake Turbulence	R,E&D	7,330	275	0	7,605	
111-110	A12.d	NextGen - Air Ground Integration	R,E&D	5,449	212	27	5,688	
111-120	A12.e	NextGen - Self Separation	R,E&D	7,796	366	85	8,247	
111-140	A12.f	NextGen - Weather Technology in the Cockpit	R,E&D	8,945	539	86	9,570	
011-130	A14.a.	System Planning and Resource Management	R,E&D	497	13	5	515	/2
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	250	780	23	1,053	/2
		Subtotal	**R,E&D**	**44,286**	**5,231**	**593**	**50,111**	/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	8,000	0	0	8,000	
M08.27-00	1A01D	NAS Weather Requirements	F&E	1,000	0	0	1,000	
M08.28-04	1A01E	Airspace Management Program	F&E	3,000	0	0	3,000	
M08.36-01	1A01I	Wake Turbulence Research	F&E	1,000	0	0	1,000	
G8M.01-01	1A07	NextGen Demonstrations and Infrastructure Development	F&E	33,774	0	0	33,774	
G1M.02-01	1A08A	NextGen - ATC/Tech Ops Human Factors - Controller Efficiency/Air Ground Integration	F&E	10,000	0	0	10,000	
G1M.02-02	1A08B	NextGen - New ATM Requirements	F&E	13,200	0	0	13,200	
G1M.02-03	1A08C	NextGen - Operations Concept Development Validation Modeling	F&E	10,000	0	0	10,000	
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	16,300	0	0	16,300	
G6M.02-02	1A08E	NextGen - Wake Turbulence Re-categorization	F&E	2,000	0	0	2,000	
G7M.03-01	1A08F	NextGen - Operational Assessments	F&E	4,500	0	0	4,500	
M25.00-00	1A08H	NextGen - Initial Operation Test & Evaluation	F&E	100	0	0	100	/5
M03.02-00	4A09A	Center for Advanced Aviation System Development	F&E	23,226	0	0	23,226	/6
		Subtotal	**F&E**	**130,200**	**0**	**0**	**130,200**	
--	--	Airports Technology Research - Capacity	AIP	8,856	1,740	0	10,596	
--	--	Airport Cooperative Research - Capacity	AIP	3,750	1,250	0	5,000	
		Subtotal	**AIP**	**12,606**	**2,990**	**0**	**15,596**	
		Increase Percent of On-time Arrivals		**187,092**	**8,221**	**593**	**195,907**	
		TOTAL MOBILITY		**187,092**	**8,221**	**593**	**195,907**	
4. ENVIRONMENTAL STEWARDSHIP								
a. Reduce Exposure to Significant Aircraft Noise								
091-110/111/116	A13.a.	Environment and Energy	R,E&D	12,796	2,319	407	15,522	
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	18,312	954	204	19,470	
011-130	A14.a.	System Planning and Resource Management	R,E&D	342	9	3	354	/2
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	172	536	16	724	/2
		Subtotal	**R,E&D**	**31,622**	**3,818**	**630**	**36,070**	/3
G6M.02-01	1A08D	NextGen - Environment and Energy - Environmental Management Systems and Noise and Emissions Reduction	F&E	7,000	0	0	7,000	
G7M.03-01	1A08F	NextGen - Operational Assessments (Environment and Energy)	F&E	3,000	0	0	3,000	
		Subtotal	**F&E**	**10,000**	**0**	**0**	**10,000**	
--	--	Airport Cooperative Research Program - Environment	AIP	3,750	1,250	0	5,000	
			TOTAL ENVIRONMENT	**45,372**	**5,068**	**630**	**51,070**	
			GRAND TOTAL	**314,880**	**49,378**	**3,559**	**367,818**	

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 50.8 percent; Mobility at 29.1 percent; and Environment at 20.1 percent.

/3 Personnel for R,E&D measured in full time equivalents is as follows: 252 for Safety; 31 for Mobility; and 25 for Environment.

/4 The Airport Technology Research - Safety program total budget request is divided between reducing the commercial air carrier fatal accident rate ($11,476K) and reducing the number of general aviation fatal accidents ($400K).

/5 There is no budget narrative in Appendix A for 1A08H, NextGen - Initial Test & Evaluation.

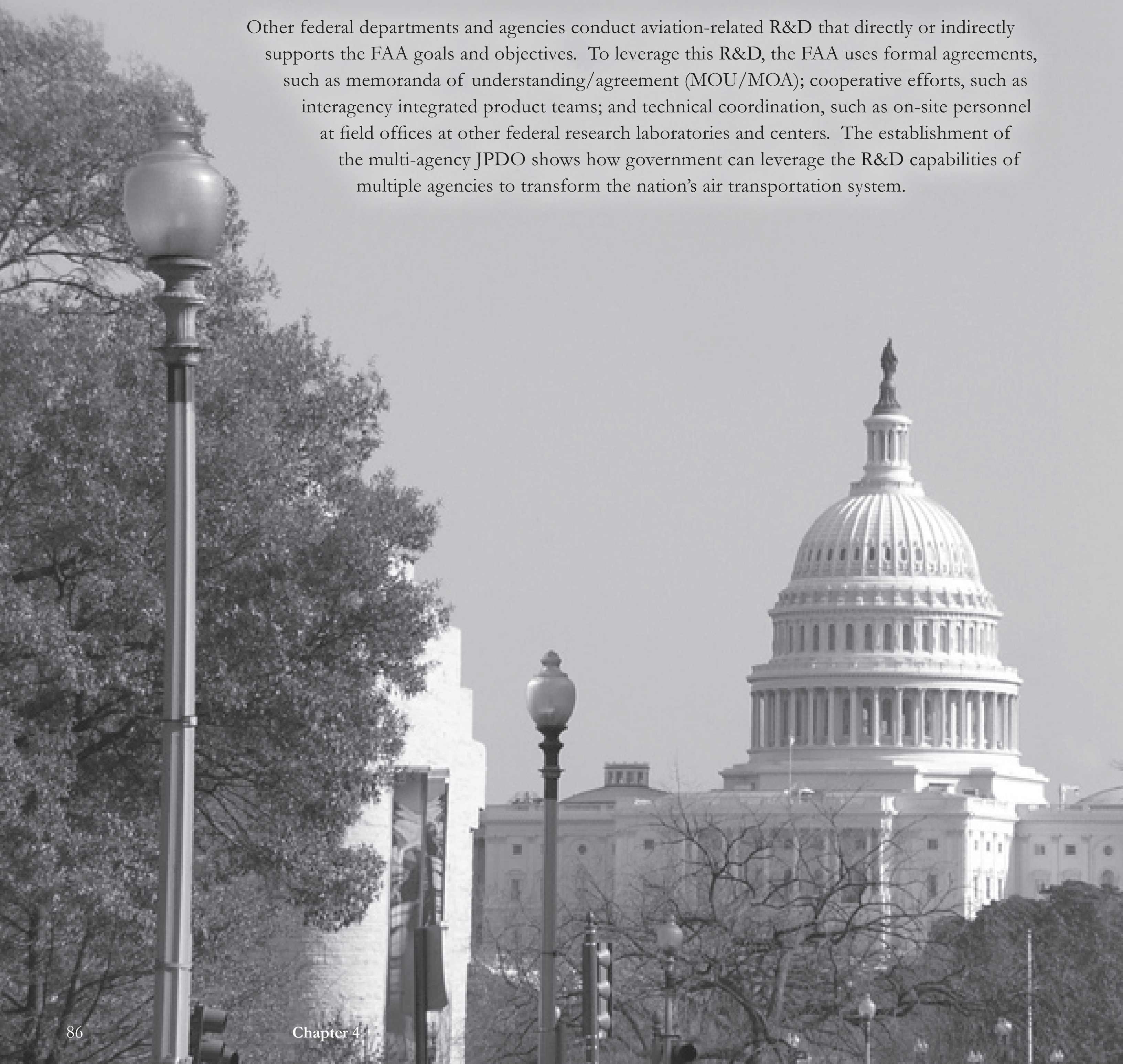
/6 The budget request amount shown for CAASD is only the R&D program portion of the total CAASD line item amount, based on the R&D percentage in FY 09 of 29.4%.

PARTNERSHIPS AND OTHER RESEARCH MECHANISMS

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

FEDERAL GOVERNMENT

Other federal departments and agencies conduct aviation-related R&D that directly or indirectly supports the FAA goals and objectives. To leverage this R&D, the FAA uses formal agreements, such as memoranda of understanding/agreement (MOU/MOA); cooperative efforts, such as interagency integrated product 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 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 aviation R&D. 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 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 the FAA and other agencies in which the FAA agrees to receive from, or exchange supplies or services with, the other agency. Appendix C lists the FAA MOUs, MOAs, and IAs.

FAA Field Offices

The 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 ATO-P.

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*[27] provides the research areas and questions the program addresses. The 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.

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 & water quality monitoring, modeling, and emissions. Under GEOSS, the 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.

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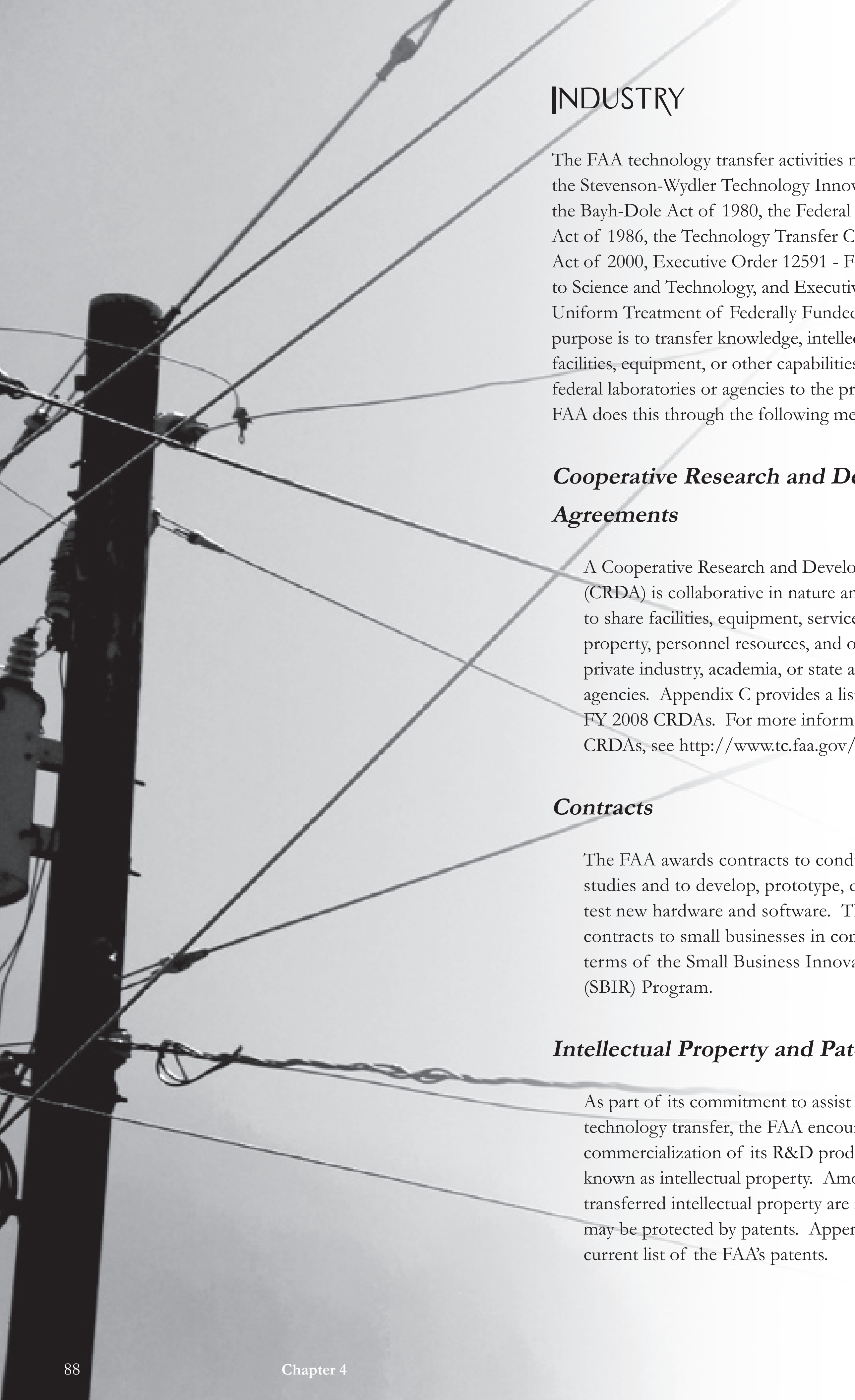
[27] *Strategic Plan for the Climate Change Science Program*, report by the Climate Change Science Program and the Subcommittee on Climate Change Research, July 2003 (http://www.climatescience.gov).



INDUSTRY

The 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. The FAA does this through the following mechanisms:

Cooperative Research and Development Agreements

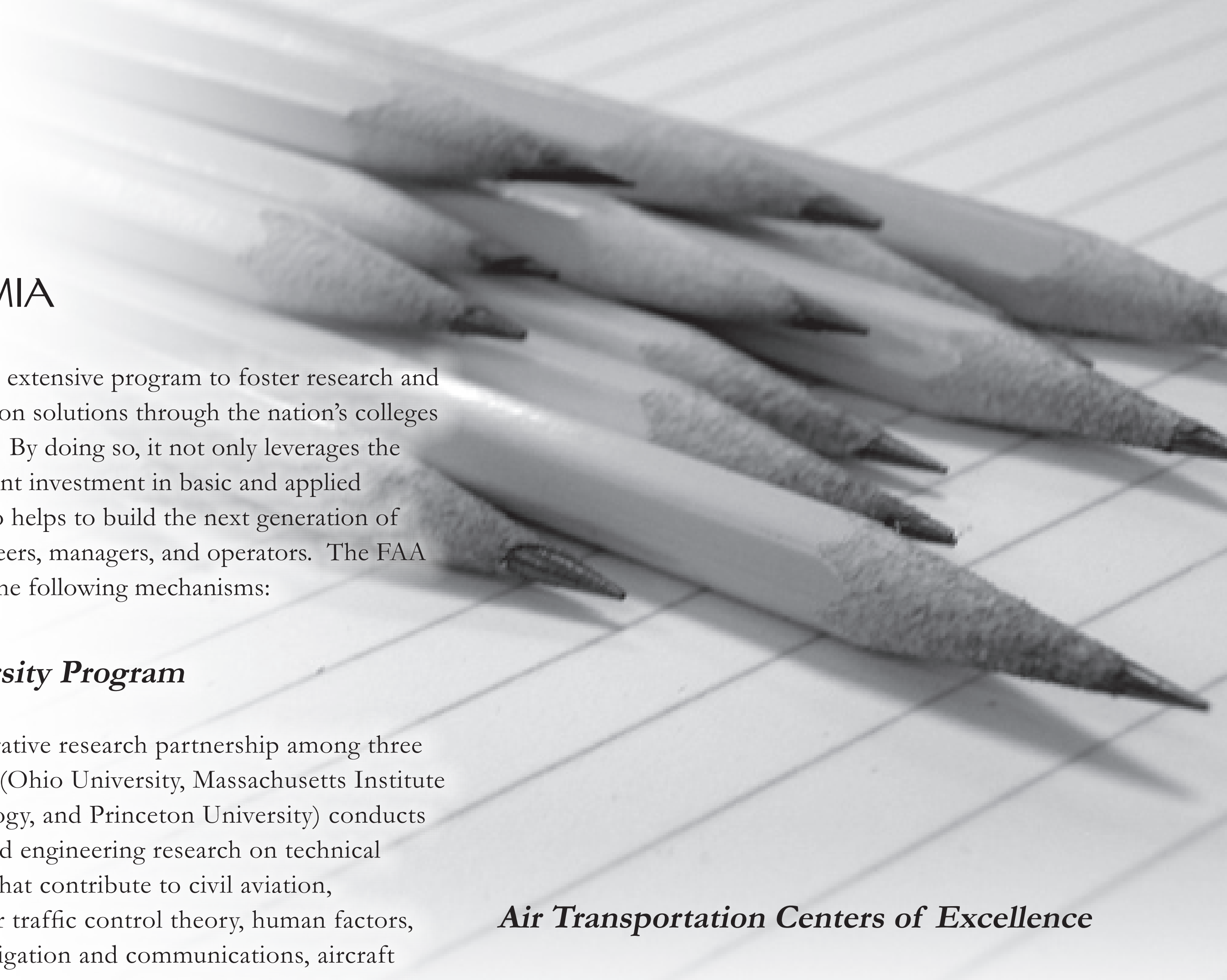
A Cooperative Research and Development Agreement (CRDA) is collaborative in nature and allows the FAA to share facilities, equipment, services, intellectual property, personnel resources, and other resources with private industry, academia, or state and local government agencies. Appendix C provides a list the Agency's active FY 2008 CRDAs. For more information on using CRDAs, see http://www.tc.faa.gov/technologytransfer.

Contracts

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

Intellectual Property and Patents

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



ACADEMIA

The 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. The 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. 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 experts in industry, academia, and government.

Aviation Research Grants

All colleges, universities, and legally incorporated non-profit research institutions qualify for research grants. Research grants may use any scientific methodology deemed appropriate by the grantee. At the FAA, the evaluation criteria for grant proposals include the potential application of research results to the FAA's far-term goals for civil aviation technology. Appendix C provides a summary of grants issued in FY 2008. For more information, see http://www.tc.faa.gov/logistics/grants.

Air Transportation Centers of Excellence

The 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 research, airport technology, general aviation, and noise and emissions mitigation. Through these multi-year, collaborative, cost-sharing efforts, the government and university-industry teams leverage each other's resources to advance the technological future of the nation's aviation community. Appendix C 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

The 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.

Transport Canada

In the spring of 2004, Transport Canada joined the 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 Authority (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.

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 the 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.

Under the MOC, Action Plan 25 (called Support to Planning, Monitoring and Analysis of ATM R&D) was developed to aid collaboration between Europe and the FAA on managing, harmonizing, sharing, and exchanging knowledge about ATM R&D plans. This collaboration is a foundation for coordination between EUROCONTROL's Single European Sky ATM Research (SESAR) and NextGen. The scope of this Action Plan entails both programmatic and technical content of R&D activities.

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. Instead, evaluation of R&D requires consideration of its quality, relevance, and performance. Today, the FAA conducts evaluation through formal and informal reviews performed by internal and external groups.

INTERNAL PROGRAM REVIEWS

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

Integrated Capability Maturity Model (iCMM®)

The FAA uses the iCMM® to evaluate and improve the quality of its processes. The iCMM® provides a single model of best practice for enterprise-wide improvement. As a result of an internal review, the FAA created processes to improve its management of the R&D program. These processes received maturity ratings of level 2 and 3.

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

The NextGen Review Board and the NextGen Management Board

The NextGen Review Board (formerly the OEP 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 will assist 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 (formerly called the OEP Associates Team), 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, see http://www.faa.gov/about/initiatives/nextgen/.

Joint Resources Council

The Joint Resources Council (JRC) is the 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 portfolios.

External Program Reviews

The FAA R&D program receives periodic external review from advisory committees to ensure that it meets customer needs and is technically sound. The 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 the 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[28]. A maximum of 30 members can serve on the REDAC and represent corporations, universities, associations, consumers, and government agencies. For more information, see http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/nextgen/research_planning/redac/.

During 2008, the REDAC held three committee meetings and eleven subcommittee meetings and produced two reports. Appendix D provides the recommendations from these reports and the Agency responses. It also includes the FAA response to the *REDAC Report of the Weather-ATM Integration Working Group*.

Commercial Space Transportation Advisory Committee

Established in 1984, the Commercial Space Transportation Advisory Committee (COMSTAC) advises the 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-seven 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 the FAA commercial space R&D reports and activities. For more information, see: http://www.faa.gov/about/office_org/headquarters_offices/ast/industry/advisory_committee.

During 2008, the COMSTAC held two committee meetings and six working group meetings and produced the report, *2008 Commercial Geosynchronous Orbit Launch Demand Forecast*.

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

National Academy of Science - Aeronautics and Space Engineering Board

The National Academy of Science established the Aeronautics and Space Engineering Board (ASEB) in 1967 to focus talents and energies of the engineering community on significant aerospace policies and programs. The Board recommends priorities and procedures for achieving aerospace engineering objectives and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance. In response to the 2005 NASA Authorization Act (P.L. 109-155), NASA tasked ASEB to assemble the Committee to Conduct an Independent Assessment of the Nation's Wake Turbulence Research and Development Program. The Committee was tasked with prioritizing wake vortex research challenges, identifying gaps in federal research programs, and identifying the extent of federal leveraging of non-federal research.

The Committee completed the task and produced a report, *Wake Turbulence: An Obstacle to Increased Air Traffic Capacity*, in 2008. The report includes findings and recommendations on both the organizational and technical challenges to addressing wake turbulence and a proposal for a wake turbulence program plan. For more information, see http://www.nap.edu/catalog.php?record_id=12044.

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 the FAA with program oversight and governance provided by representatives of airport operating agencies.

The ACRP Oversight Committee announced their FY 2009 projects in August 2008. They will examine 14 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.

National Academy of Public Administration

The National Academy of Public Administration (NAPA) is an independent, non-partisan organization chartered by Congress to assist federal, state, and local governments in improving their effectiveness, efficiency, and accountability. Federal agencies, Congress, and state and local governments seek the Academy's assistance in addressing both near- and far-term challenges, including budgeting and finance, alternative agency structures, performance measurement, human resources management, information technology, devolution of federal programs, strategic planning, and managing for results.

In July 2007, the FAA chartered a NAPA study with two primary objectives:

- Identify the skill sets required by FAA's ATO to integrate and implement NextGen, including, but not limited to, technical and contract management skills
- Define the strategies to obtain the expertise necessary to manage, integrate, and implement the complex activities inherent in the transformation to NextGen

The report, *Identifying the Workforce to Respond to a National Imperative – The Next Generation Air Transportation System (NextGen)*, is available online at www.napawash.org.

ACRONYMS AND ABBREVIATIONS

AC	Advisory Circular
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance
AIP	Airport Improvement Program (appropriations account)
AMC	Aerospace Medical Certification
ANSP	Air Navigation Service Provider
ASAP	Aviation Safety Action Program
ASEB	Aeronautics and Space Engineering Board
ASIAS	Aviation Safety Information Analysis and Sharing
ATC	Air Traffic Control
ATD&P	Advanced Technology Development and Prototyping
ATM	Air Traffic Management
ATO	Air Traffic Organization (FAA)
ATOP	Advanced Technologies and Oceanic Procedures
ATO-P	Air Traffic Organization - NextGen and Operations Planning (FAA)
CAASD	Center for Advanced Aviation System Development
CAVS-S	Cockpit Display of Traffic Information Assisted Visual Separation
C3	Command, Control, and Communications
CDA	Continuous Descent Approach
CDTI	Cockpit Display of Traffic Information
CFR	Code of Federal Regulations
CIP	*Capital Investment Plan*
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
CONUS	Continental United States
CoSPA	Consolidated Storm Product for Aviation
CRDA	Cooperative Research and Development Agreement
DARWIN	Design Assessment of Reliability with INspection
DHS	Department of Homeland Security
DOC	Department of Commerce
DoD	Department of Defense
DOT	Department of Transportation
DSA	Detect, Sense, and Avoid
EA	Enterprise Architecture
EDMS	Emissions and Dispersion Model System
EDS	Environment Design System
EMS	Environmental Management System
ERAM	En Route Automation Modernization
ERIDS	En Route Information Display System
EUROCONTROL	European Organization for the Safety of Air Navigation
F&E	Facilities and Equipment (appropriations account)
FAA	Federal Aviation Administration
FASTGEN	Fast Shot-Line Generator
FEWS	Future En Route Workstation
FICON	Field Condition
FOD	Foreign Object Debris
FRM	Flammability Reduction Means
FSS	Flight Service Specialists
FY	Fiscal Year
GA	General Aviation
GEOSS	Global Earth Observation System of Systems
GIAA	Grant-in-Aid for Airports (appropriations account, see AIP)
HAP	Hazardous Air Pollutant
HFACS	Human Factors Analysis and Classification System
HUMS	Health and Usage Monitoring Systems
IA	Interagency Agreement
I&I	Integration and Implementation
ICAO	International Civil Aviation Organization
iCMM®	Integrated Capability Maturity Model
IMA	Integrated Modular Avionics
IMC	Instrument Meteorological Conditions
IWP	JPDO Next Generation Air transportation System (NextGen) Integrated Work Plan: A Functional Outline
JPDO	Joint Planning and Development Office
JRC	Joint Resources Council
MAF	Microprocessor Approval Framework
MMPI	Multiphasic Personality Inventory
MOA	Memorandum of Agreement
MOC	Memorandum of Cooperation

MOU	Memorandum of Understanding
NAPA	National Academy of Public Administration
NARP	*National Aviation Research Plan*
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEO	Net Enabled Operations
NextGen	Next Generation Air Transportation System
NGIP	FAA's Next Generation Air Transportation System (NextGen) Implementation Plan
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NOx	Nitrogen Oxide
NTSB	U.S. National Transportation Safety Board
OAM	Office of Aerospace Medicine (FAA)
OE	Operational Error
OEP	Operational Evolution Partnership
OI	Operational Improvements
OMB	U.S. Office of Management and Budget
OPD	Optimized Profile Descent
Ops	Operations (appropriations account)
OSTP	Office of Science and Technology Policy
PAPR	Powered Air Purifying Respirators
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
R&D	Research and Development
R,E&D	Research, Engineering and Development (appropriations account)
REB	FAA R&D Executive Board
REDAC	Research, Engineering, and Development Advisory Committee
RNAV	Required Navigation
RNP	Required Navigation Performance
RWSL	Runway Status Lights
SBIR	Small Business Innovation Research
SESAR	Single European Sky ATM Research
SMS	Safety Management System
SoC	System on a Chip
TBO	Trajectory Based Operations
TCAS	Traffic Alert and Collision Avoidance System
TMA	Traffic Management Advisor
TRB	Transportation Research Board
UEDDAM	Uncontained Engine Debris Damage Assessment Model
UAS	Unmanned Aircraft Systems
VFR	Visual Flight Rules
VOC	Volatile Organic Compounds
WJHTC	William J. Hughes Technical Center
WTIC	Weather Technology in the Cockpit

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Federal Aviation
Administration

2009
National Aviation Research Plan (NARP)

Appendices

A - Program Descriptions
B - 2008 R&D Annual Review
C - Partnership Activities
D - Research, Engineering, and Development Advisory Committee
E - Alignment of FAA NextGen R&D Programs
F - Acronyms and Abbreviations

June 22, 2009

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

FAA Budget Appropriation	Budget Item	R&D Program Title	Page
R,E&D	A11.a.	Fire Research and Safety	A-1
R,E&D	A11.b.	Propulsion and Fuel Systems	A-7
R,E&D	A11.c.	Advanced Materials/Structural Safety	A-13
R,E&D	A11.d.	Atmospheric Hazards/Digital System Safety	A-19
R,E&D	A11.e.	Continued Airworthiness/Aging Aircraft	A-27
R,E&D	A11.f.	Aircraft Catastrophic Failure Prevention Research	A-33
R,E&D	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	A-38
R,E&D	A11.h.	System Safety Management/Aviation Safety Risk Analysis	A-44
R,E&D	A11.i.	Air Traffic Control/Technical Operations Human Factors	A-52
R,E&D	A11.j.	Aeromedical Research	A-60
R,E&D	A11.k.	Weather Program	A-74
R,E&D	A11.l.	Unmanned Aircraft Systems Research	A-80
R,E&D	A12.a.	Joint Planning and Development Office (JPDO)	A-85
R,E&D	A12.b.	Wake Turbulence	A-92
R,E&D	A12.d.	NextGen – Air Ground Integration	A-98
R,E&D	A12.e.	NextGen – Self Separation	A-105
R,E&D	A12.f.	NextGen – Weather Technology in the Cockpit	A-113
R,E&D	A13.a.	Environment and Energy	A-118
R,E&D	A13.b.	NextGen Environmental Research – Aircraft Technologies, Fuels, and Metrics	A-130
R,E&D	A14.a.	System Planning and Resource Management	A-138
R,E&D	A14.b.	William J. Hughes Technical Center Laboratory Facility	A-142
F&E	1A01A	Runway Incursion Reduction	A-148
F&E	1A01B	System Capacity, Planning and Improvement	A-152
F&E	1A01C	Operations Concept Validation	A-158
F&E	1A01D	NAS Weather Requirements	A-163
F&E	1A01E	Airspace Management Program	A-168
F&E	1A01I	Wake Turbulence Research	A-174
F&E	1A07	NextGen Demonstrations and Infrastructure Development	A-178
F&E	1A08A	NextGen – ATC/Technical Ops Human Factors – Controller Efficiency & Air/Ground Integration	A-184
F&E	1A08B	NextGen – New Air Traffic Management Requirement	A-191
F&E	1A08C	NextGen – Operations Concept Validation – Validation Modeling	A-197
F&E	1A08D	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	A-201
F&E	1A08E	NextGen – Wake Turbulence – Re-categorization	A-208
F&E	1A08F	NextGen - Operational Assessments	A-213
F&E	1A08G	NextGen – System Safety Management Transformation	A-217
F&E	4A09A	Center for Advanced Aviation Systems Development (CAASD)	A-222
AIP	*	Airport Cooperative Research– Capacity	A-228
AIP	*	Airport Cooperative Research– Environment	A-233
AIP	*	Airport Cooperative Research– Safety	A-237
AIP	*	Airport Technology Research – Capacity	A-241
AIP	*	Airport Technology Research – Safety	A-246
OPS	*	Commercial Space Transportation Safety	A-251

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

FAA Budget Appropriation	Budget Item	R&D Program Title	Page
R,E&D	A11.c.	Advanced Materials/Structural Safety	A-13
R,E&D	A11.j.	Aeromedical Research	A-60
R,E&D	A11.i.	Air Traffic Control/Technical Operations Human Factors	A-52
R,E&D	A11.f.	Aircraft Catastrophic Failure Prevention Research	A-33
AIP	*	Airport Cooperative Research– Capacity	A-228
AIP	*	Airport Cooperative Research– Environment	A-233
AIP	*	Airport Cooperative Research– Safety	A-237
AIP	*	Airport Technology Research – Capacity	A-241
AIP	*	Airport Technology Research – Safety	A-246
F&E	1A01E	Airspace Management Program	A-168
R,E&D	A11.d.	Atmospheric Hazards/Digital System Safety	A-19
F&E	4A09A	Center for Advanced Aviation Systems Development (CAASD)	A-222
OPS	*	Commercial Space Transportation Safety	A-251
R,E&D	A11.e.	Continued Airworthiness/Aging Aircraft	A-27
R,E&D	A13.a.	Environment and Energy	A-118
R,E&D	A11.a.	Fire Research and Safety	A-1
R,E&D	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	A-38
R,E&D	A12.a.	Joint Planning and Development Office (JPDO)	A-85
F&E	1A01D	NAS Weather Requirements	A-163
R,E&D	A12.d.	NextGen – Air Ground Integration	A-98
F&E	1A08A	NextGen – ATC/Technical Ops Human Factors – Controller Efficiency & Air/Ground Integration	A-184
F&E	1A08D	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	A-201
F&E	1A08B	NextGen – New Air Traffic Management Requirement	A-191
F&E	1A08F	NextGen - Operational Assessments	A-213
F&E	1A08C	NextGen – Operations Concept Validation – Validation Modeling	A-197
R,E&D	A12.e.	NextGen – Self Separation	A-105
F&E	1A08G	NextGen – System Safety Management Transformation	A-217
F&E	1A08E	NextGen – Wake Turbulence – Re-categorization	A-208
R,E&D	A12.f.	NextGen – Weather Technology in the Cockpit	A-113
F&E	1A07	NextGen Demonstrations and Infrastructure Development	A-178
R,E&D	A13.b.	NextGen Environmental Research – Aircraft Technologies, Fuels, and Metrics	A-130
F&E	1A01C	Operations Concept Validation	A-158
R,E&D	A11.b.	Propulsion and Fuel Systems	A-7
F&E	1A01A	Runway Incursion Reduction	A-148
F&E	1A01B	System Capacity, Planning and Improvement	A-152
R,E&D	A14.a.	System Planning and Resource Management	A-138
R,E&D	A11.h.	System Safety Management/Aviation Safety Risk Analysis	A-44
R,E&D	A11.l.	Unmanned Aircraft Systems Research	A-80
R,E&D	A12.b.	Wake Turbulence	A-92
F&E	1A01I	Wake Turbulence Research	A-174
R,E&D	A11.k.	Weather Program	A-74
R,E&D	A14.b.	William J. Hughes Technical Center Laboratory Facility	A-142

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

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
R,E&D	**A11.a.**	**Fire Research and Safety**	**$7,799,000**

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. Through this research, which is also producing new materials and government-owned patents, FAA provides industry with state-of-the-art safety products and information.

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 2010, develop and validate a methodology for predicting flammability of wing fuel tanks of aluminum or composite construction.
- By FY 2011, provide comprehensive fire safety guidance for high energy density lithium batteries in passenger carry-on items, shipped as cargo and in 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 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.

FY 2005:

- Issued the first Department of Transportation licenses to manufacture the FAA-patented microscale combustion calorimeter for evaluating the heat release rate of extremely small research samples of advanced ultra-fire resistant material.
- Developed technology to support the use of low false alarm cargo fire/smoke detectors.

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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fire Safety Improvements

- Developed guidance for the effective extinguishment of cabin fires involving lithium batteries in passenger carry-on items.
- Developed fire test criteria to limit the emission of hazardous gases during post-crash fire exposure of a burn-through resistant fuselage, including composite construction.
- Demonstrated the application of non-intrusive oxygen measurement technology in aircraft fuel tanks.
- Developed analytical model to predict the flammability in wing fuel tanks.

Fire Resistant Materials

- Fabricated small-scale samples of ultra-fire resistant thermoplastic components (e.g., seat tray or passenger service unit applications) and measure fire and mechanical performance; down select optimal thermoplastic materials for aircraft cabin.

FY 2010 PROGRAM REQUEST:

Ongoing Activities

- Research on in-flight fire safety will address all-cargo (freighter) aircraft and the growing problem with lithium battery fire hazards. This research responds to improved freighter fire safety recommendations issued by NTSB and the escalating incidence of lithium battery fires.
- 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. A number of fire safety concerns will be studied, associated with the replacement of aluminum with a combustible composite material that can burn and is a poor conductor of heat.
- Research will also 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 which offers potential large weight savings.
- Fuel tank explosion protection research will focus on supporting the proposed introduction of fuel tank inerting systems in the U.S. Fleet, and understanding and predicting the flammability of wing fuel tanks, which is an immediate concern for aluminum and composite (e.g., B-787) constructions.
- 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 2010.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fire Safety Improvements

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

- Evaluate the fire hazards of magnesium alloy seat structure during full-scale post-crash fire tests.

Fire Resistant Materials

- Fabricate small-scale samples of ultra-fire resistant fabrics and foams (e.g., seat cushions application) and measure fire and mechanical performance; down select optimal fabric and foam materials for aircraft cabin.
- Extend the FAA thermal-kinetic burning model (ThermaKin) to charring materials and laminates/composites.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	148,348
FY 2009 Appropriated	6,650
FY 2010 Request	7,799
Out-Year Planning Levels (FY 2011-2014)	32,535
Total	195,332

Budget Authority ($000)	FY 2006 Enacted	FY 2007 Enacted	FY 2008 Enacted	FY 2009 Enacted	FY 2010 Request
Contracts:					
Fire Research and Safety	2,570	2,816	3,355	2,961	3.495
Personnel Costs	3,379	3,588	3,650	3,443	3,940
Other In-house Costs	233	234	345	246	364
Total	**6,182**	**6,638**	**7,350**	**6,650**	**7,799**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 2006 Enacted	FY 2007 Enacted	FY 2008 Enacted	FY 2009 Enacted	FY 2010 Request
Basic	0	0	0	0	0
Applied	6,182	6,638	7,350	6,650	7,799
Development (includes prototypes)	0	0	0	0	0
Total	**6,182**	**6,638**	**7,350**	**6,650**	**7,799**

A11.a. - Fire Research and Safety Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
061-110 Fire Research & Safety							
Fire Resistant Materials	**337**						
Fabricate/test small-scale cabin plastics		◆					
Fabricate/test small-scale cabin fabrics and foams			◊				
Evaluate improvement in post-crash fire survivability provided by ultra-fire resistant materials using full-scale fire test simulations						◊	
Demonstrate ThermaKin model for charring materials and laminates/composites			◊				
Fire Safety Improvement	**3,158**						
Assess need/develop improved fire test criteria for hidden materials not previously addressed		◆					
Examine aircraft lithium battery technology for fire safety risks		◆					
Develop guidance for extinguishment of lithium battery fires in passenger carry on items		◆					
Develop fire test criteria gas emissions during burn-through resistant fuselage post-crash fire exposure		◆					
Develop analytical model wing fuel tank flammability		◆					
Demonstrate oxygen measurement technology for fuel tanks		◆					
Develop and validate wing fuel tank prediction method (aluminum and composite)			◊				
Examine 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			◊				
Provide comprehensive guidance on lithium battery fire safety				◊			
Standardize composite fire tests				◊			
Develop a small-scale test for seat structure, if warranted				◊			
Define composite fuselage fire-safety design criteria					◊		
Develop fire safety improvements in freighter					◊		
Develop detection/extinguishing system to suppress hidden in-flight fires						◊	
Examine fire safety aspects of aircraft oxygen systems							◊
Personnel and Other In-House Costs	**4,304**						
Total Budget Authority	**7,799**	**6,650**	**7,799**	**7,941**	**8,065**	**8,196**	**8,333**

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
R,E&D	**A11.b.**	**Propulsion and Fuel Systems**	**$3,105,000**

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. 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), as well as the testing and development of jet fuel made from alternative sources.

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: There are two main research areas within the Propulsion and Fuels Program. The first 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.

The second research area is aviation fuels. One goal is to find an unleaded replacement for current leaded avgas (100LL) used in piston engines. The replacement fuel should be equivalent in performance to 100LL and be a seamless, transparent change to a general aviation (GA) pilot. In addition, research will be conducted evaluating technologies for modification of piston engines to enable their safe operation using unleaded fuel. Extensive laboratory and test cell dynamometer engine testing will evaluate and characterize all new fuel formulations provided by industry for consideration. Lastly, research will be conducted related to developing jet fuel from alternative sources such as coal, natural gas, and biomass.

- 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.
- By FY 2014, evaluate the technology of modifying general aviation piston engines to run on unleaded fuels.
- Through FY 2014, evaluate and characterize all candidate replacement formulations for 100LL.
- Through FY 2014, evaluate and characterize candidate formulations for jet fuel made from alternative sources.

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 Coordinating Research Council (CRC) Unleaded Aviation Gasoline Development Group – representatives from Texaco, Exxon Mobil, Phillips Petroleum, Chevron, British Petroleum, Cessna, Raytheon (Beech), Teledyne Continental, and Textron Lycoming facilitate two-way transfer of technology between government and industry to benefit all participants.
- The CRC Molecular Marker Ad Hoc Committee – representatives from turbine engine manufacturers, major oil companies and FAA provide oversight to ensure the safe implementation when adding molecular markers to jet fuel.
- 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.
- The Ohio State University, is conducting research on a failure mode of titanium rotor disks known as cold dwell fatigue.
- SwRI is conducting research to determine the acceptable level of fuel dye contamination allowable for the safe, continuous operation of turbine engines in partnership with the Defense Energy Support Center, Internal Revenue Service, Air Transport Association, American Petroleum Institute, General Electric Aircraft Engines, Pratt and Whitney, Rolls Royce, Honeywell and Boeing.
- CRC Unleaded Aviation Gasoline Development Group – includes Texaco, Exxon-Mobil, Phillips Petroleum, Chevron, British Petroleum, Cessna, Raytheon (Beech), Teledyne Continental, and Textron Lycoming; this group facilitates two-way transfer of technology between government and industry to benefit all participants.
- Cooperative Research & Development Agreements (CRDA) with various industry partners.
- The FAA General Aviation Center of Excellence in conjunction with direct grants with the University of North Dakota, South Dakota State University and Baylor University – these relationships produce feasibility studies for the use of ethanol fuel blends as a possible unleaded piston fuel replacement for 100LL avgas.

Accomplishments: Outstanding program accomplishments include:

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

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.

FY 2004:

- 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.

Previous Years:

- 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Turbine Engine Research

- 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.

Aviation Fuels and Fuel System Safety Research

- Continued laboratory characterization and engine ground testing of candidate unleaded fuels to replace 100LL avgas.
- Completed research on the effects of molecular markers in Jet A fuel with results published in a final report.

FY 2010 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.
- Continue laboratory characterization and engine ground testing of candidate unleaded fuels to replace 100LL avgas.

New Initiatives

- Conduct research into technology of modifying general aviation piston engines to run on unleaded fuels.
- Conduct research related to developing jet fuel from alternative sources such as coal, natural gas, and biomass.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Turbine Engine Research

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

Aviation Fuels and Fuel System Safety Research

- Continue 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.
- Conduct research related to developing jet fuel from alternative sources such as coal, natural gas, and biomass.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	97,916
FY 2009 Appropriated	3,669
FY 2010 Request	3,105
Out-Year Planning Levels (FY 2011-2014)	12,824
Total	117,514

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Propulsion And Fuel Systems	4,508	2,592	2,463	2,415	1,579
Personnel Costs	1,155	1,366	1,476	1,168	1,400
Other In-house Costs	78	90	147	86	126
Total	**5,741**	**4,048**	**4,086**	**3,669**	**3,105**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	5,741	4,048	4,086	3,669	3,150
Development (includes prototypes)	0	0	0	0	0
Total	**5,741**	**4,048**	**4,086**	**3,669**	**3,150**

A11.b. - Propulsion and Fuel Systems Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
063-110 Propulsion and Fuel Systems							
Turbine Engine Research	**1.579**						
Develop 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 capabilities for automatic rotor modeling		♦					
Release an enhanced version of the DARWIN™ probabilistic rotor design code with second generation capabilities for automatic rotor modeling			◊				
Complete experiments to calibrate and verify analytical methods for time-dependent crack growth and thermo-mechanical fatigue crack growth.		♦					
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.		♦	◊	◊	◊		
Unleaded Fuels and Fuel System Safety Research	**0**						
Complete research on the effects of molecular markers in Jet A fuel.		♦					
Evaluate the technology of modifying general aviation piston engines to run on unleaded fuels		♦	◊	◊	◊	◊	◊
Evaluate and characterize all candidate replacement formulations for 100LL			◊	◊	◊	◊	◊
Evaluate and characterize candidate formulations for Jet fuel made from alternative sources			◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**1,526**						
Total Budget Authority	**3,105**	**3,669**	**3,105**	**3,150**	**3,186**	**3,224**	**3,264**

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
R,E&D	**A11.c.**	**Advanced Materials/Structural Safety**	**$2,448,000**

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 20-107A, “Composite 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, and guidance. 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 2010, generate data using full-scale structure with a goal of uniform, accepted certification methodology for damage tolerance and fatigue of composite airframe.
- By FY 2010, develop test and analysis protocols for repeated loads and damage threats.
- By FY 2011, identify required data and test methods for high temperature materials to assure safety of new constructions.
- By FY 2012, initiate study of ceramics as they are used in engine components.
- 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, define criteria for use of embedded sensors in fault tolerant structures.
- By FY 2013, develop criteria for damage tolerance assessments of laminate composite structures.

- By FY 2013, generate methodology for demonstrating aircraft structure crashworthiness certification by analysis.
- By FY 2014 evaluate threats from flight line activities on composite aircraft structures.
- By FY 2014 evaluate the ability of models to predict off-axis and multiple terrain impacts.

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) AC20-107A, 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 the ARAC, 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 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:

- Completed the validation of analytical methodology to predict residual strength of a 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 an Advisory Circular.
- 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Materials

- Generated composite material dynamic properties.
- Initiated studies for the types of threats to composite aircraft structures while at the service gate and on the flight line.
- Provided data to the FAA Office of Aviation Safety (AVS) in support of the revision of AC 20-107A to AC 20-107B
- Continued to develop consensus for a damage tolerance and fatigue certification protocol.

Structural Safety

- Develop analytical modeling techniques of aircraft crash conditions.
- Initiate review of the need for off axis analysis capabilities to assist in certification of structures for crashworthiness.

FY 2010 PROGRAM REQUEST:

Ongoing Activities

The program will continue to focus on damage tolerance and fatigue issues of composite airframes. 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. Bonded joints will be studied for damage tolerance and durability. Researchers will also explore savings in maintenance costs, of using embedded sensors to monitor in-service damage and will investigate the long-term safety 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 2010.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Materials

- Verify accepted certification methodology for damage tolerance and fatigue using full-scale test data.
- Develop test and analysis protocols for repeated loads and damage threats

Structural Safety

- Develop analytical modeling techniques of aircraft structures crash conditions

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	98,081
FY 2009 Appropriated	2,920
FY 2010 Request	2,448
Out-Year Planning Levels (FY 2011-2014)	10,023
Total	113,472

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Advanced Materials	4,383	1,211	6,054	1,838	1,368
Structural Safety	174	165	0	0	0
Personnel Costs	1,247	1,394	945	1022	1,004
Other In-house Costs	77	73	84	60	76
Total	**5,881**	**2,843**	**7,083**	**2,920**	**2,448**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	5,881	2,843	7,083	2,920	2,448
Development (includes prototypes)	0	0	0	0	0
Total	**5,881**	**2,843**	**7,083**	**2,920**	**2,448**

A11.c. – Advanced Materials/Structural Safety Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
062-111 Advanced Materials Structures							
Advanced Materials	**1,368**						
Generate composite materials dynamic properties		◆					
Verify accepted certification methodology for damage tolerance and fatigue using full-scale test data.			◊				
Develop test and analysis protocols for repeated loads and damage threats			◊				
Identify data and test for materials at elevated temperatures				◊			
Initiate research in ceramic composites					◊		
Develop criteria for damage tolerance assessments of laminate composite structures						◊	
Evaluate threats from flight line activities on composite aircraft structures.							◊
Define criteria for use of embedded sensors in fault tolerant structures.					◊		
062-110 Structural Safety	**0**						
Structural Safety							
Develop analytical modeling techniques of aircraft structures crash conditions		◆	◊				
Develop analytical model protocols and detailed requirements for crashworthiness certification analysis						◊	
Evaluate the ability of models to predict off-axis and multiple terrain impacts.							◊
Establish design criteria for restraint systems at highest levels that aircraft can sustain					◊		
Personnel and Other In-House Costs	**1,080**						
Total Budget Authority	**2,448**	**2,920**	**2.448**	**2,476**	**2,495**	**2,515**	**2,537**

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
R,E&D	**A11.d.**	**Atmospheric Hazards/Digital System Safety**	**$4,482,000**

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, complex 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, per 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 complex hardware techniques and tools for qualification, verification, and assurance to develop additional evaluation methods that may improve the certification process for complex 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 updating the Aircraft Icing Handbook, including the Icing Bibliography, and in establishing standards for icing simulation methods.
- RTCA (formerly known as Radio Technical Commission for Aeronautics) – members of this U.S. Federal Advisory Committee and its special committees 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 complex electronic hardware (CEH) specialists who collaborate and make recommendations to regulatory authorities on the resolution of software and CEH 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.

- 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 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.

FY 2004:

- Investigated and analyzed atmospheric icing environment - supercooled water and mixed-phase conditions – to provide data for formulation of expanded atmospheric icing envelopes for new proposed rules.

Digital System Safety

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 Phase 3 onboard network security and integrity issues, Aeronautical Security Requirements to Ensure Aircraft Safety, which provided the Phase 4 inputs of airworthiness

security analysis, electronic maintenance security procedures for aircraft, cyber security for unmanned aircraft systems, and inputs for Phase 4. The results are essential for the continuation Phase 4 effort, development of RTCA SC-216 (Aeronautical Systems Security) minimum aviation system performance standards, and assurance/assessment processes and methods.

- Evaluated CEH tools to determine the major safety issues in the qualification process and CEH items for sufficiency of verification coverage analysis that includes development of criteria. The results 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.

Previous Years:

- 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aircraft Icing

- Continued 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 mixed conditions for determination of fluid failure and holdover times.
- Began development of methods to test engines in simulated high ice water content environments.
- 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.

Digital System Safety

- Completed an additional microprocessor evaluation pertaining to risk and safety that includes a Microprocessor Selection and Evaluation Handbook that will be used by the FAA and industry to assure the safety of aircraft microprocessor systems.
- Completed the first phase of CEH techniques and tools for qualification, verification, and assurance that will be used to develop policy and guidance.
- Evaluated Phase 4 onboard network security and integrity issues to identify potential security vulnerabilities to aircraft, proposes protection requirements, and applies previous research in data networks, Ethernet, and COTS software and airborne electronics.
- Evaluated COTS technology in complex and safety-critical systems for obsolescence and life cycle maintenance of aviation electronics to improve compliance to airworthiness directives through a better recognition of availability and affordability of parts and better ways to implement corrective actions.
- Evaluated verification and validation techniques for safety-critical digital systems to ensure that they comply with regulations and perform their intended functions under all foreseeable operating conditions.
- Investigated the feasibility of using reverse engineering as a viable alternate means of compliance for achieving objectives of DO-178B versus what has become the standard approach to software development assurance. Cover gaps in compliance with DO-178B and mitigate safety issues resulting from these gaps.

FY 2010 PROGRAM REQUEST:

Ongoing Activities

Researchers will continue to refine laboratory methods to determine de-icing fluid holdover times in a variety of environmental conditions. Will study 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, integration and development techniques for highly-integrated aircraft systems, COTS technology in complex and safety-critical systems, and verification and validation techniques.

New Initiatives

None.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aircraft Icing

- Begin 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.
- Complete the development of methods for simulation of ice pellet and mixed conditions for determination of fluid failure and holdover times.
- Continue development of methods to test engines in simulated high ice water content environments.

Digital System Safety

- Evaluate Phase 5 onboard network security and integrity issues to insure security protection requirements are consistent with aircraft safety.
- Continue to evaluate COTS technology in complex and safety-critical systems for obsolescence and life cycle maintenance of aviation electronics.
- Determine software development assurance level for highly integrated aircraft systems.
- Continue to evaluate verification and validation techniques for safety-critical digital systems.
- Evaluate model-based development criteria considered by industry and address technical and certification issues.

- Complete investigation into the feasibility of using reverse engineering as a viable alternate means of compliance for achieving objectives of DO-178B.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	90,393
FY 2009 Appropriated	4,838
FY 2010 Request	4,482
Out-Year Planning Levels (FY 2011-2014)	18,226
Total	114,365

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Digital System Safety	232	842	737	1,080	1,158
Atmospheric Hazards	1,287	1,316	1,052	1,811	1,526
Personnel Costs	1,786	1,614	1,653	1,832	1,660
Other In-house Costs	102	76	132	115	138
Total	**3,407**	**3,848**	**3,574**	**4,838**	**4,482**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	3,407	3,848	3,574	4,838	4,482
Development (includes prototypes)	0	0	0	0	0
Total	**3,407**	**3,848**	**3,574**	**4,838**	**4,482**

A11.d. – Atmospheric Hazards/Digital System Safety Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
064-110 Digital System Safety							
Digital System Safety	**1,158**						
Complete an additional microprocessor evaluation pertaining to risk and safety		◆					
Evaluate CEH techniques and tools for qualification, verification, and assurance		◆			◊	◊	
Evaluate onboard network security and integrity		◆	◊	◊			
Evaluate COTS technology in complex and safety-critical systems		◆	◊	◊			
Determine software development assurance level			◊	◊	◊	◊	
Evaluate verification and validation techniques		◆	◊	◊	◊	◊	
Evaluate model-based development criteria			◊	◊			
Investigate the feasibility of using reverse engineering.		◆	◊				
Determine applicability of safety engineering and reliability engineering				◊	◊	◊	◊
064-111 Atmospheric Hazards							
Aircraft Icing	**1,526**						
Characterize high ice water content atmospheric environments for engines		◆	◊	◊			
Conduct experimental work on the physics of engine icing in high ice water content environments.		◆	◊	◊	◊		
Develop improved methods for simulation of ice pellet, mixed, and other conditions for determination of fluid failure and holdover times		◆					
Develop methods to test engines in simulated high ice water content environments		◆	◊	◊	◊	◊	
Investigate formation and aerodynamic effects of runback ice for thermal ice protection for simulated flight conditions.		◆					
Develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments				◊	◊	◊	◊
Personnel and Other In-House Costs	**1,798**						
Total Budget Authority	**4.482**	**4,838**	**4,482**	**4,521**	**4,545**	**4,568**	**4,592**

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
R,E&D	**A11.e.**	**Continued Airworthiness/Aging Aircraft**	**$10,944,000**

GOALS:

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

Intended Outcomes: The Continued Airworthiness/Aging Aircraft Program (formerly known as the 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 develops 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 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. Technologies, procedures, technical data, and analytical models produced by the Continued Airworthiness/Aging Aircraft Program provide a major source of technical information used in developing these regulations and related advisories. Through this research, FAA also provides the aviation community with critical new safety technologies and data.

Research Goals: The goal of the Continued Airworthiness/Aging Aircraft 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, develops 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 development of nondestructive inspection (NDI) technologies 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.

Customer/Stakeholder Involvement: The Continued Airworthiness/Aging Aircraft 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/Aging Aircraft 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 11 joint Aging Aircraft Conferences.

The FAA collaborates closely with several private and public organizations, including:

- The National Rotorcraft Technology Center – comprised of the U.S. Army, U.S. Navy, FAA, and NASA.
- 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 technologies.

Accomplishments: The Continued Airworthiness/Aging Aircraft 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 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).

FY 2005:

- Completed airworthiness evaluations of two aging Cessna airplanes, a 402A and 402C, and a teardown evaluation of a T-34A accident aircraft.
- Evaluated and verified methods to assess multiple site damage.
- Developed the fatigue crack growth database that is used in support of damage tolerance assessments of airframe structure.
- Developed and demonstrated a prototype micro-energy, high-voltage nondestructive test method for inspecting aircraft wiring.
- Completed research to determine the interrelationship of landing gear lateral loads on the body and wing gear during ground turns of FAA's multiple main gear B-747SP aircraft. Results of this research support development of landing gear certification standards.

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 and flight tested aircraft arc-fault circuit breaker prototypes; they mitigate the hazardous effects of potentially catastrophic arc-faults.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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 studies to quantitatively determine the impact of process variables on the performance of FPI and integrate results into industry inspection standards.
- Developed technical data for a draft rotorcraft HUMS certification plan to substantiate HUMS AC.
- Conducted research on advanced NDI technologies for composite structures and for evaluation of the strength of bonded structures.
- Continued research on damage tolerance and durability issues for emerging structural technologies to ensure safety, support maintenance, and support future certification policies and guidance.
- Completed initial evaluation of thermal acoustic technology as a potential replacement for FPI in inspecting critical engine components.
- Completed nondestructive evaluation of manufacturing-induced anomalies in 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 2010 PROGRAM REQUEST:

Ongoing Activities

The FY 2010 funding request will support Continued Airworthiness/Aging Aircraft research requirements that contribute to FAA's aviation safety goal. The program will continue its focus 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 health and usage monitoring systems for rotorcraft. 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 design, maintenance and pilot training to increase safety. Researchers will also continue efforts on investigation of nondestructive evaluation 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.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continue development of probabilistic structural risk assessment and risk management methodologies for small airplanes.
- Continue 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 policies and guidance.
- Develop technical data for certification process for rotorcraft health and usage monitoring systems using condition-based maintenance approach for mechanical systems.
- Complete interim reliability assessments of conventional and advanced inspection devices to detect hidden flaws in thick, complex composite laminates.
- Complete study on usage, design, and training issues for rudder control systems in transport aircraft.
- Develop advisory guidance and recommendations for the separation and segregation of EWIS in transport aircraft.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	390,955
FY 2009 Appropriated	14,589
FY 2010 Request	10,944
Out-Year Planning Levels (FY 2011-2014)	44,300
Total	460,788

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Aging Aircraft	14,881	14,211	11,680	9,839	6,847
Personnel Costs	4,631	4,159	3,946	4,447	3,831
Other In-house Costs	295	251	320	303	266
Total	**19,807**	**18,621**	**15,946**	**14,589**	**10,944**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	19,807	18,621	15,946	14,589	10,944
Development (includes prototypes)	0	0	0	0	0
Total	**19,807**	**18,621**	**15,946**	**14,589**	**10,944**

A11e –Continued Airworthiness/Aging Aircraft Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
065-110 Continued Airworthiness							
Structural Integrity and Inspection Systems Research	**4,637**						
Develop risk-based fleet management methods for small-airplane continued operational safety		♦	◊	◊	◊	◊	
Conduct research on application of damage tolerance methods to emerging structural technologies		♦	◊	◊	◊		
Assess the effect of FPI process variables on inspection performance and reliability		♦					
Assess performance of in-situ damage detection technologies for inspection of remote and inaccessible areas in aircraft		♦	◊	◊			
Investigate advanced NDI systems for composite and bonded structures.		♦	◊	◊	◊	◊	◊
Rotorcraft Structural Integrity and Safety	**1,579**						
Establish guidance for certification of HUMS applications for usage credits		♦	◊	◊	◊	◊	
Continued Airworthiness of Aircraft Engines	**526**						
Evaluate thermal acoustic technology as a potential replacement of FPI for critical engine components		♦					
Evaluate advanced techniques to detect manufacturing-induced surface anomalies on critical engine components		♦					
Continued Airworthiness of Aircraft Systems	**105**						
Provide technical guidance on pilot rudder usage, design, and training issues for certification standards		♦	◊	◊			
Assess single element, dual-load path flight control linkages for corrosion		♦					
Assess EWIS separation and segregation standards and develop advisory guidance		♦	◊				
Personnel and Other In-House Costs	**4,097**						
Total Budget Authority	**10,944**	**14,589**	**10,944**	**11,022**	**11,057**	**11,092**	**11,129**

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
R,E&D	**A11.f.**	**Aircraft Catastrophic Failure Prevention Research**	**$1,545,000**

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.

- By 2010, 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 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 LS-DYNA 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 2008:

- Continue FAA/NASA/Industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA)
- Continue 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:

- Complete 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
- Complete testing and material model development for aluminum using the Johnson-Cook formula.
- Develop an oversight process for generic aerospace problems run in LSDYNA that ensures consistent results as computers and programs continue to evolve.

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 2008:

- Continue 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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 LS-DYNA.
- Propulsion malfunction research completed a demonstration of the information-based display for the engine lubrication system.

FY 2010 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 2010 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 development of Material Model 224 for fragments impacting 2024 aluminum structure.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	36,074
FY 2009 Appropriated	436
FY 2010 Request	1,545
Out-Year Planning Levels (FY 2011-2014)	6,268
Total	44,323

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Aircraft Catastrophic Failure Prevention Research	2,703	947	1,684	0	947
Personnel Costs	566	533	482	415	555
Other In-house Costs	37	32	36	21	43
Total	**3,306**	**1,512**	**2,202**	**436**	**1,545**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	3,306	1,512	2,202	436	1,545
Development (includes prototypes)	0	0	0	0	0
Total	**3,306**	**1,512**	**2,202**	**436**	**1,545**

A11.f. - Aircraft Catastrophic Failure Prevention Research Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
066-110 Aircraft Catastrophic Failure Prevention Research							
Engine Uncontainment Research	**947**						
Continue FAA/NASA/industry sponsored quality control program for modeling aircraft problems in the manufacturer's supported finite element code (LSDYNA)		◆	◊	◊	◊	◊	◊
Complete testing of 2024 aluminum necessary to populate the new Material Model 224 failure map in LS-DYNA.		◆					
Complete development of Material Model 224 for fragments impacting 2024 aluminum structure			◊				
Develop modular UEDDAM Code (version 4)			◊				
Complete verification of MAT 224 for Aluminum and Titanium						◊	
Propulsion Malfunction	**0**						
Demonstrate an information based cockpit display for the engine lubrication system		◆					
Personnel and Other In-House Costs	**598**						
Total Budget Authority	**1,545**	**436**	**1,545**	**1,557**	**1,564**	**1,570**	**1,577**

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
R,E&D	**A11.g.**	**Flightdeck/Maintenance/System Integration Human Factors**	**$7,128,000**

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 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 CNS/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.
- Twenty-one FAA grants to 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 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 accidents 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 Line Operations Safety Audit methodology that has been adopted by the International Civil Aviation Authority (ICAO) to help air carriers identify human-centered safety vulnerabilities.

FY 2005:

- Worked with the aviation community to produce a list of knowledge and skills that are important for pilots, instructors and evaluators who operate, teach and test in technically advanced aircraft.
- Developed a manual adopted for use by ICAO that addresses appropriate human factors considerations in designing air carrier flight deck operating documents.
- Developed and validated a proceduralized air carrier pilot Crew Resource Management training and assessment system as part of normal flight operations.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Information Management and Display

- Updated human factors guidance for electronic flight bag certification, operational approval and training based on performance data.
- Developed guidance for moving map displays in surface operations.
- Identified human factors issues in instrument procedures design.
- Developed guidance to address human factors issues associated with using 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 human factors guidance for ADS-B certification and operational approval.
- 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.

Human Performance Assessment

- Designed a safety audit tool for maintenance and ramp operations to evaluate a maintenance organization’s effectiveness.
- Identified effective methods for mitigating maintainer fatigue.
- Provided human factors guidance for the operation of unmanned aerial vehicles 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 effective upset recovery training both for the experienced pilot and for the low-time pilot.
- Determined the appropriate training intervals to reduce pilot skill decay.

FY 2010 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.

On-Going Activities

Information Management and Display

- Update human factors guidance for electronic flight bag certification, operational approval and training based on performance data.
- Develop guidance for moving map displays in surface operations.
- Identify human factors issues in instrument procedures design.

Human-Centered Automation

- 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.

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 unmanned aerial vehicles 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

Information Management and Display

- 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 advanced autopilots and automation technologies in small airplanes.

Human Performance Assessment

- Develop mitigation strategies for human factors issues that are contributing to very light jet incidents.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Information Management and Display

- 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

- 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 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

- 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.
- Develop mitigation strategies for human factors issues that are contributing to very light jet incidents.

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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	213,063
FY 2009 Appropriated	7,465
FY 2010 Request	7,128
Out-Year Planning Levels (FY 2011-2014)	29,179
Total	256,835

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Flightdeck/Maintenance/System Integration Human Factors	5,338	4,954	5,957	4,714	3,995
Personnel Costs	2,626	2,902	3,066	2,587	2,919
Other In-house Costs	135	143	177	164	214
Total	**8,099**	**7,999**	**9,200**	**7,465**	**7,128**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	8,099	7,999	9,200	7,465	7,128
Development (includes prototypes)	0	0	0	0	0
Total	**8,099**	**7,999**	**9,200**	**7,465**	**7,128**

A11.g. – Flightdeck/Maintenance/System Integration Human Factors Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
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	**1,025**						
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	**970**						
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	**900**						
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	**3,133**						
Total Budget Authority	**7,128**	**7,465**	**7,128**	**7,208**	**7,264**	**7,323**	**7,384**

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
R,E&D	**A11.h.**	**System Safety Management / Aviation Safety Risk Analysis**	**$12,698,000**

Goals:

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

Intended Outcomes: The System Safety Management/Aviation Safety Risk Analysis 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 research to evaluate proposed new technologies and procedures, which will improve safety by making relevant information available to the pilot 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 research and analysis to maintain the desired level of safety while accommodating the need for more efficient use of the terminal area.

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 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, pilot-in-the-loop simulation evaluations and operational flight data analysis will be conducted.

- By 2011, characterize risks associated with undesired laser cockpit illumination, providing FAA with data to determine mitigation strategies.
- By 2011, complete an evaluation of air traffic and flight procedures for terminal area operations by 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.

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.
- Air Transportation Association and National Air Transport Association – to assist in the development of functional and operational models.

Accomplishments: Significant accomplishments from prior years include:

Risk Management Decision Support

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 International Air Transport Association Operational Safety Audit (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 2007:

- Released first draft of the ASIAS Concept of Operations (CONOPS) that is focused on the new data sharing concepts among commercial aviation stakeholders.

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.

Aircraft Maintenance - Maintainability and Reliability

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.

FY 2004:

- Provided technical data and recommendations for designing an effective repair station training program, including the recommended number of hours and topics for training mechanics, managers, supervisors, and inspectors. The FAA issued AC 145-10 “Repair Station Training Program” in July 2005.

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

FY2008:

- 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aviation Safety Information and Analysis Sharing

- 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, 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.
- Developed methods and risk models to evaluate advanced aircraft systems and component integration.

Risk Management Decision Support

- 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 IOSA.
- Determined injury ratios for well-defined unsafe conditions (e.g., structure failure, electrical system failure, landing gear vibration, power plant failure, and so forth) on aircraft systems or components.

Aircraft Maintenance - Maintainability and Reliability

- Completed technical data for the purpose of preparing standards for carbon monoxide detection devices and inspection methods to determine the integrity of exhaust systems.

Terminal Area Safety

- Developed 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 human-in-the-loop flight and air traffic simulators.
- Evaluated devices and risks associated with undesired laser cockpit illumination.
- Analyzed operational landing distance performance of selected aircraft make/model/series.

FY 2010 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

Safety Impact Assessment of Very Light jets (VLJs). There is a need to assess the risk and impact of VLJs on the NAS. Introduction of VLJs will require the development of separation standards as required between fast moving 14 CFR Part 121 and slower moving VLJs, the design of separate highway-in-the-sky of tubes for VLJs, VLJ flight track distribution and the development or modification of obstruction clearance surface (OCS) for VLJ.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Aviation Safety information Analysis and Sharing (ASIAS)

- Expand ASIAS architecture to include the sharing of air traffic information and air carrier information among industry stakeholders.
- 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.

Risk Management Decision Support

- Initiate development of a method and associated metrics to measure progress in reducing the rate of fatalities and significant injuries.
- Develop at least one methodology for the mid-air collision risk analysis between VLJ and 14 CFR Part 121 aircraft and develop one prototype tool to assess the risk.
- Complete injury ratios for well-defined unsafe conditions (e.g., structure failure, electrical system failure, landing gear vibration, power plant failure, and so forth) on aircraft systems or components.
- Continue risk management concept, model and analytical tool development in support of commercial and general aviation.

Terminal Area Safety

- Complete testing procedures and requirements to identify RNP constraints related to terminal area operations.
- Continue evaluating devices and risks associated with undesired laser cockpit illumination.
- Evaluate air traffic and flight procedures for terminal area operations by using the pilot-in-the-loop flight simulator.
- Analyze the operational landing distance performance of selected aircraft make/model/series.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	78,915
FY 2009 Appropriated	12,488
FY 2010 Request	12,698
Out-Year Planning Levels (FY 2011-2014)	50,044
Total	154,145

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
System Safety Management	3,303	3,232	6,402	9,608	9,879
Personnel Costs	1,494	1,947	2,892	2,669	2,531
Other In-house Costs	86	113	223	211	288
Total	**4,883**	**5,292**	**9,517**	**12,488**	**12,698**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	4,883	5,292	9,517	12,488	12,698
Development (includes prototypes)	0	0	0	0	0
Total	**4,883**	**5,292**	**9,517**	**12,488**	**12,698**

A11.h. - System Safety Management / Aviation Safety Risk Analysis Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
060-110 Aviation Safety Risk Analysis							
Risk Management Decision Support	**526**						
Develop method and associated metrics to measure progress in reducing the rate of fatalities and significant injuries		◆	◊	◊	◊	◊	◊
Continue risk management concept, model and analytical tool development in support of commercial and general aviation.		◆	◊	◊	◊		
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 IOSA.		◆					
Conduct System Safety Assessment of VLJs			◊	◊	◊		
Aviation Safety Information Analysis and Sharing	**7,658**						
Complete ASIAS Concept of Operations (CONOPS) focused on the new data sharing concepts among commercial aviation stakeholders.		◆					
Develop an architecture for ASIAS		◆	◊				
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.		◆	◊	◊	◊		
Aircraft Maintenance – Maintainability & Reliability	**0**						
Develop standards for carbon monoxide detection devices and inspection methods to determine the integrity of exhaust systems		◆					
Terminal Area Safety	**1,695**						
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		◆	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**2,819**						
Total Budget Authority	**12,698**	**12,488**	**12,698**	**12,668**	**12,566**	**12,460**	**12,350**

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
R,E&D	**A11.i.**	**Air Traffic Control/Technical Operations Human Factors**	**$10,302,000**

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, greater capacity, and organizational excellence by developing research products and promoting the use of those products to meet the future demands of the aviation system. This human factors research program for FY 2010 will emphasize the safety aspects of the functions performed by air traffic controllers and technical operations personnel. 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. It is enhancing 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. In addition, 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 air traffic service providers to meet increased 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.
    - 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.
- Candidate technology evaluations that purport to provide a specified human-in-the-loop performance level or safety benefit when used by the ATO workforce.
- 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.

Research Goals:

- By FY 2010, complete a study to determine the role of time on position as it impacts the potential for an operational error.
- By FY 2010, identify the changes to the ATO technical operations safety culture that resulted from previous research initiatives as they transition to the operational domain.
- 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 employee attitudes.
- 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 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 identifying future NAS human factors air-ground integration research issues as technology brings changes to flight deck capabilities.
- Collaboration with EUROCONTROL includes participation in semi-annual Air Traffic Management (ATM) Seminars, leadership of an Action Plan 15 Safety workgroup for human reliability, and ATM Safety Research symposia participation.
- Program personnel represent the agency in the Normal Operations Safety Survey (NOSS) Study Group of International Civil Aviation Organization (ICAO).
- The University of Texas has performed NOSS research at ATM facilities in New Zealand, Australia, Canada, and Finland with ICAO endorsement.
- Cooperative research agreements are in place with Massachusetts Institute of Technology, St. Louis University, Ohio State University, and American Institutes for Research.

Accomplishments: Program highlights include:

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 2006:

- Explored human performance limitations to find controller workload limits using current technology and procedures as traffic levels increase.
- Completed an initial effort to transform the ATO work force safety culture.
- Initiated data collection to update the anthropometric database to guide maintenance workstation ergonomic design.
- Initiated development of a pre-screening alternative form for air traffic controller job applicants that are selected to take the Air Traffic Selection and Training (AT-SAT) test battery.
- Initiated a tower controller duties and functions task analysis to enhance the terminal training option method of selecting candidates.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Initiated second stage of transforming the safety culture of the Technical Operations organization and assess intervention effectiveness of first stage efforts.
- Delivered initial results of a study of time-on-position as a predictor of the potential for operational errors due to lack of initial situation awareness when beginning a shift or relieving another controller.
- Estimated the safety risk of an operational error (OE) occurring based on the exposure to daily activities while working on a given shift at a particular time of day and time on position to use in establishing safety priorities.
- Continued methodology validation to assign controller applicants to tower versus radar training.
- Continue assessment of new NextGen systems and procedures impact on selection and training for future air traffic service providers and maintainers.
- Transferred interim color vision test for air traffic controller evaluation to the operational domain.
- Completed the validity assessment of the Credentialing Skills Evaluation process for air traffic controller compliance with ICAO credential requirements.
- Completed data collection for TRACON supervisor best practices to identify an exportable package of materials that can be used to suppress operational errors in the terminal domain.

FY 2010 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 and personnel. 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

- Developing human factors display requirements for weather information to mitigate the hazards to flight presented by icing, low ceiling and visibility, and convective activity with the objective of accident prevention.
- Developing a human factors display standard for air traffic control displays.

Individual and Team Performance

- Develop a model of controller time-on-position to predict the probability of operational errors for various rotation cycle lengths for position relief to determine the range of optimum times that reduce the probability of error.

- Continue work in human error reduction and reporting by expanding the application of research in transformation of the ATO safety culture.

Advanced Technical Operations Systems

- Assess the impact of preventive maintenance on unscheduled outages. Determine the causes of human error during scheduled maintenance that results in premature NAS system failure.
- Design and develop the maintenance workstation for the future NAS to reduce staffing and skill level requirements and enhance availability of the NAS.

Personnel Selection and Training

- Develop a technical operations road map to utilize human-system integration concepts as a method to assure that as new technology is developed and fielded in the NAS the human component of the system is planned on a plane equal to that of technology to assure that personnel staffing, skills, and training are adequate to meet future needs.
- Initiate strategic training analysis to support the conceptual development of NextGen procedures and systems.
- Transform the critical performance requirements of the NAS maintainer job and required skills into selection and training criteria for the future work force.

New Initiatives

New initiatives will focus on the maintenance aspects of the ATC system. The NAS architecture plan, the *NextGen Implementation Plan* (NGIP) and the JPDO concept of operations introduce many automation concepts that will 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:

- Develop a human-system integration road map for the technical operations work force in a strategic view.
- Develop new methods to proactively identify the potential for human error to interrupt NAS operations as increased levels of automation amplify the consequences of system outages
- Develop new workstations that allow faster recovery from NAS system failures

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Advanced Air Traffic Systems

- Develop 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.
- Deliver guidelines and requirements for weather information displays for controllers that will aid in further reduction of the aviation accident and fatality rate.

Individual and Team Performance

- Conduct 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.
- Refine 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.
- Conduct a survey to determine the effectiveness of controller fatigue management changes introduced in FAA Orders during 2009

Advanced Technical Operations (TO) Systems

- Deliver an analysis of the impact of human error on availability of the NAS.
- Continue a Human System Integration Study of the impact future air traffic maintenance concepts on the Technical Operations workforce.

Personnel Selection and Training

- Deliver an initial Technical Operations Human-System Integration Roadmap to complement the NAS Enterprise Architecture.
- Perform a strategic training analysis to support the conceptual development of NextGen procedures and systems for controllers and maintainers
- Prepare a set of required skills and NAS maintainer performance requirements suitable for transformation into selection and training requirements for the future NAS.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	172,105
FY 2009 Appropriated	10,469
FY 2010 Request	10,302
Out-Year Planning Levels (FY 2011-2014)	43,142
Total	236,018

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Air Traffic Control/Technical Operations	4,234	4,130	4,130	4,042	4,389
Personnel Costs	5,079	5,285	5,285	6,128	5,617
Other In-house Costs	245	239	239	299	296
Total	**9,558**	**9,654**	**9,654**	**10,469**	**10,302**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	9,558	9,654	10,000	10,469	10,302
Development (includes prototypes)	0	0	0	0	0
Total	**9,558**	**9,654**	**10,000**	**10,469**	**10,302**

A11.i. – Air Traffic Control/Technical Operations Human Factors Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
082-110 Air Traffic Control/Technical Operations Human Factors							
Advanced Air Traffic Systems	**450**						
Develop human factors display standard for common display platform		♦	◊	◊			
Deliver guidelines and requirement for improved weather products for controllers		♦	◊	◊	◊		
Individual and Team Performance	**1,469**						
Conduct simulations and analyses of controller time-on-position			◊	◊	◊	◊	
Refine Human Reliability Analysis tool		♦	◊				
Conduct a controller fatigue management survey			◊	◊			
Transform the technical operations work force safety culture		♦	◊	◊	◊		
Technical Operations (TO)	**1,381**						
Deliver analysis of human error impact on NAS availability		♦	◊	◊	◊		
Conduct HSI study of maintenance CONOPS			◊	◊			
Personnel Selection and Training	**1,089**						
Deliver an initial TO Personnel Road Map		♦	◊	◊	◊		
Perform strategic training analysis for systems and procedures		♦	◊	◊	◊		
Prepare required skills and performance requirements		♦	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**5,913**						
Total Budget Authority	**10,302**	**10,469**	**10,302**	**10,505**	**10,686**	**10,876**	**11,075**

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
R,E&D	**A11.j.**	**Aeromedical Research**	**$10,378,000**

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 air contamination incidents during flight and ground operations.
- Developing of 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

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. It addresses public, aircrew, and congressional concerns regarding these issues including disease transmission, contaminant transport, and ozone that include chemical reactivity research of aircraft cabin interiors and contaminants that may be carcinogenic. Pesticides, both residual and spraying, are chemicals similar to phosphate esters 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 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. RITE conducts R&D on cabin air quality and on chemical and biological agents, decontamination, and materials compatibility for aircraft.

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 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.

- 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 2010, develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants.
- By 2010, validate computational models of chemical air contaminants, such as volatile organic compounds, to evaluate health and safety impacts on passengers and crew.
- 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.

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. Office of Aerospace Medicine staff members collaborate with leadership positions in the following associated with aerospace medicine, aviation health, airliner cabin environment and safety:

- 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 2008

CAMI Aeromedical Research Program

Aeromedical Safety Management System

- 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 phases 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.
- Collaborative research with CAMI (RITE – Harvard University): to assess the physiological effects of 7,000 ft cabin altitudes on passengers with chronic and stable cardiac and/or pulmonary disease.
- Extensive study of the chemicals deposited on high efficiency particulate air (HEPA) filters during airliner service; identification of key markers of contamination.
- Conducted chamber studies with older and health compromised subjects.
- 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 cabin.
- Developed advanced computer simulations for evaluation of airflow and contaminant transport.
- 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.
- Tested of a range of commercial off-the-shelf biosensors for aircraft cabin environment completed.

FY 2006

CAMI Aeromedical Research Program

- Completed gene expression research review to identify fatigue in collaboration with the US Air Force.
- Development of computer-modeling methods will provide faster, safer, more cost-effective aircraft certification decisions.
- Conducted initial evaluations of lap belt and shoulder strap mounted airbags.
- Provided near real-time warning of solar events, with recommendations for reduced aircraft flight altitudes and potential diversions for polar routes.

Airliner Cabin Environment Research Program

- An experimental study using a ground-based ozone exposure facility that simulates the interior of the airliner cabin was completed and analysis of the resulting data started to be analyzed and in-flight ozone measurements were commenced.
- Pesticides sampling procedures were developed in the laboratory for pesticides.
- Protocols for the Air Quality Incidents and establishment of an Incident Reporting System for air quality incident study were developed.
- Survey of potential physical and chemical decontamination technologies was completed.
- The first generation of a full-scale demonstration of combining the vapor hydrogen peroxide (VHP), specified by Congress as a benchmark, with enhanced environmental preconditioning was constructed and initial testing undertaken. Protocols for a formal evaluation of the full-scale demonstration were developed.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

CAMI Aeromedical Research Program

Aeromedical Safety Management System

- Aerospace Medical Research Scientific Information System (SIS): Applied and validated it by addressing disqualifying pathologies: 1) complete atrial fibrillation, 2) complete female pilot, and 3) continue diabetes.
- Aerospace Accident Injury and Autopsy Data System (AAIADS): Continued collaboration with AQS (ASIAS) in support of safety management system concepts as applied to aerospace medicine.

Accident Prevention and Investigation

- Gene Expression Changes in Response to Fatigue: Continued to develop methods and tools to manage risks to human safety in stressful aviation environments.
- Analyzed post-mortem aviation accidents for fatigue gene expression; collected new specimens, identify biomarkers, and perform pathway analysis.
- Prevalence of Abused Drugs: Examined the prevalence of abused drugs by region, drug type, pilot certificate type, pre-employment vs. random, and other factors critical for rule-making on drug abatement.

Protection and Survival

- Side Facing Seat Certification: Used recent research findings to develop comprehensive technical requirements for certification of side facing seats towards developing new policy.
- Oblique Seat Injury Potential: Evaluated the unique occupant kinematics and loading that could occur in impacts involving oblique seat installations.
- Aviation Child Restraint Certification: Developed the specifications and test requirements needed to support certification of advanced aviation child restraint systems; potential revision to TSO-C100.
- Passenger Aircraft Safety and Emergency Information Resources: Assessed the degree of understanding by passengers.
- Mathematical Prediction of Emergency Evacuation Performance.
  - Continued support of potential technical revision of TSO C69
  - Evaluated Inflation Performance of Emergency Escape Slides at High Altitude.

Aviation Physiology

- Pulse Oxygen Systems: Developed a methodology to assess physiological models of high altitude breathing systems to support certification of systems proposed for use in the B-747 and other aircraft.
- 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 close to 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.

FY 2010 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

- Seat Cushion Component Test Methods: Develop methods for replacement of worn seat cushions.
- Develop analytical procedures to assess the smoke toxicity of advanced materials for post-crash survivability.
- Develop analytical procedures to assess alternative aviation fuels vapor toxicity.

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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

CAMI Aeromedical Research Program

Aeromedical Safety Management System

- Complete 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: Continue to develop methods and tools.
- Analyze post-mortem aviation accidents specimens for fatigue gene expression.
- Assess prevalence of abused drugs.
- Develop analytical procedures to assess the smoke toxicity of advanced materials for post-crash survivability.
- Develop analytical procedures to assess alternative aviation fuels vapor toxicity.

Protection and Survival

- Complete:
  - Assessment of Oblique Seat Injury Potential.
  - Aviation Child Restraint Certification: Develop the specifications and test requirements - TSO-C100.
  - Evaluation of Passenger Aircraft Safety and Emergency Information Resources.
  - Mathematical Prediction of Emergency Evacuation Performance.
  - Inflation Performance of Emergency Escape Slides at High Altitude.
  - Seat Cushion Component Test Methods: Develop methods for replacement of worn seat cushions.

Aviation Physiology

- Complete methodology to evaluate Pulse Oxygen Systems.
- Complete evaluation of Hypoxia Training Devices.

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 1982-2008)	132,418
FY 2009 Appropriated	8,395
FY 2010 Request	10,378
Out-Year Planning Levels (FY 2011-2014)	43,889
Total	195,080

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
CAMI Aeromedical Research	3,569	1,504	1,712	2,038	1,811
Airliner Cabin Environment Research	0	0	0	0	2,000
Personnel Costs	5,091	5,893	5,893	6,177	6,342
Other In-house Costs	140	145	155	180	225
Total	**8,800**	**7,032**	**7,760**	**8,395**	**10,378**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	8,800	7,032	7,760	8,395	10,378
Development (includes prototypes)	0	0	0	0	0
Total	**8,800**	**7,032**	**7,760**	**8,395**	**10,378**

A11.j. – Aeromedical Research Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
086-110 CAMI AEROMEDICAL RESEARCH (CAMI)	**1,811**						
Validate mathematical models - evacuation and emergency response capability.		♦	◊	◊	◊		
Establish design criteria for restraint systems.		♦	◊	◊	◊		
Develop gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors.		♦	◊	◊	◊	◊	◊
Incorporate aerospace medical issues in the development of safety strategies- aeromedical aspects of human performance.		♦	◊	◊	◊	◊	◊
Perform Aeromedical Safety Risk Management: identify human safety risks.		♦	◊	◊	◊	◊	◊
Develop Aerospace Accident Injury and Autopsy Data System (AAIADS)		♦	◊	◊	◊	◊	◊
.							
086-111 AIRLINER CABIN ENVIRONMENT RESEARCH	**2,000**						
Develop and analyze methods to detect and analyze aircraft cabin contamination.		♦	◊				
Computational models of air contaminants, volatile organic compounds, biologicals and virals		♦	◊				
Advanced air sensing technology for volatile organic compounds.		♦	◊	◊			
Bleed air contamination models of engine compressors and high temperature air system.		♦	◊	◊			
Support of regulatory, certification, and operations for existing Aviation Rulemaking Committees.		♦	◊	◊	◊	◊	◊
Chemical kinetic models for bleed air systems for health and safety effects on passengers and crew.		♦	◊	◊	◊		
Personnel and Other In-House Costs	**6,567**						
Total Budget Authority	**10,378**	**8,395**	**10,378**	**10,621**	**10,848**	**11,086**	**11,334**

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
R,E&D	**A11.k.**	**Weather Program**	**$16,789,000**

GOALS:
This program supports the following *Flight Plan* goals: Increased Safety and Greater Capacity.

Intended Outcomes: The Weather Program helps achieve FAA's strategic goal of increasing aviation safety by reducing the number of accidents associated with hazardous weather conditions. The Weather Program strives to increase capacity by reducing the impacts of adverse weather events on the operational capacity of the National Airspace System (NAS). This research program also supports FAA Flight Plan goals of greater capacity. Additionally the Weather Program is performing the research necessary to meet the requirements of the NextGen Integrated Work Plan (IWP). FAA efforts, undertaken in collaboration with the National Weather Service (NWS) and NASA, increase FAA's ability to provide improved 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 research program develops new and improved weather algorithms for NAS platforms such as the Weather and Radar Processor, the Integrated Terminal Weather System, the Operational and Supportability Implementation System, the Advanced Technologies and Oceanic Procedures, the Dynamic Ocean Track System, and the Enhanced Traffic Management System. The NWS platforms also use these improved algorithms. The weather research program also provides knowledge that can be used by the FAA to support design approvals for weather data link systems and to issue appropriate operational approvals for weather products for use in the cockpit.

The weather capabilities developed by 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 research are:

- By FY 2012, development of timely and accurate deterministic (and an initial set of probabilistic) aviation weather forecast data for operational use by ATM, dispatchers, and pilots.
- By FY 2016, development of improved accuracy of deterministic and an expanded set of probabilistic aviation weather forecast data 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:

- Close collaboration with FAA organizations such as the Air Traffic Organization Oceanic and Off-Shore Programs Office, various Aviation Safety Offices.
- 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.
- Guidance from the Joint Planning and Development Office Next Generation Air Transportation System initiative.
- Inputs from the aviation community, such as the annual National Business Aircraft Association /Friends/Partners in Aviation Weather Forum, and scheduled public user group meetings.
- 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).
- Naval Research Laboratory (volcanic ash, flight level winds).
- NASA Research Centers (in-flight icing, turbulence, satellite data).
- Army Cold Regions Research and Engineering Laboratory (in-flight icing).
- Universities (modeling).
- Airlines, port authorities, cities (user assessments).

Accomplishments:

FY2008:

- Implemented an experimental rapid refresh Weather Research and Forecast (WRF) model.
- Implemented turbulence detection algorithm into NEXRAD operations.

FY2007:

- 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.

FY2006:

- 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.

FY2005:

- 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 decay 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Obtained FAA approval to test in-flight icing forecast capability for Alaska.
- Transitioned turbulence forecast greater than 10,000 feet for implementation on operational ADDS.
- Developed a consolidated convective weather forecast capability with probabilistic forecasts and weather avoidance fields.
- Transitioned CONUS display of ceiling, visibility, and flight category analysis capability for implementation on operational ADDS.
- Conducted testing of the Rapid Refresh Weather Research and Forecast (WRF) model.
- Obtained FAA approval to test volcanic ash dispersion and oceanic flight level winds forecast capability.
- Improved in-flight icing forecasts via enhanced polarimetric measurement in low-reflectivity clouds.
- Developed prototype Network-Enabled Verification Service for meeting System Wide Information Management architecture requirements.
- Conducted quality assessment evaluations, automated verification tools, of weather research capabilities to support the FAA/NWS NextGen Weather Evaluation Capability process.
- Completed guidance for certification of airborne weather radar with turbulence detection capability for additional aircraft types.
- Determined liquid water equivalent (LWE) rate & resultant intensity for snow, freezing rain & freezing drizzle

FY 2010 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 IWP requirements, through the conduct of applied research in naturally occurring atmospheric hazards including turbulence, severe convective activity, icing, and restricted visibility. In FY2010, additional turbulence forecast capabilities are being developed to enhance en route safety and capacity, a consolidated 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. Capabilities developed transition to NWS, FAA, and industry weather systems.

New Initiatives

No new initiatives are planned in FY 2010

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Upgrade in-flight icing forecast and nowcast severity capability for WRF rapid refresh.
- Develop in-flight icing forecast capability for Alaska.
- Demonstrate Northeast corridor 0-6 hour consolidated convective weather forecast capability via NNEW.

- Transition probabilistic and mountain-wave turbulence forecast for implementation on operational ADDS
- Develop CONUS display of ceiling, visibility, and flight category forecast capability.
- Integrate Canadian radar data into the real-time national three dimensional radar mosaics.
- Demonstrate global capability for volcanic ash plume dispersion forecast.
- Utilize rapid refresh WRF model forecasts to produce probabilistic forecasts for convection and ceiling/visibility.
- Demonstrate initial operating capability for NEVS utilizing output from consolidated convective weather forecast capability
- Conduct quality assessment evaluations, utilizing automated verification tools, of weather research capabilities to support the FAA/NWS NextGen Weather Evaluation Capability (NWEC) process.
- Develop specification for operational approval of liquid water equivalent technology for ground de-icing guidance.
- Transition WRF rapid refresh model for implementation into NWS operations

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	371,613
FY 2008 Appropriated	16,968
FY 2009 Enacted	16,789
Out-Year Planning Levels (FY 2011-2014)	64,283
Total	469,653

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Weather Program	19,212	18,432	15,936	15,855	15,750
Personnel Costs	1,074	1,035	863	979	862
Other In-house Costs	90	78	89	134	177
Total	**20,376**	**19,545**	**16,888**	**16,968**	**16,789**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	20,376	19,545	16,888	16,968	16.789
Development (includes prototypes)	0	0	0	0	0
Total	**20,376**	**19,545**	**16,888**	**16,968**	**16.789**

A11.k. – Weather Program – Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
041-110 Aviation Weather Analysis and Forecasting							
Convective Analysis and Forecast Improvement	**5,220**						
Developed consolidated conv wx forecast capability		◆		◊	◊		
Demo NE 0-6 hour consolidated conv wx forecast via NNEW			◊				
Improved in-flight icing forecasts via enhanced NEXRAD polarimetric measurements in low-reflectivity clouds		◆					
Integrate Canadian radar data into real/time national 3D mosaic			◊				
Analysis and Forecast Improvement	**6,017**						
Obtained FAA approval to test in-flight icing forecast capability for Alaska		◆					
Upgrade in-flight icing fc & nc severity for WRF RR			◊				
Develop in-flight icing forecast capability for Alaska			◊				
Transition AK in-flight icing forecast capability for implementation on operation ADDS.				◊			
Obtained FAA approval to test global in-flight icing forecast capability					◊		
Conducted test of WRF RR model		◆					
Transition rapid refresh WRF model for implement. into NWS operations			◊				
Implement RR WRF model fcs for probabilistic conv & C&V			◊				
Transitioned turb forecast >10,000 ft for implementation on operational ADDS		◆					
Transition probabilistic and mountain wave turbulence forecast capability for implement on operational ADDS			◊				
Transition convectively-induced turbulence forecast capability for implement on oper. ADDS				◊			
Transition probabilistic turbulence nowcast for implement. on oper ADDS							◊
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 3D cloud probabilistic forecast/ncst							◊
Obtained FAA approval to test volcanic ash dispersion fc		◆					
Demo global capability for VA plume dispersion forecast			◊				
Obtain FAA approval of volcanic ash disp fc for oper read.						◊	
Verification and Technology Implementation	**4,513**						
Developed prototype Network-Enabled Verification Service (NEVS) for meeting SWIM architecture requirements		◆					
Demonstrate IOC for NEVS utilizing conv wx fc capability			◊				
Implement FAA approved products at the AWC		◆	◊	◊	◊	◊	◊
Conduct QA evaluations for NWEC process		◆	◊	◊	◊	◊	◊
Completed guidance for cert. of airborne weather radar with turb detection capability for additional aircraft		◆					
Determined LWE rate & resultant intensity for snow, frz rain & frz drizzle		◆					
Develop specification for operational approval of liquid water equivalent for ground de-icing guidance			◊				
Personnel and Other In-House Costs	**1,039**						
Total Budget Authority	**16,789**	**16,888**	**16,789**	**16,580**	**16,251**	**15,906**	**15,546**

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
R,E&D	**A11.l.**	**Unmanned Aircraft Systems Research**	**$3,467,000**

GOALS:

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

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. This research program also supports the development of aircraft technologies to meet requirements of NextGen enablers that facilitate the implementation of NextGen operational improvements (OIs). 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 define UAS design and performance characteristics. 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; detect, sense and avoid (DSA); control, command, and communication (C3); flight termination, system safety, certification and airworthiness standards, and maintenance and repairs. 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 2010, complete UAS technology survey and gap analysis and document results in technical reports.
- 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.

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:

FY2008:

- 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.

FY2007:

- Completed the first set of FAA-USAF joint flight tests to evaluate a DSA technology.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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.
- Continued FAA-USAF joint flight tests to study on-board DSA technology.
- Continued to identify potential safety implications of system performance impediments to C3.
- Established safety management system (SMS) approach and develop methodology to identify system-level risks and associated causal factors for safety integration of UAS in the NAS.
- 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.
- Established UAS data collection and information system.

FY 2010 PROGRAM REQUEST:

New Initiatives:
None.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Complete technology surveys on UAS designs and operations.
- Complete technology surveys on UAS flight termination and recovery.
- 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).
- Continue FAA-USAF joint flight tests to study on-board DSA technology.
- 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 interactions with other NAS users.
- Continue to develop a methodology to identify system-level risks and associated causal factors for safety integration of UAS in the NAS.
- Develop risk management concepts, models, and tools for unmanned aircraft systems.
- Perform risk analysis 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.
- Initiate the collection of UAS operation data and perform analyses to develop technical information required to support establishment of regulatory standards.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	4,120
FY 2009 Appropriated	1,876
FY 2010 Request	3,467
Out-Year Planning Levels (FY 2011-2014)	13,895
Total	23,358

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Unmanned Aircraft System Research	0	1,200	2,768	735	2,368
Personnel Costs	0	0	136	1,080	1,024
Other In-house Costs	0	0	16	61	75
Total	**0**	**1,200**	**2,920**	**1,876**	**3,467**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	1,200	2,920	1,876	3,467
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**1,200**	**2,920**	**1,876**	**3,467**

A11.l. – Unmanned Aircraft Systems Research Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
069-110 Unmanned Aircraft System Research							
Technology Surveys							
Conduct technology survey on UAS designs and operations		◆	◊				
Conduct technology survey on UAS flight termination and recovery		◆	◊				
Detect, Sense, and Avoid (DSA) Research	**789**						
Determine performance characteristics and operational requirements for DSA technologies		◆	◊	◊	◊		
Joint USAF-FAA flight tests on DSA technology		◆	◊	◊	◊	◊	
Conduct field evaluation of DSA technology				◊	◊		
Command, Control, and Communications (C3)	**789**						
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 interactions with other NAS users			◊	◊	◊	◊	◊
Study requirements of Ground Control System for certification and operations					◊		
Conduct C3 field tests and evaluate technologies				◊	◊		
Flight Termination							
Determine requirements, risks, and mitigation strategies for flight termination				◊	◊		
Conduct flight termination procedure field test and evaluate technologies						◊	◊
UAS System Safety Management	**790**						
Develop a methodology to identify system-level risks and associated causal factors for safety integration of UAS in the NAS		◆	◊	◊	◊	◊	◊
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.			◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**1,099**						
Total Budget Authority	**3,467**	**1,876**	**3,467**	**3,479**	**3,476**	**3472**	**3,468**

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
R,E&D	**A12.a.**	**Joint Planning and Development Office (JPDO)**	**$14,407,000**

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.

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 2010

- 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 Integrated Surveillance Study Team results, 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.
- Develop an inter-agency integrated surveillance architecture, concept of operations and funding profile, and governance process recommendation.
- Establish Network Enabled information sharing standards for participating agencies & organizations including multi-agency governance processes.
- Develop FY 2012 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 FY 2012 formulation package to support NextGen resource planning and development of the NextGen business case.
- Develop FY 2012 NextGen business case including results of environmental mitigation methods and benefits.
- Develop Dynamic Airspace Configuration research transition plan that results in a far-term concept for efficient partitioning of airspace and allocation of resources to meet 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 for NEO Spiral 2, Virtual Tower demonstration, UAS Flight Trials in Florida, Surface Trajectory Based Operations in Memphis, and Oceanic In-trail Climb and Descent Initiative.
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FY 2011

- Continue research in key areas such as Trajectory Based Operations and Collaborative Air Traffic Management as well as other priority areas identified in the Integrated Work Plan.
- Based on research results, assist agencies in deploying critical infrastructure for NextGen operations.
- Initiate research in key areas such as Trajectory Based Operations and Collaborative Air Traffic Management.

FY 2012-2014

- Continue research and development to support all NextGen solution sets.

FY 2015 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 Work Plan, and Business Case information.
- Enhanced the JPE to reflect a federated architecture for participating agencies' Enterprise Architectures..
- Developed FY2011 Formulation Package to support NextGen resource planning and development of the NextGen business case.
- Developed FY2011 NextGen business case and released NextGen foundational documents consistent with FY2011 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 FY2010 Formulation Package to support NextGen resource planning and development of the NextGen business case.
- Developed FY2010 NextGen business case

- Released the Enterprise Architecture and Concept of Operations supporting FY2010 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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.

FY 2010 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 2011 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 2010 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 1982-2008)	58,399
FY 2009 Appropriated	14,494
FY 2010 Request	14,407
Out-Year Planning Levels (FY 2011-2014)	56,555
Total	143,855

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Joint Planning & Development Office	16,539	16,112	12,910	11,221	11,528
Personnel Costs	1,313	1,867	1,256	2,663	2,622
Other In-house Costs	67	121	155	610	257
Total	**17,919**	**18,100**	**14,321**	**14,494**	**14,407**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	17,919	18,100	14,321	14,494	14,407
Development (includes prototypes)	0	0	0	0	0
Total	**17,919**	**18,100**	**14,321**	**14,494**	**14,407**

A12.a. - Joint Planning & Development Office Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Planning and Agency/Industry Alignment:							
Update and carry out an integrated plan for a Next Generation Air Transportation System (NextGen).	**693**	♦	◊	◊	◊	◊	◊
Coordinate and facilitate the transfer of technologies from aeronautics research programs and direct research that will result in achieving NextGen.	**272**	♦	◊	◊	◊	◊	◊
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.	**2,249**	♦	◊	◊	◊	◊	◊
Develop Enterprise Architecture for systems-of systems engineering and expand lower levels of the enterprise.	**2,064**	♦	◊	◊	◊	◊	◊
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.	**2,013**	♦	◊	◊	◊	◊	◊
Conduct policy analyses that focus on early decisions to establish guiding principles for the transformation	**1,385**	♦	◊	◊	◊	◊	◊
Model the planned system improvements to validate their efficacy in accomplishing the NextGen goals. Update roadmaps and research agenda's as required.	**350**	♦	◊	◊	◊	◊	◊
Assist agencies in selecting the best approaches/alternatives for transforming the current air transportation system to NextGen;	**2,002**	♦	◊	◊	◊	◊	◊
Conduct and report interagency budget analysis and progress	**500**	♦	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**2,879**						
Total Budget Authority	**14,407**	**14,494**	**14,407**	**14,352**	**14,214**	**14,070**	**13,919**

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
R,E&D	**A12.b.**	**Wake Turbulence**	**$10,631,000[1]**

GOALS:

This program supports the following *Flight Plan* goal: Greater Capacity.

Intended Outcomes: The Wake Turbulence Program addresses 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." The program was originally focused on the near-term objectives of increasing airport capacity and the capacity of terminal airspace during by developing modifications to air traffic control wake turbulence mitigation procedures used during weather conditions requiring instrument flight procedures. During FY 2009, the program began to address the broader research agenda required to progress to the envisioned NextGen era flight operations. In FY10, the Wake Turbulence Research will continue its broader research agenda, addressing wake turbulence restrictions in today's terminal and en route airspace in the future NextGen airspace designs. Program outcomes include:

- increased NextGen capacity for more flights, and
- aircraft that are provided with more space and flight efficient separations with the same or reduced safety risk.

Agency Outputs: The 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 2010 will continue work begun in FY 2008 to address the feasibility and benefit of a wake/collision avoidance decision support capability for the flight deck.

Research Goals:

- By FY 2010, determine pilot and ANSP situational aircraft separation display concepts required for implementation of the NextGen "Trajectory Based Operation" and "High Density" concepts. [NG]
- 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. [NG]

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.

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[1] The Wake Turbulence Program contains funding for both legacy research and NextGen research. The legacy component of this request is $3,026,000 and the NextGen component is $7,605,000

[NG] Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the legacy program resources.

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 Center [PartNG];
- Mitre/Center for Advanced Aviation and Systems Development (CAASD) [NG];
- NASA Ames and Langley Research Centers;
- EUROCONTROL and associated research organizations;
- Massachusetts Institute of Technology's Lincoln Laboratory [NG];
- National Center for Aviation Operations Research [NG];
- National Institute of Aeronautics [NG].

Accomplishments: The following represent major accomplishments of the wake turbulence program:

- FY 2008 – Developed a national air traffic control order for conducting dependent integrated landing system staggered approach operations on an airport's closely spaced parallel runways.
- FY2006-2008 - 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.

[NG] Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the legacy program resources.

[Part NG] Partnership with Volpe is partially funded NextGen resources and partially with legacy program resources.

FY 2009 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 dependent integrated landing system 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.
- Completed development of the enhanced suite of wake turbulence encounter analysis tools and begin their application in the evaluation of air route changes, modifications to en route air traffic control aircraft separation procedures changes and introduction of new aircraft designs. [NG]
- Analyzed of wake turbulence data base to upgrade 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. [NG]
- Developed airport specific procedure modifications to enable dependent ILS approaches to closely spaced parallel runways.
- Completed development of wind prediction algorithm suitable for use in the development of a cross wind dependent wake mitigation for ground based decision support tool for approaches of 757 and "heavy" category aircraft to closely spaced parallel runways. [NG]
- 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. [NG]
- Completed program to evaluate the impact to fuel efficiency from the addition of a spiroid winglet to an aircraft's wing.

FY 2010 PROGRAM REQUEST:

In FY 2010, FAA must continue developing 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 provide 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 wake turbulence, reduce collision risk and keep traffic flowing 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 and collision risks while optimizing capacity, for all flight regimes, including the effects of weather.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Incorporate wake transport/decay and aircraft navigation performance analysis results into FAA wake encounter and collision risk models.
- Accomplish air traffic procedure/air route proposal reviews utilizing the enhanced suite of wake turbulence encounter and collision risk analysis tools.
- Complete two airport specific procedure modifications to enable dependent ILS approaches to 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. [Part NG]
- Initiate development of wake turbulence transport and decay modeling tools for use in evaluating proposed trajectory based operational concepts. [NG]

[NG] Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the legacy program resources.

[Part NG] This activity is partially funded NextGen resources and partially with legacy program resources.

- Continue development of ground and flight deck based situational display concepts (joint work with EUROCONTROL) for showing separation constraints (driven by collision risk, wake encounter risk, weather, and visibility) for aircraft operating in NextGen air corridors and high density airspace. [NG]
- Complete development (joint work with EUROCONTROL) of analytical capability-benefit tradeoff models of potential procedures/processes/systems that would provide the desired Flight Deck capability for self separating from adjacent aircraft and their wakes. [NG]
- Initiate development of modeling tools to evaluate system-wide safety risk associated with the NextGen pair-wise separation concepts. [NG]
- Continue to conduct experiments/analyses and aviation community forums to define in terms of collision and wake encounter hazard – what is a low, major and catastrophic impact safety event and acceptable safety risk for each. [NG]
- 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. [NG]

[NG] Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the legacy program resources.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	35,036
FY 2009 Appropriated	10,132
FY 2010 Request	10,631
Out-Year Planning Levels (FY 2011-2014)	43,415
Total	99,214

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts					
Wake Turbulence	2,036	2,833	12,543	9,734	9,502
Personnel Costs	225	222	251	374	700
Other In-house Costs	12	11	19	24	110
Total	**2,273**	**3,066**	**12,813**	**10,132**	**10,631**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	2,273	3,066	12,813	10,132	10,631
Development (includes prototypes)	0	0	0	0	0
Total	**2,273**	**3,066**	**12,813**	**10,132**	**10,631**

A12.b.- Wake Turbulence Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
041-150 - Wake Turbulence Legacy	**2,491**						
Incorporate Wake Transport/decay and aircraft navigation performance into FAA models	**500**	◆	◊	◊	◊	◊	◊
Continued data collection and analysis to determine the characteristics of wake vortices generated by aircraft – for enhancing the fidelity of wake models	**1,191**	◆	◊	◊	◊	◊	◊
Accomplish air traffic procedure/air route proposal reviews for wake turbulence impacts	**300**	◆	◊	◊	◊	◊	◊
Develop airport specific procedure modifications to enable dependent ILS approaches to closely spaced parallel runways	**500**	◆	◊	◊	◊		
Evaluate the fuel efficiency impact from addition of a spiroid winglet to an aircraft's wing	**0**	◆					
111-150 - Wake Turbulence NextGen	**7,330**						
Development of enhanced analysis tools for evaluating wake encounter and collision risk resulting from the design of airspace efficient routes, air traffic procedure changes, and the introduction of new aircraft designs [NG]	**600**	◆	◊	◊			
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 [NG]	**800**	◆	◊	◊	◊	◊	
Development of modeling and other analysis tools required for evaluation of wake encounter risks of trajectory based operations [NG]	**300**		◊	◊	◊		
Accomplish wake turbulence and collision risk assessments of potential air traffic routing and separation changes associated with evolution to NextGen [NG]	**800**	◆	◊	◊	◊	◊	◊
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 [NG]	**1,400**	◆	◊	◊	◊	◊	◊
Development of analytical capability-benefit tradeoff models of potential procedures/processes/systems that would provide the desired Flight Deck capability for self separating from adjacent aircraft and their wakes [NG]	**600**	◆	◊	◊	◊	◊	
Conduct experiments/analyses and aviation community forums to define in terms of allowable safety risk for potential results from wake encounter or blunder in aircraft navigation [NG]	**830**	◆	◊	◊	◊	◊	◊
Complete development of ANSP prototype decision support system for use in reducing required wake mitigation separations in dependent instrument landing system arrivals of 757 and heavier aircraft on an airport's closely spaced parallel runways [NG]	**1,500**	◆	◊				
Develop an approach and associated modeling tools to evaluate system-wide safety risk for NextGen era reduced separation standards [NG]	**500**	◆	◊	◊	◊		
Personnel and Other In-House Costs	**810**						
Total Budget Authority	**10,631**	**10,132**	**10,631**	**10,750**	**10,842**	**10,932**	**10891**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.
The Wake Turbulence BLI contains both Legacy and NextGen program data.

[NG] Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the legacy program resources.

FAA Budget Appropriation	Budget Item	Program Title	Budget Request
R,E&D	**A12.d.**	**NextGen – Air Ground Integration**	**$5,688,000**

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 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 conduct 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 2012 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 personnel in assessing suitability of design methods to support human error detection and correction.
  - By 2012 complete initial research investigating methods to mitigate mode errors in 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 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.
  - By 2010 complete initial simulation and demonstration roadmap to support future research and integrated demonstrations.
  - By 2010 initiate research to identify human factors issues associated with instrument procedure design and use to support development of human factors guidelines for instrument procedures.

- 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 initial research to address human-automation integration issues regarding the certification of pilots, procedures, training and equipment necessary to achieve NextGen capabilities.
- By 2013 complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.
- 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 2014 complete initial research to provide recommendations for displays, alerts, procedures and training associated with data communications.
- 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 includes 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 will leverage NASA cockpit and Air Traffic Management (ATM) simulation facilities and other resources.
- Cooperative research agreements will be 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.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

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

- Developed initial concepts for cockpit and ATC displays of time domain information to support 2 ½ to 4D trajectory information.
- Began research to identify impact of data communications on flight deck information needs and shared situation awareness.
- Initiated research to investigate issues associated with single pilot aircraft in NextGen procedures.
- 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.
- Initiated research to identify human factors issues associated with instrument procedure design and use.

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 PROGRAM REQUEST:

The program will 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 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

- Assess the impact of function allocation, human-automated system coordination, negotiation procedures and interface design on flight deck and ANSP performance.

Human System Integration – Information Needs

- Identify flight deck and ATC information needs, display and alerting methods to support NextGen shared information requirements.
- Identify human factors issues associated with instrument procedure design and use to support development of human factors guidelines for instrument procedures.

Human System Integration – Human Capabilities and Limitations

- Assess pilot performance in normal and non-normal situations for NextGen operational procedures.

Human System Integration – System Integration

- Assess human factors issues associated with the use of legacy avionics in NextGen procedures.
- Evaluate display and alerting requirements as well as information needs associated with data communications.

Risk and Error Management

- Develop methods to identify and mitigate human error pathways in the use of NextGen equipment and procedures.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Roles and Responsibilities

- Develop initial guidance addressing allocation of functions between the aircrew and automation.
- Develop initial guidance on procedures for flight deck-ANSP negotiations.

Human System Integration – Information Needs

- Develop initial guidance for the design of NextGen flight deck and ATC displays and alerts, including those required for oceanic in trail procedures.
- Continue research to identify human factors issues associated with instrument procedure design and begin development of human factors guidelines for instrument procedures.

Human System Integration – Human Capabilities and Limitations

- Develop 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.
- Evaluate flight technical error in all four dimensions for TBO.

Human System Integration – System Integration

- Identify the human factors issues associated with use of legacy avionics on near-term NextGen procedures and provide recommended mitigation strategies where appropriate.
- Conduct research to support guidance for data communications procedures, training, displays and alerts.
- Assess information needs, displays, alerts, procedures and training associated with oceanic in trail procedures.

Risk and Error Management

- Deliver initial results of proactive analyses of human error hazards to understand and predict human error vulnerabilities.
- Assess human error impact and mitigation in oceanic in trail procedures and RNP operations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	2,554
FY 2010 Request	5,688
Out-Year Planning Levels (FY 2011-2014)	46,308
Total	54,550

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NextGen - Air Ground Integration	0	0	0	2,485	5,449
Personnel Costs	0	0	0	69	239
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**2,554**	**5,688**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	2,554	5,688
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	2,554	**5,688**

A12.d. – NextGen Air Ground Integration	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
111-110 NextGen Air-Ground Integration							
Roles and Responsibilities	**604**						
Assess methods of allocating functions and structuring the coordination between pilots/controllers and automated systems,				◊	◊	◊	
Develop certification guidance for new methods of automating flight tasks based on observed strengths and weakness					◊	◊	◊
Identify design and procedural methods to support collaboration and negotiation between flight deck, ANSP and AOC personnel			◊	◊	◊	◊	◊
Assess skill loss and mitigation strategies associated with NextGen changes in pilot roles and responsibilities				◊	◊	◊	◊
Human System Integration	**3,333**						
Information Needs							
Identify flight deck and ATC information needs, display and alerting methods to support NextGen shared information requirements.			◊	◊	◊	◊	◊
Identify human factors issues associated with instrument procedure design and use to support development of human factors guidelines for instrument procedure design.		♦	◊	◊	◊	◊	◊
Human Capabilities and Limitations							
Assess pilot performance in normal and non-normal situations for NextGen operational procedures, including single pilot operations		♦	◊	◊	◊	◊	
Identify human capabilities and limitations for pilot/ANSP/AOC shared decision-making, and provide recommended mitigation strategies to address identified risks			◊	◊	◊	◊	◊
Interface Design							
Develop design guidance to support display of shared information considering user needs and relevant information properties, including requirements for location in the forward field of view		♦	◊	◊	◊	◊	◊
Develop design and procedural guidance to support dissemination, entry and evaluation of 2 ½ to 4D clearances via data communications				◊	◊	◊	◊
System Integration							
Develop training standards and procedures to support NextGen operations and associated transitions in normal and non-normal conditions				◊	◊	◊	◊
Assess human factors issues associated with use of legacy avionics in NextGen procedures		♦	◊	◊	◊	◊	◊
Risk and Error Management	**1,112**						
Provide interface design guidance to support error detection, identification and correction				◊	◊	◊	◊
Develop training and procedural requirements to support error detection and correction in NextGen procedures to include oceanic in trail procedures			◊	◊	◊	◊	◊
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			◊	◊	◊		
Integrated Demonstrations	**400**						
Develop simulation roadmap		♦	◊				
Demonstrate pilot and controller functional capabilities via simulation (specific demonstrations executed under activities listed above)				◊	◊	◊	◊
Personnel and Other In-House Costs	**239**						
Total Budget Authority	**5,688**	**2,554**	**5,688**	**11,355**	**11,536**	**11,716**	**11,701**

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
R,E&D	**A12.e.**	**NextGen – Self-Separation**	**$8,247,000**

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 include:

- 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 2010 identify 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.
  - 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 2010 develop initial methodology for conducting robust systematic assessments of separation procedures to ensure non-normal and emergency operations are evaluated.
  - 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 includes 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 will be used with universities to address NextGen human factors issues.
- Coordination on research issues and plans with aircraft and avionics manufacturers and operators.
- Coordination will occur with appropriate RTCA Committees, e.g., Airborne Separation Assurance System.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

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.
- Began to develop recommendations for use of autopilot coupled collision avoidance and pilot procedures for overriding the automation in each flight phase.
- 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.
- For oceanic pair-wise separation procedures, began to determine information needs, time requirements and pilot accuracy for detection and resolution of potential conflicts.
- Began 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).
- 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 planning for robust assessments of separation procedures to ensure non-normal and emergency operations are evaluated including system failures and reversion impacts.
- Initiated needs assessment for pilot training use of automation in NextGen separation operations.
- Began to develop risk and error management strategies to identify and mitigate human-system errors with use of advanced cockpit automation for navigation, conformance monitoring and decision-making during various NextGen operations.
- Began human factors assessments of new information requirements for NextGen alerts and displays in reduced and delegated separation operations.
- Initiated examination to identify potential uses of TCAS equipment and symbology in reduced and delegated separation operations.
- Began to determine the expected nature, frequency and potential impact of instrument procedure design on pilot errors.
- 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 PROGRAM REQUEST:

The program will 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

- Evaluate all-weather ground movement area and runway operations using enhanced cockpit technologies, including EFVS)/SVS, TCAS, and CDTI.
- Assess contributions of airport signage and lighting on ground operations at night and in low-visibility weather conditions.

Reduced Separation

- Assess changing roles and responsibilities associated with shifting separation responsibility between pilot and controller under different operational separation situations.
- Evaluate pilot performance in reduced separation operations, such as closely spaced parallel operations, and develop pilot training and performance standards to ensure flight safety.

Delegated Separation

- Provide guidance for training pilots to assure adequate understanding of automation functions and display limitations as they apply to separation operations using CDTI and TCAS.
- For near to mid-term delegated separation procedures and applications for single-pilot operations, continue assessing the impact of systems failures and begin development of procedures to safely and efficiently revert to backup separation methods.
- For oceanic pair-wise separation procedures, determine information needs, time requirements and pilot accuracy for detection and resolution of potential conflicts.

- Conduct research efforts to evaluate ADS-B/CDTI displays and procedures in a human-in-the-loop (HITL) simulation of merging and spacing operations.

Cross-cutting

- Provide robust assessments of separation procedures to ensure non-normal and emergency operations are evaluated including system failures and reversion impacts.
- Provide initial guidance for the integration of CDTI and TCAS symbology.
- Develop advanced methods including efficient and standardized procedures to certify pilots and automation for different separation operations.
- Determine the expected nature, frequency and potential impact of instrument procedure design on pilot errors.
- Conduct a gap analysis that will identify major human factors research needs for NextGen, by comparing results of completed research and operations data with projected requirements for human performance in future NextGen applications.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Surface/Runway Operations Awareness

- Continue study to define pilot information display requirements for use of enhanced cockpit technologies, including EFVS/SVS, TCAS, and CDTI to support all-weather operations.
- Evaluate airport signage and lighting effects on pilot navigation at night and reduced visibility.

Reduced Separation

- Evaluate pilot conformance, conflict detection and avoidance capabilities, and recommend pilot training and performance standards to ensure safe separation.
- Develop recommendations for use of autopilot coupled collision avoidance and pilot procedures for overriding the automation in each flight phase.
- For closely spaced parallel operations, continue 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

- Continue analysis to evaluate pilot training requirements for use of limited delegation of separation authority in the oceanic environment.
- Develop 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, continue assessing the impact of systems failures and begin development of procedures to safely and efficiently revert to backup separation methods.
- For oceanic pair-wise separation procedures, continue to determine information needs, time requirements and pilot accuracy for detection and resolution of potential conflicts.
- 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).

Cross-cutting

- Continue robust assessments of separation procedures to ensure non-normal and emergency operations are evaluated including system failures and reversion impacts.
- Provide guidance for training pilots to use automation in NextGen separation operations.
- Provide human factors assessments of new information requirements for NextGen alerts and displays in reduced and delegated separation operations.
- Provide guidance for the integration and use of TCAS equipment and symbology in reduced and delegated separation operations.
- Continue to determine the expected nature, frequency and potential impact of instrument procedure design on pilot errors.
- Continue 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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	8,025
FY 2010 Request	8,247
Out-Year Planning Levels (FY 2011-2015)	41,140
Total	57,412

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NextGen - Self Separation	0	0	0	7,956	7,796
Personnel Costs	0	0	0	69	451
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**8,025**	**8,247**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	8,025	8,247
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**8,025**	**8,247**

A12.e. – NextGen – Self-Separation	**FY 2010 Request** ($000)	**Program Schedule**					
Product and Activities		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
111-120 NextGen – Self Separation							
Surface / Runway Operations Awareness	**1,403**						
For aircraft operations in all weather conditions (including low visibility conditions and at night),		♦	◊	◊	◊	◊	◊
Define pilot information display requirements and develop recommendations for policy and safe operating procedures for use of enhanced and synthetic vision systems		♦	◊	◊	◊	◊	◊
Develop requirements for alerts, CDTI and pilot performance for low visibility ground operations		♦	◊	◊	◊	◊	◊
Evaluate airport signage and lighting effects on pilot navigation performance in aircraft movement areas		♦	◊	◊	◊	◊	◊
Reduced Separation	**2,339**						
For closely spaced parallel operations, determine CDTI requirements to support dual missed approaches, and evaluate controller and flight crew workload and effects of blunder during the missed approach.		♦	◊	◊	◊	◊	◊
For aircraft operations in a reduced separation environment (3 miles or less everywhere),							
Evaluate pilot conformance, conflict detection and avoidance capabilities, and recommend pilot training and performance standards to ensure safe separation		♦	◊	◊	◊	◊	◊
Develop recommendations for use of autopilot coupled collision avoidance and pilot procedures for overriding the automation in each flight phase		♦	◊	◊	◊	◊	◊
Delegated Separation	**3,196**						
For near to mid-term delegated separation procedures and applications for single-pilot operations, assess the impact of systems failures and begin development of procedures to safely and efficiently revert to backup separation methods.		♦	◊	◊	◊	◊	◊
For oceanic pair-wise separation procedures, determine information needs, time requirements and pilot accuracy for detection and resolution of potential conflicts.		♦	◊	◊	◊	◊	◊
For specific transient situations in which separation responsibility is delegated to the pilot, such as climb-in-trail passing,							
Evaluate pilot training requirements for use of limited delegation of separation authority in the oceanic environment.		♦	◊	◊	◊	◊	◊
Develop recommendations for pilot use of display technologies including CDTI and TCAS to designate the reference aircraft and to maintain separation		♦	◊	◊	◊	◊	◊
Cross-Cutting	**858**						
Provide guidance for training pilots to use automation in NextGen separation operations		♦	◊	◊	◊	◊	◊
Develop risk and error management strategies to identify and mitigate human-system errors				◊	◊	◊	◊
Provide human factors assessments of new information requirements		♦	◊	◊	◊	◊	
Provide guidance for the integration TCAS symbology into CDTI		♦	◊	◊	◊	◊	◊
Determine the expected nature, frequency and potential impact of instrument procedure design on pilot errors.		♦	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**451**						
Total Budget Authority	**8,247**	**8,025**	**8,247**	**10,076**	**10,243**	**10,411**	**10,410**

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
R,E&D	**A12.f.**	**NextGen – Weather Technology in the Cockpit**	**$9,570,000**

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 of reducing weather delays leading to more efficient air traffic management (ATM) and improving 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 will be accomplished through the successful completion of research in the following areas:

- 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.
- Proof of Concept Demonstration – Simulate and evaluate currently available systems for providing weather information to the cockpit.
- Weather Technology in the Cockpit Prototype – Develop prototypes of weather information integration modules for flight deck technologies (e.g., flight management systems (FMS), electronic flight bags (EFB), etc.), perform full, mission demonstrations, and assess the integration of navigation, flight, and weather information into cockpit decision-making processes.
- 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 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 information 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: There are no previous accomplishments because the Weather Technology in the Cockpit program was a new start in FY 2009.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Developed initial Concept of Operations 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).
- Identified test bed(s) to develop prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).

FY 2010 PROGRAM REQUEST:

Ongoing Activities

Work will continue in FY10 on the development of the comprehensive weather information user needs statement and the completion of the technology assessment, including on FMS ingestion of weather information and communications systems. A number of activities related to the proof of concept demonstrations and Weather Technology in the Cockpit prototyping will also continue in FY10. In addition, research activities related to the development of various types of guidance will be ongoing in FY10.

New Initiatives

The new research initiatives that will commence in FY10 are related to the proof of concept demonstrations. There will be an emphasis on determining the impact of communications systems on the provision of weather information in the cockpit and developing the standards and guidance necessary for obtaining design approvals for weather decision support systems.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Complete the initial comprehensive weather information user needs statement for the various part operators (i.e., Parts 91, 135, 121) for the different stages of flight in the near-, mid-, and long-term NextGen operating environments.
- Simulate and evaluate candidate systems for providing weather information to the cockpit in both machine-to-human and machine-to-machine modes.
- Identify, validate, and document data link system attributes that may affect the provision and use of weather-in-the-cockpit products and services.
- Conduct research to develop standards and guidance for design approval of weather decision support for cockpit use including integration of weather information with existing CNS/ATM information on multi-function displays.
- Continue development of prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).
- Continue research activities necessary to develop design approval guidance for hardware and software standards and data archiving and guidance for operational approval of products from non-government vendors.
- Conduct research to develop guidance for airmen training and evaluation criteria.
- Conduct research necessary to develop guidance to enhance the use of forecast products for pilot decision making.
- Conduct research necessary to evaluate procedures for including weather information in the flight deck decision making processes.
- Conduct research to quantify the regulatory impact of integrating weather information into flight deck decision-making processes.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	8,049
FY 2010 Request	9,570
Out-Year Planning Levels (FY 2011-2014)	42,172
Total	59,791

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts					
Weather Technology in the Cockpit	0	0	0	7,894	8,945
Personnel Costs	0	0	0	155	539
Other In-house Costs	0	0	0	0	86
Total	**0**	**0**	**0**	**8,049**	**9,570**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	8,049	9,570
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**8,049**	**9,570**

A12.f. – Weather Technology in the Cockpit Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
111-140 Weather in the Cockpit							
Concept and Requirements Development	**500**						
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	**1,100**						
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	**2,811**						
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	**2,900**						
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	**1,634**						
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	**625**						
Total Budget Authority	**9,570**	**8,049**	**9,570**	**10,320**	**10,497**	**10,674**	**10,681**

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
R,E&D	**A13.a.**	**Environment and Energy**	**$15,522,000**

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 technology and operational solutions and environmental management systems and models development under NextGen research.

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 2012 as measured by a three-year moving average, from the three-year average for calendar year 2000 – 2002. 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.
- Through the PARTNER Center of Excellence (COE) identify and better measure the issues and impacts associated with aircraft noise, and generate improved solutions to mitigate these problems.
- Identify and assess the impact and enable implementation of operational procedures to reduce noise in the NAS.
- Minimize the impact of aircraft noise – actions include: advancing the state of science/knowledge concerning effects of aircraft noise; improving aircraft certification standards and current operational procedures; and implementing improved noise control and mitigation measures.

The *Flight Plan* Aviation Fuel Efficiency Performance Target improves aviation fuel efficiency per revenue plane-mile by one percent each year through FY 2012, as measured by a three-year moving average, from the three-year average for calendar years 2000-2002. 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.
- Through the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence (COE) develop methodology and collect data to identify and more accurately characterize the sources and incremental impacts associated with aviation emissions, and generate improved solutions to mitigate these 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 implementing improved emissions control and mitigation measures.

Flight Plan International targets include fostering international environmental standards, recommended practices, and guidance material that are technically feasible, economically reasonable, provide a measurable environmental benefit and take interdependencies between various emissions and between emissions and noise into account. Specific activities include:

- Working with the international aviation community to reduce aircraft noise and emissions – actions include:
- 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 research and development investments that help achieve 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 two to three-fold growth in capacity 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 2010, demonstrate capability to conduct comprehensive cost-benefit analyses of environmental policy options with quantified uncertainties.
- By FY 2010, develop beta version of integrated framework for Aviation Environmental Design Tool (AEDT), Aviation Portfolio Management Tool (APMT), and Environmental Design (EDS) Tool.
- By FY 2010, deliver Version 1.0 of AEDT local for airport applications to Design Review Group.
- By FY 2010, incorporate methodology to account for population growth in the environmental impact assessments.
- By FY 2010, 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 2010, exercise databases of particulate matter 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.
- By FY 2010, advance our understanding of the evolution of volatile particulate matter emissions in order to specify measurement and sampling procedures.
- By FY 2010, develop new technical guidance for noise and aircraft engine emissions certification.
- By FY 2010, develop new standards and methodologies to quantify and assess the impact of aircraft noise.
- By FY 2010, publish guidance material related to dispersion, chemical and transport modeling
- By FY 2010 provide computer models and impact criteria for use by civil aviation authorities in environmental assessments.
- By FY 2010 develop noise propagation models to better capture air turbulence, meteorology, terrain, and wave nature of low-frequency noise

- By FY 2010, test and deploy 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.
- By FY 2011, 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 Aviation Environmental Portfolio Management Tool (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

In addition, the program is conducting government-industry sponsored research through the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence (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 2010 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 2010, Advance best practices in aviation emissions particulate matter (PM) and Hazardous Air Pollutants (HAPs) measurements and characterize in-service aircraft
- By FY 2010, assess current understanding of aviation impacts on sleep disturbance and/or annoyance.
- By FY 2010, assess the impacts of aviation on regional air quality including the effects of particulate matter emissions that result when aircraft climb and cruise.
- By FY 2010 test and deploy elements of an Internet capability to educate and inform the public about aviation and the environment.
- 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 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.

- 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 2007. 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 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 2005:

- Developed a handbook on aviation emissions that serves as the definitive source on this evolving issue.
- Developed a first order approximation to help airports assess aircraft particulate emissions and demonstrate compliance with the National Environmental Policy Act and the Clean Air Act.
- Developed a novel methodology for assessing noise, air quality emissions, and aviation climate impacts using a common currency.

FY 2004:

- Initiated a long-term, strategic effort to develop analytical tools to address the relationship between noise and emissions and different types of emissions. The long-term aim is a comprehensive approach to addressing all aspects of noise and emissions. The tools will facilitate better-informed decisions that can cost in excess of $10 billion to government and industry.
- Developed a modeling capability to produce annual inventories of aircraft greenhouse gas emissions and to assess aviation's forecasted global emissions.
- FY 2003:
- Established the PARTNER COE to allow partnerships with universities, research institutions, and industry to conduct exploratory research to identify and better measure the issues and impacts associated with aircraft noise and aviation emissions, and generate improved solutions to deal with these problems.
- Demonstrated new Continuous Descent Arrival noise abatement procedures in collaboration with NASA, academia, manufacturers, and airline and airport operators.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise and Emissions Analyses and interrelationships

- Completed an annual assessment of noise exposure and fuel burn.
- Delivered Aviation Environmental Design Tool (AEDT) Version 2.0, including Environmental Design Space (EDS), capability for ICAO Committee on Aviation Environmental Protection (CAEP)/8-related analysis.
- Delivered Aviation Portfolio Management Tool (APMT) Version 2.0 for CAEP/8 related analysis.
- Developed alpha version of AEDT tool for local application.
- Assessed noise and emissions for various technology, operational, and airspace enhancement scenarios.
- Demonstrated a new comprehensive approach to aviation environmental impact mitigation through a significant example problem.
- Continued upgrades to Integrated Noise Model (INM), Emissions and Dispersion Modeling System (EDMS), Modeling System For Assessing Global Noise Exposure (MAGENTA), and System For Assessing Aviation Global Emissions (SAGE) modules for incorporation into AEDT and to support existing customers as necessary.
- Developed business case and cost allocation for implementation of clean and quiet operational procedures.
- Worked with candidate airports to identify opportunities to implement clean and quiet operational procedures.
- Explored provisions for clean and quiet procedure usage in airspace redesign projects.

Aircraft noise

- Updated, developed, and published: procedures and technical guidance for noise certification of aircraft (subsonic jet and large transport airplanes, small propeller airplanes, and rotorcraft) that are both harmonized and simplified.
- Recommended and develop widely accepted impact metrics within noise community on sleep disturbance, annoyance, speech interference and perceptible vibration.
- Investigated the role of aviation noise in combined transportation noise around airports and its impact to communities.
- Investigated how average Day-Night-Level (DNL) performs compared to other noise impact metrics;
- Completed Land Use metrics study and publish a report.
- Conducted a study to analyze the four elements of the Balanced Approach (technology to reduce noise at the source, land use planning and management, quieter operational procedures, and operational restrictions) to noise abatement and their relationships.
- Continued to assess potential benefits of using newly developed noise reduction technologies and operational procedures; identify technology and operational goals for long-term reduction of aircraft noise.
- Continued developing interactive website/software to communicate complex noise technical information in a manner suitable for public distribution (NoiseQuest) and complete educational component of NoiseQuest.
- Advanced the sonic boom metric definition and continue to assess the applicability of existing noise metrics to sonic boom and determined annoyance of low boom waveforms to inform future decision-making regarding supersonic flight over land.
- With the “Aviation emissions activity,” 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 aircraft engine exhaust emissions testing and certification that are internationally harmonized and simplified, taking into account modernization in measurement methodologies and advancements in technical understanding.

- Continued to develop and disseminate methodologies and procedures to quantify and assess the impact of Particulate Matter and Hazardous Air Pollutant emissions on the environment.
- Conducted analysis of actual aircraft engine emissions measurements to better understand the generation of emissions during engine start-up, ground idle and taxi operation, during aircraft ground roll immediately prior to takeoff, and under varying ambient conditions.
- Continued to:
    - Assess potential benefits of using newly developed engine emissions reduction technologies, monitor state of technology advancements against the established goals for long term reduction of aircraft engine NO_X emissions, and initiate establishment of aircraft technology goals for long term reduction of fuel burn.
    - Assess potential benefits of optimized operational procedures to reduce emissions and fuel burn
    - Assess the atmospheric and health effects of aviation related emissions through the PARTNER COE.
- Tested and analyze particulate matter emissions and hazardous air pollutants from aircraft engines as identified under the AEC Roadmap; establish databases of PM emissions from aircraft engines that can be used for trends assessment.
- Initiated effort required to plan an additional broad airport and aircraft engine study to collect particulate matter and plume evolution/expansion data using light detection and ranging (LIDAR) technology that can be used advance our understanding of particulate emissions impact and to enhance dispersion analytical models embodied in our air quality tools.
- Developed preliminary agreed upon methods to measure PM emissions from commercial aircraft engines, taking into account an assessment of the impact of PM emissions.
- Assessed whether there are unique health effects associated with particulate matter emissions and hazardous air pollutants from aviation sources.
- Initiated assessment of uncertainty of impact of aviation on climate change with special emphasis on practical application of research results to aid the development of models to assess mitigation options.
- Initiated an assessment of the impacts of aviation on regional air quality, including the effects of emissions attributable to aircraft climb and cruise operations.
- With the “Aircraft noise activity,” conducted two COE focused sessions at a national and an international conference.

FY 2010 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 EDS and other integrated aviation noise and emissions modules – will provide integrated capability of generating interrelationships between noise and emissions and among emissions at the local, regional and global levels.
- APMT comprises AEDT and other modules – will provide the common, transparent cost/benefit methodology needed to optimize national aviation policy in harmony with environmental policy.
- These AEDT and APMT 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.
- 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.
- Continue updating and enhancing existing analytical tool modules (e.g., INM, EDMS, SAGE, MAGENTA), as necessary, to support existing customers and transition to AEDT.
- Support FAA role in the 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 2010 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.
- Deliver Aviation Environmental Design Tool (AEDT) Version 3.0 for CAEP/8 related analysis.
- Deliver Aviation Portfolio Management Tool (APMT) Version 3.0 for CAEP/8 related analysis.
- Deliver Environmental Design Tool Version 3.0, including validated vehicle library and demonstrated capability within AEDT framework for CAEP/8 related analysis.
- Continue upgrades to INM, EDMS, MAGENTA, and SAGE modules for incorporation into AEDT and to support existing customers as necessary.
- Deliver comprehensive assessment, including quantified uncertainties, of EDS, AEDT, and APMT.

- Deliver tools to aid in demonstrating Continuous Descent Arrival (CDA) procedures in high-density environment.
- Develop tools to aid in demonstrating other environmentally beneficial procedures in the National Airspace System (NAS).

Aircraft noise

- Update and/or develop, as well as publish: procedures and technical guidance for noise certification of aircraft (subsonic jet and large transport 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 and simplified.
- Initiate studies to:
- Advance understanding of long-term health impacts of noise exposure
- Update current understanding of aviation noise impacts on annoyance and/or sleep disturbance.
- 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, terrain, and wave nature of low-frequency noise.
- Assess state of knowledge on potential health impacts of aircraft noise and investigate methodologies to incorporate these impacts in the APMT framework.
- Support efforts to update land use planning compatibility guidance.
- Continue to assess potential global benefits of using newly-developed noise reduction technologies; identify technology goals for long term reduction of aircraft noise.
- Assess efficacy of NoiseQuest website.
- With the “Aviation emissions activity,” conduct two COE focused sessions at a national and an international conference.

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 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.

- 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)	168,470
FY 2009 Appropriated	15,608
FY 2010 Request	15,522
Out-Year Planning Levels (FY 2011-2014)	60,669
Total	260,269

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Aircraft Noise	1,358	1,667	1,359	1,572	1,245
Engine Emissions	1,598	1,846	1,600	1,700	1,451
Noise & Emissions Analyses	10,759	10,320	10,213	9,900	10,100
Personnel Costs	1,985	2,005	2,036	2,127	2,319
Other In-house Costs	145	170	261	309	407
Total	**15,845**	**16,008**	**15,469**	**15,608**	**15,522**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**	
Basic	0	0	0	0	0	0
Applied	15,840	16,008	15,469	15,608	1	15,840
Development (includes prototypes)	0	0	0	0	0	0
Total	**15,840**	**16,008**	**15,469**	**15,608**	**1**	**15,840**

A13.a. - Environment and Energy Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
091-016 Noise and Emissions Analysis							
Noise and Emissions Analysis	**10,100**						
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		◆		◊	◊	◊	◊
Aircraft Noise	**1,245**						
Assess aircraft noise reduction strategies research		◆	◊	◊	◊	◊	◊
Assess land use practices and metrics		◆		◊	◊	◊	◊
Publish AC 36-4 (and updates)		◆		◊		◊	
Develop a new international noise standard for subsonic jets and large airplanes					◊		◊
Develop a new international noise standard for small props and helicopters				◊			
Apply methodologies used to assess aircraft noise exposure and impact (APMT)			◊	◊			
Prepare COE reports, findings, and other activities		◆	◊	◊	◊	◊	◊
Engine Emissions	**1,451**						
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 on climate change			◊	◊			◊
Prepare COE reports, findings, and other activities		◆	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**2,726**						
Total Budget Authority	**15,522**	**15,608**	**15,522**	**15,440**	**15,264**	**15,079**	**14,886**

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
R,E&D	**A13.b**	**NextGen Environmental Research – Aircraft Technologies, Fuels and Metrics**	**$19,470,000**

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 limit or reduce aviation greenhouse gas emissions impacts on the global climate. The program is focused on reducing current levels of aircraft noise, lair quality and greenhouse gas emissions and energy use and advancing alternative fuels for aviation use.

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 a B737/CFM56, reducing energy consumption and greenhouse gas (CO_2) emissions;
- Certifiable engine technology that reduces landing and takeoff cycle (LTO) nitrogen oxide emissions by 70 percent, without increasing other gaseous or particle emissions, over the ICAO standard adopted at CAEP 2;
- 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
- Ensuring safety and devising transition strategies that enable “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 allow a three times capacity growth.

Specific activities include:

- 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 projected NextGen and support EMSs 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 assess the feasibility of developing alternative aviation fuels that could serve as “drop in” replacements for today’s petroleum derived turbine engine fuels. 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 dynamic environmental management systems (EMSs) to better manage and reduce aviation’s environmental impacts.

Research Goals:

By FY 2014, complete system analyses and demonstrations of near-and (CLEEN) mid-term 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:

- Advance system analyses and identify and pursue the development of first round engine and airframe technologies that will be the most effective at producing environmental benefits. (by FY 2010)
- Initiate demonstration of CLEEN technologies in ground rig tests (by FY 2010)
- Establish preliminary metrics and goals to guide CLEEN technology and alternative fuels development and support EMSs (by FY 2010)
- 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 2014)
- 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 2014)

By FY 2013, complete comprehensive assessment of “drop in” alterative turbine engine fuels and develop implementation plan to address certification.

Alternative fuels supporting milestones:

- Complete effort to experimentally measure environmental impacts of “drop in” alternative turbine engine fuels. (by FY 2010)
- Complete detailed feasibility study, including economic feasibility, environmental impacts, and assessment of potential for gas turbine renewable alternative fuels. (by FY 2010)
- Initiate effort to experimentally assess environmental impacts and benefits and costs of renewable alternative turbine engine fuels. (by FY 2011)
- Conduct significant demonstration of “drop in” alternative turbine engine fuels. (by FY 2012)
- Conduct renewable alternative turbine engine fuels safety, environmental and business case assessments. (by FY 2012)

- Complete assessment of “drop in” alterative turbine engine fuels and develop implementation plan. (by FY 2013)

By FY 2014, investigate metrics, uncertainties on aviation emissions health and welfare and climate impact to facilitate EMSs implementation.

Metrics supporting milestones:

- Complete preliminary assessment of aviation’s impact on climate. (by FY 2011)
- Complete assessment of NextGen air quality and noise impacts. (by FY 2011)
- 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)
- Complete an updated assessment of aviation’s impact on climate. (by FY 2014)

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.

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 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 percent between 1975 and 2006. 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.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise, emissions and fuel burn reduction technologies maturation

- Established consortium for Continuous Low Energy, Emissions and Noise (CLEEN) Technologies.
- Awarded grants and contracts to conduct research.
- Developed a detailed plan to achieve NextGen environmental goals.
- Identified promising technologies for the reduction of noise, air quality and greenhouse gas emissions, and fuel burn that can be quickly matured for commercialization.
- Conducted component level analyses for promising technologies to optimize environmental and fuel burn performance.
- Conducted detailed integrated system level analyses for large and regional jets in order to identify the most promising technologies that can be quickly matured for commercialization.
- Initiated design of experiments for demonstration of technologies that optimize environmental and fuel burn performance.

Alternative turbine engine fuels

- Completed detailed feasibility study, including economic feasibility of “drop in” alternative turbine engine fuels.
- Initiated planning for experimentally quantifying environmental impacts of “drop in” gas turbine fuels in commercial aircraft engines.
- Initiated efforts to explore the potential of renewable gas turbine fuels for commercial applications.

NextGen Environmental Metrics, Goals and Targets

- Initiated efforts to improve understanding of how projected NextGen operations-generated emissions and noise impact human health and welfare, and global climate and identify key uncertainties.
- Determined 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.
- Initiated comprehensive modeling efforts to establish the relationship between aviation engine exhaust and the gaseous and particulate matter emissions that are deposited in the atmosphere.
- Identified and assess potential metrics to quantify the climate related impacts of commercial aircraft operations.
- Initiated baseline analyses of potential climate response due to aviation emissions with quantified uncertainties, based on the best available science and modeling tools.

FY 2010 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 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 NexGen, 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 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.
- Assess and advance the development of alternative "drop in" and renewable turbine fuels for aviation.
- 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 EMSs 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 elements: (1) enhance scientific understanding; (2) accelerate air traffic management efficiencies and improvements; (3) hasten the development of promising environmental improvements in aircraft technology; (4) advance renewable 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 development/penetration cycle and advancing alternative fuels. 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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Noise, emissions and fuel burn reduction technologies maturation

- Advance CLEEN systems analyses.
- Initiate CLEEN component level tests.
- Conduct detailed integrated system level analyses to identify the most promising technologies.
- Identify CLEEN airframe and engine technologies to pursue.
- Complete demonstration of CLEEN technologies in ground rig tests.
- Complete preliminary design of CLEEN demonstration experiment.

Alternative turbine engine fuels

- Experimentally measure environmental impacts of “drop in” alternative turbine engine fuels.
- Initiate planning for comprehensive “drop in” alternative fuel demonstration
- Initiate effort to experimentally quantify renewable fuels environmental impacts

NextGen Environmental Metrics, Goals and Targets

- Continue efforts to determine how projected NextGen operations-generated emissions and noise impact human health and welfare, and global climate and identify key uncertainties.
- Initiate 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.
- 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.
- Initiate a comprehensive particulate matter (PM), hazardous air pollutants (HAPs) and noise measurement campaign.
- 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.
- Initiate comprehensive assessment of NextGen air quality and noise impacts.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	16,050
FY 2010 Request	19,470
Out-Year Planning Levels (FY 2011-2014)	83,794
Total	119,314

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Request**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NextGen Environmental Research—Aircraft Technologies, Fuels and Metrics	0	0	0	15,829	18,312
Personnel Costs	0	0	0	221	954
Other In-house Costs	0	0	0	0	204
Total	**0**	**0**	**0**	**16,050**	**19,470**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Request**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	16,050	19,470
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**16,050**	**19,470**

A13.b.- NextGen Environmental Research—Aircraft Technologies, Fuels and Metrics Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
111-150 NextGen Environmental Research							
Technology Maturation	**13,812**						
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	**2,000**						
“Drop in” Fuels Feasibility Study		◆	◊				
Renewable Fuels Feasibility Study				◊	◊		
“Drop in” Fuels environmental Assessment		◆	◊				
Renewable Fuels Environmental Assessment				◊	◊		
Renewable Fuels Safety Assessment					◊		
“Drop in” Safety Assessment				◊	◊	◊	
“Drop in” Alternative Fuels Demonstration						◊	
Renewable Fuels Safety Assessment							◊
Renewable Fuels Demonstration							◊
Transition Plans						◊	◊
Prepare Annual Report		◆	◊	◊	◊	◊	◊
Metrics, Goals and Targets	**2,500**						
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						◊	
Publish Research Reports		◆	◊	◊	◊	◊	◊
Personnel and Other In-House Costs	**1,158**						
Total Budget Authority	**19,470**	**16,050**	**19,470**	**20,510**	**20,858**	**21,207**	**21,219**

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
R,E&D	**A14.a.**	**System Planning and Resource Management**	**$1,766,000**

Goals:

This program supports the following *Flight Plan* goals: Increased Safety, Greater Capacity, International Leadership, and Organizational Excellence.

Intended Outcomes: Demonstrate the value of working with international partners to leverage research programs and studies in order 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 2010, the FAA will:

- Publish the annual *National Aviation Research Plan*.
- 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 program.
- Support the NextGen initiative.
- Prepare the annual R,E&D budget submission.
- Manage the R,E&D portfolio.
- Coordinate research activities with NASA through FAA's R&D Field Offices.
- Determine measures for the exchange of research information.

Research Goals:

- In FY 2010 through FY 2014, 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 two percent or less of the total R,E&D budget.
- By FY 2011, develop a strategic mapping for international collaboration.
- By FY 2011, identify a process to measure quality, timeliness, and value of collaboration.
- By FY 2016, calculate the value of R&D 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, as well as 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 and other Federal Agencies, and EUROCONTROL.

Accomplishments: Program accomplishments include:

- Published the *National Aviation Research Plan* (February 2008) and submitted to Congress with The President's FY 2009 Budget.
- Managed two REDAC meetings and over twelve subcommittee meetings, which reviewed FAA's proposed FY 2010 R,E&D program.
- Developed the FY 2010 R,E&D budget submission.
- Supported the JPDO's NextGen activities.
- Mapped FAA NextGen R&D programs to the R&D needs in the JPDO R&D Plan.

- Met the research goal for R,E&D management workforce and funding for System Planning and Resource Management in FY 2008.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Delivered the *National Aviation Research Plan* to Congress and submitted to Congress with The President's FY 2010 Budget.
- Provided strategic direction for the FAA R,E&D program.
- Obtained REDAC guidance for the FY 2011 R,E&D Program.
- Obtained REDAC review of and recommendations for FY 2011 R,E&D Program.
- Developed the FY 2011 R,E&D budget submission.
- Coordinated R&D activities with NASA and other partners.
- Supported NextGen activities.

FY 2010 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 2012 program, review the proposed FY 2012 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 2011 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 generate value in the international market. In FY 2010, this initiative will determine measures for the exchange of research information.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Deliver the *National Aviation Research Plan* to the Congress (February 2010) with The President's FY 2011 Budget.
- Obtain REDAC recommendations on planned R,E&D investments for FY 2012.
- Support the REDAC in its preparation of other reports, as requested by the Administrator.
- Prepare the FY 2012 R,E&D budget submission.
- Manage FAA's R&D portfolio development process.
- Support NextGen activities.
- Coordinate R&D activities with NASA and other partners.
- Determine measures for the exchange of research information.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	40,503
FY 2009 Appropriated	1,817
FY 2010 Request	1,766
Out-Year Planning Levels (FY 2011-2014)	6,727
Total	$50,813

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
R,E&D Plans and Programs	1,143	1,346	1,075	1,714	1,706
Personnel Costs	46	39	37	103	44
Other In-house Costs	0	3	72	0	16
Total	**1,189**	**1,388**	**1,184**	**1,817**	**1,766**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	1,189	1,388	1,184	1,817	1,766
Development (includes prototypes)	0	0	0	0	0
Total	**1,189**	**1,388**	**1,184**	**1,817**	**1,766**

A14.a. – System Planning and Resource Management Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
011-130 R,E&D Plans and Programs							
R,E&D Portfolio Development	**225**						
Prepare guidance for budget formulation		◆	◊	◊	◊	◊	◊
Conduct R,E&D financial management		◆	◊	◊	◊	◊	◊
Prepare annual budget submissions		◆	◊	◊	◊	◊	◊
Congressionally Mandated	**445**						
Publish National Aviation Research Plan (NARP)		◆	◊	◊	◊	◊	◊
Conduct REDAC Meetings		◆	◊	◊	◊	◊	◊
NASA Field Offices	**350**	◆	◊	◊	◊	◊	◊
Performance Measurement	**686**						
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 values of collaboration					◊	◊	◊
Personnel and Other In-House Costs	**60**						
Total Budget Authority	**1,766**	**1,817**	**1,766**	**1,741**	**1,702**	**1,664**	**1,620**

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
R,E&D	**A14.b.**	**William J. Hughes Technical Center Laboratory Facility**	**$3,614,000**

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 Future Development Laboratories including the Human Factors Laboratory and the NextGen Laboratory.

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 has been supporting on site flight tests of the Precision Runway Monitoring System in Detroit to aid in the development of a system to aid in the reduction of runway incursions.
- Next generation air transportation system (NextGen) – The WJHTC laboratories support concept validation.
- 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, in the past, participated in 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
- Research & Development Flight Program – Airborne Laboratories
    - Satellite Communications and Navigation Programs
    - Separation Standards
    - Wide Area Augmentation System
    - Terminal Instrumentation Procedures
    - Aircraft Safety
    - Runway Incursion
    - Next Generation Air Transportation System
    - Local Area Augmentation System
    - ADS-B
    - Common Automated Radar Terminal System
- Research & Development Human Factors Laboratory
    - Air Traffic Control Human Factors
    - Airway Facilities Human Factors
    - Operational Evolution Plan Concept Validation

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 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 2006:

- Numerous flight tests were performed, in multiple aircraft, throughout the US to test GPS WAAS performance, availability and accuracy.
- Simulation Team successfully supported research and development of large airspace sectors in a study called Big Airspace
- Simulation Team successfully supported research and development of an integration controller workstation in a study called Future En route Workstation (FEWS).
- Research Development & Human Factors Laboratory (RDHFL) is Big Airspace: 2006 This experiment examined the impact of extending terminal procedures and spacing into en route airspace (Big Airspace (BA) concept) for both arrival and departure sectors. The simulation examined controller performance in a high fidelity, human-in-the-loop simulation designed to compare a baseline condition to two alternative operating conditions: a Big Airspace/Collocated condition (BA/C) and a Big Airspace/Non-collocated condition (BA/N).
- The NextGen Laboratory Team (NGL) supported HOST testing with the Display System Replacement (DSR) team to provide DSR CHI (Computer Human Interface) requirements for the demonstration that took place on January 18 and 19, 2006.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

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 improved its operational aircraft to enhance their ability to support project flight test. These included the installation of three 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).

Future Development Laboratories

- The Laboratory Future Development Team made improvements to laboratory environment to enhance our capability to support NextGen. These included the reallocation of Laboratory Space and Resources, co-locating, connecting, designing and installing necessary Laboratory Infrastructure and components to support, ADS-B, SWIM and NextGen programs based on their requirements and schedules.

FY 2010 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 2010.

KEY 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 will conduct a human in the loop (HITL) simulation of UAS in the NAS.
- Simulation Team will conduct 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 Team hopes to make great progress in the replacement of the Convair flight test aircraft with new and more fleet-representative test aircraft. This effort includes the completion of the Exhibit 300 process and the authorization from the Capital Investment Team for FY-11 funding.

Future Development Laboratories

- The Laboratory Future Development Team intends on making improvements to laboratory environment to enhance our capability to support NextGen. These includes the reallocation of Laboratory Space and Resources, co-locating, connecting, designing and installing necessary Laboratory Infrastructure and components to support, ADS-B, SWIM and NextGen programs based on their requirements and schedules.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	106,890
FY 2009 Appropriated	3,536
FY 2010 Request	3,614
Out-Year Planning Levels (FY 2011-2014)	15,612
Total	129,652

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
WJHTC Laboratory Facility	572	779	667	684	859
Personnel Costs	2,712	2,584	2,642	2,672	2,675
Other In-house Costs	75	67	106	180	80
Total	**3,359**	**3,430**	**3,415**	**3,536**	**3,614**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	3,359	3,430	3,415	3,536	3,614
Development (includes prototypes)	0	0	0	0	0
Total	**3,359**	**3,430**	**3,415**	**3,536**	**3,614**

A14.b. – WJHTC Laboratory Facility Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
011-140 WJHTC Laboratory Facility							
Simulation Facilities (Target Generator Facility, Cockpit Simulators)	**60**						
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)		◆	◊	◊	◊	◊	◊
Research & Development Flight Program (Airborne Laboratories)	**739**						
Satellite Communications and Navigation Programs		◆	◊	◊	◊	◊	◊
Separation Standards		◆	◊	◊	◊	◊	◊
Wide Area Augmentation System (WAAS).		◆	◊	◊	◊	◊	◊
TERPS		◆	◊	◊	◊	◊	◊
Aircraft Safety		◆	◊	◊	◊	◊	◊
Runway Incursion		◆	◊	◊	◊	◊	◊
Next Generation Air Transportation System (NextGen)		◆	◊	◊	◊	◊	◊
Local Area Augmentation System (LAAS)		◆	◊	◊	◊	◊	◊
ADS-B		◆	◊	◊	◊	◊	◊
Common Automated Radar Terminal System		◆	◊	◊	◊	◊	◊
Research and Development Human Factors Laboratory	**60**						
Air Traffic Control Human Factors		◆	◊	◊	◊	◊	◊
Airway Facilities Human Factors		◆	◊	◊	◊	◊	◊
Operational Evolution Plan Concept Validation		◆	◊				
Personnel and Other In-House Costs	**2,755**						
Total Budget Authority	**3,614**	**3.536**	**3,614**	**3,728**	**3,841**	**3,959**	**4,084**

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**	**$10,000,000**

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

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:

- 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.
- Initiated Final Approach Runway Occupancy Signal (eFAROS) field evaluation at DFW.
- Installed Runway Status Light (RWSL) Airfield Lighting Equipment (ALE).
- 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 ORD.

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), and with other government agencies (e.g., the Volpe National Transportation Systems Center).

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Completed installation of RWSL test system at one additional airport.
- Initiated RWSL Field Operational Evaluation at one additional airport.
- Awarded contracts for pilot LCGS procurement.
- Completed installation of LCGS product at additional "to be scheduled" airports.
- Completed RIL engineering tests at BOS.

FY 2010 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.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	68,735
FY 2009 Appropriated	12,000
FY 2010 Request	10,000
Out-Year Planning Levels (FY 2010-2014)	14,000
Total	104,735

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Runway Incursion Reduction	6,440	8,000	8,000	12,000	10,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**6,440**	**8,000**	**8,000**	**12,000**	**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	6,440	8,000	8,000	12,000	10,000
Total	**6,440**	**8,000**	**8,000**	**10,000**	**10,000**

1A01A - Runway Incursion Reduction Product and Activities	**FY 2009 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Runway Incursion Reduction	**10,000**						
Runway Status Lights (RWSL)							
Initiate RWSL test system		♦					
Initiate RWSL Field Operation		♦					
Complete Install of RWSL test system		♦					
Complete RIL Eng Tests at BOS		♦					
Conduct RIL operational trials			◊				
Develop Low Cost RWSL system at non ASDE-X airports.			◊				
Evaluate LED technology for runway safety systems			◊				
Evaluate airport wireless data comm. Design alternatives			◊				
Low-Cost Ground Surveillance (LCGS)							
Award contract for Pilot Program		♦					
Complete install at two airports by FY09		♦					
Complete install at three add'l airports by FY10			◊				
Complete Investment analysis activity			◊				
Total Budget Authority	**10,000**	**8,000**	**10,000**	**5,000**	**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 ATO CAPITAL 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 2013 Plan and the Agencies 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 2013

- Provides focus and alignment to successfully implement FAA Flight Plan and ATO initiatives and all activities necessary to achieve our objectives. Strategy 2013 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 2013 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 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.
- Performed a review of the ATO Strategy Map which identifies ATO Objectives in four pathways or areas of concentration. These four Pathways were updated and a new pathway with an employee focus was developed and populated with new Objectives and metrics.

KEY FY 2009 MAJOR ACTIVITIES AND ANTICIPATED 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 2013 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 2010-2014 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 2013.
- 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.

FY 2010 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 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 Five Year 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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	41,158
FY 2009 Appropriated	6,500
FY 2010 Request	4,100
Out-Year Planning Levels (FY 2011-2014)	26,000
Total	77,758

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
System Capacity, Planning, and Improvement	6,435	5,500	6,500	6,500	4,100
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**6,435**	**5,500**	**6,500**	**6,500**	**4,100**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	6,435	5,500	6,500	6,500	4,100
Total	**6,435**	**5,500**	**6,500**	**6,500**	**4,100**

1A01B - System Capacity, Planning, and Improvement Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
System Capacity, Planning and Improvement	**6,500**						
NAS Performance Measurement							
Prepare FAA Flight Plan		◆	◊	◊	◊	◊	◊
Update Strategy 2013		◆	◊	◊	◊	◊	◊
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	**6,500**	**6,500**	**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**	**$8,000,000**

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 “if”, “when”, and “where” 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 the supported procedural changes. In particular, the program is analyzing the methods for “genericizing” controller areas of specialty recognizing differences between high and low altitude work, opportunities to use multi-sector planners, and the expanded role of Traffic Flow Managers in managing airspace capacity versus limiting demand. It is looking at new ways of providing tower services to enhance tower operations under low visibility conditions. 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.

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 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 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. The concept development and concept validation effort described here is also coordinated with the European community, via agreements with EUROCONTROL through various Action Plans. This cooperation ensures that unique solutions and transitions are not developed in different quadrants of the globe, a situation that would impose an undue burden on all carriers and manufacturers participating in the global airspace system.

Accomplishments: Significant program accomplishments include:

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

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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
- Continued support for the Validation Data Repository
- 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 2010 PROGRAM REQUEST:

The FY10 funding request will be used for concept development, concept validation, and requirements development for lower level NAS concepts, such as requirements development and transition planning for the Multi-Sector Planner concept, development of mid-term (2018) requirements for new high altitude concepts and concept validation of far term (2025) high altitude concepts, modeling and requirements analysis of flexible airspace concepts, concept validation of surface concepts, and requirements development for Enhanced Visual Operations, and alternatives analysis and concept validation activities for flexible tower services. 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.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop 2nd-level concepts (multiple)
- Continued support for the Validation Data Repository
- 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
- EUROCONTROL Action Plan Activities

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	27,838
FY 2009 Appropriated	7,400
FY 2010 Request	8,000
Out-Year Planning Levels (FY 2011-2014)	28,000
Total	71,238

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Operational Concept Validation	2,970	3,000	3,000	7,400	8,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**2,970**	**3,000**	**3,000**	**7,400**	**8,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	2,970	3,000	3,000	7,400	8,000
Total	**2,970**	**3,000**	**3,000**	**7,400**	**8,000**

1A01C - Operations Concept Validation **Product and Activities**	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Operations Concept Validation	**8,000**						
Operational Concept Development							
High altitude, generic airspace		◆	◊				
Flexible & dynamic airspace re-sectorization			◊	◊	◊		
Concepts of operations for the evolution of Traffic Flow Management		◆	◊	◊	◊	◊	◊
Phase 2/3 Concepts for NextGen Towers		◆	◊	◊	◊	◊	◊
Concept Validation							
Validation Data Repository and metrics		◆	◊	◊	◊	◊	◊
High/low airspace split		◆	◊				
Flexible & dynamic airspace re-sectorization				◊	◊	◊	◊
Concept validation/verification standard		◆	◊				
Delegation for separation authority			◊	◊	◊	◊	◊
Traffic Flow Management evolution			◊	◊	◊	◊	◊
Multi-sector Planner		◆	◊	◊			
Provision of NextGen Tower Services		◆	◊	◊	◊	◊	◊
EUROCONTROL Action Plans		◆	◊	◊	◊	◊	◊
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	**8,000**	**7,400**	**8,000**	**8,000**	**8,000**	**6,000**	**6,000**

NOTE: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.
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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 performance requirements for weather research and development 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:

Research Goals:

- By 2010, validate the first iteration of NextGen weather performance requirements with internal and external users representatives
- By 2011, refine FAA's weather research plans to improve alignment with NextGen weather performance requirements
- By 2011, align NextGen with SESAR weather requirements and generate a joint proposal to ICAO to update Annex 3 weather SARPS
- By 2013, demonstrate how probabilistic weather information, in conjunction with metrics, can improve the collaborative ATM decision making process and improve the operational efficiency of the Air Traffic System

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, Operations Planning, Aviation Weather Office, Weather Policy and Requirements Group 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 technology transfer process. The office partners with the Flight Standards and NWS personnel on a full range of aviation weather development activities. The office partners with the Joint Program Development Office (JPDO) to align FAA and NextGen weather architecture and address public/private roles and responsibilities for efficient sourcing. In the international arena, the office closely partners with ICAO and its contracting members.

Accomplishments:
The following summarizes major accomplishments to date:

- Developed a reliable technique to measure avoidable weather delays as subset of overall weather delays.
- Defined a program plan to produce a baseline of the quality of U.S. aviation weather information and the on-going measurements of product.
- Populated a weather capabilities roadmap with information the current weather systems architecture roadmap and information contained in the JPDO enterprise architecture document.
- Developed and obtained agreement that defines a common weather exchange model for use by JPDO agencies, EUROCONTROL and ultimately becomes an ICAO standard.
- Researched, assessed, and developed and obtained initial display standards for meteorological information on flight deck displays.
- Developed plan to align FAA with NextGen policies to optimize government and commercial vendor's roles in observations, forecasting, and dissemination.
- 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 interest at ICAO to minimize operating costs for U.S. carriers.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continued to develop a weather capabilities roadmap that aligns FAA and JPDO goals.
- Continued to develop and obtain agreement on display standards for meteorological information on flight deck displays.
- Continued to develop a plan to align FAA with NextGen policies to optimize government and commercial vendor's roles in observations, forecasting, and dissemination.
- Continued to develop users' needs analyses, simulations, and performance requirements and integrate ATO, NextGen and AVS requirements.
- Developed various Concept and Requirements Definition (CRD) for weather.

- Developed NextGen Network Enabled Weather Requirements.
- Continued to manage the Weather Portfolio Investment Management Plan.
- Continued to refine/validate/balance performance requirements, including identifying gaps in JPDO/legacy systems; developing draft next tier performance requirements; planning, monitoring and conducting validation workshops with user groups; developing demonstration/simulations plans; and develop safety assessments for SPR data link applications;.
- 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 to analyze and develop policies leading to requirements for phase-out of text products; safe use of gridded information within the NEO concept; MDCRS data use; converting VOR to lat/long; TAF Service Standards; government vs. commercial services.
- 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.

FY 2010 PROGRAM REQUEST:

The funding will continue to supports contract services that allow the Aviation Weather Office to prepare for the future increased demand for aviation weather services. Funding will continue to support requirements identification and setting, planning and analysis for investment decisions and setting performance requirements for weather research and development and the transition of that research into operational use by a variety of users.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Validate NextGen weather performance requirements with external customer representatives.
- Refine weather research plans to meet NextGen weather performance requirements
- 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 1982-2008)	12,978
FY 2009 Appropriated	1,000
FY 2010 Request	1,000
Out-Year Planning Levels (FY 2011-2014)	8,700
Total	23,678

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NAS Weather Requirements	790	800	1,000	1,000	1,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**790**	**800**	**1,000**	**1,000**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	790	800	1,000	1,000	1,000
Total	**790**	**800**	**1,000**	**1,000**	**1,000**

1A01D - NAS Weather Requirements Product and Activities	**FY 2009 Request ($000)**	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
NAS Requirements (Office of Weather Policy and Standards, NAS Weather Office, ATO-P)	**1,000**						
Aviation Weather Requirements Development							
Develop next tier performance requirements		◆	◊	◊	◊	◊	◊
Develop, plan, conduct and monitor validation workshops with user groups.		◆	◊	◊	◊	◊	◊
Develop and implement weather information verification program against performance requirements.		◆	◊	◊	◊	◊	◊
Develop data link requirements in support of RTCA and NextCom.		◆	◊	◊	◊	◊	◊
Develop requirements for weather information to be integrated into decision support tools.		◆	◊	◊	◊	◊	◊
Develop NextGen weather requirements tooptimize government and commercial provision of observations, forecasting, dissemination and integration.		◆	◊	◊	◊		
Weather Policy Studies							
Develop and establish policy and requirements for US phase out of test products.		◆	◊	◊	◊		
Develop and establish regulatory requirement that assures safe use of gridded information within the NEO concept.		◆	◊	◊	◊		
Develop and implement policy and requirements for MDCRS Optimization and new Data Source.		◆	◊	◊	◊	◊	
Develop and establish policy requirements for converting from VOR to lat/long.		◆	◊				
Develop and implement policy and requirements for domain authority of 4D Cube		◆	◊	◊	◊	◊	◊
International Standards							
Develop and implement US plan under FAA/EUROCONTROL MOC for aligning ICAO SARPS and Guidance with NextGen/SESAR requirements.		◆	◊	◊	◊	◊	◊
Develop program plan, cost and schedule for developing and implementing WAFS requirements.		◆	◊	◊	◊	◊	◊
Total Budget Authority	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**3,300**	**3,400**

◆ - Activities Accomplished ◇ - Activities Planned

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FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01E**	**Airspace Management Program**	**$3,000,000**

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
HAATS	Houston Area Air Traffic System
IAH	George Bush Intercontinental Airport; Houston, Texas
LAS	McCarran International Airport; Las Vegas, Nevada
NCT	Northern California Terminal Radar Approach Control
PHX	Sky Harbor International Airport; Phoenix, Arizona
ZAB	Albuquerque Air Route Traffic Control Center
ZHU	Houston Air Route Traffic Control Center
ZJX	Jacksonville Air Route Traffic Control Center
ZKC	Kansas City Air Route Traffic Control Center
ZLA	Los Angeles Air Route Traffic Control Center
ZMA	Miami Air Route Traffic Control Center
ZME	Memphis 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 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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

FY 2010 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 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

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	7,800
FY 2009 Appropriated	3,000
FY 2010 Request	3,000
Out-Year Planning Levels (FY 2011-2014)	20,000
Total	33,800

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Airspace Redesign	0	2,800	5,000	3,000	3,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**2,800**	**5,000**	**3,000**	**3,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	2,800	5,000	3,000	3,000
Total	**0**	**2,800**	**5,000**	**3,000**	**3,000**

1A01E - Airspace Redesign Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Airspace Design							
Equipment and other ATO Capital expenditures to support Airspace Management Program projects	**3,000**	—	—	—	—	—	—
Develop/Initiate regional optimization and redesign		◆	◇	◇	◇	◇	◇
Develop/Initiate high altitude and oceanic redesign		◆	◇	◇	◇	◇	◇
Total Budget Authority	**3,000**	**3,000**	**3,000**	**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.
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FAA Budget Appropriation	Budget Item	Program Title	Budget Request
F&E	**1A01I**	**Wake Turbulence Research**	**$1,000,000**

GOALS:

The program supports the following Flight Plan goals: Increased Safety and Greater Capacity.

Intended Outcomes: If the evaluations of air traffic control wake mitigation decision support tools done by this project show operational benefits, these tools will be added to the National Airspace System capabilities, enabling a more capacity efficient utilization of our nation's air space and airport runways. Outcomes will be more airport arrival operations during periods of heavy demand and the capability to fly aircraft between airports with reduced aircraft to aircraft wake separations – resulting in more aircraft that can be accommodated in a given corridor of high demand airspace.

Agency Outputs: This program will evaluate air traffic control decision support tool feasibility prototypes as possible enablers to safely meet the predicted NextGen demand for additional flights in the nation's air transportation system. If these prototypes are successful, more flights can be accommodated in the existing airspace because the required wake mitigation separations between aircraft can be safely reduced. This program is taking the results of technology research and development and new wake separation concept modeling and simulation efforts and evaluating the resulting concept prototypes for flight safety and impact on the National Airspace System (NAS) capability for meeting demand for more flights.

In FY 2010, it is expected that research and development will be sufficiently complete to allow the airport environment evaluation of a prototype Wake Turbulence Mitigation for Arrivals (WTMA) decision support tool. This tool would be used by controllers in reducing wake separations imposed on aircraft following behind Boeing 757 or heavier aircraft when landing on an airport's set of closely spaced parallel runways (runways that are less than 2500 feet apart). Research is ongoing in Europe for developing a similar solution for aircraft landing directly behind each other on a single runway. In FY 2013, it is expected that this program will begin evaluating an FAA R,E&D developed an air traffic control prototype system that is based on the European research effort. The "single runway" prototype (WTMSR) will be used to evaluate its overall system safety and its ability to create more NAS capacity.

Research Goals: This project collects prototype performance data and performs analyses and modeling based on this performance data as a means to finalize requirements for systems that support the R&D goals of:

- By 2012, finish evaluation of the Wake Turbulence Mitigation for Arrivals (WTMA) air traffic control decision support tool feasibility prototype

It is expected that the capability provided by WTMA will allow better utilization of closely spaced parallel runways for arrival operations at airports having closely spaced parallel runways and significant number of 757 and heavier aircraft operations. Twelve to seventeen OEP airports are estimated to obtain operational benefit from the WTMA capability - allowing from 4 to 6 additional airport arrivals on the closely spaced parallel runways per hour (depending on the fleet mix operating at the airport) during periods of heavy arrival demand and the airport having to conduct ILS operations. Benefits are delay reduction during periods of heavy runway demand and low visibility; and, viewed in terms of a yearly basis, the capability will increase the airport's average daily arrival rate.

Customer/Stakeholder Involvement: A key stratagem of the FAA Wake Turbulence Program is providing semi-annual program status meetings (WakeNet USA) with the aviation community's stakeholders, which include aircraft manufacturers, airport authorities, air carriers, pilot and controller unions, air traffic control system manufacturers, aviation safety regulators, academia, and other air navigation service providers. These forums (meetings) allow an exchange of ideas concerning the next steps in the development of the wake separation procedures, processes and systems that will facilitate the needed air traffic capacity increases of the NextGen era. The planning for the WTMA field evaluation has been a topic at the WakeNet USA meetings.

R&D Partnerships: As described under Customer/Stakeholder Involvement, the FAA Wake Turbulence Program is supported by a collaboration of researchers across FAA, NASA, EUROCONTROL and supporting organizations. Entities participating in the research program include:

- NASA, Efficient Aircraft Spacing Projects
- NASA, ASRS Support
- FAA, Air Traffic Organization – System Operations, Planning
- DOT, Volpe National Transportation Systems Center.
- MITRE/Center for Advanced Aviation Systems Development.
- NEXTOR Universities.
- National Institute of Aerospace
- MIT Lincoln Laboratory.
- NorthWest Research Associates.
- ASE Inc.
- Coherent Technologies Inc.
- CASE, LLC.
- Air Traffic Simulation, Inc.

Accomplishments: The evaluation of the WTMA prototype will be starting in FY2010; however the feasibility prototype WTMA system will not complete its R,E&D development until early to mid FY 2010 and become available for evaluation by this project. The following accomplishments listed are related to the R,E&D development of WTMA only:

- FY-2008: Completed high level economic feasibility assessment of potential concept for the WTMA system
- FY 2008: Began assessment of the crosswind persistence that occur on the candidate airports' approach corridors
- FY2008: Began study of potential concept alternatives for accomplishing dependent instrument approaches to an airport's closely spaced parallel runways with heavy aircraft leading some of the dependent pairs.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS: The evaluation of the WTMA prototype will be starting in FY2010. The following activities and anticipated accomplishments listed are related to the R,E&D development of WTMA only:

- Initiated study of useful crosswind information that could be obtained from ACARS transmissions from aircraft on approach to an airport.
- Selected the WTMA system concept for feasibility prototype system development.

FY 2010 PROGRAM REQUEST: The requested $1,000,000 funding will initiate the activities associated with the evaluation of the WTMA concept feasibility prototype in an airport environment. Performance data collected in FY10 and FY11 will be analyzed for the required benefit, cost, and safety assessments needed for an FAA decision to initiate acquisition planning to acquire and implement a WTMA capability. Projected first operation use of WTMA will occur in FY2015.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Develop WTMA data collection and evaluation plan
- Install WTMA prototype in evaluation airport/TRACON environment
- Instrument airport environment for WTMA performance data collection
- Initiate the WTMA data collection and analysis at the evaluation airport

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	12,000
FY 2009 Appropriated	0
FY 2010 Request	1,000
Out-Year Planning Levels (FY 2011-2014)	4,000
Total	17,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Wake Turbulence Research	3,960	1,000	3,000	0	1,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**3,960**	**1,000**	**3,000**	**0**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	3,960	1,000	3,000	0	1,000
Total	**3,960**	**1,000**	**3,000**	**0**	**1,000**

1A01I – Wake Turbulence Research **Product and Activities**	**FY 20010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Evaluate WTMA Prototype in an airport environment							
Develop WTMA Prototype data collection and evaluation plan	**150**		◊				
Install WTMA Prototype, design and install associated data interfaces	**350**		◊				
Install evaluation instrumentation and begin data collection and analysis	**500**		◊				
Continue data collection and analysis				◊	◊		
Complete analyses and prepare documentation for the FAA initial investment decision for WTMA					◊	◊	
Evaluate Wake Turbulence Mitigation for Single Runway (WTMSR) Prototype in an airport environment						◊	◊
Personnel and Other In-House Costs							
Total Budget Authority	**1,000**	**0**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**

◆ - 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	**1A07**	**NextGen Demonstrations and Infrastructure Development**	**$33,774,000**

GOALS:

This program supports the following *Flight Plan* goal: Greater Capacity.

The FAA has identified this program as a "Transformational" program for NextGen.

Description of Problem: The United Nations Intergovernmental Panel on Climate Change (IPCC) allocates only 2–3% of today's global carbon dioxide (CO_2) emissions to aviation. While its overall contribution is relatively small, aviation is considered one of the few rapidly-growing contributors. Efforts to minimize the industry's environmental impacts will be complicated by anticipated increases in both domestic and international air transportation operations.
Environmental impacts resulting from aircraft noise and emissions could emerge as a significant constraint on aviation industry growth. Cooperation to address the industry's environmental challenges could both maximize aviation's collective environmental improvements, and mitigate the potential adverse effects that environmental impacts and society's concerns may impose on industry growth.

With increasing demand the need grows to achieve peak throughput performance at the busiest airports and in the busiest arrival/departure airspace. Capability improvement via new procedures to improve airport surface movements, reduce route spacing and separation requirements, and improve overall tactical flow management into and out of busy metropolitan airspace is needed to maximize traffic flow and airport usage. Essentially the problem is getting the right aircraft to the right runway in the right order and time to minimize its individual impact on the system and maximize the use of these airports. Thus operations are conducted to achieve maximum throughput while facilitating efficient arrival and departure. Inefficiencies in any aspect of the operation reduces the total use of the capacity and, because of high demand, causes excessive compounding of delay.

Operation of Unmanned Aircraft Systems (UAS) in the NAS is strictly controlled. Operators of UAS must apply to the FAA for authorization to engage in flight activities and operations must be specifically authorized. Other restrictions may be applied that hamper the accomplishment of the UAS operator's mission. The Certificate of Authorization (COA) process has been implemented until concerns over the safety of UAS operations can be allayed. The demonstration project is part of the process to prove the viability of UAS to operate safely in the NAS without undue risk. The ultimate goal is that UAS have unfettered access to the NAS. Unfettered access to the NAS for DoD UAS is a growing imperative. Future civilian demand is anticipated.

Additionally, the following shortfalls in developing and demonstrating the future NAS need to be considered and resolved:

- The integration of individual-domain (intra-domain) that would allow for end-to-end (or multi-domain) demonstration and testing;
- The immediate (near-term) integration of new emerging technologies, or applications into existing or planned demonstrations;
- NAS near-term demonstration initiatives supporting government / industry partnership demonstrations;
- The sustainment of the individual or end-to-end (multi-domain) demonstration sites; and
- Costs for new airport air traffic control towers are between $25 and $30 million per airport, with some approaching a $100 million or more. With several hundred towers needing repair or expansion, the total annual operating costs are, or will exceed, budget expectations by a substantial margin.

Description of Solution: For FY 2010, $24,800,000 is requested to fund the following activities:

- International Air Traffic Interoperability – This demonstration is designed to help the FAA promote safe, affordable and rapidly implemented innovations into Air Traffic Management (ATM). The flight trials development stage will include system architecture, design, hardware and software development (where applicable), procedures development, simulations, component and subsystem testing and certification, and system checkout. Flight trial execution could include scripted flight tests, limited operational testing, and extended operational evaluations. The demonstrations will contribute directly to NextGen concepts and support international collaboration, avoid overlaps, and will "deconflict" activities with national and international organizations, including DoD. Further, this international air traffic interoperability demonstrations and development initiatives will assist the international communities and the FAA in validating 4-D Trajectory Based Operations (TBO) and Performance-based Air Traffic Management (PATM) alternatives.

- High Density Airport (HDA) Capacity and Efficiency Improvement Project. Two arrival management projects associated with HDA; the 3-Dimsional (3-D) Path Arrival Management (3-D PAM) Project and Tailored Arrivals (TA). The two projects are symbiotic in nature in that the heart of the 3-D PAM is the development of a 4-D trajectory (4-DT) ground tool and voice-based procedures for non-datalink aircraft and the TA project is working the cross facility and sector procedures along with the datalink requirements required by both projects. In time the two projects will blend together creating a single 4-D trajectory capability in the arrival domain. The series of demonstrations associated with each project will provide enhanced airspace to accommodate the anticipated future demand. The demonstrations, along with the associated activities, will feature the development and demonstration of the 4-D trajectory automation tool that works in conjunction with the Traffic Management Advisor. The tool will calculate a trajectory from the Top of Descent (TOD) to an airport meter fix, and will eventually be extended into the TRACON. The clearance is issued by the controller and transmitted via voice or datalink to an aircraft which when loaded in the Flight Management System, will execute a fuel efficient arrival. The demonstrations will also measure whether increased capacity is achievable. The TA Arrivals project is aiming to implement an intermediate capability before the full development of the 4-DT ground tool that will enable fuel efficient arrivals for datalink equipped aircraft into medium to high density airports. The 4-DT tool will significantly enhance this capability when available.
- Unmanned Aircraft Systems (UAS) 4-Dimemsional Trajectory Based Operations (4-D TBO) Demonstration – This demonstration project consists of periodic demonstrations of actual and evolving capabilities, and will include corresponding risk assessments. The project has a phased approach with initial concept and requirements definition, performance modeling and simulation, and analyses including operational scenarios, metrics definition and procedures development. This preliminary work transfers to proof-of-concept demonstrations for both laboratory and live flight trials. This demonstration project completely complements and is coordinated with the DoD UAS NAS oriented demonstrations, leveraging community efforts.
- Staffed NextGen Tower (Staffed and Autonomous) – Staffed NextGen Towers (SNTs) are planned for medium and high density airports as these airports are likely to have the surveillance infrastructure and the most aircraft equipped with avionics that will support SNT operations. A companion vision is for an Automated NextGen Tower (ANT) concept for non-towered and low density airports. The SNT field demonstration will serve as a proof of concept as well as a comprehensive site testing of the technology in an operational environment. It will serve to validate the SNT operational concept and develop preliminary program requirements. Operational, technical, and human factors data will be collected and user feedback obtained on their assessment of the operational feasibility, suitability, and acceptability of the concept. The SNT and ANT concepts will require substantial concept engineering funding commencing in FY-10 as advanced decision support tools will be needed for such events as conformance monitoring using aircraft movement tracking and advanced Data Communications to ensure safe operations. Certified surveillance will increase capacity in low-visibility/night conditions. New capabilities such as pre-departure clearance, coded taxi routes, and runway balancing will lead to increased airport capacity, enhanced safety and increased efficiency as well reducing the user's operational costs.
- JPDO Program Management – The JPDO's oversight of NextGen requires approximately $18 million annually in support from the FAA. Prior to FY 2008, the entire amount was requested through the Research, Engineering, and Development appropriation. Beginning in FY 2008, as programs move toward implementation, part of that funding is being required in the F&E appropriation.

Benefits: The NextGen Technology Demonstration program is a development effort to support the transformation of the NAS to 4-D trajectory management and a performance-based system. The program provided integration and demonstration of alternate technologies and concepts, while supporting procedures and standards development, integration of near-term emerging technologies and airspace customers' initiatives with on-going scheduled demonstrations. This program provides a vehicle to test concepts and leverage individual transformational program and project technology to create multi-domain cohesive demonstrations to capture the synergies needed to transform the NAS in an expedited manner. The evaluation of technology and the collaboration between public / private industry partners, ANSPs, customers, and owners will continue into perpetuity. These demonstration and early implementation initiatives will provide the Agency and its public / private partner critical information to refine operating concepts and tools, including the following:

- International Air Traffic Interoperability. The expected benefits are proof-of-concept and working prototypes for an operational environment with flight profile predictability and efficiency on long-duration international flights, where fuel burn optimization is a prime concern. This activity will demonstrate the benefits of flexibility in a four-dimensionally managed environment through en route flexibility; demonstrate exchange of operational data between aircraft operators and air traffic / air navigation service providers for informed decision making in near real-time to increase productivity; and demonstrate efficient transition from the oceanic/en route phase of flight to the domestic/en route and offshore descent phases of flight to increase transition area efficiency and productivity.
- High Density Airport (HDA) Capacity and Efficiency Improvement Project. This demonstration will show enhanced airspace use to accommodate the expected demand. It links two important activities: time based metering and procedures that reduce separation minima (RNAV/RNP) to more fully and efficiently utilize every landing opportunity at the airport runway. The demonstration will also test whether or not the FAA can increase capacity without additional staffing.
- Unmanned Aircraft Systems (UAS) 4D Trajectory Based Demonstration. Initially, UAS will be used as surrogate transportation aircraft in this demonstration. The results of these tasks will allow for early implementation of trajectory management flight planning capabilities for all aircraft operating in the NAS. Significant benefits can be realized in airspace designated for high performance aircraft through problem identification and resolution earlier in the process, workload spread more evenly, and more effective management of airspace.
- Staffed NextGen Tower (Staffed and Autonomous). The near-term goal and expected benefits are a proof-of-concept and working prototype for a Staffed NextGen Tower (SNT). The longer-term goal will be the Automated NextGen Tower (ANT). Both systems will support the predicted increases in future traffic demands while improving operational efficiency and enabling cost-effective expansion of air traffic services to a significantly larger number of airports than possible with traditional methods of service delivery.

Accomplishments:

- Conducted Tailored Arrival (TA) demonstrations at San Francisco (SFO), and Miami (MIA).
- Conducted Continuous Descent Arrival (CDA) demonstrations at Atlanta (ATL) and MIA.
- Developed prioritized list of sites for Optimized Profile Descent (OPD) implementation in the National Airspace System (NAS).
- Conducted a collaborative surface management demonstration at Memphis International Airport (MEM).
- Conducted an Oceanic TBO demonstration, using manual procedures, to identify optimal flight profiles.
- Conducted metrics evaluation throughout FY08 to determine the amount of jet fuel and emissions being reduced by the AIRE partnership demonstrations.
- Developed and received approval for the NextGen Towers (NT) concept of operations (ConOps) including both Staffed NextGen Towers (SNT) and Automated NextGen Towers (ANT). Approval of the NT ConOps was an Enterprise Architecture milestone that was completed on time.
- FAA approved a research management plan for Phase 1, Supplemental Operations of SNT that includes certification of ASDE-X.
- Completed a technology assessment for SNT and provided recommendations for SNT alternatives.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Conducted an interoperable oceanic and arrival demonstration into a U.S. east coast airport.
- Conducted a collaborative surface management demonstration at Memphis International Airport (MEM).
- Expanded Oceanic demonstration using existing oceanic systems and trajectory optimization tools to identify optimal flight profiles to improve fuel savings and reduce emissions.
- Developed the ability to generate and issue Optimum Descent Profile arrivals (Tailored Arrival and/or 3-D Path Arrival Management (PAM) advisories to non-equipped aircraft.
- Integrated en route descent advisor (EDA) functionality into the Miami International Airport (MIA) demonstration.
- Developed a UAS Demonstration Project Concept of Operations
- Prepared a UAS Demonstration Project Plan
- Conducted preliminary UAS baseline flight demonstration
- Established site selection criteria and select a site for the SNT field demonstration.
- Developed a Field Demonstration Test Plan and Metrics Data Collection Plan for the SNT field demonstration.
- Initiated site preparation at the selected airport for the SNT field demonstration.

FY 2010 PROGRAM REQUEST:

- The UAS demonstration project has two objectives. UAS capabilities are being used to validate 4D trajectory based operational concepts and flight demonstrations are being conducted to support unfettered access to the NAS for UAS. The project in FY10 focuses on continuing flight demonstrations following structured initial concept and requirements definition, performance modeling and simulation, and analyses including operational scenarios, metrics definition and procedures development. This preliminary work transfers to proof-of-concept demonstrations in both laboratory environments and live flight trials. This demonstration project complements and is coordinated with the DoD UAS NAS oriented demonstrations, leveraging community efforts.
- The Staffed NextGen Towers (SNT) field demonstration will serve as a proof of concept as well as a comprehensive site testing of the technology in an operational environment. It will serve to validate the SNT operational concept and develop preliminary program requirements. SNT will support decreasing delays in low visibility and night conditions and provide for a long-term strategy for system capability enhancements.
- The Program request for HAD is TBD – Estimate - January 09

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Demonstrate an Oceanic pre-departure concept by utilizing trial tool set(s) such as web-enabled DOTS+ for pre-flight trajectory planning.
- Conduct international interoperable gate-to-gate demonstration.
- Conduct 4-dimenisional flight management system demonstration.
- Complete UAS baseline flight demonstrations
- Conduct UAS coupled capability flight demonstrations
- Conduct UAS integrated capability flight demonstrations
- Complete field site preparation for SNT field demonstration.
- Develop procedures for the SNT Field Demonstration.
- Conduct a Field Demonstration to validate the SNT concept.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	50,000
FY 2009 Appropriated	28,000
FY 2010 Request	33,734
Out-Year Planning Levels (FY 2011-2014)	120,000
Total	231,734

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NextGen Demonstrations and Infrastructure Development	0	0	20,000	28,000	33,734
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**20,000**	**28,000**	**33,734**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	20,000	28,000	33,734
Total	**0**	**0**	**20,000**	**28,000**	**33,734**

1A07 – NextGen Demonstrations and Infrastructure Development Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
NextGen Demonstrations and Infrastructure Development	**$33,733**						
International Air Traffic Interoperability	**7,500**						
Conduct an Oceanic Trajectory Based Operation (TBO) demonstration to identify optimal flight profiles.		◆	◊				
Conduct an interoperable oceanic and arrival demonstration into a U.S. east coast airport.		◆					
Conduct a collaborative surface management demonstration at Memphis International Airport (MEM).		◆					
Conduct an Oceanic Trajectory Based Operation (TBO) demonstration to assess the potential requirements for future automation upgrades.				◊	◊	◊	
Demonstrate Optimum Profile Descents (OPS) at selected airports to validate projected benefits and develop a business case for OPDs.		◆	◊				
Formulate global requirements and business case for Tailored Arrivals.			◊	◊	◊		
Conduct metrics evaluation to determine jet fuel and emissions reduction for demonstrations.		◆	◊	◊			
Develop initial requirements, procedures and standards for integrated surface operations.		◆	◊				
Conduct international interoperable gate-to-gate demonstration.			◊				
Conduct 4-dimenisional flight management system demonstration.			◊				
High Density Airport (HDA) Capacity and Efficiency Improvement Project	**4,000**						
Conduct a High Density Tailored Arrival (TA) at MIA.		◆					
Use fully defined 3D paths to achieve sequencing and spacing trials		◆	◊				
Demonstrate efficient transition from fuel-efficient ocean profiles to offshore/en route environment culminating in a TA.		◆	◊	◊			
Unmanned Aircraft Systems (UAS) 4D Trajectory Based Demonstration	**4,774**						
Utilize UAS community as a test bed for the exploration of future 4D trajectory based concepts		◊	◊	◊	◊		
Conduct a demonstration of UAS for validation of RTCA SC-203 performance requirements and NAS operating requirements.		◊	◊	◊	◊		
Staffed NextGen Tower	**5,700**	◆	◊	◊	◊	◊	◊
Establish site selection criteria and select a site for the SNT field demonstration		◊					
Develop a Field Demonstration Test Plan and Metrics Data Collection Plan for the SNT field demonstration.		◊					
Initiate site preparation at the selected airport for the SNT field demonstration		◊					
Complete field site preparation for SNT field demonstration.			◊				
Develop procedures for the SNT Field Demonstration			◊				
Conduct a Field Demonstration to validate the SNT concept.			◊				
Test Bed Demonstration Sites	**8,000**						
JPDO Program Management	**3,800**	◆	◊	◊	◊	◊	◊
Total Budget Authority	**$33,734**	**$28,000**	**$33,734**	**$30,000**	**$30,000**	**$30,000**	**$30,000**

◆ - 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 – ATM Human Factors – Controller Efficiency & 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: This is a new program starting in FY 2009.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

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 and continuous descent approach in the terminal area.
- Assessed types and modes of human error in operations for merging and spacing and continuous descent approach.

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 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 self-spacing, 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 and contingency 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 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 a high fidelity simulation 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 as roles and procedures delegate additional authority to the pilot.
- Assess system performance requirements to recover from controller data entry errors.
- Assess types and modes of human error in operations for merging and spacing and continuous descent approach.

Increase Flexibility in the Terminal Environment

- Model controller workload benefits from data communications for mixed equipage aircraft in the terminal area.
- Perform initial simulations to assess the benefits of integrated tower 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.

Reduce Weather Impact

- Assess NextGen concepts for the integration of weather information into decision support tools
- Assess the impact of providing controllers and pilots with probabilistic weather information

Cross-concept Human Factors Issues

- Define stability and reliability requirements for decision support tools and automation to assure that they help the service provider achieve the expected benefits.

- Define reliability requirements for 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 dynamic 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.
- Analyze the human factors aspects of the transition of operations toward a more highly automated NAS which transfers selected functions to the flight operator and aircrew.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	6,700
FY 2010 Request	10,000
Out-Year Planning Levels (FY 2011-2014)	40,000
Total	56,700

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
NextGen - Air Traffic Control/Technical Operations Human Factors – Controller Efficiency	0	0	0	6,700	10,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**6,700**	**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	6,700	10,000
Total	**0**	**0**	**0**	**6,700**	**10,000**

1A08A – Air Traffic Control/Technical Operations Human Factors – Controller Efficiency & Air Ground Integration Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Air Traffic Control/Technical Operations Human Factors – Controller Efficiency	**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**	**6,700**	**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**	**$13,200,000**

GOALS:

This program supports the following *Flight Plan* goal: 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 2010, conduct tradeoff studies to determine approaches to future air-ground data communications requirements implementing flexible airspace management
- 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: This is a new program in FY 2009.

KEY FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Trajectory Based Operations

- Initiated the investigation of 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

High Density Arrival/Departures and Airports

- Initiated TCAS effectiveness in the NextGen environment and define requirements for improved performance

Flexible Terminal and Airports

- Initiated analyses 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;

Collaborative Air Traffic Management

- Initiated analysis of approaches/methodologies for software assurance of complex air-ground systems.

FY 2010 PROGRAM REQUEST:

In FY 2010, 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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Trajectory Based Operations

- Continue the investigation of 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
- Considering the design trade-offs, propose the appropriate L-Band solution for input to a global aeronautical standardization activity.
- Analyses of common trajectory requirements and implementation strategy – identify trajectory differences, evaluated need and fidelity and propose exchange standards

High Density Arrivals/Departures and Airports

- Determine compatibility of ground-based elements with airborne elements when using new High Density trajectory based procedures
- Determine TCAS effectiveness in the NextGen environment and define requirements for improved performance

Flexible Terminal and Airports

- Identify 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;
- Evaluate and validate 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
- Develop 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.
- Analyses for RNAV/RNP via Data Communications – requirements for data communication delivery and evaluation.

Collaborative Air Traffic Management

- Conduct analysis of approaches/methodologies for software assurance of complex air-ground systems.
- Initiate development of a coordinated airborne and ground software assurance standard to support Air-Ground operational integrity.

- Analyses of weather integration into ATM decision support tools – weather requirements for individual trajectory analysis and correlation of forecast impact.
- Analyses of airborne SWIM – identify information distribution requirements for non-command and control information, evaluate alternative design and architecture, propose standard.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	5,400
FY 2010 Request	13,200
Out-Year Planning Levels (FY 2013-2014)	115,100
Total	133,700

Budget Authority ($000)	FY 2006 Enacted	FY 2007 Enacted	FY 2008 Enacted	FY 2009 Enacted	FY 2010 Request
Contracts	0	0	0	0	0
New Air Traffic Management Requirement				5,400	13,200
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**5,400**	**13,200**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 2006 Enacted	FY 2007 Enacted	FY 2008 Enacted	FY 2009 Enacted	FY 2010 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	5,400	13,200
Total	**0**	**0**	**0**	**5,400**	**13,200**

1A08B – New Air Traffic Management Requirement Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
New ATM Requirement	**13,200**						
Trajectory Based Operations							
Future international frequency standards L-band		◆	◊	◊			
Approaches for implementing flexible airspace management			◊	◊	◊	◊	◊
Requirements for interactive flight planning			◊	◊	◊	◊	◊
Conflict resolution approaches using aircraft intent data				◊	◊	◊	◊
Common Trajectory Requirements and Implementation Strategy			◊	◊	◊	◊	◊
High Density Arrivals/Departures and Airports							
TCAS 8.0 analysis and requirements		◆	◊	◊			
Surface management CNS technologies identification			◊	◊	◊	◊	
Flexible Terminal and Airports							
Surface CNS technologies C-Band		◆	◊	◊			
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)			◊	◊	◊		
Total Budget Authority	**13,200**	**5,400**	**13,200**	**1,800**	**31,200**	**32,000**	**58,100**

◆ - Activities Accomplished ◇ - Activities Planned

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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 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 a "Fast, Flexible and Efficient" system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs. The program supports these goals by 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 fits within the Air Traffic Organization's pathway 4, "Ensure Viable Future" to assure a sustainable and affordable Air Transportation System for the future by developing future operational concepts that will decrease workload and increase reliance on automation for routine tasking, and new procedures both on the ground and in the air 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 (up to three times capacity) 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 identify and validate changes to current air traffic management operations that will foster increased system capacity, efficiency, and throughput. The validated operational concept will identify system level requirements, airspace changes, and procedural changes that will need to be implemented in order to realize the capacity gains afforded by implementation of the concepts. 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.

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 EUROCONTROL and 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: This is a new program in FY 2009.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- 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
- Developed Detailed Task Descriptions including functional analyses, information flows and task lists to determine function allocation and information requirements for the midterm
- Validated the Data Communications Segment 2 Operational Concept and requirements development
- Researched 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 concept with particular emphasis on roles and responsibilities

FY 2010 PROGRAM REQUEST:

The FY 2010 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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	4,000
FY 2010 Request	10,000
Out-Year Planning Levels (FY 2011-2014)	40,000
Total	54,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Operations Concept Validation – Validation Modeling	0	0	0	4,000	10,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**4,000**	**10,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	4,000	10,000
Total	**0**	**0**	**0**	**4,000**	**10,000**

1A08C – Next Gen - Operations Concept Validation – Validation Modeling Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
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		♦	◊				
Traffic scenarios to validate the mid-term operational concept		♦	◊	◊			
Simulations to validate the mid-term concept		♦	◊	◊			
Detailed operational scenarios to support far-term concept validation			◊	◊	◊		
Traffic scenarios to validate the far-term operational concept			◊	◊	◊		
Simulations to validate the far-term concept					◊	◊	◊
Total Budget Authority	**10,000**	**4,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**

◆ - Activities Accomplished ◇ - Activities Planned

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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**	**$7,000,000**

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 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

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 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 increases environmental impacts 150-200% - even in the near term. 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 1% 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 identify and explore how advances in Communication, Navigation and Surveillance technology can be leveraged in the short- to medium-term to explore advanced air and ground operations to reduce fuel burn, noise and emissions.

The FAA is developing a robust new comprehensive framework of aviation environmental analytical tools and methodologies under the RE&D program to develop integrated noise and emissions models. This effort will build upon the RE&D investment that is developing the fundamental modules of such models to develop computer models to assess environmental impacts of NAS changes and controls to enable environmental management systems to actively mitigate noise and emissions. The effort will allow developing a the regional versions of our analyses tools in the next 3-5 years to help guide NextGen environmental activities (for example right now we are unable to assess the impact of three time growth at a level beyond a rough order of magnitude; this is inadequate to make decisions that cost millions in infrastructure development) and support the development of robust EMSs. We would also conduct the validation and verification required to make these tools acceptable for environmental impact assessments and EMS implementation.

Finally, this effort seeks to assess the impacts of new aircraft technologies and alternative fuels on the NAS and establish and advance any NAS adaptation required to implement and benefit from environmentally beneficial technologies. Elements of this initiative include:

- Explore operational procedures to mitigate NextGen environmental impacts
- Develop metrics and models to implement NAS Environmental Management Systems to reduce NextGen environmental impacts
- Establish the impacts of CLEEN aircraft technologies and alternative fuels on the NAS infrastructure and advance any changes required to adopt these aircraft technologies and fuels

Ongoing Activities

Environment and Energy –Advanced Noise and Emission Reduction

Achieving the NextGen target of meeting forecasted demand of three times current levels of capacity could cause a three times increase in aircraft noise and emissions. The potential for environmental damage could restrict capacity growth and prevent full realization of NextGen. The problem is to reduce the environmental impact of aviation in absolute terms through new operational procedures, technologies, alternative fuels, policies and market based options to allow the desired increase in capacity. The solutions must demonstrate an acceptable benefit to cost ratio and infrastructure adaptation plan.

Environment and Energy – Validation Modeling

Achieving the NextGen target of meeting forecasted demand of three times current levels of capacity could cause a three times increase in aircraft noise and emissions. There must be a thorough understanding of the economic and operational impacts of the system alternatives for reducing noise and emissions with respect to the system alternatives for increasing capacity. There must also be sufficient knowledge of human health and welfare impacts of aviation noise and emissions to enable appropriate means to mitigate these effects. As the system solutions to increase capacity develop, alternative operational procedures must be explored, and there must be validation that proposed solutions to reduce noise, fuel burn, and emission are sufficient to prevent environmental constraints that might limit the required capacity increases. Models and metrics must be developed and demonstrated to implement Environmental Management Systems (EMSs) to manage and mitigate NextGen environmental impacts. Advances in noise, fuel burn, and emissions reduction will enable the air traffic system to handle growth in demand up to three times current levels.

KEY 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.
- Conduct significant demonstration of environmental control algorithms for terminal area operational procedure to reduce emissions and noise.

Environmental Management System

- Analytically explore advanced algorithms and approaches for en route (Oceanic) automated systems that optimizes en route operations for reduced aircraft emissions that may influence climate, quantify potential benefits and design and conduct a simple experiment to demonstrate viability and validate benefits.
- Conduct a significant demonstration of the capability of integrated environmental models to analyze noise and emissions regional impacts of new NAS operations.
- Define architectural modifications to static environmental analyses models to enable dynamic assessment and control of environmental impacts.

CLEEN and Alternative Fuels and NAS Infrastructure Integration

- Define existing and planned environmental mitigation methods to counter NAS constraints (today and for NexGen).
- Analyze environmental impacts on NAS of new aircraft types (e.g., aircraft featuring CLEEN technologies, Very Light Jets (VLJ), Unmanned Air Vehicles (UAV), Supersonic Business Jet (SBJ)) and assess approaches to optimize system environmental performance.
- Analyze the environmental impacts of alternative fuels on NAS and assess approaches to optimize system environmental performance.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	7,000
FY 2010 Request	7,000
Out-Year Planning Levels (FY 2011-2014)	72,000
Total	86,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Operational Procedures Explorations/ EMSs models and metrics	0	0	0	4,500	4,500
CLEEN/Alternative Fuels NAS impacts	0	0	0	2,500	2,500
Personnel	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**7,000**	**7,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	7,000	7,000
Total	**0**	**0**	**0**	**7,000**	**7,000**

1A08D - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Validation Modeling - EMS Models and Metrics	**4,500**						
Assess efficacy of metrics		◆		◊		◊	
EMSs development		◆		◊		◊	
EMSs demonstration			◊		◊	◊	◊
Validation modeling			◊	◊	◊	◊	◊
Benefit/Cost Assessment			◊	◊	◊	◊	◊
Publish Research Reports			◊	◊	◊	◊	◊
Advanced Noise and Emissions Reduction - Operational Procedure Exploration/NAS Impacts of CLEEN/Alternative Fuels	**2,500**						
Impacts assessment		◆		◊		◊	◊
CLEEN technologies integration demonstrations			◊	◊		◊	
Alternative Fuels integration demonstrations			◊			◊	
Control Algorithm Development		◆	◊		◊		◊
Procedures Exploration		◆		◊		◊	◊
Validation Modeling			◊	◊	◊	◊	◊
Publish Research Results			◊	◊	◊	◊	◊
Total Budget Authority	**7,000**	**7,000**	**7,000**	**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**	**$2,000,000**

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 Objective to "Advance accessible, efficient, inter-modal transportation for the movement of people and goods." 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 the Joint Aviation Authorities 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, 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 requirements to support those modifications.
- 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 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:

- 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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Enhanced analysis tools (to include effects of wake encounter) for evaluating alternative methods of defining safe wake separations between various types of aircraft.
- Conducted analyses and aviation community forums to vet potential methods for determining safe wake separations between various types of aircraft
- Developed an approach for evaluating 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)

- Developed human-in-the-loop ANSP and Flight Deck simulations to evaluate usability of a proposed set of wake separation standards
- Developed potential methods for defining the minimum safe wake separations between aircraft, beginning with the more general groupings of aircraft types and progressing (subsequent years) with defining how minimum separations could be set for individual pairing of aircraft.
- Conducted analyses to link wake transport and decay characteristics to aircraft flight and surrounding weather parameters.

FY 2010 PROGRAM REQUEST:

In FY10, 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 determine if these static standards can be safely modified to allow more aircraft in the same volume of airspace. It is one component in the overall effort to apply technology toward achieving the envisioned NextGen number of aircraft operations in the NAS.

KEY 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 – which may vary for specific airport operational environments
- 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 variable wake separation standards that account for airport fleet mix, trajectories of aircraft being separated and weather conditions along route of flight

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriated	2,000
FY 2010 Request	2,000
Out-Year Planning Levels (FY 2011-2014)	12,000
Total	16,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Wake Turbulence	0	0	0	2,000	2,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**2,000**	**2,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	2,000	2,000
Total	**0**	**0**	**0**	**2,000**	**2,000**

1A08E - NextGen - Wake Turbulence – Re-categorization Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Wake Turbulence – Re-categorization	**2,000**						
Develop and apply enhanced analysis tools (to include 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		◆	◊	◊	◊	◊	◊
Evaluate safety risks associated with potential methods for applying wake separations between various groups of aircraft (i.e. Jumbo, Heavy, Large, Small, Very Small)		◆	◊	◊	◊	◊	◊
Develop and conduct human-in-the-loop (ANSP & Flight Deck) simulations for usability evaluations of potential alternative methods of defining safe wake separation between various categories of aircraft.		◆	◊		◊	◊	◊
Develop FAA/EUROCONTROL coordinated recommendation to ICAO for a change in wake separation standards		◆	◊	◊			
Using results from collected data, continue to upgrade analytical models linking wake transport and decay to aircraft flight and surrounding weather parameters		◆	◊	◊	◊	◊	◊
Develop variable wake separation standards			◊	◊	◊	◊	◊
Personnel and Other In-House Costs							
Total Budget Authority	**2,000**	**2,000**	**2,000**	**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	**1A08F**	**NextGen – Operational Assessments**	**$7,500,000**

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. 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 2010, funding is requested to conduct 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 2011, develop initial NAS wide model(s) to support operational assessments of the Airport and Terminal Domains.
- By 2011, conduct limited safety assessment of NextGen capabilities
- By 2011, conduct limited environmental assessment of NextGen capabilities
- 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 is a new program in FY 2010.

KEY FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

This is a new program in FY 2010.

FY 2010 PROGRAM REQUEST:

In FY2010, FAA must begin 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 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

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Appropriation	0
FY 2010 Request	7,500
Out-Year Planning Levels (FY 2011-2014)	40,000
Total	47,500

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts	0	0	0	0	0
Operation Assessments					7,500
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**7,500**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	0	7,500
Total	**0**	**0**	**0**	**0**	**7,500**

1A09X – NextGen – Operational Assessments **Product and Activities**	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Gap Analyses	**1,500**						
Assess and inventory of existing NAS wide operational models. Safety and environmental models			◊		◊		◊
Develop requirements for model enhancements			◊	◊			
Model Developments	**3,500**						
Develop enhancements to NAS wide operational models, safety and environmental models			◊	◊	◊	◊	◊
Modeling and Simulations	**2,500**						
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	**7,500**	**0**	**7,500**	**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	**1A08G**	**NextGen - System Safety Management Transformation**	**$16,300,000**

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

Although this budget request is a new start in FY 2009, this research will be leveraging the ongoing program System Safety Management/Aviation Safety Risk Analysis (A11.h). The scope of the ASIAS initiative being developed within that Program using RE&D funds is for near-term research initiatives. The long-term goal of the ASIAS effort is to reduce the number of aviation accidents and incidents through systemic sharing of sharing and proactive analysis of safety information. This will be done by developing a secure, 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.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Safety Management Systems

- 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

- 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

- 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 PROGRAM REQUEST:

The FY 2010 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 begin on the development of a National Level System Safety Assessment working prototype that will proactively identify emerging risk across the proposed NextGen system. Research will continue on developing 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 and contributing factor analyses and risk assessment. NextGen member agency and additional stakeholder aviation safety information needs will be included. Research supports operational implementation by 2025.

KEY FY 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Safety Management Systems

- Develop an action plan and data requirements that support a national level demonstration of SMS.
- Develop an action plan and system requirements that support the OEM evaluation criteria related to design activities within Safety Assurance and SMS.

Aviation Safety Information Analysis and Sharing (ASIAS)

- Begin implementing enhanced ASIAS, including the selected support architecture and requirements for information security, near real-time operations, and new and expanded participants.
- 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.

System Risk Assessment

- Complete identification of characteristics of the NAS which should be assessed for risk.
- Continue determining requirements for NextGen prognostic risk assessment and risk management tools.
- Promote guidance on taxonomy, analytical methods and integrated evaluation applications that ensure that consistent risk assessment processes are employed throughout AVS.

System Safety Assessment

- Extend baseline risk assessment process to incorporate human performance and infrastructure assessment modules, including airport surface and terminal area airspace specific data.
- Extend safety performance assessments for mid-term concepts (2018) NextGen implementation program in addition to long-term NextGen plan.
- Extend application of concept demonstration of the integrated assessment process to include demonstration program data collection, risk baseline comparison using demonstration results, translation to national system impact assessment for mid-term concept NextGen enhancements.
- Conduct a validation test on human performance and safety operating characteristic measures as evaluation tools and real-time trend indicators.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	0
FY 2009 Request	16,300
FY 2010 Request	16,300
Out-Year Planning Levels (FY 2011-2014)	72,000
Total	104,600

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts					
System Safety Management Transformation	0	0	0	16,300	16,300
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**16,300**	**16,300**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	16,300	16,300
Total	**0**	**0**	**0**	**16,300**	**16,300**

1A08G - NextGen - System Safety Management Transformation Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
System Safety Management Transformation							
Safety Management Systems	**2,000**						
Develop selected prototype solutions based on National SMS requirement		◆	◊	◊	◊		
Assess integration of industry SMS with FAA's internal SMS and oversight responsibilities		◆	◊				
ASIAS	**7,000**						
Develop ASIAS ConOps, with expanded scope		◆					
Baseline expanded scope of ASIAS		◆					
Conduct gap analysis		◆					
Develop ASIAS Implementation Plan		◆					
Conduct ASIAS policy research		◆	◊				
Develop ASIAS Enterprise Architecture		◆	◊	◊	◊		
Develop and validate ASIAS training curriculum			◊	◊	◊	◊	
Further expand scope of ASAIS and develop ConOps, baseline, gap analysis, and implementation plans			◊	◊	◊	◊	◊
System Risk Management	**2,000**						
Identify characteristics of the NAS which should be assessed for risk		◆	◊				
Determine requirements for NextGen prognostic risk assessment and risk management tools		◆	◊	◊			
System Safety Assessments	**7,000**						
Develop prognostic safety assessment methods for systems and operations		◆	◊				
Baseline risk assessment for system-wide risks for current operations		◆	◊	◊			
Conduct initial safety assessments of proposed concepts, algorithms, and technologies		◆	◊	◊			
Proof of concept demonstration of an assessment process on new NextGen technologies and procedures		◆	◊	◊			
Develop predictive, conceptual-level, safety assessment method for complex systems			◊	◊			
Estimate the change in safety risk resulting for changes in ATO NGIP domain			◊	◊	◊	◊	◊
Operational Safety Assessments	**1,000**						
Complete an OSED of NextGen			◊	◊	◊	◊	◊
Total Budget Authority:	**16,300**	**16,300**	**16,300**	**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	**4A09A**	**Center for Advanced Aviation Systems Development (CAASD)**	**$23,266,000**

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 the 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 under a Sponsoring Agreement with the MITRE Corporation.

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 has supported the following accomplishments:

- Developed detailed cross-domain operational and technical evolution plans for transitioning to proposed Performance-Based Air Traffic Management concepts for the mid-term. Assess and coordinate user benefits (e.g. capacity) that may be realized from the concepts. Initiate development of terminal concept extensions to the current scope of the overall Performance-Based Air Traffic Management concept that could further enable transition to NextGen.
- Developed and evaluated an evolving set of simulation capabilities and curriculum changes that can be integrated by the FAA into the overall controller training process to improve the overall controller training process to improve the quality and consistency of training, reduce the training time and costs to certify a controller, and facilitate a more effective operational transition of the implementation of the NextGen solutions. Based on the success of these capabilities at ZID, the FAA has recommended the inclusion of speech recognition and voice synthesis capabilities in the training system requirements for the ERAM Program.
- 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. Address 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. This will help the FAA to move forward with the implementation decision based on the benefits associated with safely increasing departure capacity at relevant airports.

- Provided technical and systems 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 government operators of UASs.
- Conducted several HITLS and analyses to further refine the next stage of Merging and Spacing (M&S)/Continuous Descent Arrival (CDA) concepts, algorithms, and simulations to allow the applications' benefits to be expanded, thus providing additional benefits to the airline 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 industry (collaboration in support of development of a UAT Beacon Radio for UAS);
- Embry Riddle Aeronautical University, Lockheed-Martin, NASA Ames & Langley, FAA Technical Center, UPS, Boeing, Federal Express, Crown Consulting, and Raytheon (development of the AviationSimNet standard for distributed Air Traffic Management simulation);
- EUROCONTROL (future ATM research information exchange and flight object interoperability proposed standard);
- George Mason University, Interdisciplinary Center for Economic Science (economic analyses);
- Joint University Program (research on National Airspace System capacity and NextGen concepts);
- Massachusetts Institute of Technology, Engineering Systems Division (developing tools & techniques for enterprise systems engineering);
- 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 Ames (continuous descent arrivals and merging & spacing concepts);
- NASA Langley (wake vortex and surface issues - capacity improvement);
- The National Center of Excellence for Aviation Operations Research (NEXTOR) (National Airspace System capacity analyses and operations research);
- New Mexico State University Physical Sciences Laboratory (research on UAS operations in the NAS);
- Santa Fe Institute (research on complexity and complex systems engineering);
- United Parcel Service (research on techniques for merging and spacing);
- University of North Dakota (research on ground radar surveillance of UAS);
- University of Virginia (Software Assurance)
- Virginia Polytechnic Institute and State University (system capacity analysis & modeling);
- The Volpe National Transportation Systems Center (operational evaluation of Air Traffic Management research topics);
- University of Alaska at Anchorage (ADS-B integration on UAS and operational applications);
- North Carolina Department of Transportation Aviation Division (ADS-B technology demonstrations and operational applications); and
- Aurora Flight Sciences (ADS-B integration on UAS and operational applications).

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 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Enhanced the en route Trainer prototype with additional student performance measures and ITS capabilities that include additional real-time performance feedback and skill development aids. These will be assessed at ZID during developmental training. Evaluation data supports enrouteTrainer prototype capability technology transfer and investment decision.
- Developed additional capabilities (technology, tools, and strategies) that will help the controller perform tasks for the mid-term and post mid-term concept of operations. Conduct HITL evaluations with FAA 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 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 the FAA move forward with the implementation of new procedures that will safely increase departure capacity at relevant high density airports.
- Provided enhanced en route data for the FAA to identify major issues and to facilitate investment and resource decisions.
- Provided technical and systems 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 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 en route mid-term concept. Detailed algorithmic analyses determine the sensitivity of key performance metrics to algorithm parameters (e.g., problem resolution). Evaluations and analyses of future concepts and capabilities provide operational understanding for deciding the evolution path of NextGen capabilities.

FY 2010 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 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 improved, 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 to provide better 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 UASs.
- Provide technical and system engineering analysis for 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 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 ASIAS, will result in early detection of emerging safety trends and permit early intervention by FAA and industry.
- Provide detailed concept and capability assessment as input to the FAA's down 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 justify 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 to identify major issues and to facilitate investment and resource decisions.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	236,732
FY 2009 Appropriated	22,932
FY 2010 Request	23,266
Out-Year Planning Levels (FY 2011-2014)	96,167
Total	379,097

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Center for Advanced Aviation Systems Development (CAASD)	37,895	30,100	24,640	22,932	23,266
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**37,895**	**30,100**	**24,640**	**22,932**	**23,266**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	37,895	30,100	24,640	22,932	23,266
Total	**37,895**	**30,100**	**24,640**	**22,932**	**23,266**

4A09A - Center for Advanced Aviation System Development Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Research, Engineering and Development	**23,266**						
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 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	**23,226**	**22,932**	**23,226**	**23,226**	**23,755**	**24,314**	**24,872**

◆ - 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: Program outputs during the first two years have been focused on low-cost, rapid-response projects on urgent airport problems:

FY 2007:

- Produced a report that explores alternative financing options and revenue sources currently available or that could be available in the future to airport operators, stakeholders, and policymakers. The report examines capital funding and revenue sources, as well as various finance mechanisms for airports. (ACRP Synthesis 1)
- Produced a report that examines the state of airport forecasting methods. Areas of discussion include: common aviation metrics, aviation data sources, issues in data collection and preparation, and special data issues at non-towered airports. In addition the report reviews forecast

uncertainty, accuracy, issues of optimism bias, and options for resolving differences when multiple forecast are available. (ACRP Synthesis 2)

- Produced a report that explores the different methods used by states, airports, and metropolitan planning organizations (MPOs) for counting and estimating aircraft operations at non-towered airports. The report also examines the new technologies that enable those counts and estimates. (ACRP Synthesis 4)

FY 2008:

- Produced a report containing new and updated documentation of the characteristics of ground access markets to airports. This will provide airport managers with user-friendly, concise, and accurate documentation concerning changing trends in the area of airport ground access. (ACRP Report 2, formerly 11-02/T2)
- Airport Ground Access Mode Choice Models. (ACRP Synthesis 5, formerly 11-03 / S03-02)
- Airport Economic Impact Methods and Models. (ACRP Synthesis 7, formerly 11-03 / S03-03)
- Common Use Facilities and Equipment at Airports. (ACRP Synthesis 8, formerly 11-03 / S10-02)
- Effective Rubber Removal Techniques to Minimize Damage on Grooved Runways. (ACRP Synthesis 11, formerly 11-03 / S09-01)

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fast, Flexible, and Efficient

- Guidebook for Airport Capital Project Delivery Systems Publication of Project. (ACRP 01-05)
- U.S. Airport Passenger-Related Processing Rates. (ACRP 03-02)
- Guidelines for the Collection and Use of Geospatially Referenced Data for Airfield Pavement Management. (ACRP 09-01)
- Evaluating Airport Parking Strategies and Supporting Technologies. (ACRP 10-03)

Human-Centered Design

- Guidebook for Developing and Managing Airport Contracts. (ACRP 01-02)
- Recommended Practices to Collect and Integrate Airport Operational and Financial Data. (ACRP 01-03)
- Guidebook for Airport-User Survey Methodology. (ACRP 03-04)
- Spreadsheet Models for Airport Terminal Planning and Design. (ACRP 07-04)

FY 2010 PROGRAM REQUEST:

Vision 100 authorized $10 million per year for ACRP. The FAA has requested $15 million for ACRP in FY 2010 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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Fast, Flexible, and Efficient

- Passenger Space Allocation Guidelines for Planning and Design of Airport Terminals Project Data. (ACRP 03-05)
- Guidebook for Planning and Implementing Automated People Mover Systems at Airports. (ACRP 03-06)
- Guidebook for Measuring Performance of Automated People Mover Systems at Airports. (ACRP 03-07)
- Innovative Approaches to Addressing Aviation Capacity Issues in Coastal Mega-Regions. (ACRP 03-10)
- Guidebook for Preparing Peak-Period and Operational Profiles to Improve Airport Facility Planning and Environmental Analyses. (ACRP 03-12)
- Airport Passenger Conveyance System Usage/Throughput. (ACRP 03-14)
- Effects of Constrained Public and Employee Parking on Airport Access. (ACRP 10-06)
- Airport System Planning Practices. (ACRP 11-03 / S03-04)

Human-Centered Design

- Guidebook for Managing Small Airports. (ACRP 01-01)
- Marketing Techniques for Small Airports. (ACRP 01-04)
- Guidebook for Developing an Airport Performance-Measurement System. (ACRP 01-06)
- Airport/Airline Agreements and Rate Methodologies—Practices and Characteristics. (ACRP 01-07)
- Developing Best Management Practices-Airport Leasing Policy and Metrics for Evaluating Private Investments on Airports. (ACRP 01-08)
- Passenger Air Service Development Techniques. (ACRP 03-08)
- Guidebook for Strategic Planning in the Airport Industry. (ACRP 03-09)

Situational Awareness

- Understanding Airspace, Objects, and Their Effects on Airports. (ACRP 03-13)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	14,950
FY 2009 Appropriated	5,000
FY 2010 Request	5,000
Out-Year Planning Levels (FY 2011-2014)	20,000
Total	44,950

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Airport Cooperative Research - Capacity	4,950	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	**4,950**	**5,000**	**5,000**	**5,000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	4,950	5,000	5,000	5,000	5,000
Total	**4,950**	**5,000**	**5,000**	**5,000**	**5,000**

Airport Cooperative Research - Capacity Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Airport Cooperative Research Program							
Capacity-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◊	◊	◊	◊	◊
Airport Capital Project Delivery Systems		◆					
Airport Passenger Processing Rates		◆	◊				
GIS Data for Airfield Pavement Management		◆					
Airport Parking Strategies and Technologies		◆					
Collection of Airport Operational and Financial Data		◆					
Airport User Survey Methodology		◆					
Aviation Capacity in Coastal Mega-Regions		◆	◊				
Automated People Mover Performance		◆	◊				
Automated People Mover Planning and Implementation		◆	◊				
Airport Peak-Period Operational Profiles		◆	◊				
Airport Management – Contracts /Software/ Revenue		◆					
Small Airport Management BMPs		◆	◊				
Constrained Airport Public and Employee Parking		◆	◊				
Enhancing Airport Land Use Compatibility		◆	◊				
Airport System Planning Practices		◆	◊				
Developing Airport Strategic Plans		◆	◊				
Airport Terminal Design		◆	◊	◊			
Small Airport Marketing Techniques		◆	◊				
Airport Performance Measurement Systems		◆	◊				
Airport Impacts of Very Light Jets		◆	◊				
Airspace Restrictions and Impact on Airport Performance		◆	◊				
Improving Airport Ground Access		◆	◊				
Aviation Forecasting Techniques		◆					
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 conducts research to examine the impact an airport has on the surrounding environment and advances the science and technology for creating an environmentally friendly airport system. Areas of focus include the study of airport-related hazardous air pollutants, airport impact on climate change, alternative aviation fuels, and advanced noise and emissions models.

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 2008:

- Conducting an energy-use study of Terminals B and D at Dallas-Fort Worth Airport. This effort will provide 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)

- Impacts of Airport Pavement Deicing Products (PDPs) on Aircraft and Airfield Infrastructure. (ACRP Synthesis 6, formerly 11-03 / S10-03)
- Effects of Aircraft Noise: Update on Selected Topics. (ACRP Synthesis 9, formerly 11-03 / S02-01)
- Airport Sustainability Practices. (ACRP Synthesis 10, formerly 11-03 / S02-02)

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Clean and Quiet – Baseline Measurement

- Airport-Related Hazardous Air Pollutants Analysis. (ACRP 2-03)
- Research Needs Associated with Particulate Emissions at Airports. (ACRP 2-04)

Clean and Quiet – Threshold Levels

- Summarizing and Interpreting Aircraft Gaseous and Particulate Emissions Data. (ACRP 02-04A)
- Guidebook on Preparing Airport Greenhouse Gas (GHG) Emissions Inventories. (ACRP 02-06)

Clean and Quiet – Reduction Techniques

- Alternative Aircraft and Airfield Deicing and Anti-Icing Formulations with Reduced Aquatic Toxicity and Biological Oxygen Demand. (ACRP 02-01)
- Managing Runoff from Aircraft and Airfield Deicing and Anti-Icing Operations. (ACRP 02-02)
- Handbook for Analyzing the Costs and Benefits of Alternative Turbine Engine Fuels at Airports. (ACRP 02-07)
- Optimizing the Use of Aircraft Deicing and Anti-Icing Fluids. (ACRP 10-01)

Human-Centered Design

- Guidebook for Airport Operators on Community Responses to Aircraft Noise. (ACRP 02-05)

FY 2010 PROGRAM REQUEST:

Vision 100 authorized $10 million per year for ACRP. The FAA has requested $15 million for ACRP in FY 2010 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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Clean and Quiet – Baseline Measurement

- Dependence of Hazardous Air Pollutants Emissions from Idling Aircraft on Ambient Conditions. (ACRP 02-03A)
- Estimate of National Use of Aircraft and Airfield Deicing Materials. (ACRP 11-02 / T10)

Clean and Quiet – Threshold Levels

- Guidance for Quantifying the Contribution of Airport Emissions to Local Air Quality. (ACRP 02-08)

Clean and Quiet – Prediction

- Developing a Comprehensive Work Plan for a Multimodal Noise and Emissions Model. (ACRP 02-09)
- Enhanced Modeling of Aircraft Taxiway Noise—Scoping. (ACRP 11-02 / T8)

Clean and Quiet – Reduction Techniques

- Handbook for Analyzing the Costs and Benefits of Alternative Turbine Engine Fuels at Airports. (ACRP 02-07)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	3,000
FY 2009 Appropriated	5,000
FY 2010 Request	5,000
Out-Year Planning Levels (FY 2011-2014)	20,000
Total	33,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Airport Cooperative Research - Environment	0	0	3,000	5,000	5,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**3,000**	**5,000**	**5,000**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	3,000	5,000	5,000
Total	**0**	**0**	**3,000**	**5,000**	**5,000**

Airport Cooperative Research - Environment Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Airport Cooperative Research Program							
Environment-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◊	◊	◊	◊	◊
Airport Greenhouse Gas Emissions Inventories		◆					
Managing Deicing Runoff		◆					
Cost Benefit Analysis of Alternative Aviation Fuels		◆	◊				
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		◆	◊				
Airport Hazardous Air Pollutants Analysis		◆	◊				
Optimize Alternative Deicing Fluids		◆	◊				
Particulate Emissions Analysis		◆	◊				
Community Attitudes to Aircraft Noise		◆	◊				
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 2007:

- Developing an overview document regarding airport Safety Management Systems (SMS) that defines what such a system is, and provides a summary of existing practice in other countries and industries. (ACRP Report 1, formerly 11-02/T4)
- Producing a report that examines safety and security practices at GA airports. Areas of focus include a discussion of: the resources used in the development of safety and security programs,

the funding sources and issues that determine the amount of money spent on such programs, and the current practices that GA airports use to keep their facilities safe and secure. (ACRP Synthesis 3)

FY 2008:

- Conducting a workshop for airport, airline, and federal government representatives who are involved in responding to potential pandemic events. This activity helps to clarify roles, discuss issues of mutual interest, and identify further coordination activities that are needed. (11-02/T6)
- Guidance for Developing Regionally Coordinated Airport Emergency Plans for CBRNE Events. (ACRP 5-01)
- Improving Stabilization and Use of Aircraft Evacuation Slides at Airports. (ACRP 11-02/T3)
- Quarantine Facilities for Arriving Air Travelers: Identification of Planning Needs and Costs. (11-02/T5)
- Preventing Vehicle/Aircraft Incidents During Winter Operations. (ACRP S04-02)

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Human Protection

- Aircraft Overrun and Undershoot Analysis for Runway Safety Areas. (ACRP 4-01)
- Lightning-Warning Systems for Use by Airports. (ACRP 4-02)
- Guidebook for Approach Light System Hazard Assessment and Mitigation. (ACRP 04-03)
- Exercising Command-Level Decision Making for Critical Incidents at Airports. (ACRP 04-04)
- Airport and Air Carrier Resource Manual: Employees Coping with Traumatic Events. (ACRP 06-01)
- Developing Improved Civil Aircraft Arresting Systems. (ACRP 07-03)

System Knowledge

- A Guidebook for Airport Safety Management Systems (ACRP 04-05)

FY 2010 PROGRAM REQUEST:

Vision 100 authorized $10 million per year for ACRP. The FAA has requested $15 million for ACRP in FY 2010 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 2010 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

Human-Centered Design

- Identification of the Requirements and Training To Obtain Driving Privileges on Airfields. (ACRP S04-03)

Self-Separation

- Best Practices for Improving Airport Ramp Management and Safety. (ACRP 04-07)

Situational Awareness

- Analysis and Best Management Practices for the Prevention of Wildlife Strikes at Small Airports. (ACRP 04-06)
- Airport Signage and Way-finding Information Guidelines. (ACRP 07-06)

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	15,000
FY 2009 Appropriated	5,000
FY 2010 Request	5,000
Out-Year Planning Levels (FY 2011-2014)	20,000
Total	45,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 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 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 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 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Airport Cooperative Research Program							
Safety-Related Research	**5,000**						
Conduct research on selected AOC proposals		◆	◊	◊	◊	◊	◊
Aircraft Overrun and Undershoot Analysis for RSAs		◆					
Airport Lightning-Warning Systems		◆					
Runway Structure Hazard-Mitigation Analysis		◆					
Training of Emergency Response Personnel		◆	◊				
Developing Airport Safety Management Systems		◆					
Airport Emergency Plans for CBRNE Events		◆					
Improved Civil Aircraft Arresting Systems		◆					
Improving Use of Aircraft Evacuation Slides		◆					
Airfield Driving Privilege Requirements		◆	◊				
Improve Ramp Management and Safety		◆	◊				
Airport Signage and Way-finding		◆	◊				
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**	**$10,596**

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 better airport planning, airport design, and through improved pavement thickness design, construction, and maintenance.

Agency Outputs: Federal law requires the FAA to develop standards and guidance material for airport design, 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 ACs 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, 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, 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.

R&D Partnerships:

- FAA-U.S. Army ERDC[*]
- FAA-U.S. Air Force, Tyndall Air Force Base[2]
- FAA-Center of Excellence for Airport Technology, University of Illinois[3]
- FAA-Boeing Company, Cooperative Research and Development Agreement ($7 million Boeing/$21 million total for the NAPTF)[4]
- FAA-IPRF[5]
- FAA-Auburn University[4]
- FAA-Rowan University[4]

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[2] Interagency agreement or Memorandum of Agreement
[3] Partnership through matching funds
[4] Cost Sharing
[5] Cooperative Agreement

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:

- Built the NAPTF and dedicated it on April 12, 1999; began testing at the facility on June 4, 1999.
- In FY 2004, completed reconstruction and full-scale traffic testing of three concrete pavement test items at the NAPTF.
- In FY 2005, completed overlay construction at the NAPTF and conducted full-scale traffic testing of three asphalt concrete overlay test sections (rubblized sections as well as conventional overlay).
- Issued Layered Elastic Design (LED) FAA version 1.3, a pavement design-standard software based on NAPTF-generated data, to allow the introduction of the Airbus A380 and other new aircraft into the fleet mix.
- In FY 2006, delivered FAARFIELD 1.0 (FAA Rigid and Flexible Iterative Elastic Layered Design), a new desktop computer program for pavement thickness design that incorporates 3D finite element models of pavement structures
- Conducted technical workshops in airport pavement design using LEDFAA version 1.3 and the beta version of FAARFIELD (FEDFAA).
- Maintained an airport pavement database containing full-scale test data collected at the NAPTF, and gave on-line access to international researchers.
- Established or expanded cooperative programs with non-profit research foundations, located at the Innovative Pavement Research Foundation (IPRF) and Auburn University, to conduct research into concrete and asphalt airport pavement technology.
- In FY 2006, completed the first phase of full-scale testing of concrete-on-concrete overlay pavements at the NAPTF through the IPRF cooperative research program.
- Established a new Interagency Agreement with the U.S. Army Engineer Research and Development Center (ERDC) to cooperate on research projects of interest to both military and civil aviation.
- In FY 2005, released DOT/FAA/AR-04/46, a technical report entitled “Operational Life of Airport Pavements,” that addresses the extent to which current FAA thickness design standards for airport pavements conform to the Agency’s 20-year life requirement.
- Released ProFAA, a software program that combines an inertial profiler with simulations of the standard outputs from other commonly used devices, to analyze runway smoothness.
- In FY 2007, delivered the updated FAARFIELD 1.1 (FAA Rigid and Flexible Iterative Elastic Layered Design), a desktop computer program for pavement thickness design that incorporates 3D finite element models of pavement structures.
- In FY 2007, delivered the updated and rewritten AC 150/5320-6E, “Airport Pavement Design and Evaluation” to include the new pavement design program FAARFIELD.
- In FY 2007, alpha factors used in the ICAO (International Civil Aviation Organization) ACN/PCN method developed and proposed by the FAA were accepted by IACO.
- In FY 2008, released DOT/FAA/AR-08/01, a technical report entitled “New Alpha Factor Determination as a Function of Number of Wheels and Number of Coverages,” that addresses the new accepted alpha factors.

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Continued analyzing full-scale data from the NAPTF.
- Improved upon airport pavement thickness design package, including 3D finite element structural models, using FAARFIELD, an analytical program developed for the Agency.
- Completed a final report on rubblization of airfield pavements.
- Started development of a web-based application for airport pavement database management system.
- Developed models for airport funding strategies and passenger surveys.

- Continued full scale testing and analyze effects of subgrade quality and aircraft wheel gear spacing.
- Performed full scale testing and analyze effects of high tire pressure of aircraft wheels.

FY 2010 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 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.
- Conduct technical workshops in pavement roughness criteria using PROFAA.
- Develop conceptual guidelines and computer tools for terminal building design.
- 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.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	54,994
FY 2009 Appropriated	9,109
FY 2010 Request	10,596
Out-Year Planning Levels (FY 2011-2014)	42,384
Total	117,083

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Airports Technology Research – Capacity	6,725	7,337	7,220	7,536	8,856
Personnel Costs	1,200	1,318	1,535	1,573	1,740
Other In-house Costs	0	0	0	0	0
Total	**7,925**	**8,655**	**8,755**	**9,109**	**10,596**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	7,925	8,655	8,755	9,109	10,596
Total	**7,925**	**8,655**	**8,755**	**9,109**	**10,596**

Airport Technology Research - Capacity Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Airport Technology Research – Capacity Goal							
Airport Technology Research - Capacity	**8,856**						
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			◊	◊	◊	◊	◊
Develop conceptual guidelines and computer tools for terminal building design		◆	◊				
Develop models for airport funding strategies, and passenger surveys		◆					
Personnel and Other In-House Costs	**1,740**						
Total Budget Authority	**10,596**	**9,109**	**10,596**	**10,596**	**10,596**	**10,596**	**10,596**

◆ - 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**	**$11,876**

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-USDA, National Wildlife Research Center, Sandusky, Ohio*.
- FAA-Agencies of Canadian Government (for pavement technology and winter operations safety)**.
- FAA-NASA (for joint runway traction research)*.

- FAA-Port Authorities of New York and New Jersey (for design and construction of aircraft arrestor bed)*.
- FAA-industry - soft-ground arrestor materials)**.

* Inter-agency agreement or Memorandum of Agreement (MOA)
** Cost Sharing

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:

- Installation of the Engineered Materials Arresting System (EMAS) long-term durability test bed;
- Final report on anti-icing overlay at Chicago O'Hare during winter operations;
- Final report on a polyurea alternative marking material;
- Evaluation of a prototype foreign object debris (FOD) detection radar at a large airport;
- Report on installation criteria for taxiway centerline lights;
- Evaluation of small airport firefighting systems; and
- Demonstrated use of aircraft lighting to make aircraft on the ground more conspicuous.
- Construction of a full scale New Large Aircraft fire test facility.

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

FY 2009 MAJOR ACTIVITIES AND ANTICIPATED ACCOMPLISHMENTS:

- Studied Next Generation High Reach Extendible Turret.
- Validated commercial avian radars.
- 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
- Evaluated effectiveness of a prototype alternative runway groove shape.
- Completed Study of Engineered Material Arresting System cold region freeze-thaw durability
- Completed Testing of Effects of Runway De/Anti-Icing Chemicals on Traction
- Initiated Experimentation on Alternative Arresting System Concepts

FY 2010 PROGRAM REQUEST:

The Airport Technology FY 2008 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 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 study, and develop final statistical analysis for deviation behavior of all aircraft design groups.
- 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.
- Complete Evaluation of Contaminant Drag Measurement Devices
- Complete Prototype Design of Dynamic Internal Drum Tire Pavement Test Machine
- Complete Report on Avian Radar Validation Study
- Complete Evaluation of Alternative Arresting System Concepts

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2008)	52,310
FY 2009 Appropriated	10,239
FY 2010 Request	11,876
Out-Year Planning Levels (FY 2011-2014)	47,504
Total	121,929

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Airports Technology Research – Safety	8,375	7,897	8,312	8,465	10,135
Personnel Costs	1,200	1,318	1,493	1,774	1,741
Other In-house Costs	0	0	0	0	0
Total	**9,575**	**9,215**	**9,805**	**10,239**	**11,876**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	9,575	9,215	9,805	10,239	11,876
Total	**9,575**	**9,215**	**9,805**	**10,239**	**11,876**

Airport Technology Research - Safety Product and Activities	FY 2010 Request ($000)	Program Schedule					
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Airport Technology Research – Safety Goal							
Airport Technology Research - Safety	10,135						
Complete study of Next Generation High Reach Extendible Turret.		◆					
Complete avian radar validation study.		◊	◆				
Complete evaluation of alternative runway groove shape on asphalt and concrete runway surfaces.		◊	◆				
Complete evaluation of automated FOD detection system technology.		◊	◆				
Complete evaluation of Taxiway Deviation Study for all aircraft design groups.		◊	◆				
Complete agent quantity research for NLA.		◊	◆				
Initiate full scale testing of composite fires at NLA Facility, Tyndall AFB, Panama City, FL.			◊	◆			
Complete Report on New Photoluminescent Technology for Visible Surface Markings		◊	◆				
Complete Study of Engineered Material Arresting System cold region freeze-thaw durability.		◆					
Complete Testing of Effects of Runway De/Anti-Icing Chemicals on Traction.		◆					
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 evaluation of second level access vehicle at New Large Aircraft Test Facility.		◊	◆				
Complete Evaluation of Contaminant Drag Measurement Devices		◊	◆				
Complete Prototype Design of Dynamic Internal Drum Tire Pavement Test Machine		◊	◆				
Complete Evaluation of Alternative Arresting System Concepts		◊	◆				
Personnel and Other In-House Costs	1,741						
Total Budget Authority	11,876	10,239	11,876	11,876	11,876	11,876	11,876

◆ - 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**	**$145,000**

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:

- Perform a comprehensive survey of existing technologies available for determining wind conditions from the upper troposphere to the stratosphere (50,000 to 100,000 feet). This project will address possible modifications of radar wind profilers to obtain data on winds for greater altitudes than currently available. This is a continuation of 2008 research.
- Conduct a comprehensive review of wind requirements to support the launch of unguided suborbital launch vehicles that use wind weighted systems. This project will survey the adequacy of existing winds databases with particular emphasis on temporal winds to ensure proper considerations of winds to support analysis products and day of launch decision making. This is a continuation of 2008 research.
- Prevent safety incidents (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically Hydrogen Peroxide, H2O2, and Nitrous Oxide, N2O) 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.
- Review integrated operations of reusable launch vehicles (RLVs) from spaceports, joint use airport/spaceports, as well as the airspace surrounding those facilities. This review shall provide recommendations on how to safely integrate and conduct routine RLV operations from these locations, to include minimum airspace and airport/spaceport restrictions that must be in place.
- Construct a series of scenarios to describe a broad spectrum of point-to-point suborbital missions. These scenarios will address specific regulatory measures that could be needed and explore international cooperation issues relevant to each scenario. The study to develop these scenarios will include market research to address potential demand implications for space tourism, transportation, and cargo delivery services.
- Survey and analyze existing and planned spaceport infrastructure needs. The assessment will categorize and catalogue projects that would be incorporated into future developmental plans. Estimated costs of the projects will be identified, as well as requirements for project planning and studies, environmental assessments, security requirements, and infrastructure considerations.

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:

- Recommendation for the best mix of wind technologies, atmospheric models, or best practices for obtaining wind data primarily for small RLVs operating out of remote launch sites.

- Delineation of wind requirements to support analysis of unguided suborbital launch vehicles using a wind weighting system, and recommendations with regards to the requirements for wind databases at launch site locations.
- 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.
- Identification of potential interface and safety issues associated with RLV launch and re-entry operations from existing and envisioned airports/spaceports.
- Enhancing safety for suborbital missions by identifying future needs of air traffic control (ATC). Development of requisite information to determine whether to request an appropriation to fund a spaceport grant program.
- A requirements document of infrastructure needs to safely conduct future RLV operations, i.e. unique visual approach slope information requirements, runway marking requirements, navaid requirements, etc.

Research Goals:

- To conduct a study that will assess existing technologies for determining wind conditions from the upper troposphere to the stratosphere in support of reusable launch vehicle launches in remote locations. This study will focus on identifying available technologies for retrieving wind data within the 50,000 – 150,000 ft range. The study will also investigate the sensitivities of each technology, and compare them to atmospheric model data in terms of accuracy, representativeness, and other benefits.
- The goals of the research to be conducted by Aerospace Corporation on behalf of the FAA are to clarify the impact of temporal winds on launch operator requirements for safety clear out zones for the launch of unguided suborbital launch vehicles. In addition the research will show whether wind databases which exist at these launch sites, monthly and temporal, are suitable for determining safety clear out zones for the launching of unguided suborbital launch vehicles using a wind weighting system.
- 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 H2O2 and N2O 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 H2O2 and N2O 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 develop initial guidelines and considerations for insuring safe commercial space transportation operations at airports/spaceports.
- To explore possible suborbital 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 an initial list of possible spaceport infrastructure needs/requirements to insure safe commercial space transportation operations.

Customer/Stakeholder Involvement:

- The research project concerning high altitude wind measurement is requested by the Office of Commercial Space Transportation to be performed by Aerospace Corporation. AST will review the findings of Aerospace Corporation and will work with them to perform analysis to redefine the knowledge base of best mix of wind technologies and modeling, or best practices for obtaining wind data at high-altitudes, to support analysis products and day of launch decision making to support the launch of both RLVs and ELVs.

- The research project concerning temporal winds database study is requested by the Office of Commercial Space Transportation and to be performed by Aerospace Corporation. AST will review the findings of Aerospace Corporation and work in tandem with Aerospace Corporation to perform analysis to redefine wind requirements to support the launch of unguided suborbital launch vehicles using a wind weighted system.
- 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.
- The identification of how RLVs will routinely operate, what airspace they will operation in, today's users of that airspace, and the needs of the pilots and operators of vehicles to safely integrate into common runway/spaceport environs will assist air traffic organizations, airport organizations, state and federal planners, safety professionals, and representative organizations such as the Personal Spaceflight Federation.
- Within the ISU/AST partnership, recent studies have incorporated elements of suborbital transportation. This knowledge and understanding will be a major contributor to this study and the scenarios generated from this work.
- The project will generate interfaces with launch site/spaceport operators, as well as permit and license holders. Commonality of their needs will allow airport/spaceport planners to better allocate funds.

R&D Partnerships:

- AST will partner with the Aerospace Corporation to conduct the research on high altitude wind measurement technology. This project is expected to generate interfaces with launch site operators and launch operators launching at licensed launch sites who do not have the capability of measuring winds at high altitudes.
- AST will partner with the Aerospace Corporation to investigate the impact of monthly and temporal winds on safety clear zones at commercially licensed launch sites. This project is expected to provide new methodology or additional capability for evaluating temporal winds at commercially licensed launch sites.
- 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 H_2O_2 and N_2O.
- 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.
- Likely will take advantage of the ISU/AST partnership and incorporate elements of the recent ISU study on suborbital transportation. Currently exploring other agencies to partner with in addition.

Accomplishments:

FY 2008 was the first year of funding for the activities known as:

- “Informed Consent”
    - Completed in FY 2008; Accomplishment Summary included in Appendix B
- “Temporal Winds Database Study”*
- “Low Cost ,Field Portable, High Altitude Wind Profiler”*

*These projects were extended into FY 2009, and are included in this NARP submission.

FY2009 is the first year of funding for the activities known as:

- “Lessons Learned in Handling Nontraditional Monopropellants/Oxidizers”
- “Application of GPS to Space Transportation Technologies”
- “RLV Operations: Airspace, Airport, and Spaceport Considerations”
- “Point-To-Point Suborbital Missions”
- “Critical Infrastructure Needs of Spaceports”

FY 2009 Major Activities and Anticipated Accomplishments:

- Completed the study that lead to methodologies or best practices for obtaining upper level wind data at commercially licensed launch sites who do not have the capability of measuring winds at high altitudes.
- Generated findings which will support the decision making on purchasing wind measuring equipment that in turn supports analysis products and day of launch decision making regarding public safety.
- 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 H2O2 and N2O;

  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.
- The research findings will enhanced the safety of the National Airspace System (NAS) during RLV operations by identification of operational requirements and commensurate airspace restrictions.
- Published 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.
- The requirements document is a basis for the incorporation of identified infrastructure needs in airport/spaceport plans. It will serve as a foundation for the future research that may need to be accomplished.

FY 2010 Program Request:
For all projects, authorized Commercial Space Transportation research is currently included in the Safety and Operations budget.

Key FY 2010 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 1983-2008)	328,000
FY 2009 Appropriated	145,000
FY 2010Request	145,000
Out-Year Planning Levels (FY 2011-2014)	580,000
Total	1,198,000

Budget Authority ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Contracts:					
Commercial Space Transporation Safety	75	125	125	145	145
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**75**	**125**	**125**	**145**	**145**

OMB Circular A-11, Conduct of Research and Development ($000)	**FY 2006 Enacted**	**FY 2007 Enacted**	**FY 2008 Enacted**	**FY 2009 Enacted**	**FY 2010 Request**
Basic	0	0	0	0	0
Applied	38	63	63	73	73
Development (includes prototypes)	38	63	63	73	73
Total	**75**	**125**	**125**	**145**	**145**

.

Commercial Space Transportation Safety Product and Activities	**FY 2010 Request** ($000)	**Program Schedule**					
		FY 2009	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Commercial Space Transportation Safety	**$145**						
Temporal Winds Database Study							
Report that delineates wind requirements to support analysis of unguided suborbital launch vehicles using a wind weighting system, and recommendations with regards to the requirements for wind databases at launch site locations.		◆					
Low Cost, Field Portable, High Altitude Wind Profiler							
A recommendation of the best mix of wind technologies and modeling, or best practices for obtaining wind data (model data) for small RLVs operating out of remote launch sites.		◆					
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.		◆	◇				
RLV Operations: Airspace, Airport, and Spaceport Considerations							
Identification of potential interface and safety issues associated with RLV launch and re-entry operations from existing and envisioned airports/spaceports.		◆	◇				
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.		◆	◇				
Critical Infrastructure Needs of Spaceports							
A requirements document of infrastructure needs to safely conduct future RLV operations, i.e. unique visual approach slope information requirements, runway marking requirements, navaid requirements, etc.		◆	◇				
Total Budget Authority	**$145**	****$145**	**$145**	**$145**	**$145**	**$145**	**$145**

◆ - Activities Accomplished ◇ - Activities Planned

NOTES: OUT YEAR NUMBERS ARE FOR PLANNING PURPOSES ONLY. ACTUAL FUNDING NEEDS WILL BE DETERMINED THROUGH THE ANNUAL BUDGET PROCESS.

APPENDIX B: FY 2008 R&D Annual Review: Accomplishments by FAA R&D Goals

Table of Contents

Introduction

This appendix showcases the Federal Aviation Administration's (FAA's) research and development accomplishments in 2008 that are contributing to the achievement of the ten research and development (R&D) goals described in Chapter 2.

Funding for programs supporting the Separation Assurance R&D goal starts in fiscal year (FY) 2009, so no accomplishments are reported at this time.

The majority of activities under the World Leadership R&D goal are drawn from the other nine goals. The accomplishments for those activities are shown under the other sections in this appendix.

Fast, flexible, and efficient

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

Ground Access to Major Airports by Public Transportation

Airports around the United States, and around the world, are dealing with the challenge of improvement to the ground access systems. In the past five years several major American airports have invested hundreds of millions of dollars in new capital facilities to connect their facilities with the rest of the region's public transportation systems.

To deal with this issue, the Transit Cooperative Research Program (TCRP) six years ago undertook two major studies of the issue of airport ground access, published as TCRP Report 62 and TCRP Report 83. These two studies presented accurate, up-to-date descriptions of major airport access projects and strategies around the world. With the creation of the Airport Cooperative Research Program, there is an opportunity to revise, update, and build upon a substantial body of work, which is now somewhat out of date.

The objectives of this project are to: 1) improve the documentation of all airport ground access projects, with an emphasis on those which have occurred since the publication of TCRP Report 62 in 2000; 2) improve the documentation of changes in airport access strategies since the publication of both reports with a review of recent developments in such areas as downtown check- in, automation of the check in process, and integration with existing regional rail infrastructure; 3) provide airport managers with user-friendly, concise, and accurate documentation concerning trends in the area of airport ground access; and 4) support and facilitate the dissemination of the latest information relative to airport managers through media such as printed reports, and PowerPoint presentations to relevant professional organizations. The proposed research will create new updated, timely documentation of the characteristics of ground access markets in a manner which builds upon existing products already produced under the TCRP. (Airport Cooperative Research – Capacity)

Common Use Facilities and Equipment at Airports

As airports work with airlines to increase efficiency, lower costs, and improve customer service, there is considerable interest and activity in transitioning from exclusive-use to common-use facilities. In many cases, common-use refers to information technology applications that allow airlines to manage their passenger operations at any number of gates. This project broadens the concept of common use to include facilities and practices.

Facilities that can be shared to serve the traveling public can include, but are not limited to, lobbies, ticketing, kiosks, baggage systems, hold rooms, gates, loading bridges, aprons, preconditioned air and power, remain over night, rental car facilities, and transportation centers. Common-use practices include, but are not limited to, providing or expanding common-use facilities and disbanding exclusive use facilities, gate utilization monitoring, lease and use agreement modifications, and competition plans. The focus of this project is to compile and list of the types of common use facilities, methods, and practices that improve the success of sharing facilities to increase efficiency, lower costs, and improve customer service as well as the issues that hinder common use.

The intended audience of this guidance includes airport managers considering transition to common use of some facilities. The purpose of this research is to survey airports on their current and planned common-use facilities in order to document the advantages and disadvantages of common-use systems, procedures that require modification to implement common-use, and the participant's actual experience to date. (Airport Cooperative Research – Capacity)

Controller Aids for Aircraft on Terminal Air Navigation Routes

Researchers from the Center for Advanced Aviation System Development (CAASD) completed development of two prototype aids that have the potential to help controllers manage traffic in the area navigation (RNAV) environment by providing additional information on their radar situation displays. The first aid projects an image that conveys the relative position for converging traffic that will help controllers early in coordinating merging RNAV arrivals. The second aid is an automated visual alert to controllers that provides early warning of aircraft deviations from assigned RNAV routing and altitude constraints.

The first controller aid, termed the Relative Position Indicator (RPI), projects an image (symbol) on the radar situation display that conveys the relative position for converging traffic. This allows controllers to manage merging traffic as if it were in-trail and to do so farther from the expected merge point. Early availability of relative position information enables the controller to avoid vectoring and issue subtle control inputs, such as speed control, utilizing the extra distance to allow the input to take effect. Approach controllers could use RPI to manage merges within their airspace as well as to increase awareness of traffic being worked by other controllers that will affect a downstream merge. Traffic Management Coordinators could use RPI to inform runway assignment decisions and to better manage airport configuration changes.

The second controller aid is automation to quickly alert controllers of aircraft deviation from assigned RNAV routing. The prototype monitors each aircraft's position relative to an acceptable position region defined around the RNAV centerline. If the aircraft exits this region, an alert is displayed in the data block for the aircraft on the controller's radar situation display. Compliance to altitude constraints along the RNAV route are also monitored, with the automation issuing an appropriate alert if the aircraft deviates vertically from the RNAV route profile. By helping controllers detect deviations earlier, controllers can quickly contact the pilot and issue a corrective clearance, reducing the probability of conflicts with or disruptions to surrounding traffic. (CAASD)

Equivalent Visual Operations for the National Air Space

The integrity of air traffic operations in the National Airspace System (NAS) depends on the ability to provide visual separation between airborne aircraft, either by controllers in air traffic control (ATC) towers or by aircraft flight crews. Key resources such as airport arrival and departure capacity depend to a great degree on this ability to conduct visual operations.

Operations in the NAS degrade enormously when meteorological conditions do not permit visual operations. Technologies such as Automatic Dependent Surveillance Broadcast (ADS-B), RNAV and required navigation performance (RNP), and advances in wake turbulence technology may enable a recovery of much of this lost capacity if these concepts are harnessed in a creative and integrated way. CAASD researchers formulated over a dozen promising concepts for equivalent visual operations for the NAS and achieved very promising results for one of them. The concepts range from increasing the arrival and departure capacity of single and parallel runways in low visibility, to increasing airspace capacity with more closely spaced routes.

CAASD researchers developed and evaluated an advanced version of a concept for improving arrival capacity of single runways in low visibility conditions called IMC CAVS-S (Cockpit Displays of Traffic Information (CDTI) Assisted Visual Separation for single runway approaches in Instrument Meteorological Conditions). During visual operations to single runways, pilots provide their own separation and spacing on final approach to runways, resulting in significantly more efficient operations to the airport. Although a concept had been developed in the past for enabling pilots to provide CDTI assisted visual separation, concern for potential wake encounters had precluded applying that concept in low visual meteorological conditions (VMC) and IMC. For this advanced concept CAASD developed prototype cockpit tools to allow flight crews to assess and avoid the potential for wake encounters in lower weather conditions. The evaluation, utilizing pilots in CAASD's cockpit simulator, showed that flight crews could use the proposed CAVS tools comfortably below visual approach minima, down to ceilings and visibility of 1,000 feet and 3 nautical miles respectively. The evaluation also indicated that runway arrival capacity may be improved significantly for airports like Los Angeles International when its weather conditions deteriorate below visual approach minima. This first evaluation demonstrated that there is good potential for developing a generalized capability with ADS-B-based CDTI that could significantly back-fill the capacity lost in the NAS when controllers and flight crews cannot use visual separations. (CAASD)

Integrated Departure Route Planning

In daily operations when air traffic demand on the NAS or on specific resources – sectors, routes, and fixes – is predicted to exceed capacity, a variety of traffic management initiatives (TMIs), such as reroutes, miles-in-trail flow restrictions, and ground delay programs are generated by traffic flow management to ensure an expeditious flow of aircraft. This is especially crucial when system capacity is reduced by severe weather. In current operations, with limited automation support, traffic managers must mentally integrate the traffic, weather, and airspace resource information and project that information into the future. This process is difficult and time consuming, often leading to inaccurate information. As a result, TMIs are often too large scale, too inflexible, and/or not effectively used to respond to dynamically changing weather conditions. To maximize traffic throughput while maintaining safety, it is desirable to minimize the impact of TMIs on operations and to implement only those initiatives necessary to maintain system integrity.

CAASD researchers jointly with the Massachusetts Institute of Technology (MIT) Lincoln Laboratory developed a concept and prototype for integrated departure management decision support in convective weather that, for the first time, integrates traffic, weather, and airspace resource information into a common test bed and laboratory prototype, the Integrated Departure Route Planner (IDRP). IDRP combines predictions of weather impact along departure routes, predictions of congestion at departure fixes and in nearby en route airspace, and an automated reroute identification algorithm into a single decision support tool that could help traffic managers implement reroutes for departures blocked by weather or traffic constraints. IDRP first identifies departure flights whose flight plans cannot be executed due to weather or volume constraints, and then searches a set of alternatives acceptable to TFM and airline operations to find a feasible reroute. IDRP also provides automated support and information to help decision makers evaluate and implement different solutions. It takes into account all significant data such as filed flight plans and acceptable alternatives, surface departure queues, predicted convective weather and traffic congestion impacts to routes in the terminal area and nearby en route airspace, and forecast uncertainty.

Initial experiments indicate that an integrated departure route planning capability could reduce the time needed to coordinate, implement, and revise TMIs and departure management plans as weather and traffic situations change dynamically. This could improve significantly system performance. It could also reduce the workload associated with determining 4-D (space & time) intersections of departure traffic flows, translating those impacts to departure times, and determining a suitable alternative departure route for aircraft. (CAASD)

Air Traffic Control Changes in Applying Wake Separations

In September 2008, the FAA approved a national ATC order permitting controllers at specific airports, having closely spaced parallel runways spaced less than 2500 feet apart, to use a new wake mitigation separation procedure. The procedure will allow six to ten more landings on those runways when weather conditions otherwise would have required the use of a procedure that is equivalent to using just a single runway for landing. The procedure is similar to a procedure used in inclement weather for parallel runways separated more than 2500 feet.

The development and approval of this order is based on the wake turbulence data collection and analyses, human in the loop simulations, procedure development, and safety analyses done by the Wake Turbulence Research Team (Volpe National Transportation Systems Center, MITRE CAASD, wake and weather sensor developers, and FAA).

The order is slated for initial implementation at five Next Generation Air Transportation System (NextGen)/Operational Evolution Partnership (OEP) airports (Lambert – St. Louis International Airport – currently authorized via waiver developed in 2007, Cleveland Hopkins Airport, Philadelphia International Airport, Seattle-Tacoma International Airport, and Boston Logan International Airport). (Wake Turbulence)

NextGen Wake Separation Standards, Processes, and Decision Support Tools

In January 2008, a feasibility cost/benefit analysis was completed on a potential concept for an ATC wake turbulence mitigation decision support tool that would allow more landings to an airport's closely spaced parallel runways when weather conditions at the airport require use of instrument approach procedures. Work continues to develop alternative concepts that might yield more benefit to airport operations.

In July 2008, a joint U.S. and European working group completed an initial analysis of potential static wake separation standard sets that could support the increasing number of aircraft designs that are being introduced into the world's air transportation system. The next step is to evaluation further more promising (in terms of capacity enhancing and safety) sets to include human in the loop simulations of their use. (Wake Turbulence)

Wake Turbulence Mitigation for Departures

FAA expanded the models it uses to determine the operational benefits of the Wake Turbulence Mitigation for Departures (WTMD) decision support tool at ten candidate NextGen/OEP airports to enable greater departure capacity for closely-spaced parallel runways (parallel runways spaced less than 2500 feet apart). Algorithm validation tools were developed to evaluate the reliability of the WTMD cross-wind predictions. Data-based wake encounter models, developed to evaluate the safety risk associated with the change in operational ATC wake mitigation procedures at Lambert St. Louis International Airport, were enhanced for use in evaluating the safety risk of using the procedure at other airports with similar runway configurations. Additionally, the model was modified to evaluate the safety risk of WTMD-based ATC departure procedures.

The WTMD decision support tool development was a joint research endeavor with the National Aeronautics and Space Administration (NASA) developing the concept and building the feasibility prototype, MITRE CAASD providing human in the loop simulations of the tool's use and benefit data, Volpe National Transportation Systems Center collecting and analyzing thousands of wake tracks of departing aircraft, the MIT Lincoln Laboratory developing the tool's internal cross wind forecast algorithm, and the FAA – both headquarters and field Air Traffic Organization personnel – detailing and evaluating the use of the proposed decision support tool. (Wake Turbulence)

Airport Traffic Control Tower Simulation Infrastructure Development

Although ATC simulators exist, the FAA did not own an ATC tower (ATCT) research simulator. This lack of infrastructure severely limited the FAA's ability to evaluate future concepts such as those proposed in NextGen. The FAA human factors researchers defined the requirements for a full-scale ATCT simulator, including a set of simulation pilot commands. They used these requirements to create a state-of-the-art ATCT research simulator. This simulator will be used for the systematic evaluation of NextGen ATCT concepts.

Numerous ATC simulators have been developed and marketed. However, the vast majority of ATC simulators are proprietary products developed for simulation and training purposes rather than concept research. The proprietary nature of existing ATC simulators renders them inflexible, expensive, and limited in capabilities regarding rapid prototyping and data collection.

Over the past two years, researchers established basic aircraft surface movement models and defined the requirements for a full-scale ATCT simulator, including a set of simulation pilot commands. A research team added to existing surface movement capabilities developed in the previous years by refining aircraft behavior, bolstering simulation pilot commands, and implementing data collection and reduction capabilities. They expanded the realism by creating new aircraft models and liveries and by creating the foundation to support a 270-degree out-the-window view.

The result of this project is an FAA owned and developed ATCT simulation software platform including underlying software and nine large-screen displays that can support a 270-degree out-the-window view. The ATCT simulator provides a high fidelity representation of airport operations including aircraft models, simulation pilot interface, and commands. The ATCT simulator also includes data collection and reduction applications, and adds a basic Information Display System display to the existing suite of ATCT displays. This ATCT simulation infrastructure will allow the FAA to research concepts such as the Staffed NextGen Tower, digital data communications, and integrated ATCT information displays. (ATC/Technical Operations Human Factors)

Clean and quiet

A reduction of significant aerospace environmental impacts in absolute terms

Airport Particulate Matter Emissions Research

Domestic airports and the aviation-industry partners that rely on these airports must assure compliance with current particulate matter (PM) controls, as called for in existing environmental requirements and state implementation plans and in the National Ambient Air Quality Standards (NAAQS) as enforced by the U.S. Environmental Protection Agency (EPA). In addition, it is anticipated that future standards will be more stringent. In February 2003, the U.S. General Accounting Office (GAO) released a report (GAO-03-252) titled *Aviation and the Environment: Strategic Framework Needed to Address Challenges Posed by Aircraft Emissions*. In this report, the Secretary of Transportation directed the FAA, in consultation with the EPA and NASA, to develop a strategic framework for addressing emissions from aviation-related PM sources. In developing the framework, known as the PM Roadmap, FAA was directed to coordinate with the airline industry, aircraft and engine manufacturers, airports, and the states with airports that were in areas of non-attainment of air quality standards.

A critical foundation to ensure the success of the framework rests on identification of critical gaps in existing research on PM emissions at airports. A comprehensive review of existing research findings and an evaluation of current research efforts are, therefore, essential. The roadmap also will define a prerequisite for airport inventories in the future in which databases will be augmented with practical assessments of PM emission source contributions in an airport environment. Within the aeronautical and environmental communities, gaps in the understanding of quantitative aggregate and local contributions of PM emissions at airport sites exist. Specifically, the relative contributions of various sources of PM emissions, such as the ambient environment, aircraft gas turbine engine combustion processes, diesel combustion processes, and non-combustion releases of PM emissions from other airport equipment and sources, is not known.

The aviation community needs comprehensive information on PM emissions data at airport sites. This information will lead to improved emissions and PM databases that will provide a benchmark for future measurements, modeling efforts, and estimation of emissions. More importantly, this information is needed to respond to pending compliance issues, prioritize future investment by the government and private sector, and ensure a sustainable air transportation system. An understanding of the amount, types, and sources of PM emissions at airports will enable the aviation industry to respond better to more restrictive environmental compliance issues in the future. (Airport Cooperative Research – Environment)

Energy Use at U.S. Airports

The enormous size and complexity of airport facilities are fertile ground for finding common solutions to intricate problems such as the environmental impact and operating expenses from unnecessary energy use. Many airports are under pressure to reduce air emissions from ground transportation and fossil fuels. As a result, they are constantly seeking ways to grow sustainably within their local communities. To complicate matters, the rapidly escalating energy prices continue to be a major part of airport operating expense. Energy is most often the second largest operating expense at airports, exceeded only by personnel. Airport facility managers must strive to reduce these costs to help lower the bottom line for their airline tenants.

The good news is that energy is a very controllable operating expense if they use more efficient lighting, heating, cooling, people movers, ground transportation, and other airline operations. By prudent, energy efficiency investments and optimizing operations, airports can reduce operating costs from 10 percent to 30 percent annually. For example, an energy assessment and "Continuous Commissioning (CC)®" of the new central rental car facility at Dallas/Fort Worth International Airport in 2005 has resulted in a metered 20 percent reduction in energy use. The practical solutions to improve airport efficiency are documented and can be replicated through the dissemination of "best practices".

This project completed a guidebook that provides airport managers, operators, and their operations and maintenance contractors with information to improve energy use at our nation's airports. By developing and encouraging the widespread use of energy management "best practices," airport managers can significantly reduce operating costs and reduce the impacts on environmental compliance while providing a very visible example for communities and others to follow. (Airport Cooperative Research – Environment)

Hazardous Air Pollutant Research

Increasingly, airports and the FAA are asked by various agencies and communities surrounding airports to analyze the health impacts of aircraft and other airport-related sources of air toxics, also known as hazardous air pollutants (HAPs), in the National Environmental Policy Act (NEPA) and state-level documents. Unlike criteria air pollutants, however, information on the emission, transformation, and transport of aircraft and other airport-related HAPs and their health impacts is extremely rudimentary. Without an understanding of aircraft HAPs emissions, airports are unable to quantify the contribution of aircraft and non-aircraft emissions. As airport activity continues to grow, understanding the relationship between HAPs and their impact will become increasingly important.

Several studies have been conducted to understand this relationship better, including the airport development program Environmental Impact Statements for Philadelphia International Airport and Chicago O'Hare International Airport, and a HAPs-related human health risk assessment at Oakland International Airport. Additionally, as a follow-up effort to its 2003 state of science report, the FAA is currently assembling a HAPs Emissions Inventory Guidance document to establish a nationally consistent methodology for quantifying HAPs from aircraft engines. The methodology will be able to incorporate future data on HAPs emissions as they become available. However, as emphasized in the *Critical Issues of Aviation and the Environment 2005* report issued by the Transportation Research Board Committee on Environmental Impacts of Aviation (AV030), these studies are only a starting point to understand the impacts of HAPs.

This project produced a comprehensive prioritized agenda of research needs associated with aircraft and other airport-related sources of HAPs. The agenda provides a framework that allows the aviation community to perform future research in a coordinated manner. The agenda identifies the types of HAPs being emitted, their sources, detection and measurement, and possible health and other environmental impacts. It has a schedule, explains how the findings would be used by airport operators and the general public, and provides supporting evidence for the reasoning behind the agenda priorities. (Airport Cooperative Research – Environment)

Impact of Airport Pavement Deicing Products on Aircraft and Airfield Infrastructure

Field reports increasingly suggest that the use of pavement deicing products (PDPs), including alkali acetate and alkali formate products (such as sodium- and potassium- acetate and formate based products), on aprons, runways, and taxiways may result in substantial damage to various aircraft and airfield infrastructure. One example is the impact on the carbon brakes of modern transport aircraft. Damage may result in reduced brake life and introduces the possibility of brake failure during high-speed aborted takeoff with the concomitant risk of fire from hydraulic fluid released during such an event. Other examples include reports of cadmium corrosion, aluminum corrosion, corrosion in landing gear joints, electrical wire bundle degradation, corrosion of runway lighting fixtures, and damage to airfield infrastructure associated with the use of PDPs.

This research assembled information obtained from other related research and updates it to include quantities and types of PDPs used over the years. The report contains a matrix identifying specific PDPs used and their respective volumes at each surveyed airport. It examines results from a literature search and assembles documentation of damage reported from the use of PDPs at airports, including reports from the FAA, aircraft brake manufacturers, airframe manufacturers, airlines, airports, and PDP manufacturers, along with any information on outcomes from reported damage.

The report examines how airports deice their airfield pavements, what chemicals are commonly used, the amounts applied, and the existence and validity of any evidence of associated corrosion or degradation of aircraft and airfield infrastructure. These results will help federal authorities institute appropriate regulatory requirements and help airport operators and airlines perform more efficiently during winter operations. (Airport Cooperative Research – Environment)

Aircraft Emissions Inventories

In collaboration with the EPA, the FAA has completed a new speciated hydrocarbon profile for aircraft equipped with turbofan, turbojet, and turboprop engines. The new speciated hydrocarbon profile identifies 77 individual organic compounds, including 17 known hazardous air pollutants. It is based on the multiple measurement data sets generated from three Aircraft Particle Emission eXperiments (APEX) field campaigns, which are co-sponsored by NASA, FAA, California Air Resources Board (CARB), and the EPA. This is the first time that aircraft hydrocarbon emissions have been characterized based on repeatable measurements spanning multiple commercial aircraft engines from every major manufacturer.

The FAA and EPA have jointly developed a recommended best practice document that provides the technical support information for the new speciated hydrocarbon profile as well as how to conduct aircraft emission inventories for individual hydrocarbon species. The EPA has included this new profile into their SPECIATE database for use in national emission inventories. Likewise, the FAA has incorporated it into its Emissions and Dispersion Model System version 5.1 for improved accuracy. The profile is also being used to develop guidance for quantifying speciated gas phase hydrocarbon emissions to provide consistency in aircraft emission inventories assembled for disclosure purposes under NEPA. (Environment and Energy)

Alternative Fuels for Aviation

Interest in alternative fuels for commercial aviation has continued to grow. While the price of oil has declined since a high of $147 per barrel during the summer of 2008, its volatility and expected increase continues to drive the development of alternative fuels. Environmental concerns and energy supply security also continue to be critical drivers, and alternative jet fuels can significantly contribute to addressing these concerns.

The FAA and U.S. industry-sponsored Commercial Aviation Alternative Fuels Initiative (CAAFI) has become the principal forum to coordinate an international effort to develop, certify, and deploy alternative aviation fuels to supplement petroleum-based jet fuel. CAAFI's participants include a cross-section of airlines, manufacturers, airports, fuel producers, researchers, federal agencies, and international players. This innovative group of stakeholders continues to implement a CAAFI roadmap to explore the use of alternative fuels for commercial aviation. The combined efforts of CAAFI stakeholders are rapidly advancing the potential move to alternative aviation fuels.

CAAFI stakeholders lead critical activities to develop new fuel specification and certification processes via ASTM International. If certification activities are successful, alternative synthetic paraffinic kerosene (SPK) jet fuel produced from coal, natural gas, and biomass via the Fischer-Tropsch (F-T) process may be approved by June of 2009. This generic fuel approval will enable the use of SPK fuel from many different producers. Approval of similar fuel approvals for bio-jet fuels from hydro-treated renewable oils and other advanced processes are expected within a few of years.

In September 2008, the CAAFI Business and Economics Team convened a two-day summit of 130 representatives of the commercial aviation and alternative fuels development and production communities. The meeting strengthened relationships among the airlines and potential alternative fuel suppliers, which will significantly advance commercial negotiations critical to deployment. It also refined CAAFI's roadmaps that address technical and approval hurdles for alternative jet fuel implementation and presented federal government investment opportunities for alternative fuel producers. The CAAFI business meeting demonstrates that the commercial aviation sector has the desire to lead a movement toward eco-friendly alternative fuels.

In coordination with CAAFI, investigators from the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) have completed a landmark study of alternative fuels that addresses the technical feasibility, identifies the drivers for adoption, identifies the types of infrastructure to support transition, and determines what measures might promote alternative fuels. The study concluded that alternative fuels now exist that could reduce greenhouse gas emissions and improve local air quality, but at present the ability to produce these fuels is limited and the costs of production are high. Some of these potential environmental benefits are possible from alternative fuels that are lower in sulfur and aromatics than conventional petroleum fuels. In the short term, air quality benefits could be attained through the removal of sulfur from conventional petroleum fuels to yield lower particulate matter emissions.

The study also began to investigate the environmental life-cycle of various fuel options to understand the full impact of their production and distribution. Alternative aviation fuels from biomass were found to offer substantial life-cycle greenhouse gas emissions reductions relative to conventional jet fuels; however, land use changes could potentially offset these gains. For alternative aviation fuels, attaining carbon neutral growth will be a challenge without carbon capture and sequestration, investments in new plants to process alternative fuels, investments in new technologies for higher efficiencies from renewable resources, and minimizing the possible impacts on land and water resources that may occur. Further work will focus on refining the life-cycle analysis data to include these land use impacts. Some of these important considerations include possible displacement of food crops, carbon capture and sequestration, striking a balance between aviation and other transportation modes, and incorporating these results into models that will highlight the local, national, and global changes that may occur in their use.

In December 2007, in collaboration with industry and the U.S. Department of Defense, PARTNER investigators conducted a study to quantify changes in particulate matter and hazardous air pollutant emissions on a high production commercial aircraft engine using standard jet fuel and various blends of alternative fuels. The study also aimed to demonstrate the viability of alternative “drop-in” fuels, such as bio-fuel and F-T fuel, for normal use in commercial aviation. During the emissions tests, the engine was cycled through a matrix of reproducible engine operating conditions. Emissions and steady-state engine data were collected at each condition using a sampling probe that was positioned near the engine exhaust nozzle. The test cycle was repeated for each fuel-blend and baseline fuel. The measurements indicated that, especially for the 100 percent F-T fuel, particulate matter emissions number and mass was diminished at all powers relative to baseline fuel. Some significant differences in hydrocarbon emissions speciation were also observed for the 100 percent F-T fuel. Differences were less pronounced for mixes of alternative fuels with standard jet fuel.

In July 2008, the Secretary of Transportation announced the award of an FAA grant to the X Prize Foundation (www.xprize.org) to develop a prize contest that will spur innovation in alternative aviation fuels. Prize contests have a storied history in aviation, inspiring achievements and innovations that have advanced the human frontier -- the Orteig prize, for example, inspired Charles Lindbergh to cross the Atlantic. So, it is fitting that this tradition be continued to advance a new frontier for aviation – environmentally sound, renewable alternative fuels. Over the next 14 months, the X Prize Foundation will use experts from the government, industry, and academia to develop the aviation renewable fuels prize package and implementation plan. The prize package and implementation plan will be used by industry and the government to identify prize sponsors and initiate the prize competition. In addition to

CAAFI and PARTNER's activities, the Alternative Aviation Fuels X Prize should also help to stimulate private investment in technology, focus public attention, and develop the supply of renewable fuel in quantities to serve the commercial aviation sector. (Environment and Energy)

Aviation Climate Change Research Initiative

Aviation is an integral part of the global economy and transportation system. Projections indicate that the demand for aviation could grow by a factor of 2-3 over the next two decades. Although rising and volatile fuel prices are slowing demand at present, expansion of aviation is likely to continue and, as in the past, could outpace economic growth. In the absence of mitigating actions, increased aviation operations will likely result in higher related emissions and associated environmental impacts including those on climate.

At present, aircraft emissions are a very minor contributor to overall emissions. However, the relative magnitude of aircraft emissions is expected to increase due to projected growth in its own sector as well as decreasing emissions from non-aviation sources. If not effectively managed and mitigated in a timely manner, future environmental impacts will be the principal constraint on the capacity and flexibility of NextGen that is being designed and implemented to meet the projected aviation growth. One of the NextGen environmental goals is to limit or reduce climate impacts of aviation.

Actions needed to mitigate environmental impacts will likely include technological innovation (e.g., engines, aircraft and fuels), operational and market-measures, and regulatory interventions. No single action will likely achieve all targeted goals. Mitigation options generally come with tradeoffs and interdependencies that must be properly understood before optimally balanced cost-beneficial options can be designed and implemented. On the climate front, development of the mitigation options requires better scientific understanding and characterization of the non-CO_2 climate impacts due to aircraft gaseous and particle emissions as well as the formation of contrails and induced cirrus clouds. There is also a need for a suitable metric that can interrelate these non-CO_2 climate impacts and that can measure aviation CO_2 emissions alone. These are the areas of the most scientific uncertainties, which must be understood so that the well-informed options for decision-making can be developed.

To meet the NextGen environmental goals, the FAA has developed the Aviation Climate Change Research Initiative (ACCRI) with participation from NASA, the National Oceanic and Atmospheric Administration, and EPA. These federal agencies are also key contributors to the U.S. Climate Change Science Program. The main objective of ACCRI is to identify and address key scientific gaps and uncertainties regarding climate impacts while providing timely scientific input to inform optimum mitigation actions and policies. The ACCRI approach is to support aviation-specific climate change research that is policy relevant and solution focused and to coordinate as well as link its research needs and activities with related national and international climate change research efforts.

ACCRI completed two key initial steps as part of its 4-step structured and sequential approach to: 1) review of science and analysis capability, and 2) identify gaps and develop recommendations for the priority research. Under the first step, ACCRI funded eight national and international groups of research experts to develop eight whitepapers. These were on various aspects of aviation climate change to review the state of science, analysis capability, scientific uncertainties as well as to identify gaps and develop research priority based on the maximum return of the investment on near (up to 18 months), mid (up to 36 months) and long (beyond 36 months) time horizons. Under the second step, ACCRI convened an international science meeting that was attended by about 100 experts from academia, research institutions, and industry. A report on *The Way Forward* with collective recommendations on the research priority was released. The science meeting concluded that ACCRI needs to be a priority driven research program with responsibility to deliver realistic outcomes scheduled to match decision-making. The eight whitepapers and the ACCRI report can be accessed via the internet at http://www.faa.gov/about/office_org/headquarters_offices/aep/aviation_climate.

The recommendations for the way forward are already being used to communicate with stakeholders as well as national and international research programs to seek their support and to develop strategy and planning for near-term and mid- to long- term research activities and practical applications. All are being designed to better inform decision-making in a timely manner. (Environment and Energy)

Aviation Environmental Design Tool

The accuracy of estimating fuel burn, noise, and emissions during low speed portions of flight has been greatly enhanced in the Aviation Environmental Design Tool (AEDT) as a result of an agreement between Boeing and FAA to exchange aircraft performance tools. This improved modeling capability was used in the analysis of continuous decent arrivals (CDA) and tailored arrivals (TAs) at several major U.S. airports, and benchmarked against historical dive-n-drive procedures to understand the benefits of reduced fuel burn, noise, and emissions. AEDT was used to model CDA and TA implementations as part of the Atlantic Interoperability Initiative to Reduced Emissions (AIRE) program and NextGen operational scenarios.

AEDT was used in support of the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) to begin the policy analyses for setting new nitrogen oxide (NO_x) emissions standards for new certified engines. Researchers integrated common modules and databases as well as implemented many concepts of the overall AEDT architecture to develop worldwide estimates of fuel burn, emissions, and noise. The modeling effort, also known as the “NO_x Stringency” analysis, included modeling the global fleet at reduced engine NO_x levels ranging from zero percent (no stringency) to 20 percent lower standards than what exists today for the implementation years of 2012 and 2016. These NO_x stringency scenarios are then modeled for future forecasted years of 2016, 2026, and 2036 to investigate the overall NO_x emission reduction trends as a result of these policy options. Even though ICAO’s focus is on NO_x emission standards, AEDT also produced the interdependent impacts of noise and fuel burn, unlike any other aviation environmental tool in use today to support ICAO’s policy decisions. Demonstration to inform policymakers is the integration of AEDT results with the economic analysis capability in the Aviation environmental Portfolio Management Tool.

Development efforts included further integration of AEDT with databases that support the Joint Planning and Development Office's vision for NextGen. This work involved updating AEDT modules and databases to link directly with the NASA Airspace Conflict Evaluation Simulator (ACES) tool. Full integration of ACES and AEDT will allow for streamlined and consistent analysis of aviation environmental issues during the design of NextGen. In addition, AEDT was selected as the aviation environmental consequence model by the winning teams of NASA research announcements for the design of advanced aircraft concepts deployed in NextGen operational scenarios. In this capacity, AEDT will be integrated with other airspace and airport planning tools such as FAA's airspace and airport simulation tool (SIMMOD) and the FAA's Terminal Area Route Generation, Evaluation, and Traffic Simulation (TARGETS). (Environment and Energy)

Aviation Environmental Portfolio Management Tool

Historically, aviation environmental modeling tools generated either noise or emissions outputs, after which the costs to implement a policy were considered against a single environmental performance indicator (e.g., NO_x emitted). Subsequent advances on common databases and inputs have highlighted the need to consider noise, local air quality, fuel burn, and greenhouse gas emissions interdependencies and to monetize costs and benefits. The FAA is developing a comprehensive suite of software tools that will allow for thorough assessment of the environmental effects of aviation. The main goal of the effort is to develop a new capability to assess the interdependencies between aviation-related noise and emissions effects, and provide comprehensive impact, and cost and benefit analyses of aviation environmental policy options. The impact and economic analysis function of this suite of software tools has been given the rubric Aviation environmental Portfolio Management Tool (APMT).

APMT takes aviation demand and policy scenarios as inputs, and simulates the behavior of aviation producers and consumers to evaluate policy costs. Detailed operational modeling of the air transportation system within the Aviation Environmental Design Tool provides estimates of the emissions inventories and noise exposure. A benefits valuation module within APMT then is used to estimate the health and welfare impacts of aviation noise, local air quality, and climate effects, using a variety of metrics. These metrics include monetary estimates of the value of changes in environmental quality.

A substantial effort to engage the scientific and stakeholder community in review of APMT methods and outputs culminated in acceptance for APMT use in upcoming ICAO/CAEP/8 cost effectiveness analyses. The benefits valuation aspects of APMT were used to support the Joint Planning and Development Office submission to the Office of Management and Budget (OMB). A study of the high-density airports case was the first practical domestic use of APMT to monetize aviation environmental impacts. Technical advances in APMT methodology were documented in a graduate thesis on "World Housing Valuation" and a journal article on the "Impact of Reduced Vertical Separation Minimum on Aircraft-related Fuel Burn and Emissions."

2008 also saw the initiation of a collaborative effort with the University of Cambridge, Aviation Integrated Modeling (AIM) group. Under the auspices of the PARTNER Center of Excellence, the APMT development team held two workshops with the AIM group to develop research initiatives that will benefit both modeling teams. Tangible collaboration and resource sharing has become a part of both programs with researchers spending time at both institutions. This work has shown that impacts of cruise emissions on air quality are much larger than originally thought and must be accounted for in health impact analyses. (Environment and Energy)

Continuous Lower Energy, Emissions, and Noise Program

Continuous Lower Energy, Emissions and Noise (CLEEN) technologies program is designed to target maturation of promising technologies to reduce aircraft environmental impact and energy usage. Award of contracts under CLEEN is dependent on approval of FY 2009 funding.

A market research conference for the proposed CLEEN program was held in May 2008. At the conference, the FAA presented information on CLEEN and obtained feedback from potential bidders on the program scope. In parallel with the conference, FAA conducted a market survey for the CLEEN program. In the survey, the FAA requested information from interested parties on capabilities, expected programmatic approach, teaming partners, and potential technology development efforts. The FAA is using information obtained from these activities in developing the request for proposals for the CLEEN procurement.

Under the proposed CLEEN program, FAA and industry will cost share, on a 1:1 minimum basis, development of CLEEN technologies for civil subsonic jet airplanes to help achieve the NextGen goals to increase airspace system capacity by reducing significant aircraft noise and emissions. The CLEEN program is also focused on increasing the fuel efficiency and advancing alternative fuels for aviation use. The focus of this effort is to: 1) mature previously conceived noise, emissions and fuel burn reduction technologies to enable industry to expedite introduction of these technologies into current and future aircraft and engines, and 2) assess the benefits and advance the development and introduction of alternative “drop in” fuels for aviation, with particular focus on renewable options, including blends. (Environment and Energy)

Desulfurization of Aviation Fuel to Mitigate Environmental Impacts

Aircraft exhaust emissions contribute to both air quality and climate impacts which could be the limiting factor for aviation growth. Therefore, to allow sustain aviation growth, one of the environmental goals of the NextGen is to limit or reduce emissions impacts on the environment.

Generally, there are tradeoffs in emissions and associated environmental impacts when there is an attempt to reduce a particular type of ‘direct’ emission. For example, high temperature combustion is desirable for maximum thermodynamic efficiency and lowest fuel efficiency (i.e., low CO_2 emissions). However, NO_x emissions could be reduced by controlling combustor temperatures and decreasing the residence time during high temperature operations. Emissions of CO_2 are known to contribute positively to climate impacts whereas NO_x emissions potentially contribute to both air quality through formation of secondary air pollutants, such as particulate matter and ozone, and climate impacts through changes in atmospheric distributions of ozone and methane. However, there are no significant tradeoffs with other emissions in reducing gaseous emissions of sulfur dioxide (SO_2).

Sulfur is present in the jet fuel as a part of crude oil processing. It is considered to be useful in engine lubrication. During fuel combustion, sulfur in the fuel undergoes oxidation process which leads to direct emissions of gaseous SO_2. While interacting with the background atmosphere and with other emissions from aircraft exhaust, gaseous emissions of SO_2 ultimately lead to the formation of secondary sulfate aerosols which contribute to ambient air quality. A number of FAA funded research studies have conclusively demonstrated the contribution of sulfate aerosols to the overall change in particulate matter at various spatial scales brought by aircraft emissions. Therefore, there is an obvious air quality benefit of desulfurization of aircraft fuel. Sulfate aerosols, in general, are known for negative climate impacts (i.e. cooling) and also participate in heterogeneous chemistry that could affect ozone distribution and also aid the formation and persistence of contrails and induced cirrus clouds – all of which potentially contribute to climate change. However, there is no clear indication about the net climate impacts of change in direct emissions of SO_2.

Preliminary cost-benefit analysis of aircraft fuel desulfurization using FAA's APMT has shown results of sufficient merit that warrants more detailed and more complete study. It has conclusively demonstrated air quality benefits of using ultra low sulfur aircraft fuel. This initial study only focused on aircraft emissions within the landing and takeoff (LTO) cycle. The FAA has just funded a project to PARTNER to examine the environmental benefits of ultra low sulfur aircraft fuel. This project will focus on two scenarios of fuel sulfur content (600 parts per million and 15 parts per million worldwide) and will use a number of air quality and chemistry-climate models for simulations and analysis. This study will also examine the relative contributions from aircraft emissions within LTO cycle and at cruise altitude to surface air quality. Results from air quality and climate impact analyses will be used in FAA's APMT model for cost-benefit analyses. This project is being led by MIT with participation from Stanford University, Cambridge University and University of Houston as well as consulting support from Harvard University. MIT will work very closely with the Coordinating Research Council to develop the cost associated with desulfurization of jet fuel as well as infrastructure needed for implementation of ultra low sulfur aircraft fuel. Results from this study are expected to be available by the end of summer next year. (Environment and Energy)

International Aviation Interoperability to Reduce Environment Impacts over the Atlantic and Pacific Oceans

Since the launch of the Atlantic Interoperability Initiative to Reduce Emissions Partnership with Europe, FAA has worked closely to: 1) hasten development of operational procedures to reduce aviation's environmental footprint for all phases of flight; 2) accelerate world-wide interoperability of environmentally-friendly procedures and standards; 3) capitalize on existing technology and best practices; and 4) provide a systematic approach to ensure appropriate mitigation actions with short, medium and long-term results.

Simply put, the FAA and European authorities continue to enhance air traffic management interoperability, improve energy efficiency, reduce engine emissions, and lower aircraft noise. In fact, FAA has moved swiftly to establish partnerships and execute several system demonstrations of oceanic, surface, and terminal/en route system and/or procedures. In May

2008, demonstrations of oceanic procedure enhancements with Air Europa proved that rerouting and altitude changes offered near-term fuel consumption and emission reduction benefits within the current standards of operating procedures. Similarly, two continuous descent arrival demonstrations were performed by FAA in joint collaboration with American Airlines at Miami International Airport and Delta Airlines at Atlanta International Airport. Significant fuel saving, reductions in noise and engine emission were achieved. The environmental benefits ranged from savings of 38-50 gallons of jet fuel per flight that equates to a reduction of carbon dioxide (CO_2) of approximately 500 kg per flight.

On February 18, 2008, a multi-lateral partnership known as the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) was created in Singapore. The first air navigation service providers to sign the ASPIRE joint statement were Airservices Australia, Airways New Zealand, and the FAA. Similar to AIRE, the initial partners under ASPIRE are committed to work closely with airlines and other stakeholders in the region in order to:

- accelerate the development and implementation of operational procedures to reduce the environmental footprint for all phases of flight on an operation by operation basis, from gate to gate;
- facilitate world-wide interoperability of environmentally friendly procedures and standards;
- capitalize on existing technology and best practices;
- develop shared performance metrics to measure improvements in the environmental performance of the air transport system;
- provide a systematic approach to ensure appropriate mitigation actions with short, medium and long-term results; and
- communicate and publicize ASPIRE environmental initiatives, goals, progress and performance to the global aviation community, the press and the general public.

The first flight to participate under ASPIRE was designated “Aspire 1” when departing 19:30, Friday 12, September 2008 from Auckland, New Zealand, to San Francisco. This flight brings together Air New Zealand, the FAA, and Airways New Zealand to demonstrate the advances being made to reduce aviation emissions in the Asia/South Pacific region, through a demonstration of the most advanced air navigation services and airline fuel optimization initiatives in current operation. (Environment and Energy)

International Noise Technology Goals

Future efforts to mitigate aircraft noise are dependent on quieter technologies and operations. The FAA is working with the International Coordinating Council of Aerospace Industries (ICCAIA) under the auspices of ICAO/CAEP to establish aircraft noise technology and air traffic operational goals in the mid-term (10 years) and the long-term (20 years).

In September 2008, FAA co-sponsored a workshop and independent expert review in Seattle, Washington, dedicated to aircraft noise reduction technology that was a significant step toward this goal. Through a detailed and comprehensive review of noise reduction technologies currently being developed worldwide, an international panel comprised of experts from Canada, France, Japan, Russia, United Kingdom, and the U.S., will make recommendations for a consensus set of mid-term and long-term noise technology goals. The goal setting process offers multiple benefits. It provides an independent perspective that may be used to help guide technology investment decisions, including those of the CLEEN program, provide benchmarks against which to chart technological progress, help us envision and plan for aviation's future environmental performance (globally as well as domestically for NextGen), and inform and complement the noise standard-setting process. (Environment and Energy)

National Parks and Air Tour Noise Research

In June 2008, the FAA Western Pacific Region, the FAA Office of Environment and Energy, and Volpe National Transportation System Center signed a memorandum of understanding to pursue several research efforts to advance noise impact analyses for the National Parks Air Tour Management Plan (ATMP). The program aims to develop a scientifically defensible approach for determining significant noise impacts from aviation-related projects in naturally quiet areas. The objectives of the program are to: 1) enhance noise modeling fidelity to capture noise propagation effects critical for naturally quiet areas; 2) establish noise exposure-response relationships for naturally quiet areas; 3) identify noise exposure thresholds to establish significant noise impact; and 4) establish analytical procedures specific to determining significant noise impact in naturally quiet areas. The program will support implementation of the National Park Air Tour Management Act of 2000, which requires the FAA, in cooperation with the National Park Service, to develop an ATMP for parks and tribal lands where air tour operations occur or are proposed.

Research is being pursued by four noise projects. The first focuses on the complex noise modeling issues associated with parks, modeling method enhancements are sought to better capture effects of terrain, ground and meteorology on noise propagation and effects of overlapping flights in high altitude. This project will apply a parabolic equation model, deemed by consulted experts, to be the most promising approach to simulating the effects of terrain, ground and weather on noise propagation. For the second project, a source data collection is underway to acquire noise data for several air tour aircraft currently not available in the INM aircraft database, as well as to support of helicopter noise modeling and data validation in collaboration with manufacturers. Noise measurement testing has been scheduled this year for the Bell 407 helicopter, the Schweizer 300C helicopter, and the Piper PA-42 Cheyenne fixed-wing propeller aircraft. The third project is developing guidance on characterizing ambient noise for diverse National Park settings that will lead to a comprehensive guidance document for noise impact analyses in naturally quiet areas such as National Parks. Lastly, the fourth project is to map out the next phase of research to establish noise exposure-response relationships applicable to National Parks based on a workshop feedback from October 2008 in which leading experts participated. (Environment and Energy)

New Noise Research Program

Despite our favorable historical record in having substantially reduced the number of people exposed to significant noise, airport noise restrictions and public opposition to airport and airspace projects continue to rise. Therefore, a robust noise research program is needed to realize our NextGen vision of providing a level of environmental protection that allows sustained aviation growth. A strategic research framework has thus been developed aimed at: improving public health and welfare near-term and in future growth scenarios; informing NextGen decisions with more accurate, comprehensive, and integrated analyses; and garnering greater public acceptance of future airport and airspace capacity projects, as well as the operation of future unconventional aircraft. To accomplish these goals, the research program must improve our understanding and quantification of aviation's noise impacts as well as develop more cost-effective/cost-beneficial mitigation solutions.

The first half of the FAA strategy focuses on research and development to improve our understanding of the airport community noise problem – following the path of the noise from its point of emission through its propagation and transmission to the community, and ending with the community's response to the noise. The second half of the research strategy focuses on solutions to alleviate the problem, which includes advancing each of the four elements of a balanced approach towards community noise mitigation, comprising of noise reduction at the source (i.e., the aircraft), land use compatibility planning and management, noise abatement operational procedures, and aircraft operational restrictions. The new research strategy will be presented to potential research partners and stakeholders who will jointly develop an execution strategy. (Environment and Energy)

Scenarios and the Environmental Design Space Tool

The Environmental Design Space (EDS) tool estimates source noise, exhaust emissions, performance, and economic parameters for aircraft designs under different technological, policy, and market scenarios. The model quantifies engine/airplane system design trades in a manner that is technically feasible in terms of performance, noise, and emissions. This capability allows for assessments of interdependencies between aviation-related noise and emissions effects. Design trade spaces will be developed for each of the ICAO passenger classes, ranging from 50 passengers to 650 passengers. Each vehicle passenger class will have both a current technology trade space and a future technology trade space. The current technology trade space allows for changes to engine cycle parameters that are bounded by the limits of current certified technology. The future technology trade space would produce potential future vehicles defined within trade spaces estimated assuming potential future technology with a mid- to long-term development focus.

The EDS development team completed validation of the current technology 300- passenger twin-aisle and 150-passenger single-aisle aircraft trade spaces. The 50-passenger aircraft trade space is currently being reviewed by the EDS Independent Review Group. In addition, the FAA refocused EDS development to future technology trade spaces to enable technology applications in support of NextGen analysis. As a result, the EDS fundamental architecture was significantly enhanced to streamline the structure of execution and file conventions. The new EDS Version 3.0 enables the development team to reduce human error and enhance version control of inputs and outputs generated. Further enhancements have been made to improve compressor and turbine map generation, to include technology factors and vary the aircraft within the trade space generation, to develop a fan stratification model to enable proper fan technology modeling, and to incorporate low speed aerodynamic surrogates. (Environment and Energy)

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The best qualified and trained workforce in the world

Air Traffic Control Safety Risk Assessment Analysis

Researchers from the Civil Aerospace Medical Institute (CAMI) conducted a study to assess the probability that an ATC operational error (OE) will occur based on: 1) exposure to daily activities while working on a given shift at a particular time of day, and 2) the amount of time spent on position. In the past, most information about OEs was based only on their frequency of occurrence under various conditions. Data recently became available that allowed analyses to be conducted that take into account the amount of time spent on position during normal operations. The probability distribution of an OE occurring based on the number of “sign-ins - sign-outs” that occur within ten minute time intervals was computed for six en route centers having the largest number of OEs during 2006. The probability of an OE occurring within any given 10 minute interval ranged from .002 percent (at the 90 min. interval) to .006 percent (at > 120 min. interval), resulting in an overall cumulative probability of .05 percent.

This means that, within the NAS, on average, there is a .05 percent chance that an OE will occur during a position change sometime within a given two hour period. This kind of information is useful for constructing Bayesian networks to determine the risks associated with controlling air traffic and, as such, would be useful for monitoring the effectiveness of automation designed to mitigate those risks. However, it should be pointed out that not all risks associated with ATC can be empirically derived. If data do not exist, such as in the case of the probability that a controller will make decision A, B, or C, then expert judgments must be made. These judgments then can be used in conjunction with empirical data to create a more comprehensive ATC safety risk assessment, which would then feed into an ATC Safety Management System. (ATC/Technical Operations Human Factors)

Air Traffic Control Selection Instruments: Assessment of Cognitive Aptitude

CAMI tested 72 FAA Academy ATC classes (1,069 students). The purposes of the test were to: 1) obtain biographical information about incoming ATC students; 2) obtain information relevant to the longitudinal validation of the Air Traffic Selection and Training (AT-SAT) test battery; and 3) to assess, in an experimental setting, the effectiveness of new tests that might be used to replace AT-SAT subtests when selecting air navigation service providers (ANSPs) for the NextGen system. This will help FAA determine if the job of the ANSP will be sufficiently different from today’s ATC Specialist to require changes to selection requirements.

An analysis was conducted to assess validity of AT-SAT in predicting performance verification (PV) outcomes. AT-SAT data and PV outcomes were compared for six hundred fifty applicants who took AT-SAT as part of the hiring process and completed initial training at the FAA Academy. Using logistic regression on a subset, AT-SAT was shown to predict correctly PV outcomes for 73.5 percent of the trainees. Thus, the use of AT-SAT as a selection instrument has additional support. (ATC/Technical Operations Human Factors)

Air Traffic Control Specialist Biographical Data and Interview Selection Procedures

CAMI developed a structured interview process for ATC Specialist applicants. Interviews are conducted by facility managers after a centralized selection panel has made a tentative job offer. The interview is used to make a placement decision, based on past experience, and assess candidate suitability for the job. The interview process was accepted by the Air Traffic Organization and operational use began in FY 2007. Follow-up will occur in FY 2009 to determine that the process is being used properly.

Researchers developed a biographical inventory called the CAMI Life Experiences Questionnaire (CLEQ). It was intended to be used to refer ATC specialist applicants to second-stage aptitude testing using the Air Traffic Selection and Training (AT-SAT) selection battery. While the original CLEQ is not being used for that purpose, a shortened, empirically-keyed, response-option scored version is currently being developed and will be completed in 2009. The CLEQ v2.0 may eventually be added to the AT-SAT testing process.

Researchers examined applicants' reactions to the ATC Specialist selection process. Several focus groups were held with newly hired controllers during CAMI research testing sessions. Issues about the hiring process that were identified by the new controllers were summarized and reported as an interim product. (ATC/ Technical Operations Human Factors)

Color Vision Tests for Air Traffic Control Specialist Applicants

CAMI researchers developed a new, practical color vision test for selection of air traffic controllers to ensure that those selected have adequate color vision to be able to operate the color displays used extensively in ATC facilities today.

The Air Traffic Color Vision Test (ATCOV) was developed in FY 2007, and was validated for operational use the following year. ATCOV validation consisted of two studies. The first tested 81 color vision deficient and 152 color-normal subjects. This study provided information about the test's validity, reliability, and standardization. The validation empirically indicated that, with selected cut-off scores, ATCOV exhibits high specificity and sensitivity. Approximately 7 percent of color vision deficient applicants are expected to pass the test, as they will perform as well as 95 percent of the normal population. ATCOV was demonstrated to be highly reliable and can be self-administrated or instructor-administrated with minor training of proctors. (ATC/ Technical Operations Human Factors)

Controller Displays for Severe Weather Avoidance

Adverse weather conditions affect flight operations overall but are especially hazardous to general aviation aircraft. The primary weather hazards are icing, convective activity (i.e., thunderstorms), and reductions in ceiling/visibility. Some two-thirds of all general aviation accidents that occur in IMC are fatal. As a result, air traffic controllers are being asked to take a more pronounced role in ensuring that pilots, particularly general aviation pilots, remain clear from hazardous weather conditions. Tactical controllers, however, have only limited information available to provide this service.

Because of this information shortcoming in en route and Terminal Radar Approach Control operations, researchers at the William J. Hughes Technical Center developed concepts for how to display relevant weather information on air traffic controller workstations. Additionally, they developed a working prototype of an automated support tool called AIRWOLF that tracks general aviation aircraft and hazardous weather areas. When the automated system detects a future conflict with an aircraft and a hazardous weather region, the system alerts the controller about the aircraft and the hazard. These weather tools can give air traffic controllers the information they need to help general aviation pilots avoid weather hazards. Used together, they could help to reduce weather-related general aviation accidents and provide information that would enhance cockpit decision-making. (ATC/Technical Operations Human Factors)

Future En Route Workstation II Simulation

There are estimates that the demand for air transportation may double or even triple over the next twenty years. To achieve this, air navigation service provider efficiency and effectiveness will have to double or triple. This project is one in a series of Future En Route Workstation (FEWS) simulations aimed at demonstrating that these increases are feasible through the use of automation and standardization of operations, procedures, and information.

The FEWS II simulation compared controller performance, workload, and capacity to safely control increasing amounts of air traffic using the three workstations. First, the FAA has added automation to the current en route ATC workstation – the Display System Replacement (DSR) – that controllers use through existing or auxiliary displays. The En Route Automation Modernization (ERAM) workstation under development provides some integration of these capabilities. FEWS is based on ERAM but has additional integration of the capabilities as well as automation to minimize the amount of “housekeeping” tasks that controllers must perform. These modifications are guided by human factors design principles that strive to: limit or eliminate the number of disparate windows and lists or makes them optional, provide access to information through the fewest number of steps possible, present information to the user when and where needed, prevent time sharing of information, maintain consistency across display windows, connect information across the display that relates to the same object, place related information in close proximity, and use consistent layout formats to support user learning and automated human behaviors. In addition, the simulation compared the workstations with and without data communications and with staffing of either one or two controllers per sector.

Twelve Certified Professional Controllers from Level 11 and 12 Air Route Traffic Control Centers participated in the simulation. Generic airspace was used that participants from different facilities could learn quickly. In the primary experimental design, each participant completed 12 test scenarios that lasted up to 60 minutes, but the controllers could stop earlier if the traffic level exceeded their capacity (approximately 50 aircraft would be in the sector at 50 minutes). The simulation was conducted at the FAA William J. Hughes Technical Center Research, Development, and Human Factors Laboratory. The Distributed Environment for Simulation, Rapid Engineering, and Experimentation was used to emulate features and functions of the alternative controller workstations; the Target Generation Facility to transmit aircraft information from simulation pilot workstations to the controller display; and the Center-Terminal Radar Approach Control (TRACON) Automation System to transmit and receive additional system data. System and controller performance data was recorded and analyzed, including the number of aircraft handled, time and distance in the sector, controller workload, situation awareness, and ratings of system features. Controller eye movement data and data entries was measured and analyzed for each test condition.

The FEWS II simulation resulted in fewer data entries and showed a reduction in controller workload when data communications was available in a two-person sector but not under the one-person sector conditions. The results indicate that the FEWS II workstation with a two-person sector and data communications available also had a significantly lower number of controller deviations. Regression analyses showed that, at the same workload level, controllers could handle more aircraft when they worked as a team using data communications instead of voice communications only. When controllers worked the one-person sector with the FEWS II workstation, they were not able to handle more aircraft with the addition of data communications. The results of the simulation were published in a 2008 technical report *Future En Route Workstation Study (FEWS II): Part I – Automation Integration Research* (DOT/FAA/TC-08/14, II). (ATC/Technical Operations Human Factors)

Methods to Assess Applicant Temperament and Emotional Stability

Based on empirical research, CAMI replaced the 16 Personality Factor (16 PF) test, a psychological screening test for ATC Specialist applicants, with the Minnesota Multiphasic Personality Inventory-2 (MMPI-2). Such screening is mandated by FAA Order 3930.3A. The MMPI-2 was found to be a more sensitive indicator of potential psychopathology than was the 16PF. Now candidates who are flagged with psychological testing will be offered secondary screening. The assessment process has also been moved from a paper-and-pencil task requiring two hours to administer and a week to score, to an on-line experience requiring only 35 minutes to administer with near-instantaneous scoring. Using the MMPI-2 and the improved secondary screening process, the FAA is now more likely to identify applicants with medically disqualifying conditions as early in the application process as possible.

This involved developing plans for administering and scoring the MMPI-2, identifying a set of scales and cutoff scores to be used to refer unsuccessful applicants for further testing, developing letters to both notify applicants who will be required to undergo additional assessment before they can be medically cleared, and informing psychologists about the procedures they should use when conducting the second tier testing. Coordination also occurred with FAA headquarters to identify their role in the administration and interpretation of MMPI-2 results and to provide feedback to applicants who do not pass.

CAMI personnel also established procedures for collecting test data on personal computers and transmitting the results in a secure fashion over the internet. In support of this effort, they: 1) worked with ATO Information Technology personnel to define security needs to ensure secure administration of the MMPI-2 at every FAA facility; 2) arranged with Pearson Assessments, owners of the MMPI-2, to place the software on an FAA server; 3) pilot tested the software with several groups of pseudo-applicants to be sure it worked and ensure the security of the data transmission; and 4) established a procedure for applicants to take the test locally, then upload the responses so they could be scored at a centralized location.

Researchers provided assistance to the ATO with efforts to incorporate the MMPI-2 in the Pre-Employment Processing Center (PEPC) concept that allowed rapid processing of application data from candidate air traffic controllers. The research team traveled to the first PEPC in each region, ensuring that MMPI-2 testing was conducted successfully, and interacted with the Regional Flight Surgeons to ensure that they understood how to conduct second-tier testing. Finally, researchers reviewed the psychological tests submitted by candidates who failed the MMPI-2. (ATC/Technical Operations Human Factors)

Advanced Systems for Air Traffic Workforce Training

The FAA has a critical need for innovative approaches that will strengthen air traffic controller training to reduce the time and resources required to provide ongoing instruction of current controllers as well as a strong training program for the thousands of controllers that will be hired over the next decade. CAASD researchers made significant progress in helping the FAA leverage advanced training technologies to meet the challenge in both the en route and terminal domains.

Utilizing the CAASD developed high-fidelity en route ATC training prototype (known as the *enroute* Trainer), the FAA conducted training sessions with Developmental Controllers at the FAA's Indianapolis Air Route Traffic Control Center to evaluate new training technologies and capabilities and their associated benefits, and to define baseline requirements for integrating these new en route training capabilities across the NAS. These capabilities included a fully automated simulation pilot capability that can be used in place of human simulation pilots for many scenarios. Based on the evaluations, functional requirements and specifications for an automated simulation pilot capability, including aviation-specific speech recognition algorithms, were documented and tech-transferred for use in ERAM. Other capabilities that were evaluated included the use of skill enhancement scenarios and recorded live traffic that provided a more solid foundation for key skills needed for on-the-job training; the use of "pause and playback" during student scenario operation that enabled the instructors to stop scenarios and point out key emerging events and discuss different control options; and the use of student performance measures to help the instructor assess achievement of key competencies.

CAASD has also developed a terminal trainer prototype that is designed to demonstrate the use and benefits of interactive training technology and intelligent training system design for use in the terminal ATC training domain. Phase 1 of the prototype is a stand-alone capability that leads students through the Miami TRACON training curriculum using state of the art voice synthesis, game technology, simulation, and interactive design. The Phase 1 prototype was reviewed with Miami TRACON representatives in September 2008, and received approval for a field evaluation by students and instructors at the Miami TRACON. The field evaluation will be used to validate these capabilities through use in training actual terminal ATC students. The benefits of these capabilities will be assessed in terms of improved training quality and efficiency. (CAASD)

Flight Simulator Fidelity Requirements Research

Much of initial and recurrent airline pilot training is done using simulators. A great deal of interest centers on simulator fidelity requirements for effective training. Human factors research focuses on four tasks: 1) examining the effect of existing flight simulator requirements on the transfer of skills of pilots between airplane and simulator according to existing knowledge; 2) providing original research in cases where existing knowledge is inconclusive; 3) developing requirements, knowledge, guidance, and standards for the design, certification, and use of flight simulators based on all research findings; and 4) applying and disseminating research results in national and international forums. The overall goal is to improve air-transport-pilot training world-wide to ensure that training tools are available to face the challenges brought on by the shrinking pilot applicant pool, the decreasing experience of applicants, and the increasing complexity of the traffic mix and the pilot task with the transition to NextGen. Two important considerations are: a) ensuring that flight simulator cueing requirements are sufficient to ensure positive transfer of pilot performance and behavior between the simulator and airplane, and b) ensuring that cueing requirements do contribute to this transfer.

A systematic examination of full fight simulator (FFS) requirements and a subsequent empirical research program found no operationally relevant benefit from simulator platform motion. Researchers also found evidence that other aspects of simulation, such as the lack of realistic radio-communications, should be addressed to improve training. Recent activities include reviewing relevant literature and examining regulatory and research output, monitoring the impact of work accomplished in this program on industry and on other research and regulatory activities, and continuing to maintain and update a flight simulator fidelity requirements literature database at the Volpe National Transportation System Center. This research is being coordinated with ICAO working groups. Research is also focused on evaluation of the Full Flight Trainer, a fixed-base trainer with FFS-quality data. Planning, research design, setting up of data collection and analysis are underway. Researchers have also started looking at research needs for advanced maneuvers training (such as upset recovery) and have helped coordinate the work of the many entities exploring this issue. The goal is to examine the effectiveness of existing simulators for training and evaluation of advanced maneuvers.
(Flightdeck/Maintenance/System Integration Human Factors)

Mental Model Assessments for Training Design and Assessment

Research has established that the structure of a pilot’s knowledge may predict his/her performance while conducting operations. While valid knowledge structure evaluation tools and procedures have been developed (i.e., concept mapping and card sorting), many airlines rely on other assessment methods that may only evaluate superficial levels of a pilot’s knowledge. Inadequate knowledge evaluation practices may be evidenced by the consistent findings of gaps and misunderstandings in pilots’ knowledge of the automation they interact with. So far, research has yielded several important results: a software tool to computerize the process of knowledge solicitation and assessment using card sorts and concept maps, guidelines for the effective use of the tools, and identification of the suitability of simplified assessment methods while maintaining the reliability and validity of the method.

In an effort to encourage the use of knowledge structure assessment methods that can assess and diagnose misunderstandings or gaps, researchers at the University of Central Florida developed a study protocol that aims to support development of guidelines that will standardize the use of knowledge structure evaluation methods. Specifically, human factors researchers are focusing on developing guidelines for using knowledge structure assessment methods that facilitate both valid and reliable evaluations of the knowledge structures pilots use to interact with an aircraft.

The study, which began in 2008, addresses the need for knowledge structure assessment guidelines by investigating factors that may influence the validity and reliability of concept map assessments and the role check pilots play in the assessment process. Factors such as experiences with the assessment process and the information being assessed are empirically investigated to determine the conditions under which these factors are optimal for producing the most valid (i.e., accurate) and reliable (i.e., inter-rater agreement) evaluations. Although this study focuses on knowledge structure evaluation, the guidelines produced here can be extended to other subjective assessment methods such as simulator observations. (Flightdeck/Maintenance/System Integration Human Factors)

Research on the Human Factors of Conveying Safety-Critical Information

A major factor in aviation accident prevention is information gleaned from pilot reports of incidents that occur in flight. The Aviation Safety Action Program (ASAP) was developed to provide a means for collecting this information in a voluntary, secure environment. Ultimately, information collected from ASAP can provide valuable insight into aspects of flight safety that can lead to improvements in training, awareness, and policy. Among the challenges associated with this program is ensuring the array of information that can be addressed through ASAP is communicated efficiently and accurately. In support of the FAA Voluntary Safety Program Office, researchers at the University of Central Florida (UCF) are actively involved with research on systems that convey safety critical information, including Notices to Airmen (NOTAMs) and the ASAP Web Based Application Tool (WBAT) systems. UCF researchers aim to investigate safety critical information systems in an effort to optimize efficiency and usability of these types of systems.

This research addresses the need to investigate current information transmission systems within the aviation community to improve the flow of safety critical information.A systematic human factors analysis of the current WBAT system was conducted in co-operation with researchers from UCF and from George Mason University. UCF researchers also established a partnership with an airline to obtain realistic data samples from its voluntary programs for data mining and analysis studies. By having access to the results from these systematic examinations, FAA will be better able to understand the quality, frequency, and type of information transmitted through these systems. Further, by applying human factors guidelines and understanding the psychometric principles of these programs, the FAA intends to make recommendations on current and future information sharing programs. (Flightdeck/Maintenance/ System Integration Human Factors)

Understanding Human Performance in Aviation

This research supports the re-design of the NOTAM system. NOTAMs provide safety- and time-critical information to pilots, dispatchers, and other participants in the NAS. In the past, this system relied mostly on a format appropriate for limited bandwidth teletype machines. With the introduction of modern telecommunications tools and means, such as the internet and the World-Wide Web, the format of NOTAMs, which had many human factors shortcomings, could be improved considerably. Graphical depictions of NOTAMs, as well as natural language text, are formats that are now technically feasible. The FAA plans to overhaul the NOTAM system with the objective of developing a fully digitized NOTAM system.

The American Institutes for Research (AIR) disseminated reports on NOTAM and Field Condition (FICON), along with a previous report from dispatchers regarding NOTAM data, to the FAA's Aeronautical Information Management Group (AIM) group, which is responsible for modernizing the NOTAM system. AIR also provided this information to AIM and other stakeholders through a series of four Digital NOTAM Working Group meetings held between October 2007 and August 2008, and one FAA NOTAM Industry Day meeting.

In addition to providing input to AIM regarding challenges associated with the use of NOTAM and FICON data and recommendations for change, researchers from AIR and the University of Central Florida provided AIM with human factors related guidance regarding the digital NOTAM data entry system. AIR disseminated FICON information to the Take-Off and Landing Performance Assessment Aviation Rule-Making Committee in the form of dispatchers' recommendations for change to Advisory Circular 150/5200-30B entitled, *Airport Winter Safety and Operations*. (Flightdeck/Maintenance/System Integration Human Factors)

Weather-related Training and Testing of General Aviation Pilots

Weather-related accidents, particularly accidents due to visual flight rules (VFR) flight into IMC, are associated with the highest fatality rate within general aviation (GA). Specifically, the fatality rate of VFR into IMC accidents is approximately 80 percent compared to roughly 19 percent for other types of GA accidents. Previous research at the University of Wisconsin indicates that accidents related to VFR flight into IMC often involve inexperienced pilots who lack the skills to properly plan VFR cross-country flights, effectively assess changes in weather during flight, and appropriately evaluate risks of continuing flight into adverse weather or safely avoid/exit IMC when it is encountered. These findings point to the need to improve weather-related training as well as the manner in which weather-knowledge and decision-making skills are tested and evaluated.

To address this problem, researchers are exploring better ways to train and test weather-related decision making among GA pilots. They are developing advanced flight simulation scenarios, based on known VFR flight into IMC accident profiles, to train and evaluate the skills of GA pilots empirically in applying basic weather knowledge in "real time" during dynamic simulated flight. These simulation scenarios will provide an innovative tool for systematically training and assessing pilot weather-related decision making skills, as well as evaluating the effectiveness of new intervention programs targeted at reducing accidents associated with VFR flight into IMC.

The results of this project will provide empirical data to inform FAA decision-makers about how best to redesign flight training, testing, and currency requirements in an efficacious yet cost-effective manner. This project also addresses the goal of the FAA to reduce GA fatalities and the need to develop Advanced Simulator Weather Simulations. Accomplishments include:

- A systematic review and critique of the weather-related material disseminated by the FAA and weather-related test questions contained in the FAA private pilot written exam. Researchers also examined knowledge deficiencies of pilots on weather-related exam questions and the relationship between performance on the written exam and performance on the private pilot oral exam. Results were published as a technical report located at http://www.humanfactors.illinois.edu/Reports&PapersPDFs/TechReport/08-01.pdf
- The research team completed a study involving a flight simulation protocol which required VFR-only pilots to interpret pre-flight weather information for a specific route of flight that had been prepared using real-time weather information. Pilots were tasked to make pre-flight decisions based on this information, and they were then asked to fly the routes in the flight simulator. Data analysis is currently in progress.

(Flightdeck/Maintenance/Systems Integration Human Factors, Weather Program)

Cockpit Task Demands

In conducting research on airliner cockpit demands for the FAA, NASA researchers observed pilot training classes and participated as pilots in airline training for new hires. They analyzed flight operations manuals, observed actual flight operations from the jump seat, and discussed those observations with the crews. The results were used to generate search terms to identify an extensive set of reports involving concurrent task demands. The research team published a book titled *Multitasking in Real World Operations: Myths and Realities*. This book is the final report of their multi-year ethnographic study of cockpit tasks and crew performance in normal flight operations that was conducted in collaboration with two major U.S. air carriers.

The team found that flight operations manuals, and the training associated with them, portrayed cockpit tasks as if they were linear (each task performed in sequence), predictable in timing and nature, and under the moment-to-moment control of the crew. Jump seat observations, however, revealed cockpit work to be much more dynamic with frequent interruptions, unexpected new task demands, and situations requiring tasks to be performed out of the expected sequence. Pilots often had to perform more than one task concurrently. The dynamic and concurrent nature of task demands was a major source of inadvertent failures to perform intended actions.

Prototypical situations were identified in which pilots were vulnerable to forgetting to perform intended actions, such as when: 1) ongoing tasks are interrupted; 2) tasks must be performed out of the normal, practiced sequence; 3) tasks must be deferred; and, 4) multiple tasks must be interleaved concurrently. Researchers were able to identify the cognitive demands of these prototypical situations and plausible reasons why even the most expert of pilots was vulnerable to commit errors. The book provides detailed guidance on countermeasures that individuals and organizations can take to reduce vulnerability to error in these common situations. It also provides a basis for conducting more realistic cockpit task analyses for advanced qualification programs. Although the book’s examples are based on pilot performance, the principles and recommendations are treated in a way that they can be applied to any area of skilled operator performance. This research provides measures to improve the design of pilot training and of operating procedures, which addresses the FAA objective of improving aviation safety. (Flightdeck/ Maintenance/Systems Integration Human Factors)

Human-centered design

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

Airport Ground Access Mode Choice Models

Airport ground access mode choice models form a key analytical component of airport landside planning as well as airport system planning. Without an accepted and validated process for predicting how airport users will change their access or egress mode in response to changes in the airport ground transportation system (e.g., changes in fares, rates or service levels) or the introduction of new modes (e.g., extension of a light rail system to the airport), it is difficult to determine the economic feasibility of proposed projects to improve airport ground transportation or effectively manage the existing airport ground transportation system.

These models are highly specialized and not well understood by airport managers, planners, and consultants. With increasing emphasis on intermodal connections as illustrated by the recent Government Accountability Office study on this issue, there is a pressing need for more widely accepted and accessible reference material and guidelines.

This project updated previous efforts to document the state of practice for airport ground access and egress mode choice models. It also addressed the issues involved in the development and use of such models to improve their understanding and acceptance in airport planning and management and provide guidance on their use and development. The research results also serve to focus research and development efforts to continue to improve the state of the art for modeling airport ground access mode choice. (Airport Cooperative Research – Capacity)

Air Traffic Control Display Standard – Terminal Color

The FAA *Human Factors Design Standard* (HFDS) contains standards that can be used to develop user interfaces that are easy to learn, efficient to use, and reduce the likelihood of human error. However, the HFDS is not ATC-specific; for example, it does not provide specific color values for elements appearing on ATC situation displays, such as data blocks and radar targets. The ATC Display Standard - Terminal Color project used human factors standards such as the HFDS to develop detailed human factors color standards specific to the terminal ATC primary situation display.

In the case of color on terminal ATC primary situation displays, current programs individually choose their colors. The chosen colors do not always conform to human factors best practices and are often inconsistent across systems. These issues can decrease the usability of terminal systems overall, increase the likelihood of human error, and increase training requirements. In addition, resources are spent redundantly when each program develops its own color requirements and designs.

In this project, researchers used a spectrophotometer to measure colors used by current terminal ATC primary situation displays as shown on four different monitors. The measurements allowed the researchers to compare the current colors to human factors standards. Researchers evaluated the colors on factors such as text readability, the ability of colors to draw attention, how easily colors can be identified and named, and how easily two similar colors can be discriminated from each other. Where the researchers identified deficiencies with the current colors, they proposed alternative colors that better met human factors standards.

The project culminated in a final report that contains a detailed standard color palette for terminal ATC primary situation displays that: 1) follows human factors guidelines and best practices, 2) considers the operational, procedural, and environmental factors of ATC, 3) is specific with regard to display elements and color values, and 4) provides standards that can be directly implemented by system developers. The final report (DOT/FAA/TC-08/15) describes each display element (e.g., data block, target, map) and specifies a color for that element, expressed in hardware-independent coordinates. To assist programs in implementing the colors, the researchers have provided hardware-specific coordinates for several existing monitors. This information can be used for the development and acquisition of ATC terminal primary situation displays. (ATC/Technical Operations Human Factors)

Future Terminal Workstation

NextGen will bring substantial changes to terminal airspace in the 2015 – 2025 timeframe. However, it is not known how the NextGen operational concepts, procedures, and technology, combined with higher traffic complexity, will affect controller performance, decision-making, or workload. It is also not known how the information necessary to support NextGen in the terminal domain can be best presented and integrated onto the controller workstation.

The objective of the Future Terminal Workstation (FTWS) project is to create a prototype workstation for the terminal domain that incorporates the technology needed to support NextGen, and then use it to conduct human factors research on NextGen operational concepts and procedures. The prototype will be designed to follow human factors best practices, keep controller workload at manageable levels, and reduce the likelihood for human error. The prototype will build on research and designs created for other projects, and lessons learned from other systems, domains, and countries. The FTWS prototype and accompanying traffic scenarios was created. The prototype and scenarios will serve as the platform for human-in-the-loop simulations in FY 2009 through FY 2011.

Research is directed at developing the FTWS platform using the Distributed Environment for Simulation, Rapid Engineering, and Experimentation (DESIREE). FTWS will consist of several user interface “skins” that include different display designs and capabilities. One skin will reflect the current Standard Terminal Automation Replacement System (STARS). The second skin will reflect STARS with several important new capabilities added, including Automatic Dependent Surveillance Broadcast (ADS-B) and controller-pilot Data Communications (DataComm). The third skin will bring advanced user interface capabilities designed by other projects in the laboratory. (ATC/Technical Operations Human Factors)

Human Factors Concept of Operations

CAMI initiated a project to develop a human factors-driven concept of operations (ConOps) that will provide designers with the knowledge needed to develop a new ATC system capable of accommodating greater amounts of air traffic while also maintaining or increasing air traffic safety levels above those of today. In support of this effort, researchers conducted two independent studies in parallel. Both relied on an updated hierarchical job/task analysis of en route ATC.

The first study reviewed the current Joint Planning and Development Office ConOps, the FAA Operational Evolution Partnership solution sets, and studies associated with the ConOps that have been performed by MITRE to determine how each ATC function included in the task analysis is allocated in NextGen. The second study used knowledge of human factors and cognitive psychology literature to identify the relevant issues associated with each function. The two matrices that resulted from these studies have been used to identify inconsistencies and problem areas and suggest whether human factors research can be conducted to fill in any identified gaps. In addition, CAMI personnel conducted a feasibility study to identify a draft set of factors/events to include in scenarios against which ConOps solutions can be tested. This will show the extent of solution benefits and reveal situations where ConOps solutions need to be improved or extended. (ATC/Technical Operations Human Factors)

Allowable Manual Control Forces in Aircraft Control Systems

The objective of this effort was to update FAA Regulations 25.143(c) and 23.142(c) with current information based on present and future demographics and current and anticipated control-input devices to be found in part Code of Federal Regulations (CFR) Part 25 and Part 23 aircraft. While the intent was to provide data relating to the maximum forces, both momentary and sustained, that could be exerted by the pilot, information/recommendations were also generated for minimum forces. Additionally, a recommendation was sought regarding what percentage of the population should be accommodated in the setting of maximum-force requirements.

A survey of the literature was conducted to determine to what extent guidelines and standards existed for the application of force to assorted aviation control devices. A number of sources were consulted that used reasonably large samples of either military personnel or the civilian population. Additionally, empirical data collections were conducted at CAMI and at three remote sites to collect force-application data for both pilots and non-pilots with the intent of comparing those results with the reference sources. Specialized equipment was designed and fabricated for the offsite data collections, with modifications and enhancements being made to collect joystick data for the second sample of Part 121 pilots and non-pilots (flight attendants).

Data from the last sample of CFR Part 121 pilots (both women and men) suggested that not all of the female pilots flying Part 121 operations today are likely to meet or exceed the allowable values in the CFR. To a lesser degree, some of the male pilots were also unable to reach tabled force values on some tasks (e.g., foot force). It should be noted that the lower-percentile values appeared to be in agreement with previously obtained data distributions. As such, the older data appear to be usable for our purposes. Some of these values, however, may not have a significant impact in some systems, particularly in fly-by-wire side-stick aircraft where proportional force feedback may not be felt as readily. The values presented in *HumanScale 4* (Diffrient et al.)

appear to suffice for the women's performance in that they are consistent with the present findings. The data obtained during this project should provide a foundation from which data can be developed to guide future policy decisions based upon those norms, if the distributions are deemed equivalent. (Flightdeck/Maintenance/System Integration Human Factors)

Assessment of Flight Attendant Fatigue

In 2005, Congress directed CAMI to conduct a preliminary investigation of flight attendant schedules and potential vulnerability to fatigue. CAMI collaborated with NASA Ames Research Center to produce a report in 2006 that provided evidence that fatigue-related performance decrements were likely under the current regulations, and suggested six areas of research that would facilitate a more complete understanding of flight attendant fatigue and government-industry decision making. Citing the 2006 report recommendations, Congress recently directed CAMI to conduct analyses in the six areas: a survey of field operations; field research on the effects of fatigue; a validation of models for assessing flight attendant fatigue; a focused study of incident reports; a review of international policies and practices; and the potential benefits of training. Reports of these efforts are to be submitted to Congress not later than December 31, 2009.

Coordination of the survey and field studies is underway with Air Transport Association's Cabin Operations Committee, the Regional Airline Association's (RAA) In-flight Committee, the Coalition of Flight Attendants, and non-unionized airlines for focused assistance in accomplishing these recommendations. Additionally, pre-sampling tests of flight attendants and subject matter experts (SMEs) are being conducted to evaluate the relevance and quality of both the survey and the field study procedures, instructional quality, and to address unforeseen issues. The field study will solicit recruitment of 210 volunteer flight attendants who will be compensated (paid as SMEs) for participation under a cooperative research agreement. The field study is expected to begin in November 2008 and proceed over a five-month period with a draft report to follow in April 2009.

A CAMI Research and Technical Team was formed to coordinate and accomplish the six recommendations. To date, the following milestones have been accomplished: 1) provided multiple briefings to Regional Airline Association, Air Transport Association, and Coalition of Flight Attendants, 2) developed National Flight Attendant Duty/Rest/Fatigue Survey, 3) obtained Investment Review Board (IRB) and OMB approval for survey, 4) established cooperative agreement for field study, 5) developed National Flight Attendant Duty/Rest/Fatigue Field Study protocol, 6) obtained IRB approval for field study, 7) documented FA policy and regulations from around the world, and 8) obtained more than 2000 Aviation Safety Reporting System incident reports for flight attendants.

The task will continue in FY 2009 with data collection, analysis, and reporting of all six projects. The approach will be to develop technical reports describing the results of each separate project before combining relevant aspects into a final report that will be submitted for distribution to Congress by December 31, 2009. (Flightdeck/Maintenance/ System Integration Human Factors)

Aviation Accident/Incident Prevention/Mitigation

To address the human component of aviation safety, many in the field have embraced a system safety approach. Previous efforts have targeted hazard identification and prioritization using the Human Factors Analysis and Classification System (HFACS). The next step in the system safety process is to identify and assess potential interventions. One tool that may prove useful is the Human Factors Intervention Matrix (HFIX). HFIX includes five broad areas around which interventions can be developed: organizational, human, technology, task, and environment. To assess the utility of HFIX, the current research employed HFIX to address VFR flight into IMC.

Five pilot experts were recruited for the intervention prioritization part of the HFIX process. The pilot experts were instructed to rate 136 interventions on a five-point Likert scale on each of four dimensions: 1) effectiveness (i.e., What is the likelihood that it will reduce general aviation accidents?); 2) cost (i.e., Can the organization afford the intervention?); 3) feasibility (i.e., How easy will it be to implement the intervention?); and 4) acceptability (i.e., Will the aviation community accept the proposed intervention?). For the effectiveness dimension, the top intervention for reducing VFR-IMC was standardizing flight training that covers VFR flight into IMC. However, several new interventions surfaced: increasing oversight for equipment and training, ensuring that the FAA allocates resources to increase pilot proficiency and awareness, and installing weather radar in aircraft. A technical report summarizes the results and links previous studies using HFACS with those employing HFIX within a system safety model has been submitted for consideration. (Flightdeck/Maintenance/System Integration Human Factors)

Color Vision Requirements for Pilots

Although the FAA has maintained a color vision standard for pilots for many years, manufacturers have continually modified the pilot’s tasks by introducing new technology that uses color to alert, inform, direct, and capture attention. During FY 2008, the major objective was to document colors used in modern glass cockpits and in the airport environment and to determine whether the current color vision screening tests are adequate, given the increased color usage inside the cockpit.

To do this, a Minolta CS-100 colorimeter was used to create color chromaticity. The size of the text and type of symbology of color-coded information were recorded along with placement, documentation of other colors on the display, target/background combinations, usage, and criticality of the information. The colors in use in the cockpit and in the airport environment will be used to create a generic work-task to compare performance against currently approved color vision screening tests and with new computer-based screening and diagnostic tests. The measurements obtained from airport lighting will serve two purposes: to measure the variability resulting from longtime exposure to heat, cold, ice, sun, and exposure to the incandescent lamps that burn 24 hours per day, seven days per week; and to document the in-service chromaticity and the range of that chromaticity resulting from use.

Data collection forms, database formatting, and chromaticity display graphs have been completed and 90 percent of the data collected has been screened and entered into the database. Colors were measured in modern glass cockpit displays, including a Boeing 777, an MD-80, and several military aircraft. The chromaticity of airport lighting systems, including the Precision

Approach Path Indicator (PAPI), Visual Approach Slope Indicator, taxiway, and runway lights, were measured at 20 airports. Data gathering will continue and include cockpit simulators, airports representing various environmental/climatic zones, additional aircraft manufacturers, and general aviation aircraft. According to data collected at London City University as part of an FAA grant that compared performance on a PAPI light simulator to one of the FAA's color vision screening tests (i.e., Dvorine Pseudoisochromatic Plate Test), the results show that about 93 percent of those passing the screening test were able to identify the red and white lights of the PAPI lights test correctly. (Flightdeck/Maintenance/System Integration Human Factors)

Electronic Flight Bags

Volpe Center researchers are updating and finalizing a draft report on electronic flight bag (EFB)-related safety events to understand how they impact the overall safety of flight operations. Thirty-seven relevant events were gathered for this report from the public online Aviation Safety Reporting System (ASRS) database. In addition, two accident reports from the National Transportation Safety Board (NTSB) that call out the EFB as a contributing factor were reviewed. Recommendations were provided to the FAA regarding EFB guidance, which was prepared for inclusion in the Flight Standards Information Management System (FSIMS). The revised FAA guidance was based on past work done by the Volpe National Transportation Systems Center to develop Notice N8200.98 (October 2007). The guidance is currently undergoing internal FAA coordination.

Results of the review of EFB-related safety events are described separately for the ASRS data and NTSB reports. Descriptive statistics for the ASRS events show that the most common anomaly to occur was a spatial deviation in heading, altitude, or speed. Underlying EFB issues are also ascribed to each of the events. One key issue is related to display configuration of charts, which can induce workload and may also cause the pilot to miss important information. A second key issue is the introduction of the EFB technology. In ten reports (most of which were from corporate or private operators) pilots mentioned that they were new to the EFB and this may have been a contributing factor in the safety event.

Both NTSB reports identified the use of an EFB for calculating landing distance as a contributing factor. In the first NTSB report (*Runway Overrun and Collision, Southwest Airlines Flight 1248, Boeing 737-7H4, N471WN, Chicago Midway International Airport, Chicago, Illinois, December 8, 2005*), the key issue was that assumptions underlying the performance calculations on an EFB must be presented to the crew as clearly as they are shown on paper-based performance tables. In the other NTSB report (*Crash During Landing, Federal Express, Inc. McDonnell Douglas MD-11, N611FE Newark International Airport Newark, New Jersey, July 31, 1997*), the key issue was assessment of the adequacy of training and procedures for using EFB performance calculations functions. (Flightdeck/Maintenance/System Integration Human Factors)

Fatigue Assessment under Ultra Long Range Flight Operations

In December 2007 and January of 2008, data was collected from 23 pilots and 20 flight attendants on 10 New York (JFK) to Bombay, India (BOM) ULR flights. Measures included actigraphy (i.e., that monitors when crewmembers were awake and asleep), Psychomotor Vigilance Task (PVT) performance, and subjective logbook entries of sleep ratings, visual analogue mood scale (VAS) ratings, Stanford Sleepiness Scale (SSS) ratings, and ratings of the Sustained Operations Assessment Profile (SOAP).

Four post hoc groupings of participants were formed with flight and cabin crewmembers that were scheduled for “better” (aligned with circadian rhythm conducive to sleep) vs. “poorer” (not aligned nor conducive to sleep) sleep-time opportunities on the outbound and return segments of the trip, and whether those sleep-time opportunities were reversed during the two segments or remained the same. Differences in crew operations required separate comparisons; pilots were scheduled for two sleep-time opportunities en route, whereas flight attendants were scheduled for only one longer sleep-time opportunity; pilots were scheduled for 48 hour layovers versus 24 hours for the flight attendants.

All data reduction and formatting has been completed. Analyses of the PVT, SOAP, VAS, and Sleep Ratings data have been completed. Specific trip parameters, including block times, flight/duty times, and latitude/longitude waypoints, as well as actigraphy and logbook entries of sleep have been entered into the Fatigue Avoidance Scheduling Tool (FAST™). A briefing to FAA and Delta Air Lines on all results is scheduled for early October 2008. Results provided evidence that the predictions from the modeling tools were generally met and that fatigue and alertness levels varied across the operation and were influenced by the quantity and quality of sleep attained by crewmembers. These results support a continued use of prediction modeling tools in the A332 Operation Specification pre-approval process along with the additional requirement for air carriers to acquire similar data to verify that crewmembers are well-rested during critical phases of flight. (Flightdeck/Maintenance/System Integration Human Factors)

Flight Symbology

Researchers at the Volpe National Transportation System Center are working with the Society of Automotive Engineers (SAE) International Aerospace Behavioral Engineering Technology Committee (SAE G-10) Aeronautical Charting Committee to update an industry document on recommendations for charting symbology in order to promote consistency across displays, aircraft types, and operations. The Volpe Center is also coordinating research on traffic symbology with the RTCA Special Committee (SC) 186, ADS-B CDTI subgroup.

Data have been collected from approximately 140 pilots without instrument ratings in regard to their use of lines and linear patterns. Pilots first sorted several lines and linear patterns based on how much they use and recognize them. Then, they tried to name a few specific linear patterns that were expected to be relatively well known, even though the patterns were shown in isolation. The new data were combined with data from more than 100 instrument-rated pilots collected in FY 2007. Results of the study found that pilots use and recognize lines and linear patterns differently based on their qualifications (instrument-rated versus not), types of flight operations (e.g., air transport, corporate, or private), and typical flight length. Recognition of the linear patterns in isolation was a difficult task, although some patterns (e.g., for restricted airspace) were more recognizable than others (e.g., for an air routing traffic control center). Results of this study were documented in a draft report.

Another draft technical report from FY 2007, on navigation-aid and airport symbols, lines, and linear patterns that are currently in use, was updated with further information from manufacturers. Definitions for several line types were also obtained and included in a new appendix for the report. A final technical report documenting navigation-aid and airport symbols, lines, and linear patterns currently in use was completed and published. (Flightdeck/Maintenance/System Integration Human Factors)

General Aviation Data Collection

Though the FAA, airlines, and their employee representatives have undertaken more proactive approaches to identify risk through Flight Operational Quality Assurance (FOQA) data and internal safety reports, GA safety remains driven primarily by accident investigation. This project explores whether data could be captured for GA, enabling more proactive approaches to risk management.

FAA provided CAMI personnel with information concerning over 150 events. After reviewing the events, CAMI determined that approximately 90 events involved adverse weather encounters such as icing, thunderstorm activity, high winds, or some other weather-related activity of interest. CAMI contacted approximately 45 Flight Standards District Offices and 125 Aviation Safety Inspectors. As a result of these efforts, twenty-one pilots were interviewed regarding their experiences during a flight assist, emergency, or weather encounter.

Circumstances that preceded the pilot events varied from a failure to appreciate and/or understand the weather, underlying motivating factors that encouraged the pilot to press-on, and relying on incomplete or conflicting weather information. Previous Human Factors Analysis and Classification System analyses of weather accidents lacked the richness that these cases provide. The majority of pilots were instrument rated, so their reaction to these types of events would be different from those who had not previously encountered them. Several sources of weather products were mentioned. The synchronicity of these products with real-time weather, reliability, and standardization should be addressed.

Sponsors were provided a mid-year briefing and an annual report that summarized all interviews with pilots. An interview protocol was developed that could be used by Flight Standards Aviation Safety Inspectors. (Flightdeck/Maintenance/System Integration Human Factors, Weather Program)

Human Factors Analysis and Classification System Database for Aviation Community Research

The Human Factors Analysis and Classification System (HFACS) is a tool for investigating and analyzing human error associated with accidents. Previous research has shown that HFACS can be reliably used to identify general trends in human factors associated with commercial and GA accidents. This project supports development of a larger civil aviation safety program whose ultimate goal is to reduce the aviation accident rate through systematic, data-driven investment strategies. An online HFACS database will provide access to appropriate FAA officials and committees for needed analyses.

Accident data used in this project were downloaded via records maintained by the NTSB. After several hours of training for the online HFACS database, pilot and mechanic subject matter experts (SMEs) coded finalized NTSB accident indformation into it. SMEs were randomly assigned accidents so that two separate SMEs independently analyzed each accident. After the SMEs assigned their initial codes, the two independent codes were compared. Where disagreements existed, the corresponding SMEs were instructed to reconcile their differences, and the consensus code was analyzed further.

The HFACS database contains nearly 34,000 U.S. accidents for the period 1990 - 2006 across all types of operations. Over 28,500 have been coded for human error as identified by the NTSB. More than 25,000 accidents are GA accidents and nearly 1,500 accidents in the database are commercial accidents. CAMI personnel have conducted detailed analysis of each of the different human error forms (e.g., decision errors, skill-based errors, perceptual errors, violations), and ultra-fine grained analysis on selected error forms.

Discussions were held with the Aviation Safety Information Analysis and Sharing (ASIAS) program office and it has agreed to transition the on-line HFACS database to their network server in the future to foster the sharing and centralizing data among the FAA workforce. (Flightdeck/Maintenance/System Integration Human Factors)

Instrument Procedures

The goal of the first stage of this instrument procedures design project is for the Volpe National Transportation System Center to become familiar with the research issues and various implementation perspectives related to RNP/RNAV. In addition, researchers are working to generate a plan for research activity in this area in collaboration with the project sponsors. To accomplish these goals, the research team attended and participated in forums such as the Communications, Navigation, and Surveillance (CNS) Task Force, Pilot-Controller Procedures and Systems Integration (PCPSI) working group, and the Aeronautical Charting Forum (ACF).

Briefings at the CNS Task Force meetings provided a range of information regarding policy and technical issues affecting the RNP/RNAV community. The current task of the PCPSI group is to document RNP/RNAV lessons-learned by gathering input from experts from industry and government who have been involved in implementing RNP/RNAV procedures. The ACF Instrument Procedures group consists of charting and aviation experts who meet to document and address highly technical and operational issues related to instrument procedures. In addition to participating in these formal group discussions, the Volpe Center has initiated informal discussions with researchers, charting experts, and airline staff about these issues.

Through discussions with the FAA, the Volpe Center concluded that research in this area should begin with a careful look at the design and charting of departure procedures. These charts are typically highly complex and non-standardized, making them especially difficult to use accurately. This research area ties in well with activities in the ACF, so the Volpe Center has proposed that the ACF create a working subgroup to address this issue. The goal of the subgroup will be to flesh out ideas and plans for research to improve the design and usability of departure charts. Progress towards a coordinated plan for this research was documented in a status report. (Flightdeck/ Maintenance/Systems Integration Human Factors)

Native and Foreign Airline Pilots' International Language Experiences

There is a lack of baseline data regarding the effect of language differences of airline transport pilots (ATP) who fly internationally. Research is needed to identify and address the gaps in communications data that may contribute to language issues, communication problems, and procedural differences these pilots encounter. Also, as digital voice communications systems and their applications emerge, it is important to know if they will present problems for non-native English speaking pilots.

A structured interview was developed and administered to small groups of ATP-rated pilots to identify language issues that can become barriers to efficient and effective ATC communication. The structured interview was divided into nine sections: 1) Background Information, 2) General/Pre-Flight Preparation, 3) Word Meaning and Pronunciation, 4) Language Experiences in Non-native English Speaking Airspace/Airports, 5) Language Experiences in Native English Speaking Airspace/Airports, 6) Non-native English Speaking ATC/Native English speaking Pilot Communication, 7) ATC/Pilot Same versus Different Language Interaction, 8) Communication Problems, and 9) Technological Interventions. Forty-eight airline transport pilots from American, Continental, Delta, and United airlines were interviewed, and twelve pilots from Aeroflot, Alitalia, China Air, and LAN Chile airlines were interviewed.

The pilots' responses had several major thrusts: cultural differences exert an important but negligible influence on international aviation; when English language proficiency is deficient it hampers effective communication; and when mixed languages are on frequency, party-line communications pose a safety concern and impede situational awareness. In addition, other findings include: pronunciation and naming conventions for locations and other identifiers lack a uniform pronunciation; three- or five-letter identifiers may not be connected with the pronunciation; there is no uniform agreement as to what standard phraseology is or should be; and technological advancements such as data link may help solve some of the language problems. (Flightdeck/Maintenance/System Integration Human Factors)

Operational Voice Communications between Native and Foreign Airline Pilots and Controllers during Oceanic Operations

There is a shortfall in our understanding of operational communications in the en route environment and international voice communications within the NAS. ICAO has mandated an English language proficiency requirement, and the FAA lacks baseline data to gauge its effect on NAS operations and safety. By updating our communication databases, the FAA will be able to measure how the English language proficiency requirements will affect ATC operations and safety. Also, as digital voice communications systems and their applications emerge, it is important to know which messages may present a problem for non-native English speaking pilots.

Five en route facilities were used to provide at least 10 hours of pilot-controller voice communications, with each facility selecting time samples that were representative of peak international (i.e., oceanic) air traffic operations and peak traffic periods with the most communications-intensive operations. Pilot read back errors and communication problems were examined and quantified, and the frequency with which each of the ICAO scales were implicated examined. Fifty-one hours of air-ground transmissions were analyzed. Each controller transmission was paired with its read back and scored for accuracy. In the first of three reports, controller messages were classified according to complexity, message length, and pilot read back accuracy. For the second and third reports, aircraft call signs were used to classify transmissions by aircraft registry (e.g., United States, foreign) and language (e.g., English, other). English language proficiency was examined for pilots in the second report, with communications problems in the third report, and controllers and pilots were graded on their level of language proficiency using the ICAO Language Proficiency Rating Scales.

For the first report, 93.8 percent of the pilots' read backs were correct. When an error did occur, pilots experienced more difficulty reading back approach control high-complexity messages than departure control high-complexity messages or low-complexity messages from either approach or departure control. As message length increased, so did the mean number of read back errors, but only during the approach segment when pilots experience the most challenging aspects of their flights and controller messages are complex and lengthy. For the second report, communications were analyzed from 832 aircraft (77 percent U.S., 23 percent foreign) for 4816 pilot transmissions (80 percent English, 20 percent other). In this analysis, 5.8 percent contained problems. When English was the primary language, or pilots flew U.S. aircraft, there were fewer communication problems, less time was spent on frequency, and fewer messages were transmitted than when pilots flew foreign aircraft or the primary language was not English. English language proficiency was a factor for many of the communication problems among foreign aircraft.

Three technical reports were completed: 1) *The outcome of ATC message length and complexity on en route pilot read back performance*; (2) *Pilot English language proficiency and the prevalence of communication problems at five U.S. air route traffic control centers*; and 3) *United States Airline Transport Pilot International Flight Language Experiences Report 1: Background Information, General/Pre-Flight Preparation and General/ATC Procedures*. (Flightdeck/Maintenance/System Integration Human Factors)

Pilot Training and Experience with Transport Category Rudder Control Systems

Several recent events indicate that rudder control systems may have been involved in a number of hazardous situations. System design, human factors, and pilot training are considered potential event factors. Therefore, CAMI and the William J. Hughes Technical Center collected data on pilot training and experience with transport category rudder control systems. The goal is to assess current airplane control characteristics, pilot interfaces, and training so as to better understand their relationship to pilot use/misuse of the rudder.

A survey designed to assess pilot training and experience with flight control and rudder systems provided vital information. The survey furthered the FAA's knowledge of pilot training and experience with transport category rudder control systems. Responses provided information on upsets in broad terms and also on specific aspects of pedal/rudder control systems. Results were analyzed to identify the primary airplane flown and the country of primary employment as well as the items listed above. Most pilots had unusual attitude training with training in the pitch, roll, and yaw axes. Pilots reported that they found recurrent simulator training to be effective.

When asked if more training in transport airplane rudder usage would be beneficial, over half responded yes, and when asked if recurrent training in rudder usage would be beneficial, over three-quarters responded yes. This information supplements anecdotal information and allows further evaluation of the factors that affect rudder use. Information gained from this research may be used to develop the following products: improved CFR Part 25 aircraft certification rules, policy, and guidance; training guidance; and, responses to NTSB safety recommendations. (Flightdeck/ Maintenance/System Integration Human Factors)

Surface Moving Maps

The Volpe National Transportation System Center conducted three activities regarding the implementation and integration of surface moving map displays on the flight deck. First, a list of research issues was identified based on a preliminary analysis examining the circumstances leading to runway incursions and a glimpse of the state of the industry with respect to surface moving map technology. Second, a formal industry review was started to identify what information is being depicted and what functions are being implemented. Of particular interest are the presentations of ownship, traffic, visual or auditory indications or alerts, and route guidance. Manufacturers and research organizations developing surface moving map applications have been identified based on participation in a previous industry review, presentations at industry meetings, and a web search. Third, the Volpe Center reviewed existing guidance for evaluation of the surface moving map application to understand any potential limitations in the use of this technology and to identify possible mitigations. Two topics were of interest. One was the accuracy specified for depiction of ownship position and the likelihood of depicting ownship on an incorrect runway or taxiway. The other was the presentation of runway incursion indications and alerts and their effectiveness depending on where they are presented in the pilot’s field of view.

The results of the activities are documented in two draft reports. The first describes causal factors contributing to pilot deviations that led to a runway incursion, provides a brief review of current surface moving map capabilities, and lists areas where research is needed to facilitate the design and approval of surface moving map displays. In particular, there is a need for guidance to support the development of runway incursion indications and alerts. Since the surface moving map may be presented on installed or portable display systems, the location of any alerts or indications in the pilot’s field of view may vary. A literature review is in progress to provide information on this issue and an experiment to address issues related to the design of effective runway incursion indications and alerts is being designed.

The second draft report addresses the implications of the allowable tolerance for the depiction of ownship position. The Volpe Center documented the likelihood of depicting ownship on an incorrect runway or taxiway using information regarding the configuration of runways and taxiways at U.S. airports and the distances between them to determine the potential for error in ownship depiction. Characteristics of runway incursions and the results of research to understand why pilots get lost are also included. (Flightdeck/ Maintenance/Systems Integration Human Factors)

Synthetic Vision for Primary and Multifunction Flight Displays

The objective of this project was to determine the potential effects on pilot performance resulting from incorporating synthetic vision system features into primary-flight and/or multi-function displays. The intent was to: 1) generate data that could be used to formulate appropriate certification criteria across a number of platforms on which this graphical imagery may be hosted (both aircraft-referenced and pilot-referenced display systems); and 2) provide data that could be helpful in assessing levels of operational credit that might be granted for the use of such systems.

A survey of the literature was conducted to determine to what extent guidelines and standards for the design and use of pictorial imaging displays (e.g., synthetic vision, enhanced vision, perspective primary flight displays) had been developed, and what data regarding both display design and human performance were available that had not already been captured in a guideline or a standard. A number of references, documents, and guidelines were found that had direct or indirect bearing on the issues involved in synthetic vision systems, enhanced vision systems, and perspective primary flight displays. These references were enumerated, and in some cases summarized, and forwarded to the sponsor. Findings were also used to assist in the preparation of the Minimum Aviation System Performance Specifications for Synthetic Vision Systems in the form of a document undergoing final revision and approval in RTCA Special Committee 213 (Enhanced Vision Systems (EVS), Enhanced Flight Vision Systems (EFVS), Synthetic Vision Systems (SVS)), of which the CAMI principal investigator is a participating member. Significant issues were identified that may be important for implementation of EVS, EFVS, and SVS in the NextGen environment, particularly where additional operational credit is sought. (Flightdeck/ Maintenance/System Integration Human Factors)

Human Factors Generic Guidance

The Volpe Center submitted a draft general guidance document to the FAA to help aircraft certification specialists identify and resolve common human factors issues in avionics submitted for approval and to identify important sources to reference. The document is intended to apply to all types of display systems (e.g., EFBs, Global Positioning System (GPS) displays, and electronic map displays) used for all types of operations (Part 91, Part 121, Part 125, and Part 135).

Topics in the document include: address system hardware, display and organization of information elements and features, and design of control devices. A discussion is included on the importance of a design philosophy and considerations for assessing workload, managing errors, automation, and protecting against and managing system failures. The document has two sections. The FAA Requirements and Guidance includes of human factors material excerpted from FAA CFRs, Advisory Circulars (ACs), Technical Standard Orders (TSOs), and independent documents invoked or referenced by the FAA (e.g., RTCA and SAE publications).

Other Recommendations provide additional guidance from design standards, human factors texts, research articles, and reports. (Flightdeck/Maintenance/System Integration Human Factors)

Human protection

No fatalities, injuries, or adverse health impacts due to aerospace operations

Aircraft Decontamination System

Aircraft provide the ideal environment for the spread of infections diseases on a global basis. The aviation industry expects that the number of passengers flying to foreign destinations will continue to increase. These flights usually involve a large number of people seated together for long periods of time. Further, the materials and surfaces of an aircraft cabin are generally porous and difficult to clean. Finally, viruses, bacteria, and infections may be unwittingly brought onboard and the current decontamination procedures may be inadequate.

The FAA has sponsored two studies through the Airliner Cabin Environmental Research Center of Excellence to assess the feasibility of using a thermal decontamination system developed by the AeroClave Company with a vaporized hydrogen peroxide (VHP) system developed by the Steris Corporation. Specifically, the studies were to determine if the decontamination systems could be operated in an efficient fashion, without requiring bulky vaporizers or other heavy equipment within the cabin and if the system was capable of delivering controlled quantities of VHP such that sporicidal conditions could be achieved throughout the cabin and kill a full spectrum of biological agents.

Field evaluations have been performed on a McDonnell Douglas DC-9 and the CAMI's Aircraft Environmental Research Facility, a grounded Boeing-747. The thermal decontamination system was shown to be capable of reproducing the environmental conditions (temperature and RH) that were found in an earlier study to be efficacious as an antiviral process. It was also found to provide an effective means of achieving environmental preconditioning for the subsequent use of VHP along with aeration after the VHP cycle.

In addition, successful decontamination was accomplished on a rail car. This decontamination technology has potentially multiple applications, such as commercial aircraft, rail cars, buildings, commuter trains, ambulances, and air ambulances. In commercial aircraft, materials compatibility issues must be fully tested and addressed before using VHP and/or Thermal decontamination. VHP and thermal decontamination could affect the continued airworthiness of aircraft and aircraft systems. Even though the feasibility studies showed promise for decontamination aircraft against biological agents and spores, the FAA is not continuing the aircraft decontamination research based on other research priorities. (Aeromedical Research)

Comprehension of Safety Briefing Card Pictorials and Pictograms

The presence of fire and smoke is a major cause of passenger and crew fatalities and injuries in airplane accidents. The speed and effectiveness of passenger actions often determines the probability of survival and have been shown to be highly dependent on the information and preparedness passengers have regarding cabin safety and emergency procedures. The safety card in aircraft used to provide much of this information, however, differ significantly among airline operators.

The NTSB has called for both standardization and testing for comprehension of briefing cards. CAMI Protection and Survival Laboratory scientists designed a study to address these recommendations. Among other things, the study gauged the efficacy of current briefing card pictorial components and determined the best presentation techniques for safety briefing cards to enhance the speed and effectiveness of passenger actions.

A total of 358 (46 percent) males and 457 females (54 percent) participated in the study. The participants' commercial flight history, expertise in cabin safety, education level, and other variables were considered. Preliminary findings show that pictorial comprehension scores ranged from 38 percent to 85 percent. Less than half of the comprehension scores exceeded the ISO international standard success criterion of 67 percent and only one pictogram score exceeded the American National Standards Institute criterion of 85 percent. These scores indicate that airline safety cards do not inform passengers of necessary safety information, in part because many cards are too crowded or too complex, which masks important parts of the presentations. (Aeromedical Research)

Drug Usage in Pilots Involved in Aviation Accidents Compared With Drug Usage in the General Population

Forensic toxicology researchers at the CAMI continue to make significant advances in the analysis of postmortem fluids and tissues following fatal aircraft accidents. Its scientists routinely detect and measure drugs, alcohol, toxic gases, and toxic industrial chemicals in the remains of accident victims. Recently, CAMI conducted a research study to compare the usage of illegal drugs and abused prescription medications in pilots involved in civil aviation accidents with that of the general population in the United States.

The comparisons included abused drugs routinely screened by the FAA, such as marijuana, cocaine, methamphetamine, and ecstasy, as well as prescription medications, such as barbiturates, benzodiazepines, opiates, and ketamine. Trends in illicit and prescription drug use in pilots of civil aviation accidents were found to be comparable to those seen in emergency departments and community data from major metropolitan areas collected by the Drug Abuse Warning Network and the Community Epidemiology Work Group.

Drug analysis was conducted on 5,321 pilots who were involved in aviation accidents during the examined time period (1990 - 2005). The analysis found 473 occurrences of either illicit drugs or commonly abused prescription drugs, accounting for 9 percent of all pilots. Marijuana or its metabolite, tetrahydrocannabinol carboxylic acid, was the most common compound detected in pilots involved in civil aviation accidents. These compounds were detected approximately twice as often as all other drugs in the study. These research findings are critical to the enhancement of civil aviation medical certification, accident investigation, education, and drug abatement processes. (Aeromedical Research)

Laser Illumination of Aircraft by Geographic Location

Incidents involving laser illumination of aircraft in the NAS have raised concerns within the aviation community for more than a decade. The principal concern is the visual effect laser illumination may have on flight crew performance during terminal operations, such as landing and departure maneuvers, when operational activities are extremely critical. A study conducted by researchers at CAMI examined the frequency and rate of aviation-related laser incidents by year and location.

Incident reports of civilian aircraft illuminated by high-intensity lights have been collected from various sources and entered into a database. Reported incidents of laser exposure of civilian aircraft in the United States for a 3-year period (January 1, 2004 to December 31, 2006) were collated and analyzed. A total of 832 incidents during the study period took place within the United States in the nine FAA-designated regions. Total laser incident rates per 100,000 flight operations ranged from zero in the Alaskan region to 0.86 in the Western Pacific Region. Of the 202 airports where laser incidents occurred, there were 20 (9.9 percent) that reported 10 or more laser incidents during the study period. The majority of airports (52.6 percent) with 10 or more laser incidents reported a higher number of incidents in 2005 than in 2006.

Laser illumination incidents that could compromise aviation safety and threaten flight crew vision performance occur with some regularity within the contiguous United States. While the study data indicate the Western Pacific Region had a significantly higher prevalence rate than the other FAA regions, analysis was complicated by incident clusters that occurred randomly at various airports. Actions taken by aviators via notification of air traffic or other authorities, as well as action by local air traffic and law enforcement authorities, can minimize this threat to aviation safety. (Aeromedical Research)

Occupant Seat and Restraint Models

Aircraft manufacturers are under strong pressure to reduce costs and development cycles in a highly competitive market. The development of aircraft interiors is driven by customer demands, increasingly complex materials, and aviation safety requirements. To address these challenges, engineers and scientists have developed state-of-the-art computational tools and processes to reduce the amount of physical testing, certification costs, and length of regulatory development cycles.

The FAA requires passenger aircraft to have strong seats designed to increase the survivability of passengers and flight crew/attendants in accidents. A 2005 rule, which affects aircraft built after October 2009, states that seats must be able to withstand 16 times the force of gravity (16g), compared with the 9g standard in effect since 1952. Floors and the tracks on which the seats ride also must be able to withstand these forces. The new seats will have to undergo a battery of tests to determine their strength, similar to the crash tests that automakers must comply with to meet federal safety standards. Also, restraint systems that are integrated into and are as strong as the supporting aircraft structure will provide increased occupant survivability.

In conjunction with industry and academic experts, aerospace medical research engineers at CAMI have developed and tested measures of accuracy for dynamic mathematical models. This collaborative effort provides aircraft seat manufacturers with the basis for standardization of dynamic models to support increased safety and reduced cost of seat testing. (Aeromedical Research)

Aircraft Overrun and Undershoot Analysis

Recent accidents involving aircraft overruns in Little Rock, AR, Toronto, Ontario, and Chicago, IL have focused attention on improving airport runway safety areas (RSAs) in the United States and elsewhere. Undershoots are also a factor in the design or improvement of RSAs. However, many airports do not have sufficient land to accommodate standard FAA/ICAO recommended RSAs, or they face extremely expensive and controversial land acquisition or wetlands filling projects to make sufficient land available.

The recommended alternatives to a standard 1,000-foot RSA in the United States involve either applying a runway declared distance restriction, with undesirable limitations on aircraft operational payload/range, or installing an Engineering Materials Arresting System with a minimum RSA length of 600 feet. Some airports cannot practically comply with either of these requirements. Current recommendations on standard RSA length are based on a review of all overrun accidents but did not factor in variables, such as the frequency of occurrence and severity of short versus long overruns. More comprehensive research, to include additional variables related to runway overruns and undershoots, would allow more informed decisions on this difficult problem.

This project collected and analyzed historical data related to both overrun and undershoot occurrences in order to assist airport operators in evaluating runway safety areas. The information studied includes accident and incident characteristics such as: aircraft type, occupancy, exit speed, overrun/undershoot distance, weather, elevation, pavement condition, and other characteristics pertinent to the occurrences. (Airport Cooperative Research – Safety)

Evaluation and Mitigation of Aircraft Slide Evacuation Injuries

Current technology aircraft evacuation slides may not adequately protect all passengers from injury during evacuations. Airport fire and rescue personnel estimate that approximately 10 percent of evacuees require medical attention for sprains, skin burns, broken bones or other injuries resulting from the evacuation. Evacuation slides are susceptible to problems in deployment during different situations such as high wind conditions, often resulting in the slides becoming rendered useless when folded against the aircraft fuselage and when aircraft are not fully upright when slides are deployed, creating varying slope angles of the slides.

Aircraft in operation today are also of varying ages and aircraft certified over 15 years ago have slide and evacuation rate standards that are very different than newer aircraft, which can affect injury rates. Other factors that can contribute to injuries include whether the aircraft is on or off pavement, the type of clothing worn by passengers, and the differences between single versus dual aisle and single level versus double level aircraft. For larger aircraft, there can be a discrepancy between the evacuation performance of certification volunteers, who are trained in the procedure, and actual evacuees, who often hesitate at the head of the slide, pausing to sit on the door sill before entering the slide. This latter phenomenon results in slower evacuations than is demonstrated in certification.

This project identified the challenges associated with the use of slides at airports, focusing on causes of injury rates and ways to reduce those rates. This comprehensive report includes: a literature review of known incidents where aircraft evacuations via the slides occurred and identified causes of known injuries; a survey/interview of airport operators and emergency responders involved in those incidents, slide manufacturers and aircraft manufacturers, as appropriate; a review of tools relative to aircraft slide evacuations available to first responders; and recommended guidance for airport operators and emergency personnel on preparing for aircraft slide evacuations that includes best practices for minimizing injury rates. (Airport Cooperative Research – Safety)

Alternative Pavement Grooving Evaluation

An alternative pavement grooving technique, called trapezoidal grooving, was installed and evaluated at two major airports during 2008. This new shaped groove is one quarter or an inch deep and tapers from one-half of an inch wide at the top to one-quarter inch wide at the bottom. It is designed to resist damage from sweeping, snow plowing, and aircraft traffic. The standard groove, which is one quarter inch wide and one quarter inch deep, has historically been susceptible to damage, and is typically replaced after just a few years of installation. Two test sites at Chicago O'Hare International Airport and Quantico Marine Corp Facility were monitored and tested by the FAA throughout 2008. The tests found that the new groove pattern was a great improvement, offering significantly quicker water evacuation, resistance to rubber contamination, improved durability, and similar friction values to those of the standard groove. (Airport Technology Research - Safety)

Next Generation High Reach Extendable Turret

Past research done by the FAA Aircraft Rescue and Fire Fighting (ARFF) Research Program established the advantages and benefits of ARFF vehicles using High Reach Extendable Turrets (HRETs) equipped with penetrating nozzles in aviation fire fighting. Since the introduction of HRETs in 1986, approximately 400 of the turrets have been retrofitted into existing ARFF vehicles or integrated on new ARFF vehicles. This technology increases passenger survivability, protects property, and extinguished fire faster right after an aircraft crash. Since the current HRET performance criteria have been in place for over a decade, researchers have begun to develop new HRET performance criteria to meet the challenges posed by the new Airbus A380 and other New Large Aircraft.

A 65 foot next-generation HRET has been installed on a research vehicle and a series of non-fire operational tests completed to evaluate its control functions and operations. The live-fire testing of the technology has begun to evaluate the system's fire fighting performance. The objective of testing this new technology is to refine further its performance requirements to meet the challenges of the commercial aviation fleets of today and tomorrow. (Airport Technology Research - Safety)

Operation of New Large Aircraft – Second Level Fire Fighting Evaluation

Currently, two major aircraft manufacturers are developing large commercial aircraft capable of carrying over 500 passengers on two levels and 80,000 gallons of fuel. These airplanes meet the FAA's Airport Design Group VI classification. The Airbus A-380 and the Boeing 747-8i, are the largest passenger carrying aircraft ever built and are referred to as New Large Aircraft (NLA). Scheduled service for the A380 in the United States began in 2008 with the 747-8i to follow in 2010. Their physical size, both in passenger and fuel carrying capacities, require examination of the ARFF service standards and recommended practices to determine their adequacy to combat post-crash events. In January 2001, the FAA issued DOT/FAA/AR-0067, *Rescue and Firefighting Research Program*, to cover several ARFF interrelated areas to improve passenger survivability in post-crash fires. One of the key areas of that study was the identification of firefighting requirements in terms of training, firefighting techniques, and specialized equipment related to NLA. It also identified the need for a revised or new methodology to determine firefighting agent quantities for NLA type aircraft. Current federal minimum agent requirements may not be sufficient to extinguish a major NLA fire. Physically, NLA will be significantly greater in fuselage surface area, wingspan, and tail height, and feature full upper passenger deck, significantly increased fuel loads, unique tail-located fuel tanks, and greater use of composite materials.

In response to this need for ARFF-related NLA research, the FAA partnered with the U.S. Air Force Research Lab at Tyndall Air Force Base, Oklahoma, to construct a mockup of a full-scale section of a NLA that enables researchers to conduct large-scale fire evaluations. The mockup has two passenger levels, a lower cargo level, three metal evacuation slides, the beginnings of the right wing root, and one inboard engine. The entire assembly is positioned inside a 100-foot diameter, environmentally-contained fire pit that can be filled with calibrated amounts of jet fuel for ignition. In addition, the mockup features three replaceable penetration points where aircraft skin piercing equipment can be evaluated. There are also three authentic evacuation slides that can be attached to the mockup for non-fire evaluations. The mockup was completed in 2007 and underwent baseline testing throughout 2008. With this valuable testing facility completed, the FAA has initiated several evaluation programs that will help to find the answers to the questions regarding what kinds of tools, strategies, and amount of firefighting agents will be required to handle a fire event involving a NLA. (Airport Technology Research - Safety)

Powered Air Purifying Respirator Feasibility Study

Safe and efficient movement of air traffic is particularly important to the nation's air transportation system in times of national emergency. In the event of a pandemic flu, the FAA will deploy many tools to minimize spread of the disease among its workforce and to maintain NAS operations. Respiratory protection through the use of power air purifying respirators (PAPRs) is one of the methods that the FAA may use to minimize the spread of disease among staff that cannot function remotely. The goal of this study was to assess the feasibility of conducting maintainer and ATC-type tasks while wearing respirators.

Researchers measured characteristics such as the noise level created by the PAPR blower and the weight of the equipment. They also evaluated the use of other equipment such as telephones and binoculars. During the experimental evaluation, they measured human performance in part-task analyses. The tasks were representative of air traffic controller tasks and technical operations maintenance tasks. To assess feasibility, researchers measured the sound levels of the respirators and their effect on speech intelligibility, visual acuity and field of view, visual detection, ability to perform routine maintenance tasks, and subjective ratings of comfort.

While the researchers found no differences between the PAPRs in visual acuity or field of view, the use of telephones and binoculars while wearing PAPRs ranged from difficult to impossible. The most critical problem identified, however, was the difficulty participants experienced in communication while wearing respirators. The study found significant increases in errors from wearing respirators in the speech intelligibility task with the levels of interference varying from one PAPR to another. Determining the impact of PAPRs on the performance of ATC and maintainer tasks will help in the development of an effective overall crisis contingency plan. (ATC/Technical Operations Human Factors)

Informed Consent

To learn more about "informed consent" required by the Commercial Space Launch Amendments Act of 2004, the FAA initiated a project to examine the issue of what a commercial space flight operator will need to do to satisfy the regulatory requirements of 14 CFR Part 460, specifically at § 460.45(a)(1). This section requires a launch operator to inform space flight participants of each known hazard and risk that could result in a serious injury, death, disability, or total or partial loss of physical and mental function.

A report was released that provides background on the origin of informed consent, describes its place in traditional legal framework, discusses how much information should be given to a space flight participant based on past cases, and recommends what a space flight participant should be told about the possible effects of space flight on the human body. To accomplish this portion of the task, the study gathered information on the possible effects on the human body due to space flight. Consideration was given to hazards such as pressure, noise, gravity, temperature, impact, atmosphere, and radiation.

Informed consent is derived from medicine, where doctors must inform patients of any risks or alternatives to a treatment. The patient may then choose to accept or reject treatment. The right of a patient to informed consent has been an important part of medical malpractice lawsuits for over three decades. Some of the principles applied to medicine apply to commercial human spaceflight. As in medicine, the space flight participant must receive enough information to enable an informed decision.

It is important to understand that Congress expressly stated that the emerging commercial human space flight industry was not to be viewed as highly regulated transportation like the airline industry but rather was comparable to adventure travel. Congress even went so far as to compare the participants to daredevils, visionaries, and adventurers. Therefore, the report looked at the standards of informed consent for commercial recreation or adventure sports operators. As with adventure sports, the risks that must be included in any informed consent warnings are those that would affect a reasonable person's decision-making. The greatest emphasis should be placed on the areas with the most frequent or most severe risks. Space flight participants need to be aware, however, that the effects of suborbital flight on the human body are not completely known.

The report summarized the hazards to space flight participants that have been identified by research of space flight experience. It recommends three things.

- The regulation mandates written informed consent. Legally informed consent only provides legal protection, that is, defense, from the risks of an activity and not from negligence. There is some confusion as to whether any private contract that seeks pre-activity exculpation from inherent risks and negligence, which is standard in the adventure world, would be valid. Where the appendices (part 440) to the final rule provide exculpatory style documents in favor of the government as the permitting agency, there is reason to believe that exculpatory documents between a commercial operator and a space flight provider would be allowed.
- Courts differ as to whether a risk is material or not. A material risk is one in which a reasonable operator would provide to a reasonable space flight participant. It is impossible to enumerate every single risk. Clarification of how materiality gets satisfied either by what the operator believes is material or by what the space flight provider thinks is material should be provided. As stated previously, the greatest emphasis should be placed on the areas with the most frequent or most severe risks.
- Collaboration with industry may well be necessary or expedient at this point. Where it has been widely publicized that a leading suborbital provider has signed up literally thousands of prospective space flight participants and has begun working with them, or at least working with some of their "founders," using this early group to determine or establish materiality may well be revealing for industry.

The report and recommendations are provided as an example only. It is recommended that individual operators work with experienced legal counsel for advice tailored to the operator's specific operations. (Commercial Space Transportation)

Acute Human Exposure Limits for Gaseous Halocarbon Extinguishing Agents

Effective environmentally-friendly halon replacement agents are available for aircraft hand-held extinguishers. However, the use of these gaseous halocarbon hand extinguishers in the confined space of an aircraft compartment has raised concerns and stymied their use because they can pose cardiotoxic, anesthetic, and hypoxic risks to the occupants of that compartment if excessive agent weights are discharged. Yet, it is of the utmost importance that a sufficient number of halocarbon extinguishers of the proper rating are available to extinguish any in-flight fire that is likely to occur.

A report *Safe Acute Exposure Limits for Gaseous Halocarbon Extinguishing Agents in Ventilated Aircraft*, DOT/FAA/AR-08/3, was written. It provides a methodology for selecting the maximum safe agent weights for halocarbon hand extinguishers of the required fire rating for use in aircraft compartments based on compartment volume, certificated cabin pressure altitude, and ventilation air change time.

A kinetic model was also developed that provides a simplified method of using existing human physiologically-based pharmacokinetic (PBPK) modeling results for the inhalation of constant halocarbon concentrations to determine the arterial blood intake in a ventilated compartment where the agent concentration is continuously changing. The PBPK data for constant agent concentration exposure was used to determine the first order kinetic rate constants for arterial blood uptake and elimination. In addition, a separate analysis was developed to provide guidance to minimize exposure to low oxygen partial pressures resulting from the discharge of these agents into small unpressurized aircraft compartments.

Arterial concentration histories obtained using first order kinetics provided a good fit to the arterial concentration histories obtained by PBPK modeling for simulated human exposures to constant concentrations of Halon 1301 and the replacement agents Hydroflourocarbon (HFC)-227ea and HFC-236fa. Solving the equation for ventilated compartments for these agents eliminated the need to rerun costly, complex PBPK modeling programs. A good fit was not obtained for the replacement agent Hydrochloroflourocarbon (HCFC)-123, and it was necessary for the manufacturer to run the ventilated PBPK model for this agent. The safe agent weight to compartment volume guidance for halocarbons developed in this report is the basis for the safe-use guidance for halocarbon extinguishing agents in the proposed updated FAA AC 20-42D *Hand Fire Extinguishers for use in Aircraft*. (Fire Research and Safety)

Burning Behavior of Cabin Materials

One of the main obstacles to developing ultra-fire resistant materials that impart passive fire protection to transport category airplanes is the lack of understanding of the relationships between the bench-scale fire tests used to characterize the material flammability and the development of a full-scale fire.

To address this problem, the FAA has developed a thermal-kinetic numerical model called ThermaKin that simulates the pyrolysis and combustion of aircraft cabin materials in fire situations quickly and easily using only a personal computer. ThermaKin includes transient energy transport, chemical reactions, and mass transport in the calculation of the one-dimensional burning rate of an object. To calibrate ThermaKin, the FAA measured the chemical and physical properties of several plastics using laboratory (milligram) scale tests and used only these properties to calculate the burning rates of the plastics in a standard bench-scale fire test (ASTM E 1354). Burning rates were then measured of the same plastics in the bench-scale fire test and the results were compared. The comparison between the calculated and measured values was excellent, showing that ThermaKin captures the complex and coupled processes of flaming combustion without any adjustable parameters.

ThermaKin is the first step in the development of a general fire simulation methodology for aircraft cabins under a broad range of fire conditions. Future research will focus on calibrating ThermaKin for charring and composite materials and extending the simulations to 2-dimensions (flame spread) and 3-dimensions (fire growth in an aircraft cabin and fuselage burn-through). The fire simulation methodology will be calibrated at full-scale and, if successful, will provide a tool to assess the impact of ultra-fire resistant materials and material substitutions on the likelihood of an in-flight fire and the severity of a post-crash fire, and will be useful for accident investigation. A description of the model is contained in FAA Report DOT/FAA/AR-TN08/17, *Thermo-Kinetic Model of Burning*. (Fire Research and Safety)

Thermal Acoustic Insulation Burnthrough Resistance Certification and Installation Guidance Material (AC 25.856A)

On September 1, 2003, an important FAA fire safety regulation was adopted pertaining to the flammability of thermal/acoustic insulation used in transport category aircraft. The new regulation established two new flammability test methods that were products of FAA research. The first test method measured the resistance of insulation to flame spread from an in-flight fire ignition source and was more realistic and severe than the Bunsen burner test method it replaced. The second test method was a new requirement that measured the ability of insulation to resist penetration, or burnthrough, from a post-crash external fuel fire.

Although the FAA required compliance with the new burnthrough standard in 4 years, industry proposed and was granted a 24-month extension to account for unforeseen test equipment issues that had delayed certification testing. It should be noted that thermal/acoustic insulation is installed very early in the airplane assembly process, so new installations must be implemented well in advance of the actual compliance date, and new designs must be defined well in advance of the installation date. The new compliance date is September 2, 2009.

Although the new burnthrough test method was further developed and refined to maximize its repeatability, many non-test details existed with regard to the installation of insulation blankets in an aircraft. It is important that a blanket meeting the burnthrough requirement be properly installed and attached to the aircraft structure to achieve the full benefit of its fire resistance. A highly burnthrough resistant blanket will be of no value in a crash accident if it is easily displaced during the fire due to insufficient attachment hardware. To ensure all of these additional details were properly addressed, the FAA developed AC 25.856-2.

To date, numerous thermal/acoustic insulation materials have been successfully tested, and these materials can be classified into three basic categories: batting systems, barrier systems, and encapsulating systems. The AC describes each of the system types, and an appendix listes schematic examples of each. In addition, it focuses on specific installation aspects, highlighting key areas that include blanket overlap at frame members, horizontal blanket overlap, penetrations, and types of installation hardware. A detailed test methodology for evaluating the burnthrough resistance of two horizontally overlapped blankets is also included in the AC. The AC also describes the appropriate test methodology for evaluating system performance in case an alternative approach is desired, including a description of the test apparatus modifications needed to evaluate any unconventional approach.

An updated AC, was published (AC 25.856-2A) on July 29, 2008. In addition to the schematic descriptions detailing the proper installation techniques, a detailed description of the new alternative sonic burner is included. The new Next Generation burner was also developed by the FAA, and has distinct advantages over the existing electric-motor-driven burner equipment in terms of output control and repeatability. Although conceptually simple, the new burner equipment requires a fairly robust air compressor as the air source, along with additional heat exchangers and monitoring devices, all of which requires a greater level of description. The new

AC contains numerous diagrams and schematics to ensure proper set-up and operation of this equipment.

This guidance material is primarily aimed at airframe manufacturers, modifiers, foreign regulatory authorities, and FAA type certification engineers and their designees. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. An electronic version of the burnthrough AC, 25.856-2A can be found at http://www.airweb.faa.gov/rgl (Fire Research and Safety)

Icing Forecasting

National Transportation Safety Board reports indicate that in-flight icing causes more than 25 accidents annually, with over half of these resulting in fatalities and destroyed aircraft. This equates to $100 million in injuries, fatalities, and aircraft damage per year. To address this problem, FAA researchers have developed the Current Icing Product (CIP-Severity) and the Forecast Icing Product (FIP-Severity). These products alert users to areas of known and forecasted in-flight icing by graphically displaying the probability that icing will occur along their planned flight path. FIP-Severity was approved by the joint FAA/National Weather Service Aviation Weather Technology Transfer Board for experimental use in FY 2007. User feedback obtained during the experimental phase resulted in improvements, including the addition of more flight levels to the display providing enhanced flight planning information.

FIP-Severity will delineate icing conditions, so that aircraft can avoid these areas. A relative scale has been calibrated to depict the probability of encountering icing and super-cooled large droplet regions, which represent conditions outside the current certification envelopes. These areas are depicted as cross-hatched overlays for quick reference. These capabilities will allow users to plan more effective routes of flight that will avoid hazardous icing areas. Development of FIP-Severity was completed and is expected to be approved for full operational use in FY 2009. (Weather Program)

Turbulence

National Transportation Safety Board data show that turbulence continues to play a factor in more than 25 fatalities per year (mostly in the general aviation sector) and data from National Oceanic and Atmospheric Administration archives show that pilot reports of severe turbulence encounters are more than 4000 per year. To mitigate some of these accidents and incidents, FAA researchers have developed the NEXRAD Turbulence Detection Algorithm (NTDA).

The NTDA provides a new capability to remotely detect in-cloud turbulence using operational weather radar data, thereby supplying a valuable new source of information for a planned nation-wide rapid update nowcast system that will provide a comprehensive diagnosis of atmospheric turbulence hazards from clear air, mountain wave, and thunderstorm sources.

The NTDA makes use of data from the United States network of operational Doppler weather radars to measure in-cloud turbulence. It performs extensive data quality control and uses the radial velocity spectrum width to produce estimates of eddy dissipation rate an atmospheric turbulence metric. During FY 2008, the NTDA was deployed on all U.S. NEXRADs as part of the Open Radar Build 10 software. This data will be used to produce a 3-D in-cloud turbulence map that will be integrated into other turbulence products, including the Graphical Turbulence Guidance Nowcast. The NTDA provides a valuable tool for identifying potentially hazardous regions of in-cloud turbulence. This improvement will allow users to plan more effective and safer routes of flight that will avoid hazardous turbulence areas. (Weather Program)

Side-Facing Seat Crash Dynamics

This project was designed to determine the injury exposure of a human sitting in a side-facing seat during a crash event. It is intended to address the increased use of side-facing seats in the interiors of transport and other category aircraft. The project completed the planned cadaver testing and obtained the necessary data to develop neck injury criteria for side facing seats. The cadaver testing developed side force information for neck injury, which was not previously available. This testing determined the capability of the human neck in tension and moment loading from a deceleration during a crash while occupying a side-facing seat. The testing was compared to analytical models for the prediction of stresses and strains associated with side impact. The testing revealed that the conventional wisdom of using a three point restraint system may not provide the expected protection. Additional testing is proposed in areas, not thought necessary in the initial test planning, based on this work to complete the stress envelope experienced by the human body in side facing seats. The testing has developed a basic understanding of the dynamics of side facing seat reactions and provided a basis for analysis of side facing seat restraint requirements.

The information obtained from this testing program will provide the necessary human neck side force survival capability to understand the crash condition thresholds for injury while occupying a side facing seat. This will be used to establish reference stress values and correlation standards for the anthropomorphic test dummy to meet side-facing seat certification requirements. (Advanced Materials/Structural Safety)

Terminal Area Safety

The area around terminals continues to be the most hazardous area in the NAS. The majority of accidents occur in the takeoff and landing phases of flight. While capacity issues have become very important, the accelerated introduction of new technology, procedures, and equipment to solve the capacity problems must be integrated into the existing operational infrastructure so that maximum benefits for both safety and efficiency are realized. Examples of what might be involved include aircraft landing performance, terminal area navigation, ATC procedures, controlled flight into terrain on approach or landing, closely spaced runway operations, communication procedures, and airport lighting and signage.

MITRE prepared a report *Analysis of Advanced Flight Management Systems (FMS), Flight Management Computer (FMC) Field Observations Trials, Radius-to-fix Path Terminators* for FAA. This work was based on a study initiated by the FAA that discussed issues concerning the significance of potential impacts introduced by the differences in performance of various manufactures’ FMS and their associated FMC on the terminal area navigation operations.

FAA is also working with the Air Force Research Laboratory's Human Effectiveness Directorate to evaluate the protections and safety procedures for intentional and unintentional laser illuminations occurring in terminal areas during critical phases of flight operations. The goal of the research is to develop procedures and recommended equipment for flight crew and air traffic controllers to mitigate the risk associated with undesired laser illuminations. The FAA conducted pilot-in-the-loop evaluations on laser safety by using the FAA B-737-800 advanced flight simulator equipped with a tracking laser system that realistically mimics a laser flashed at an aircraft flight deck from the ground. The study results will support the development of recommended practices for pilots regarding laser illuminations.

In addition, a draft report entitled *Laser Illuminations: Pilot Operational Procedures* was submitted to SAE G-10T, the Laser Safety Subcommittee, for final publication. This report offers an overview of the flight hazards associated with laser exposures, and introduces recommended practices to pilots who encounter lasers during flight operations. The technical data contained in the report will provide guidelines for airlines and pilots with effective procedures in response to the visual disruptions associated with low to moderate laser exposures that pilots are most likely to encounter during flight operations. A video on information and instructional operations for pilots during unauthorized illumination events was also completed. Final production of this video will be published by January 2009 to provide reference and training materials for airlines and pilots regarding flight/landing operations during laser exposures. Finally, under a research agreement with the U.S. Air Force, a study was conducted to evaluate various materials for eye protection during laser exposures. Data of the optical density measurements responding to different sources of laser illuminations were collected. The results will be used in follow-up studies to determine effectiveness of laser eye protections. This study will help the aviation industry, including airlines, aircraft manufactures, and pilots develop effective procedures to mitigate risks associated with unauthorized laser illuminations. (Aviation Safety Risk Analysis/System Safety Management)

Safe aerospace vehicles

No accidents and incidents due to aerospace vehicle design, structure, and subsystems

Friction Stir Welded Aviation Structures Design Criteria

The FAA has certified specific designs for friction stir welded (FSW) aviation structures in the past few years. With the expanding number of processors and structural applications of the process, standardization of the information generated for the process will speed the certification process and allow these rapidly expanding applications to attain a high level of safety without undo cost or complexity. The FAA has worked to leverage the investment in standardization with several industry partners interested in the expansion of the process. The goal is to develop both standardized information on design safety criteria and basic joint allowables to give the structural design community a guide in the safe and efficient use of FSW in aviation structures.

The project started with the basics of determining the critical parameters yielding an effective structural joint that is reliable and durable. An extensive investigation of the parameters which are crucial to the FSW process was conducted. The parameters investigated included feed speed, mandrel rotation, inclination of the tool in relationship to the welded structure, and tool geometry. This study revealed that many parameters initially thought critical did not change the structural performance of the weld. After many experiments it was found that a standard joint configuration can be described that is path independent (i.e., processing parameters do not effect the outcome). In addition, an in-situ rivet process was also found that can be repeated without proprietary processing information. These two developments will be the basis for proceeding with standardization efforts.

This work is the foundation of standardizing the process to develop a joint values that can be compared from location to location to understand the manufacturer’s process control; and develop preliminary design capabilities that can be used to evaluate the potential of the process in new applications. The team has initiated efforts to adopt these methodologies in standard practice and material allowable handbooks, such as Metallic Materials Properties Development and Standardization. (Advanced Materials/Structural Safety)

Surface Condition Determination for Reliable Processing for Bonded Structures and Repair

The expanded use of composite materials in structural applications has focused attention on repair procedures for those products. The use of bonding for repair of composite structures is preferred for maintaining integrity of the parent structure. There are concerns with the use of bonded repairs, especially in the aircraft operations environment, due to surface cleanliness requirements for bond reliability and durability. The structures are typically contaminated with dirt, oils, and greases from the operating environment. These are known to cause severe problems with adhesion of the repairs.

This work has investigated the chemical interaction of the surface and the adhesive materials; identified the most probable contaminants; assessed the impact of those contaminants; and identified the possible means of detecting the level of contamination from the repair surface. The FAA has been assessing the ability of current and innovative detection equipment to identify the specific contaminants and the capability to determine whether the contamination level is acceptable to establish a durable bond.

This project identified the surface contaminants which cause degradation; documented technologies which identify the surface contaminants; and evaluated initial equipment able to assess surfaces for those contaminates. This work will allow applicants and operators to provide repair procedures that incorporate reliable methods for accurate determination of surface suitability for durable structural bonds. This will enable the use of more bonded structure in future aircraft while providing expected level of safety. (Advanced Materials/Structural Safety)

Geometry Conversion Tool for Rotorburst Vulnerability Reduction

Users of the Uncontained Engine Debris Damage assessment Model (UEDDAM) have had difficulty converting commercial aircraft geometry into the Fast Shot-Line Generator (FASTGEN) format used by the UEDDAM analysis code. Discussions with industry indicated that a converter from PATRAN was needed to decrease the time required to build the models for commercial users.

A FASTGEN preference was developed to support this request. The converter preserves the geometry and material identification of components and helps users build a vulnerability analysis model that can be used for either an infinite energy rotorburst analysis per the current FAA Advisory Circular (AC 20-128A), or the multiple fragment Monte-Carlo analysis anticipated for future designs. (Aircraft Catastrophic Fire Prevention Research)

Propulsion Malfunction Research

The FAA has an ongoing, multi-year effort to study propulsion malfunctions that precipitate inappropriate crew response type accidents and incidents. This effort is in response to research recommendations from a 1998 Aerospace Industries Association (AIA) report. The Engine Damage Related - Propulsion System Malfunctions, study, completed in 2007, directly supports the AIA Propulsion Indications Task Team (PITT) that is working to develop recommendations for future changes in the Federal Register, Title 14, CFR Part 25.1305. This research provided input for the propulsion section of recently published FAA Advisory Circular (AC25-11A).

The 2008 study developed concepts for information based oil system displays with the intent of minimizing crew troubleshooting in the cockpit and tying information to actions and checklists for the pilots when required. The study focused on the pilot informational needs and looked at the best means of displaying the information. Four concepts were developed and programmed into the Boeing 777 CAB simulator. Work is continuing in support of the AIA PITT team with the evaluation of the developed information based display concepts that will tie annunciations to pilot actions and minimize troubleshooting of propulsion malfunctions in the flight deck. (Aircraft Catastrophic Fire Prevention Research)

Turbine Engine Research

The FAA is working with the aircraft engine industry to develop an enhanced life management process, based on probabilistic damage tolerance principles, to address the threat of material or manufacturing anomalies in high-energy rotating components. An integrated team of Southwest Research Institute, GE Aviation, Pratt & Whitney, Honeywell, and Rolls-Royce Corporation developed a probabilistically-based damage tolerance design and life management code called Design Assessment of Reliability with Inspection (DARWIN) to determine the risk of fracture of turbine engine rotors containing undetected material anomalies.

The initial version of DARWIN addressed the subsurface material defect known as hard alpha and meets the requirements of a new FAA Advisory Circular on Damage Tolerance for High Energy Turbine Rotors (AC33.14-1). In FY 2007, a new version of DARWIN was completed to address surface damage in bolt holes and, in the following year; another new version was delivered to address surface defects on the turned surfaces of rotor disks. The FAA plans to complete new Advisory Circulars based on these new versions of DARWIN. Future versions of DARWIN will address surface damage in blade slots as well as advanced zoning capabilities and advanced probabilistic methods to treat varying inspection schedules and multiple defects. (Aircraft Catastrophic Fire Prevention Research)

Unleaded Fuels and Fuel System Safety Research

The EPA exemption of general aviation from the 1990 Clean Air Act Amendments regarding the use of leaded fuel is still in effect. Recent petitions to the EPA have reignited the call for either a ban on leaded aviation fuels or a study on the health effects of leaded aviation fuels. It is likely that environmental and cost pressures of using leaded fuels will continue to increase for the general aviation community. Extensive testing by the FAA William J. Hughes Technical Center on an unleaded replacement for the current leaded 100 low-lead (100LL) aviation gasoline involved the use of specialty chemicals. Significant engine modifications may be required on the high-compression engine legacy fleet to operate on a lower-octane, unleaded fuel, which would likely result in changes to engine and aircraft performance and pilot-operating procedures. Recent FAA tests confirmed that significant detonation performance differences exist between unleaded and leaded fuels of the same octane. The FAA, therefore, needs to continue its research on unleaded fuels and to evaluate engine technology given the increasing safety and certification concerns with the use of alternative fuels.

Working in parallel with the Coordinating Research Council, the FAA Propulsion and Fuel Systems Team was supplied with 47 separate blends of unleaded fuel containing various amounts of aviation alkylate, super alkylate, Toluene, Ethyl-tert-butyl-ether, tert-Butyl benzene, and meta-Toluidine. All blends contained 5 percent Isopentane. The blends’ compositions had motor octane numbers (MON) ranging from 97.6 to 106.3, and did not meet the current American Society for Testing and Materials (ASTM) D 910 leaded aviation gasoline specification. These 47 blends, along with a specially blended, minimum specification 100LL and unleaded reference fuels, were detonation-tested in a Lycoming IO540-K engine at the FAA William J. Hughes Technical Center. The goal was to address both the individual and synergistic compositional effects of the unleaded components on the full-scale engine detonation performance and on the ASTM D 2700 laboratory MON. The MON was correlated to the full-scale engine detonation performance and compared to the detonation performance of the specially blended 100LL.

Four power settings, ranging from takeoff to economy cruise, were evaluated with fuel mixture strength varying from 0.600 brake-specific fuel consumption to 50°F lean of peak exhaust gas temperature. Results show that the MON of the blends did trend with their detonation performance in the IO540-K engine, but equivalent unleaded blend performance of the specially blended 100LL required 2.0 greater MON. Nineteen of the 47 blends, all with higher than 102.5 MON, provided better detonation performance than the specially blended 100LL. Fourteen of the blends had higher MONs than the 100LL but performed worse in the full-scale engine. (Aircraft Catastrophic Fire Prevention Research)

Integrated Modular Avionics Research

The combination of rigorous design and verification assurances has led to safe and reliable operation of civil aviation software and digital systems. Historically, in typical federated systems, integration was a rather straight forward activity involving compiling, linking, and loading the software application onto the target computer system environment. However, Integrated Modular Avionics (IMA) systems and their ability to integrate several functions with shared resources require further guidance.

The *2008 Handbook for Real-Time Operating Systems and Component Integration Considerations in Integrated Modular Avionics Systems* (DOT/FAA/AR-07/48) is designed to inform the IMA system development role players of their commitments to each other and to the operational system. Its purpose is to aid industry and the certification authorities in the earlier integration stages of IMA system development. As such, this handbook documents some currently known issues, practices, and activities to be considered in the development and verification of IMA systems. These activities and practices include a discussion of modeling, the use of tools, and other IMA system development topics.

Information from the handbook is included in several publications: RTCA Special Committee SC-200 in the development of RTCA/DO-297 *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*; and AC20-145, *Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements*. (Atmospheric Hazards/Digital System Safety)

Microprocessors Evaluations for Safety-Critical, Real-Time Applications

Despite their extensive use in the aerospace industry, there is a lack of safe, economical methods to evaluate the reliability of microprocessors for safety-critical aerospace applications. The purpose of this research is to: investigate microprocessor use in the industry, identify assessment criteria for microprocessors, and document safety concerns for microprocessors. It identifies methods to evaluate microprocessors for safety-critical applications. Effective criteria for determining what is a high-risk versus low-risk microprocessors do not exist. The risk is the risk of microprocessor failure in critical applications that may endanger life and property, because of a resulting aircraft accident. If this research is not performed, the ability of the FAA and industry to evaluate emerging, highly complex digital hardware and software for use in advanced flight controls and avionics systems will be jeopardized, the cost of certification for the FAA and industry will increase, and the level of assured safety will be at risk. Certification specialists will find it difficult to properly assess proposed aircraft and avionics designs which employ this technology in flight essential and flight critical applications.

This research will: develop methods and procedures to permit the safe, economical qualification of microprocessor applications with complex, nondeterministic architectures; provide criteria to select microprocessors for safety critical aerospace applications that can be proven to be safe; and provide technical data for the development of FAA regulations and policy for the design and test of commercial-off-the-shelf (COTS) microprocessor components.

The 2008 report *Microprocessor Evaluations for Safety-Critical, Real-Time Applications: Authority for Expenditure No. 43 Phase 2 Report*, (DOT/FAA/AR-08/14) includes an in-depth analysis of functional test and validation of microprocessors, emerging microprocessor features safety issues, system on a chip (SoC) safety issues, and nondeterministic approaches to demonstrate safety evidence. The report provides an evaluation of modeling techniques proposed as a part of the Microprocessor Approval Framework (MAF), an assessment of the feasibility of using third party simulation tools for microprocessor and SoC safety analysis, and an evaluation of the applicability of the proposed MAF to COTS microprocessors. The MAF is the microprocessor approval framework that provides a procedural framework for new ways to evaluate these microprocessors and new ways to provide additional safety risk mitigation techniques.

In addition, a draft report was completed that contains the results of using MAF to assess the COTS Freescale MPC7447 microprocessor and the Freescale MPC8540 SoC as well as an evaluation of the Buffer Oriented Micro-architectural Validation (BOMV) technique for micro-architectural features of COTS microprocessors. (Atmospheric Hazards/Digital System Safety)

Qualification of Airborne Electronic Hardware Tools

This research initiative identified potential safety issues in the assessment and qualification of design and verification tools that are used to develop certain airborne electronic hardware (AEH), previously called complex electronic hardware (CEH), for the aircraft. The quality of the design and verification tool and the assurance provided by the tool are critical for the approval of any aircraft system containing this AEH. The AEH covered are custom, micro-coded components or devices, such as programmable logic devices, field programmable gate arrays, application specific integrated circuits, and similar circuits used as components of programmable electronic hardware. Neither the avionics standard RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, nor three Certification Authorities Software Team (CAST) papers (CAST-27, 28, and 30) written to clarify portions of RTCA/DO-254, specifically define what a design and verification tool for AEH is.

A 2008 draft report was developed to document the Phase 1 findings and results of the research. The research was conducted in several steps including literature search; industry survey;

identification of primary aircraft safety; performance and certification concerns; developing plan for validating these concerns; conducting experiments with the tools; and evaluating the experiments. The report addresses concerns related to approaches used to qualify tools used in the design and verification of AEH for airborne applications; service experience or service history used in AEH tool qualification; the potential role of the Testing Maturity Model (TMM) in tool qualification; and the impact of commercial off-the-shelf AEH on the aircraft system and AEH tools. Some of the concerns include ease of using the tool for verification, quality of the tool, and the speed with which the tool verifies designs. These concerns could be significant problems depending on the manufacturer's use of the tool and the part that the tool plays in its use within the development or verification process. Complexities with insuring independence of the verification effort, dealing with unused inputs and outputs, and solving timing issues are sample results from this research that are high on the list for resolution and review by applicants. These findings and results were presented at the 2008 FAA National Software and Airborne Electronic Hardware Standardization Conference.

The TTM provides an additional process to consider for the evaluation of AEH tools. The report documents this role through discussion of applicable TMM characteristics in the tool verification process. The research looked at the testing and verification process in the areas of testing phase definition, integration testing, the management and measurement of testing, and testing optimization and detection. The results found that TMM results may need to be reviewed independently to confirm that proper procedures were followed and that results adequately verify that the requirements have been met.

This research supports policy and guidance development for aviation systems in a rapidly evolving field of technology that exhibits a proliferation of AEH and software tools. (Atmospheric Hazards/Digital System Safety)

Cargo Fire Suppression Effectiveness of a Halon 1301/Nitrogen Enriched Air Mixture

The FAA Halon Replacement Program continues to investigate ways to eliminate or reduce the amount of Halon 1301 used in aircraft cargo compartments. In the past, the FAA has tested plain water mist, water mist combined with nitrogen, HFC-125, HFC-227, 2-BTP, and FK5-1-12; water mist combined with nitrogen was the only fire suppression system able to meet the FAA minimum performance standard (MPS) acceptance criteria. Since water mist/nitrogen systems are still under development, the FAA Fire Safety Team has been evaluating transitional techniques to reduce the use of Halon 1301 onboard the aircraft cargo compartment. One such technique is to introduce nitrogen into the cargo compartment, using the aircraft fuel tank’s onboard inert gas generation system (OBIGGS) to replace the fire suppression system metering phase (second discharge stage) of Halon 1301. There is, therefore, interest in determining the effectiveness of a mixture of Halon 1301 (first discharge) and nitrogen from an OBIGGS.

The experiments were conducted in the High Pressure Vessel Facility at the FAA William J. Hughes Technical Center. The facility had a 402.6 ft^3 pressure vessel instrumented with thermocouples, pressure transducers, gas analyzers, and a video camera. In the past, the exploding aerosol can simulator test requirement in the MPS was the primary determinant of the potential feasibility of a halon replacement agent. Therefore, the FAA aerosol can explosion simulator was installed inside the pressure vessel to conduct the tests. It contained a mixture of propane, alcohol, and water to simulate the contents of a large commercial aerosol can (i.e., hairspray). A wide range of nitrogen (to reduce the oxygen volumetric concentration) and Halon 1301 mixture concentrations were discharged inside the pressure vessel. After achieving the required oxygen and Halon 1301 concentrations, the aerosol can explosion simulator was activated to attempt to create an explosion. Temperature, pressure, and gas volumetric concentrations were recorded with a 1 Hz and a 1 kHz analog to digital data acquisition systems.

This research showed that beneficial effects resulted when Halon 1301 and nitrogen were combined to inert a closed pressure vessel (compartment) against an explosion from an aerosol containing propane, alcohol, and water. Less Halon 1301 was needed to inert a compartment having an oxygen-depleted environment. Explosions were prevented when these two gases were combined at concentrations that were below their individual inert concentrations. For example, an explosion was prevented when the volumetric concentration of Halon 1301 was 1 percent and the oxygen concentration was 17 percent. Individually, the required inert concentrations would be about 3 percent Halon 1301 and 12 percent oxygen. This means that in a typical aircraft cargo compartment fire protection system configuration, with a dual-stage discharge (high-rate/low-rate discharge), it may be more feasible to replace one of the two Halon 1301 fire bottles because of the availability of a nitrogen generator system. This approach would be particularly attractive in an aircraft with an available onboard inert gas generation system to prevent fuel tank explosions. The system integration could reduce the amount of Halon 1301 from the aircraft cargo compartment fire suppression system by 50 percent or more. (Fire Research and Safety)

In-flight Fire Exposure of Aluminum and Composite Fuselage Materials

Modern civilian transport aircraft are being constructed with increasingly greater portions of the aluminum fuselage being replaced with composite materials. The Boeing 787 is a nearly all composite aircraft. Composite materials consist of layers of fiber material held together with a resin binder. They have many benefits for the aircraft manufacturer in terms of fabrication strength and weight savings. The performance of these materials under in-flight and post crash fire conditions, however, is essentially unknown. Aircraft have been constructed with aluminum skin and structure for decades. The performance of this material when exposed to an in-flight or post crash fire is well known. Aluminum is essentially non-flammable, conducts heat very well, and has a high thermal radiation coefficient. Aluminum also melts at a relatively low temperature. These properties cause the aluminum hull material to behave very differently during an in-flight fire versus a post crash fire. During in-flight fire exposure, the aluminum skin and structure of the fuselage are cooled by the flow of air around it. This keeps the metal below its melting point and preserves the structural integrity of the aircraft. There has never been a documented case of hull penetration due to in-flight fire in an aluminum aircraft.

The FAA William J. Hughes Technical Centers Airflow Induction Facility performed a series of tests to determine the relative performance of both aluminum and composite hull materials when exposed to an internal fire while in flight. A test fixture was designed to simulate in-flight airflow over the test panels. The underside of the fixture was fitted with an enclosed box that housed the heat sources. Two heat sources were used to expose the underside of the test panel, an electric heater, and a live fire. The electric source was used to determine the relative heat conduction properties of each type of material under ground and in-flight conditions. The live fire intensity was sized to expose the test panels to a condition that was severe enough to melt through the aluminum panel under ground conditions, but not in-flight. The aluminum and composite test panels were exposed to each of these heat sources under airflows that simulated both ground and in-flight conditions. The heat transfer and conduction properties were measured with both thermocouples and forward-looking infrared cameras.

The results from these tests show that there is no significant loss in fuselage structural integrity during an in-flight fire due to the use of composite construction verses aluminum construction. The materials conduct and transmit heat very differently; however, the resistance to burn through is similar. The aluminum panels behaved as observed from experience in full scale aircraft fire tests. The aluminum transmits heat in a radial direction very effectively. Aluminum is also very effective at convective transfer of heat to air, more so in a moving air stream. If sufficient heat is applied to overwhelm these characteristics, the panels become plastic and deform when nearing the melting temperature of 1,220^o F. Once this temperature is reached, the metal turns to liquid, leaving a hole in the panel. Burn through under our test conditions occurred in 12 - 15 minutes. Burn-through is not an issue during in-flight conditions. The air stream is sufficient, even at the relatively low 200 mph in these tests, to cool the top surface of the metal and prevent it from reaching the melting point.

This has been demonstrated in real world aircraft fires; burn through occurs on the ground once the relative airflow has stopped. Although composite panels do not appear to transmit heat effectively in a radial direction, they do transmit heat normal to the surface. The panels are effective at preventing burn through, even though the resin is flammable because they have some insulating effect. Topside temperatures in the static tests were roughly half of the underside temperatures. The fire does damage the exposed face of the panel, burning the resin away and exposing the fiber. Once the outer layer of resin is burned away, however, the exposed fiber material acts like a fire blocking layer, limiting further damage. Burn through did not occur within the time frame of these tests, up to 25 minutes. Airflow over the panel during in-flight conditions is very effective at cooling the top surface of the composite material. The top surface temperature was lowered by more than 200^o F in 200 mph airflow. Off gassing from the heated composite panel did produce a flammable mixture in the box resulting in a flash fire. Further work in this area is needed to determine the magnitude of this hazard and the implications on safety. (Fire Research and Safety)

Low False Alarm Cargo Compartment Fire Detector Prototype

Cargo compartments on commercial aircraft are required to have fire detectors that will alarm within one minute of the start of a fire. The aviation industry currently uses particle sensing smoke detectors to comply with this regulation. These sensors readily detect fires but also alarm to other airborne particles not associated with fires. The ratio of false alarms from existing smoke detectors to the detection of actual cargo fires is on the order of 100 to 1. These false alarms lead to unnecessary flight diversions that are both costly and potentially hazardous.

A test project was completed that developed a series of fire detection alarm algorithms that sense not only smoke particles but also other combustion products including heat, ionized particles, carbon monoxide, and carbon dioxide. The algorithms used various combinations of absolute values of these combustion products as well as rate of change of the values. The algorithms were exposed to a variety of types of fires as well as false alarm sources. One of the alarm algorithms was successful in alarming to all of the test fires in less than one minute and displayed complete immunity to alarming to any of the false alarm sources.

This project demonstrated the potential for multi-sensor fire detectors with an appropriate alarm algorithm, to reduce dramatically the current rate of false alarms without a loss in detection sensitivity. This could lead to a safety improvement by significantly reducing the incidents of aircraft diverting from their intended flight paths due to false alarms from cargo compartment fire detectors. (Fire Research and Safety)

Unmanned Aircraft Systems

Initiated in FY 2007, the Unmanned Aircraft System (UAS) research program has yielded preliminary analysis and support for regulatory certification and oversight. The objective of the UAS technology survey is to provide the FAA with a detailed overview of UAS technology status in reference to the existing NAS. Following the regulatory framework, the FAA conducted the UAS technology survey in five (5) technical areas: airframe; propulsion; see and avoid; command, control, and communication; and flight termination. The FAA completed the technology survey and associated regulatory gap analyses in the first four technical areas. Results are documented and are being published in FAA technical reports.

As part of the UAS technology survey initiative, the FAA partnered with the U.S. Air Force Research Laboratory in a joint research effort to conduct flight tests of new see-and-avoid (SAA) technologies. The SAA technology uses electro-optical sensors to provide forward visual queues of other aircraft. In conjunction with other on-board sensors, such as Automatic Dependent Surveillance-Broadcast and Traffic Collision and Avoidance System, sophisticated image analysis and data fusion with thread identification algorithm will command the aircraft flight control systems to perform avoidance maneuvers once the system determines a collision threat is warranted. The first set of the flight testing was completed and results were published in a joint technical report.

In the development of the UAS safety management system, the research initiative implements the FAA Aviation Safety Safety Management System (SMS) Doctrine. The research focuses in two of the SMS essential elements safety risk management and safety assurance. The FAA completed an initial study of scenario driven system-level hazard analyses of UAS operating in the NAS. Based on this study, the FAA began the development of UAS safety risk management concept within the regulatory framework.

As the first step, the FAA completed the initial development of system-level hazard taxonomy for UAS – Hazard Classification and Analysis Systems (HCASs). It took a novel approach from the FAA regulatory perspective, Title 14 Code of Federal Regulation (14 CFR) Subchapters on Aircraft, Airmen, Airspace, Air Traffic and General Operating Rules. The HCAS took a top-down system approach to address potential UAS safety issues in the existing NAS within available regulatory standards. The FAA is in the process of publishing a technical report on the HCAS development and its taxonomies with representative analyses to demonstrate its potentials. (Unmanned Aircraft Systems)

FAA-Drexel Fellowship

The FAA-Drexel Fellowship Program is a collaborative effort established in 1998 to promote aviation safety within academia and support ongoing research activities within the Airport and Aircraft R&D Division. Participating students are an integral part of the program and have the opportunity to solve real-world problems that face the aviation industry. The goal of the FAA-Drexel fellowship program is to promote and train the next-generation engineer addressing aircraft safety issues.

On Oct. 17, 2007, FAA-Drexel Fellow Bao Mosinyi became the second Ph.D. graduate from the FAA-Drexel Fellowship program. The research for his dissertation, “Fatigue Damage Assessment of High-Usage In-Service Aircraft Fuselage Structure,” deals with multiple-site damage (MSD), a critical safety issue of aging airframe structure facing the aviation industry today. Dr. Mosinyi’s research involved complicated extended fatigue tests of two fuselage panels removed from a retired B727 airplane at the FAA Full-Scale Aircraft Structural Test Evaluation and Research facility. This research will provide key information for the aviation industry in developing programs to prevent the occurrence of MSD in the aging aircraft fleet. Dr. Mosinyi has accepted a position with Airbus North America in Wichita, Kansas.

The first Ph.D. graduate from the Program accepted a position with Boeing Commercial Aircraft Company in Seattle, Washington, in 2006. (Continued Airworthiness/Aging Aircraft)

Characterization of Fatigue Crack Threshold in High-Cycle Fatigue Applications

Aircraft propeller blades operate in a high-cycle fatigue (HCF) environment, accumulating a large number of fatigue cycles in a short period of time. Due to HCF, stable fatigue crack growth is of relatively short duration. For practical damage tolerance applications, it is desirable to operate propeller blades below the threshold region of fatigue crack growth. Traditional damage tolerance analysis uses near-threshold fatigue crack growth data from large cracks obtained mostly from compact and middle tension test specimens. However, in the case of aircraft propeller blades, the primary concern is the damage tolerance of small surface flaws. Therefore, this research program focuses on near-threshold fatigue crack growth of small, thumbnail-like, surface flaws in 7075-T7351 aluminum used in aircraft propeller blades. Of interest is the effect of compressive residual stresses at the outer surface of the specimens, introduced by shot-peening, on the near threshold fatigue crack growth behavior of small surface flaws.

The tests were conducted using dog bone specimens, as shown in Figure 1a, at the Material Characterization Laboratory located at the FAA William J. Hughes Technical Center, Atlantic City International Airport, New Jersey. A closed-loop, servo-hydraulic axial test stand with a

50-kip maximum capacity was used under load control mode, in accordance with ASTM E 647. To simulate the effect of small surface flaws (such as initial manufacturing flaw, in-service mechanical damage, and in-service corrosion damage), small 0.015-inch-radius semicircular surface flaws were introduced using a relatively new laser-machining technique, Figure 1b. The Direct Current Potential Difference method was used to monitor the subsequent fatigue crack growth (FCG). Initial and fatigue crack front profiles were measured using a stereomicroscope, optical microscope, and scanning electron microscope, at the end of the test.

The results are summarized in Figure 2 for the as-received 7075-T7351 aluminum specimens tested using R-ratios of 0.1 and 0.7. The fatigue precracking and subsequent load-shedding test procedures were successfully applied to obtain near-threshold FCG region and the arrest threshold stress-intensity factor range for the as-received specimens, Figure 2a. The final shape of the fatigue crack profile at the end of the cyclic loading was nearly semicircular, as shown in Figure 2b and 2c for R = 0.1 and 0.7, respectively. In general, the fatigue crack front progressed concentrically from the initial semicircular laser-machined flaw.

For the shot-peened 7075-T7351 aluminum specimens, crack initiation from the laser-machined flaws was not accomplished during fatigue precracking. Consequently, the shot-peened specimens failed outside the gage section during the fatigue tests, Figure 3a. The depth of the compressive stress region from the shot peening was greater than the depth of the surface flaw and effectively prevented crack initiation, as indicated in Figure 3b. This was further verified using the electron backscatter diffraction (EBSD) technique, which provided a two-dimensional orientation map of the material’s microstructure; i.e., the grain orientation and shape, Figure 3c. However, compared to the as-received specimens, the applied load in the shot-peened specimens was more than twice as high. This suggests that crack initiation threshold values in the shot-peened specimens would be a least double that of the as-received specimens.

Results from this study will provide the data that can be used for damage tolerance analyses of rotorcraft and aircraft materials. More details can be found in the Proceedings of the 11th Joint NASA/FAA/DoD Conference on Aging Aircraft, April 21-24, 2008 (http://www.aaproceedings.utcdayton.com/proceedings/2008/techpapers/TP891.pdf). (Continued Airworthiness/Aging Aircraft)

Situational awareness

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

Quarantine Facilities for Arriving Air Travelers

With the possibility of a worldwide outbreak of a new or emerging disease, public health authorities have revived disease control concepts, such as quarantine which is the segregation of individuals who may have been exposed to an infections disease but who are not yet ill. Quarantine historically has focused on ports of entry, which includes airports. The Centers for Disease Control and Prevention (CDC) has sponsored a series of tabletop exercises at airports that identified the need for facilities on airport property to quarantine several hundred people for days or even weeks. As a result, the CDC proposed a rule in November 2005 that requires airports to identify such facilities as part of their pandemic preparedness. [*The National Strategy for Pandemic Preparedness Implementation Strategy*, May 2006].

To date, however, there has been no discussion of: what types of facilities are necessary, whether such facilities should be located on airport property, whether other existing facilities could be adapted for this purpose or new facilities could serve multiple uses, and who should pay to provide and maintain these facilities. There is also a need to develop guidelines on how airports can maintain continuity of operations if their employees (maybe up to 30 percent) do not come to work because they are either sick or concerned about coming in contact with sick individuals.

This project developed guidance for airport operators to identify potential quarantine facilities on or off their airports and for continuity of airport operations. The guidance has been developed based on factors, such as: 1) physical needs of individuals to be quarantined (e.g., beds, sanitation, security, food); 2) non-airport resources available to provide basic necessities (e.g., Red Cross); 3) structural requirements for such facilities (e.g., square footage, climate control, plumbing); 4) transportation from aircraft to facility; 5) potential existing facilities at airports or in community, including those identified in other plans (e.g., hurricane shelters, family assistance sites); 6) potential for multiple use for new facilities; 7) operational and financial impacts of identifying on-airport facilities; and 8) planning guidelines for expected maximum number of individuals to be quarantined. (Airport Cooperative Research – Safety)

Automated Foreign Object Debris Detection System Evaluation

The presence of foreign objects in the airport environment presents a major hazard to aircraft safety. Foreign object debris (FOD) is any substance, debris, or article found on an airport surface that could potentially cause damage to an aircraft or vehicle. The presence of FOD can be the result of the loss of parts from aircraft, pavement deterioration, wildlife, ice and salt accumulation, or construction debris. Identification of FOD at airports requires frequent inspection of airport surfaces by airport personnel, or random observation by aircraft pilots operating on airport pavement. Usually, these are the only triggers for FOD removal action.

In 2005, the FAA, in cooperation with the University of Illinois, conducted a preliminary short-term evaluation of a radar-based FOD detection system at the John F. Kennedy International Airport. This millimeter-wave radar system demonstrated the capability to detect objects as small as a two-inch bolt on the pavement surface, thereby providing airport personnel with timely FOD alerts and specific information on the location of the object. Although the preliminary research demonstrated successful FOD detection under many operational and environmental conditions it also identified a need to conduct evaluation on a longer-term basis, under varying seasonal conditions.

In 2007, the FAA installed two separate millimeter-wave radar units at the Theodore Francis Green State Airport, in Providence, Rhode Island and collected 12 months of operational data, including winter operations. By March 2008, the results of this study were included in an interim report.

In addition to the radar system, the FAA identified three more FOD detection technologies that demonstrated sufficient maturity. Since each uses a different technology to detect FOD, FAA researchers decided to evaluate each one in a separate study.

In June 2008, the FAA installed another FOD detection technology at Boston Logan International Airport that uses both radar and cameras to detect FOD. The FAA installed 2 more systems, one with a high powered intelligent vision camera system and one mobile system. Evaluation of all three systems will continue into 2009. A comprehensive final report that summarizes the all four FOD detection technologies is expected in 2009. (Airport Technology Research- Safety)

Light Emitting Diode Airport Applications

Light emitting diodes (LEDs) have the potential to provide significant energy savings, reduced maintenance, and overall life-cycle cost savings while providing a more reliable visual cue. During the initial implementation of LEDs, it was discovered that caused some system integration issues. An FAA/industry team was formed in August 2007 to address the issue of a common electrical infrastructure for LED lights sources. This infrastructure should include a power distribution system that: maximizes efficiency of the LED fixture, reduces total cost of ownership, and supports an open architecture. This research will continue into FY 2009.

Additional LED implementation issues for use at aerodromes were identified through work done with the ICAO Aerodrome Panel Visual Aids Working Group. Some of these issues were: 1) How will this technology interact if interspersed with standard incandescent lights?, 2) What are the impacts of intensity changes with LEDs?, and 3) What is the impact of the reduced heat signature on the lens of LED fixtures with respect to lens contamination due to environmental conditions? An FAA engineering brief was issued that recommended that: LED and standard incandescent lights not be inner mixed, LED fixtures include electronics to mimic the intensity curve of incandescent lamps, and Arctic (heater) kits be used for all fixtures. (Airport Technology Research - Capacity)

Wildlife Mitigation

The FAA's wildlife hazards mitigation research program consists of three main areas aimed at reducing the risks of aircraft encountering wildlife on or near airports. Many of the studies are carried out through partnerships with other federal agencies and academic centers of excellence. The first area targets techniques for managing wildlife habitats in the vicinity of airports to make them less attractive for hazardous species. It also studies methods for controlling hazardous wildlife presence on an airport such as the use of pyrotechnics to scatter birds. The second area is designed to understand the capabilities of commercial avian detection radar systems to determine their applicability at U.S. civil airports. The projects in this area assess the capabilities of the radars to detect and track birds in complex airport environments. Work is also conducted on developing effective management and distribution of post-processed radar data for end-user applications. The third area collects and disseminates strike information through the FAA's National Wildlife Mitigation website. The website provides extensive information on bird strikes as a well as an online strike database and tools for reporting a strike. Data management, validation, and posting are provided under agreements with the U.S. Department of Agriculture (USDA) and Embry Riddle University. The Smithsonian Institution Feather ID Lab provides identification of bird strike remains for the FAA. In all three areas, the focus is on obtaining accurate and timely information that will lead to the effective management and reduced risks of severe and potentially catastrophic wildlife-aircraft strikes.

FAA expanded its interagency agreement with USDA to characterize bird use of storm water detention basins on airports in the Southwest region of the United States. A study was completed of alternative varieties of vegetation to identify bird foraging preferences and ultimately make airport vegetation less attractive to birds. Another study was initiated to use satellite transmitters to track the movements and habits of resident geese populations in metropolitan environments near major airports. Results from these studies provide airport wildlife biologists, tasked with controlling hazardous wildlife populations and managing habitats on the airport, with vital information regarding hazardous species behavior that poses risks to operating aircraft.

In 2006, the FAA established several cooperative agreements with key universities, agencies, and airports to develop a National Wildlife Hazard Data Network. The initial vision was to develop a national network of radar systems that could provide a near real-time view of hazardous bird activity across the country. The end product would be like a national weather map. While that long-term objective is still viable, recent lessons learned and advances in technology have shifted the approach from a national advisory system to capability validation and assessments to determine how particular systems can best be used at airports. Major partners in this study are the U.S. Air Force, USDA, University of Illinois Urbana-Champaign, Embry Riddle Aeronautical University, and several commercial airports, including Seattle-Tacoma, John F. Kennedy (JFK) International, Chicago O'Hare, and Dallas/Fort Worth (DFW) International as well as avian detection radar vendors. The FAA also serves as a participating partner in a complimentary effort being conducted by the U.S. Navy.

Field studies have continued. A radar system calibration exercise was conducted using remote control helicopter and tethered balloons at Seattle Tacoma International airport to verify target acquisition and tuning. A radar system was installed and is operational at Chicago O'Hare International Airport to determine the best location on the airport to accomplish the objectives of this effort. Additional deployments at Dallas/Fort Worth and John F. Kennedy International Airports were initiated this fiscal year. These field studies will provide the basis for developing performance specifications and use protocols for avian radar on U.S. civil airports. Ultimately, radar is envisioned to be an effective tool for identifying and tracking hazardous species' activity on and near airports. The information can then be used to manage attractive habitat features as well as control resident populations of those species. (Airport Technology Research - Capacity)

Improving Pilots' Visual Approaches through Perceptual Training

The visual approach phase of flight poses a major challenge for junior airline pilots. Airlines have reported that new hires with low flight hours experience difficulty in "managing visual approaches in line operations." The difficulty can be attributed to the often non-standard nature of the approaches and because it is difficult to model the visual and kinesthetic cues for visual approaches in today's flight simulators. Human factors researchers are investigating the skills pilots need to conduct a visual approach effectively and developing training and performance metrics that will improve training and evaluation of pilots on visual approach tasks. Through this research program and subsequent training developments, the FAA expects to impact pilot training protocol by reducing initial operating experience time and improving visual profiles.

The current focus is on training perceptual skills using a discrimination task that involves making judgments between two static visual approach images that are manipulated with fractional changes in glide slope, distance, runway orientation, and runway layout. The goal is to improve a pilot's ability to attend to critical visual cues in the environment for distance estimation. Our initial study confirmed that non-critical cues are used when making discriminations from a non-pilot population. These findings confirm that inexperienced pilots use non-critical cues when making visual approach distance estimations. The FAA expects to find that through discrimination training performance will improve on visual approach tasks. (ATC/Technical Operations Human Factors)

Vision Model to Predict Target Detection and Recognition

FAA seeks to characterize the ability of unmanned aerial system (UAS) viewing systems to support target detection and identification. Existing system evaluation methods require expensive and time-consuming subjective experiments. This project seeks to replace subjective testing with the Spatial Standard Observer (SSO), a simple model of human detection and discrimination. The current goals of the project are to: 1) measure visibility of aircraft at various distances and under various viewing conditions using human observers, and 2) compare the predictions of the SSO model to the human visibility data. In the experiment, aircraft images were created using computer graphics from geometric aircraft models. The aircraft differed in type, distance, orientation, and brightness relative to the background sky. Human observers with normal visual acuity attempted to detect the aircraft images, and from their performance, a measure of the visibility of each aircraft was derived. The completed data set shows profound effects of aircraft coloration and size (distance). For example, contrast thresholds ranged from as little as 2 percent for the largest targets to over 40 percent for the smallest.

The SSO is a simple model of visual pattern detection developed by NASA researchers to simplify visibility predictions in a broad range of technical applications. Researchers generated an SSO visibility prediction for each aircraft image and compared these predictions to the human data. This analysis shows that the SSO provides an excellent prediction of contrast detection thresholds for aircraft that vary with respect to type, distance, orientation, and contrast. This validates the use of the SSO in predictions of aircraft visibility. To our knowledge, this is the first effective tool for prediction of aircraft visibility. This tool will simplify calculations of effectiveness of unmanned aerial vehicles viewing systems and help to address the UAS "see and avoid" problem. (ATC/Technical Operations Human Factors)

Vision Model to Predict Target Detection and Unmanned Aerial System Ground Observer Requirements

The use of unmanned aerial systems (UAS) has been proposed for many civil and military applications within the NAS. For UASs to operate within the NAS, flights must comply with CFR 91.113, which outlines the "see and avoid" responsibilities for aircraft operators. One way to meet the requirements proposed by UAS operators is to employ ground observers to monitor traffic, assess collision probability, and provide operators with timely collision avoidance information. There is little data, however, on how well UAS operators can perform the tasks asked of them. The goals of this research are to: 1) determine the limits (size and distance) of observer visual detection and identification for UAS; 2) measure the accuracy of observer judgment of relative distance and altitude; 3) quantify the ability of observers to judge collision probability; and, 4) provide empirical data with which to test proposed models of detection and visibility.

A test plan was submitted and approved by the FAA. This plan includes several different experiments that: directly measure observer detection given uncertain UAS locations, detect unmanned aerial vehicles from a known location, provide judgments of distance and altitude, and examine collision potential and a means of collecting image data at detection thresholds. A protocol for human subject research has been approved.

Data were collected at a test site in Oregon to work out details and logistics of data collection. Image data have been collected at detection threshold and will be shared with researchers in the military and NASA who are developing models of detection and visibility. Further data collection is planned at the site as well as a site at New Mexico State University. These data will supplement those collected in Oregon and provide detection data that includes additional models of UAS as well as varied backgrounds on which to measure detection. A final report including recommendations for ground observer requirements is due in the fall of 2009. These data and the final report will aid in decision making and facilitate integration of UAS operations into the NAS. (ATC/Technical Operations Human Factors)

Application of Sequential Decision-making to Traffic Flow Management

Convective weather is often a main contributor to en route airspace congestion, system-wide delays, and disruption in the NAS. Present-day methods for managing congestion are mostly manual, based on uncertain forecasts of weather and traffic demand, and often involve rerouting or delaying entire flows of aircraft. CAASD developed a sequential decision-making simulation capability, in which traffic and weather forecast prediction uncertainty is quantified and used to develop efficient congestion resolution actions. It is based on Monte Carlo simulation of traffic and weather outcomes from a specific forecast. Candidate sequential decision strategies are evaluated against a range of outcomes to gain insight into the cost implications of alternate courses of action. Traffic management decisions can be improved by evaluating the estimated distribution of delay cost and other metrics across the Monte Carlo outcomes, and resolution actions are targeted at specific flights, rather than flows.

To understand the effects of weather forecast accuracy on traffic flow management (TFM) decision making, a weather-induced airspace congestion scenario was explored using the simulation. The effect of three different levels of weather forecast uncertainty was tested. More aggressive congestion resolution strategies were found to be required at higher levels of forecast uncertainty, resulting in more flight delays, higher variability in outcomes, and degradation in NAS user schedule integrity. This is an example of how a trade-off between the costs of improved weather forecasting could be evaluated against the benefits of improved TFM decision making.

The simulation has several useful applications. First, assuming computational power continues to increase, it represents a prototype of a real-time congestion resolution decision-support system. Second, it can be used to study the best decision-making strategies found in the simulation, and from them to develop heuristics for near-term congestion resolution tools and procedures. By analyzing a matrix of interesting congestion problems, rules for effective congestion resolution actions and timing can be derived. Third, the simulation is useful for other cost-benefit analyses similar to the weather forecasting example above. It allows study of the quantitative relationship between new NAS capabilities which improve traffic predictability and the effectiveness of TFM decision making. Thus, the simulation is a platform for evaluating the some of the core challenges of achieving intelligent TFM as part of the NextGen concept. (CAASD)

Runway Safety Alerting

Runway incursions at U.S. towered airports have been a major area of concern for the NAS for the past couple decades. Runway incursions have continued to occur and incursion rates have remained essentially constant. As consequence, the NTSB recommended the development of a ground movement safety system with direct pilot warning capabilities. To address the recommendation, the FAA initiated three programs: Runway Status Lights (RWSL), Final Approach Runway Occupancy Signals (FAROS), and Low Cost Ground Surveillance (LCGS).

A RWSL system consists of three subsystems: Runway Entrance Lights (RELs), Takeoff Hold Lights (THLs), and Runway Intersection Lights (RILs). RELs are undergoing testing at Dallas/ Fort Worth International Airport, TX (DFW) and San Diego International Airport, CA. THLs are undergoing testing at DFW. A RWSL system consisting of RELs and THLs is being installed at Los Angeles International Airport, CA. RILs will be tested at Boston Logan International Airport, MA. The Boston Logan tests will begin during Summer 2009. RELs and THLs will also be installed at BOS.

Flashing of the Precision Approach Path Indicator is the annunciator for FAROS. The first test system was installed at Long Beach, CA. Three induction loop segments along Runway 12/30 constitute the detection subsystem. The PAPI flashes whenever an aircraft or vehicle occupies one of the segments. Enhanced FAROS is undergoing testing at DFW. This version of FAROS will cause the Precision Approach Path Indicator to flash only when an aircraft or vehicle is on a runway and an aircraft on approach to it is within 1.5 nautical miles of the approach threshold. The surveillance source of enhanced FAROS at DFW is the Airport Surface Detection System – Model X (ASDE-X) and Airport Surface Radar (ASR)-9

LCGS is a low cost and more limited option to ASDE-X as a ground surveillance system at those airports that will not have ASDE-X. Though LCGS does not provide information directly to the cockpit, information is provided to the control tower. Two prototype systems have been installed and tested at Spokane, WA. Additional systems for testing are slated for installation at Long Island, CA; San Jose, CA; Reno, NV; Manchester, NH; and West Palm Beach, FL.

Researchers at FAA, CAASD, and industry made significant progress on flight deck-based and ground-based direct pilot warning solutions for increasing runway safety. CAASD researchers developed a laboratory simulation of a flightdeck-based surface conflict awareness and alerting capability that is an addition to existing CDTI displays. The capability improves flight crew awareness of airport surface traffic and provides alerting of potential surface conflict situations. The capability is applicable to all airports, including non-towered ones. A key enabler of this capability is the use of ADS-B to “see” surface aircraft on cockpit displays. The CAASD research results were a key input to an associated draft RTCA standard and have been transitioned to avionics equipment manufacturers that are now developing prototypes for field evaluation in 2010.

CAASD also completed work in support of a RWSL ground-based direct warning capability. As a continuation of prior year research, CAASD conducted human-in-the-loop evaluations of three possible lighting configurations to be used as the RWSL’s Final Approach Runway Occupancy Signal that provides a visual signal to flight crews on final approach that it is unsafe to land due to conflicting aircraft on the arrival runway. The lighting configurations were PAPI lights, touchdown zone (TDZ) lights, and threshold lights. The PAPI lights were modified to flash, the TDZ lights were modified to present a sequenced flashing of red and white, and the threshold lights were modified to present a red and white wig-wag flashing pattern. Each of the configurations still provided their original guidance information to the flight crews while also providing the arrival warning signal. CAASD’s 2008 and prior year research demonstrated that a RSWL system would be highly effective. RSWL has been approved for implementation. (CAASD)

Assessment of Weather-Related Training Aids

Adverse weather continues to be one of the leading causes of general aviation pilot fatalities in the United States. However, the actual effectiveness of weather training programs is rarely evaluated scientifically. CAMI investigators reviewed two well-known weather training programs to assess their impact on weather knowledge and in simulo flight behavior for 50 GA pilot volunteers.

To obtain a baseline estimate of pilot weather knowledge, CAMI first developed a computerized knowledge pretest based on weather questions. Pilots were then exposed to either one of two weather training videos (the experimental groups) or to a non-weather related video (the control group). Their weather knowledge was then retested with an alternate, matched-difficulty form of the knowledge test, to measure effect of the training products. Repeated measures analysis of variance for posttest-pretest score gains yielded a non-significant $p_F = .734$. This implies that, while there was a slight average knowledge gain associated with the training products (about 2.5 percent), the effect was not large enough to be statistically reliable. In practical terms, this simply means that weather is a complex subject to master, and there is no easy solution to adequate weather training.

Additionally, the data allowed estimation of pilot weather knowledge retention. Comparing these average weather knowledge scores ((pre + post)/2 = 64.3 percent) to official FAA test scores (82.6 percent for these questions, weighted for instrument rating), produced a group wise “weather knowledge forgetting quotient” estimate of about 22 percent over the time since pilots had taken their original tests [(82.6-64.3)/82.6 = 22 percent]. This has implications for both weather training and assessment. Namely, both could be modified to increase pilots’ retention of knowledge.

Pilots next engaged in a simulated flight through weather sufficiently challenging to elicit response variation ranging from diversions to alternate airports, to full flight completion. Pre-flight and flight behaviors were measured, including length and types of preflight weather briefing, number of in-flight weather updates requested, total flight time, penetration distance into the weather, terrain clearance, and cloud clearance. Briefly, the two experimental groups were significantly more hesitant to take off than the controls ($p_{X2} = .034$). Controls also displayed greater flight duration and, consequently, lower minimum-final-distance-to-destination (Kruskal-Wallis $p_{KW} = .007, .005$ respectively). However, there were no significant net group differences on overall flight safety as measured by terrain clearance and cloud clearance. Again, this simply implies that there is no easy solution to adequate weather training. It takes more than a 2-hour video to change pilots’ knowledge and behavior significantly.

Finally, weather knowledge and flight behavior were again assessed after an elapsed time interval of approximately three months, to test retention of training. That analysis is pending. Final reports will be provided in FY 2009. (Flightdeck/ Maintenance/System Integration Human Factors)

Sensory Deficiencies in the Operation of Unmanned Aircraft Systems

Unmanned aircraft systems (UASs) are those without a pilot onboard. UAS pilots do not have the same amount and types of sensory information available to them as pilots in manned aircraft. An assessment is needed on how these sensory deficiencies might affect the safety of UAS flights.

A technical report was written that summarizes research findings. The report includes a comparison of manned sensory information to sensory information available to the unmanned aircraft pilot, a review of remediations for sensory deficiencies from the current UAS inventory, a review of human factors research related to enhancing sensory information available to the UAS pilot, and a review of current FAA regulations related to sensory information requirements. Analyses demonstrated that pilots of UAS receive less and fewer types of sensory information compared to manned aircraft pilots. One consequence is an increased difficulty for UAS pilots to recognize and diagnose anomalous flight events that could endanger the safety of the flight. Recommendations include the incorporation of multi-sensory alert and warning systems into UAS control stations.

The research proposed for FY 2009 consists of consolidating the analyses and recommendations from FY 2008 and incorporating those recommendations in the work of several standards working groups. These working groups include the: RTCA Special Committee 203; SAE-G10 working group on unmanned aircraft system training guidelines; FAA – EUROCONTROL Memorandum of Cooperation (MoC), Annex 4, Action Plan 24 Working Group for Unmanned Aircraft Systems; and the UAS Program Office Working Group 2 on Control Station Design Issues. (Flightdeck/Maintenance/System Integration Human Factors)

Terrain Awareness and Warning System Feasibility for Helicopter Operations

Due to advances in terrain awareness and warning system (TAWS) technology and increases in rotorcraft controlled flight into terrain accident frequency, the NTSB has recommended that alerting pilots in rotorcraft operations of their proximity with terrain would be beneficial (NTSB Safety Recommendations A-06-19 through -23). Specifically, the NTSB has recommended that: all emergency medical system aircraft be equipped with TAWS; the TAWS regulation be extended to turbine-powered rotorcraft certificated for six or more passenger seats; and operators provide training to ensure the crew can use the system.

A survey of the literature was conducted to identify relevant guidelines and human performance data for research being performed by the University of North Dakota and for document preparation of Minimum Aviation System Performance Specifications by RTCA Special Committee 212 (SC-212). Additionally, scenarios and protocols were developed for data collection on pilot response to terrain alerts and warnings to be conducted during simulator trials run with the University. Minimum Operational Performance Standards for helicopter terrain awareness and warning systems were completed by RTCA SC-212. Data regarding pilot response to terrain alerts and warnings were collected by CAMI personnel, and the results were provided to SC-212 during preparation of their document. (Flightdeck/Maintenance/System Integration Human Factors)

Weather in the Cockpit Baseline and Assessment

Adverse weather is both a challenge for safe flight operations and a significant limiting factor for airspace capacity. In air transport operations, numerous takeoff and landing accidents have followed encounters with convective weather and winter precipitation. Predicting and avoiding weather and determining when conditions have deteriorated sufficiently to increase risk requires a great deal of attention from air transport pilots and airline operation centers. The Joint Program and Development Office has articulated a vision for NextGen that expects a greater degree of collaboration between pilots and controllers in weather-related decision-making and presumes a degree of shared situation awareness beyond current systems. Pilots and controllers will need consistent understanding of the weather situation to resolve challenging flight conditions collaboratively.

To support this transition, CAMI: assembled information on weather information requirements for the air transport and general aviation cockpit and for airline operations center personnel who support air transport operations assessments on weather products; documented the maturity and use of these products; and identified gaps between product capabilities and information needs. In addition, CAMI is identifying key requirements for integration or connection between cockpit and air traffic needs and products.

Data were extracted from a number of sources (e.g., 1993 National Aviation Weather Users' Forum, previous surveys/interviews of pilots, extant literature) and combined to define the categories and specific types of weather information pilots require and how they prioritize them by phase of flight. Data preferences and priorities were found to be consistent across pilots performing different types of activities and consistent, with minor variations, across levels of pilot experience. A phase one report was completed. Results were largely as expected, with visibility and ceiling data being ranked highly for initial and terminal phases of flight but with icing and convective-activity information data being ranked more highly for cruise. The data could be used to prioritize the presentation of cockpit weather information by phase of flight. An assessment of weather information use in Airline Operations Centers will continue into next year. (Weather Program)

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

Airport Economic Impact Methods and Models

The role of local airports in regional and state economies has substantially changed in the past two decades and continues to evolve. Airport operators and managers conduct economic impact studies to demonstrate the significance of their airport as a means to persuade policy makers to protect airports against adjacent incompatible uses and as rationale to pursue projects and business lines that would add vitality to regional interests.

Air cargo has the fastest growth rate of any freight mode and has gained economic importance with the growth of national and global markets and supply chains for manufactured goods. General aviation airports that focus on traditional general aviation uses and specialty segments, such as air cargo, corporate jets, or aircraft maintenance, have also emerged. Passenger air travel has taken on increased importance for education, research and development, technology, and tourism clusters. The economic role of larger airports has also changed with the growth of international gateways and shifts in passenger and freight hubs.

Increasingly, these various factors are being addressed by local airport economic impact studies, using new tools and methods for economic impact analysis. Many of the newer studies have moved far beyond the traditional method that were promulgated 15 years ago, which focused on applying multipliers to airport jobs and visitor spending (e.g., 1992 FAA document: *Estimating the Regional Economic Significance of Airports*.). New guidance might be desirable in the future, and a first step would be to have a synthesis study document the new issues and tools that comprise the state of practice today. (Airport Cooperative Research – Capacity)

Asphalt Test Sections at the National Airport Pavement Test Facility

A new series of full-scale traffic tests on asphalt pavements are underway at the FAA’s William J. Hughes National Airport Pavement Test Facility. Engineers constructed twelve pavement test items within the facilities first 300-feet over low strength subgrade with a California Bearing Ratio of approximately three. This series of test are designated Construction Cycle Five (CC5). In July 2008, the asphalt concrete test pavement construction was completed, including installation of instrumentation. Each test section is approximately 40 feet long by 30 feet wide. Traffic testing was started in August 2008 and will continue into 2009 at which time trafficking should be completed and the post-traffic materials testing should start. The present tests are intended to yield reliable performance data about the effects of aircraft landing gear spacing and the effects of the increase in the quality of sub base materials that the FAA can use to update the pavement thickness design procedures in its FAARFIELD computer program. The CC5 series of tests provides full-scale test data on the performance of asphalt concrete pavements under multiple gears loading to verify and/or modify the failure model in FAARFIELD. (Airport Technology Research - Capacity)

Monitoring and the Use of Checklists

Flight crew monitoring and use of checklists are essential defenses against threats and errors. Both the NTSB 12-year study of accidents attributed to crew error and FAA/NASA research reveal that breakdowns in monitoring and execution of checklists have played central roles in many, perhaps most, airline accidents. The FAA and industry require data on how monitoring is performed and how checklists are typically used on the line. They also require data on the factors that impede effective execution of these critical procedures.

A NASA research team completed 60 jump seat observations of how air carrier crews conduct monitoring and execute checklists in normal operations. These observations were conducted in six aircraft types at three airlines (two in the United States and one in Canada), one which is a major international airline and the other two which are regionals. Preliminary analysis revealed that errors in both monitoring and checklist use are diverse in nature and frequent. Only about 16 percent of these errors are caught. The team has completed a preliminary assessment of the cognitive factors underlying vulnerability to these errors, and this will provide a foundation for developing countermeasures to reduce vulnerability. These countermeasures, which include guidelines, training, design of checklists and operating procedures, and organizational policies for reducing crew vulnerability to inadvertent errors of omission, address the FAA goal of improving aviation safety. (Flightdeck/ Maintenance/System Integration Human Factors)

Pilot, Designee, and Inspector Perceptions of FAA Services

A variety of aviation safety functions require feedback from constituents to provide assessments of both FAA services and the adequacy of policy and regulation. Some types of feedback are further required by statute, such as the Government Performance Results Act of 1993 (GPRA). CAMI surveyed regulated populations (e.g., general aviation - GA pilots) and designees (e.g., Aviation Medical Examiners - AMEs) to evaluate satisfaction with FAA services and the adequacy of policy and regulation.

The P-ASEL survey is an annual survey designed to collect data from newly certified GA private pilots with an Airplane-Single-Engine-Land Rating. The survey asks pilots about their experience with designated pilot examiners (DPEs) and the practical exam. The 2007 survey was distributed to 5,026 pilots from July 2007 to January 2008. Responses from 1,475 pilots met the criteria for inclusion for a 29 percent response rate. A valid response included respondents who had recently been certificated by a DPE and had not failed a previous practical test. Nearly all pilots indicated that they obtained a copy of the FAA PTS and used it to review the requirements for their practical test (97.8 percent). The majority of pilots indicated that the examiner who conducted their practical was prepared and organized to a considerable or great extent (96.8 percent). When asked about events evaluated during their exam, 95 percent said they were asked about weather information, and 97 percent were asked about basic Visual Flight Rules weather minimums. Less than 3 percent of those pilots were asked to repeat either subject area during their examination. In response to items on take-offs and landings, nearly one-third of the pilots said that they did not demonstrate crosswind takeoffs and/or landings; however, 80 percent of those pilots were orally evaluated on the maneuvers. The survey results will be used by flight standards to improve GA safety.

The AME survey is a biennial survey designed to collect data from examiners about their satisfaction with the aeromedical certification services provided by the FAA. The survey complies with the requirements set forth by Executive Order No. 12862, “Setting Customer Service Standards,” and GPRA to assess customer satisfaction with services provided by or on behalf of federal agencies. The 2008 AME survey was distributed to 3,439 AMEs via e-mail and postal mail. The analysis included only those respondents who had served as an AME for at least 12 months and conducted an exam for at least one airman during that time (n = 1226). Of the AMEs who met the criteria for inclusion, 76 percent completed an online survey. The results indicate that more than 89 percent were satisfied or very satisfied with the Aerospace Medical Education Division, the Aerospace Medical Certification Division, and the Regional Flight Surgeons. In contrast, fewer AMEs (53 percent) reported being satisfied to a considerable or great extent with the Aerospace Medical Certification (AMC) Internet Subsystem.

Approximately 45 percent of AMEs indicated the Office of Aerospace Medicine (OAM) Website was useful to a considerable or great extent. Overall, domestic, non-military AMEs reported being satisfied with the personnel who provide certification services, but fewer were satisfied with the technological tools (e.g., AMC Internet Subsystem) used for medical certification applications. Specific areas in need of improvement were identified by AMEs – including the standards and guidelines for deferrals, AME training, digital ECG system, AMC Internet Subsystem, and the FAA’s OAM website. The survey results will be used by senior managers to: 1) evaluate the degree of customer satisfaction with aerospace medical certification services, 2) identify areas in which improvements in service delivery can be made, and 3) assess change in customer satisfaction as a result of those improvements. (Flightdeck/Maintenance/System Integration Human Factors)

Pilot Procedures and Practices for Automated Flight Decks

Automation has introduced changes to the nature of aircrew interaction in the cockpit. Although designers hoped that these changes would reduce errors, evidence suggests that this has not been the case. This leads to the question of how to improve the performance of crews using automated cockpit systems. Researchers at or under the direction of George Mason University have used a number of approaches to address this question.

The first approach is to understand training needs and then design training and cockpit procedures with automated systems in mind. During FY 2008, information about the design, use, and training of automated systems was obtained through interviews and observations conducted by researchers from George Mason University and Research Integrations, Inc. at several airplane manufacturers, training companies, and airlines. The team with researchers from the University of Central Florida (UCF) completed a document summarizing what is known from the last ten years of research on automation. George Mason and UCF also leveraged their earlier work on conceptually-and exemplar-based training to develop materials for use in training pilots to complete a visual approach. Many accidents/incidents are caused by new pilots failing to understand how to execute this maneuver; it is not clear what method is needed to reduce incidents and improve comprehension. UCF developed materials for their exemplar-based training and George Mason began production of materials for the conceptually-based training.

Finally, George Mason completed production of a CD containing background reports on automation training, background material on why conceptual training is useful, and sample conceptual training developed for training automated systems. The CD was circulated to 600 participants of an FAA-sponsored conference on automation to improve the safety of the flying public.

A second approach is to prevent automation errors at the source by developing new interfaces that reduce the requirement for training. This approach requires close collaboration between researchers and manufacturers to collect data on current and prototype systems and begin to predict how system modifications will affect initial learning and training requirements. The strength of this approach lies in the tight coupling of real, applied problems with scientific theories, principles, and methods. Coupling airline data with cognitive modeling and other analysis techniques allows us to develop better evaluation and training programs. By collaborating with manufacturers, training research remains relevant as automated systems evolve. This work produced a report, which will be submitted shortly to a journal for publication, describing the strengths and weaknesses of different analysis techniques that can be used to predict learning and training requirements in the future.

A third approach is to help prevent errors by developing tools that can be used in the cockpit. Researchers at Cognitive and Human Factors, Inc. continued to work with NASA to determine the best ways in which to transition from paper to electronic documents on the flight deck. The work suggested that it is not sufficient to represent paper documents in an electronic format that reproduces the “look and feel” of the original paper document. Rather, it is important to examine the ways in which electronic devices and products change interactions in the cockpit and to develop electronic flight bag procedures and training that can encourage best practices and measurably improve crew performance. (Flightdeck/Maintenance/Systems Integration Human Factors)

NextGen Towers

The air traffic in the United States 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 U.S. tower facilities will reach the end of their useful life. The cost of new tower construction is escalating. The FAA developed the NextGen towers (NTs) operational concept (ConOps) to increase capacity and address the predicted growth in airport tower operations while still addressing the cost prohibitive nature of replacing ATC towers with new towers.

The NT concept reduces the need for physical infrastructure associated with ATC towers and will provide a means to control airport traffic from a ground level location. Two types of NextGen towers are considered: 1) staffed NextGen towers (SNTs) in which air navigation service provider personnel will provide full air traffic management services from a ground-level facility to flights in and out of one or more airports; and 2) automated NextGen towers (ANTs) in which a ground-level facility will be fully automated and a limited number of basic air traffic management (ATM) services (e.g., sequences, clearances and advisories) will be provided without any human participation via synthetic voice and/or data link to the aircraft.

The ConOps develops the NT concept as a first step in the process to determine its operational feasibility. It will be used as a foundation for future analyses (e.g., functional, technical, safety) and development efforts needed to determine its operational feasibility. The FAA approved a research management plan for the first phase of SNT development, Supplemental Operations. The plan ensures the collection of all operational, technical, and economic data needed for an initial investment decision and includes certification of ASDE-X as a critical component in achieving NT. The completed SNT Technology Assessment provides a process to measure and evaluate three critical functional areas (surveillance, displays, and communications) enabling SNT operations and provided recommendations for alternatives. (Operations Concept Validation)

APPENDIX C: Partnership Activities

Table of Contents

List of Tables

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 the 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 C.1 provides details of the agreements in place in fiscal year (FY) 2008.

Table C.1 – Active MOU, MOAs, and IAs, FY 2008

MOU, MOAs, and IAs		
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/airway facilities, and bioaeronautics.

Table C.1 – Active MOU, MOAs, and IAs, FY 2008 (continued)

MOU, MOAs, and IAs		
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/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	Airborne Weather RADAR with Turbulence Detection Capability DTFAWA-07-X-00007	Establishing a cooperative procedure to develop minimum performance standards for airborne turbulence detection systems.
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/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 Agreements	Support of the FAA R&TD NASA Langley Field Team DTFAWA-08-X-00009 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	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/DOD Interagency Agreement	Rotorcraft Health Usage Monitoring System (HUMS) DTFACT-06-X-00008	Engineering support for the FAA rotorcraft structural integrity research program.

Table C.1 – Active MOU, MOAs, and IAs, FY 2008 (continued)

MOU, MOAs, and IAs		
Agreement Type	Subject	Objective
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	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	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.
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.
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; 5. Engine and Other Aircraft System Impending Failure Diagnostics Research
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/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/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/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/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.

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, or 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 (CRDA)

These agreements allow the FAA 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 FY 2008, the FAA established 6 new CRDAs, bringing the present total of active agreements to 30. Details of the CRDAs active in FY 2008 are shown in Table C.2.1.

Table C.2 – Active FAA Cooperative R&D Agreements, FY 2008

Cooperative R&D Agreements					
CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completion Date
1993-A-0043	Weather	Development of advanced weather information systems with graphical display products	WSI Corporation McLean, VA	9/13/93	9/13/08
1994-A-0065	Airport Technology	Testing of a soft ground arresting system developed to safely stop aircraft that overrun the available length of runway	DATRON Engineered Systems Division, Aston, PA	09/07/94	09/07/10
1996-A-0097	Airport Technology	Development of the National Airport Pavement Test Machine	The Boeing Company Seattle, WA	07/29/96	07/29/11
2001-A-0164	Airport Technology	Utilize 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

Table C.2 – Active FAA Cooperative R&D Agreements, FY 2008 (continued)

Cooperative R&D Agreements					
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 with implementation of capacity enhancing capabilities for the National Airspace System	The Boeing Company, McLean, VA	07/17/02	07/17/12
2003-A-0181	Communications, Navigation, and Surveillance	Controller Pilot Data-Link Communication Builds 1 and 1A	SITA Information Networking Computing, B.V. Vienna, VA	09/25/03	09/25/08
2004-A-0189	Office of Innovations and Solution	Video security system to enhance aviation security	Research Incorporated Fairfax, VA	01/27/04	01/27/08
2004-A-0199	Air Traffic Organization	Research on the success of the radical organizational change at the Federal Aviation Administration's Air Traffic Organization	University of Maryland at College Park College Park, MD	05/13/04	05/13/09
2005-A-0203	Air Traffic Management	Efficiency of the air traffic controller operator working position	Frequentis, USA Rockville, MD	04/14/05	04/14/09
2005-A-0206	Advanced Traffic Management Systems	Evaluation of the Surface Management System Capabilities and Improvements	FedEx Express Memphis, TN	05/24/05	05/24/08
2005-A-0208	Air Traffic Models and Evaluation Tools	Utilize state-of-the-art technologies and the initial development of the Aviation Integrated Reasoning Modeling Matrix to develop a system that will support the current and future needs of the FAA	Optimal Systems, Monroeville, NJ	06/08/05	06/08/08
2005-A-0209	Information Resource Management	Electronic submission of confidential financial disclosure forms	HRWorX, LLC, Herndon, VA	08/25/05	08/25/09
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	07/25/09
2006-A-0219	Human Factors	Air traffic controller cognitive modeling	Drexel University, Philadelphia, PA	2/20/07	2/20/10

Table C.2 – Active FAA Cooperative R&D Agreements, FY 2008 (continued)

Cooperative R&D Agreements					
CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completion Date
2006-A-0220	Communications, Navigation, and Surveillance	Utilize ADS-B technology to facilitate procedures improving aircraft arrival rates and situational awareness in the air and on the airport surface while reducing fuel consumption and noise generation.	Aviation Communications & Surveillance Systems, Phoenix, AZ	09/21/06	09/21/08
2006-A-0221	Atmospheric Hazards/Digital System Safety	Testing to document the shape, location, and aerodynamic effects of propeller icing.	Hartzell Propeller, Inc., Piqua OH	05/12/06	02/12/08
2006-A-0222	Atmospheric Hazards/Digital System Safety	Testing to document the shape, location, and aerodynamic effects of propeller icing.	MT-Propeller USA, Inc., DeLand, FL	05/23/06	02/23/08
2006-A-0223	Weather/ Surveillance	Airport surface surveillance	RVision LLC, Sand Diego, CA	12/13/06	04/13/09
2006-A-0227	Simulation	Voice recognition and response system	UFA Inc., Gaithersburg, MD	12/13/06	12/13/08
2007-A-0231	Aeromedical Research	Comparison of optical vision screeners currently used by Aviation Medical Examiners	Titmus Optical, Inc., Chester, VA	7/18/07	7/18/08
2007-A-0232	Aeromedical Research	Comparison of optic vision testers used by Aviation Medical Examiners	Stero Optical, Chicago, IL	7/12/07	7/12/08
2007-A-0233	Communications/ Surveillance	Flight testing for ADS-B separation standards	CNS Aviation, Vienna, VA	7/18/07	7/18/09
2007-A-0235	NextGen	Provide guidance for Net-Centric standards and protocols that may be incorporated by the NextGen Program	Network Centric Operations Industry Consortium, Newport Beach, VA	9/21/07	9/21/09
2007-A-0236	Continued Airworthiness	Composite repair of aircraft structures	The Boeing Company, Huntington Beach, CA	10/30/07	10/30/10
2008-A-0240	Airport Safety Technology	Aircraft braking performance	Snow Aviation International, Inc., Columbus, OH	11/14/07	11/14/08
2008-A-0245	Unmanned Aircraft	Unmanned aircraft system research	New Mexico State University, Las Cruces, NM	2/19/08	2/19/10
2008-A-0247	Propulsion and Fuel Systems	Full scale engine evaluation and analyses of aviation fuel	Swift Enterprises, West Lafayette, IN	6/30/08	6/30/09
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	8/5/08	4/5/14
2008-A-0250	Fire Safety	Wind tunnel research in aerodynamics	Absegami High School, Galloway Township, NJ	9/17/08	3/17/10

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, which 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 the FAA inventors are available for commercial licensing with royalty payments being 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 C.3 provides a list of the current U.S. patents issued to the U.S. Department of Transportation, FAA.

Two (2) 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." One (1) licensing agreement is in effect for the software product that automates the annual process of collecting and reviewing the Office of Government-wide Ethics Financial Disclosure Form.

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 C.3 – Patents Issued for DOT/FAA

Patents Issued			
Patent No.	Date of Patent	Title	Description
6,899,540	5/31/05	Threat image projection system	A means for training and testing baggage screening machine operators.
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.

Table C.3 – Patents Issued for DOT/FAA

Patents Issued			
Patent No.	Date of Patent	Title	Description
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	Micro-scale Combustion Calorimeter	A calorimeter for measuring flammability parameters of materials using only milligram sample quantities.

4. Working with Academia

4.1 Joint University Program (JUP) for Air Transportation Research

This cooperative research partnership among three universities (Ohio University, Massachusetts Institute of Technology, and Princeton) 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.

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 C.4 is a list of the FAA research grants initiated in FY 2008. The FAA awarded $7,522,741.32 in new grants in FY 2008. It also awarded an additional $10,092,178.00 to grants that originated in prior fiscal years for a total of $17,614,919.32 in grant awards in FY 2008.

Table C.4 – FAA Research Grants Initiated in FY 2008

Research Grants				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Aging Aircraft/ Continued Airworthiness	2008-G-001 Self Repairing Electrical Wiring Techniques	University of Dayton Research Institute	4/23/2008 4/30/2009	$200,000.00
Unmanned Aircraft Systems Research	008-G-002 Development of UAS System Hazard Descriptions and Methodologies for Safety Risk Uncertainty Modeling	Rutgers, the State University of New Jersey	7/1/2008 8/31/2009	$461,954.00
Unmanned Aircraft Systems Research	2008-G-004 The Role of Cognitive radios in Remote Operations of UAS	The Regents of the University of Colorado	7/14/2008 7/14/2010	$189,062.00
Aging Aircraft/ Continued Airworthiness	2008-G-005 Evaluation of a 21st Century AMT Program	Delaware Technical & Community College	7/15/2008 12/14/2010	$328,000.00
Flightdeck/ Maintenance/ System Integration Human Factors	2008- G-006 Flight Attendant Work/ Rest Patterns, Alertness & Performance Assessment	Institutes for Behavior Resources, Inc.	7/15/2008 8/14/2009	$498,111.32
Satellite Navigation Program	2008-G-007 Maximizing Aviation Benefits from Satellite Navigation	Board of Trustees of Leland Stanford Junior University	7/18/2008 7/17/2009	$1,832,719.00
Aging Aircraft/ Continued Airworthiness	2008-G-008 Aging Aircraft Research Infrastructure of the National Institute for Aviation Research	Wichita State University	7/31/2008 1/31/2010	$340,000.00
Propulsion and Fuel Systems	2008-G-009 The Evaluation of Cold Dwell Fatigue in Ti-6242	The Ohio State University	7/31/2008 7/30/2009	$490,000.00
Flightdeck/ Maintenance/ System Integration Human Factors	2008-G-010 Improving Human Performance in Aviation	American Institute for Research	9/26/2008 9/25/2009	$416,778.00
Aging Aircraft/Continued Airworthiness	2008-G-012 Aging Aircraft Education and Training	Wichita State University	9/2/2008 9/1/2010	$296,000.00
Aging Aircraft/Continued Airworthiness	2008-G-013 Demographic Study of General Aviation Fleet – Part II	Wichita State University	9/1/2008 4/30/2009	$50,000.00

Table C.4 – FAA Research Grants Originating in FY 2008

Research Grants				
FAA R&D Program	Grant Number and Title	Recipient Institution	Award and Completion Dates	Award Amount
Aviation Safety Research	2008-G-014 Center for Aviation Safety Research	Saint Louis University	9/12/2008 11/11/2011	$2,250,000.00
Aging Aircraft/Continued Airworthiness	2008-G-015 Flight Loads Analysis of Business Jets	Wichita State University	9/16/2008 1/15/2010	$70,035.00
Aging Aircraft/Continued Airworthiness	2008-G-016 Operational Loads Monitoring of Heavy Aerial Tankers	Wichita State University	9/16/2008 1/15/2010	$100,082.00
			Total awarded in FY 2008:	$7,522,741.32

4.3 Air Transportation Centers of Excellence (COE)

The FAA sponsors five centers of excellence (COEs) established through cooperative agreements with academic institutions throughout the United States. Through these long-term collaborative, cost-sharing efforts, government and university teams leverage their resources with industry affiliates to advance aviation technology. COE university partners, industry affiliates, and state and local governments provide matching funds to augment FAA research efforts. The five COEs are:

- 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)

The pages that follow provide a brief description of each of the five centers with a table that identifies the grants awarded in FY 2008 for each COE.

4.3.1 COE for Research in the Intermodal Transport Environment (RITE)

Established in 2004, the Center of Excellence for Airliner Cabin Environment conducted research on cabin air quality and chemical and biological threats. As a result of the Phase I evaluation, in 2008 the COE expanded its research activities to include the intermodal transport environment. Harvard University and Purdue University are the technical leads for the newly named COE for Research in the Intermodal Transport Environment (RITE). Auburn University serves as the administrative lead. Other member universities include: Boise State University, Kansas State University, the University of California–Berkeley, and the University of Medicine and Dentistry of New Jersey. For additional information, see: http://www.acer-coe.org/.

Table C.5 – Grants Awarded in 2008 to COE for Research in the Intermodal Transport Environment (RITE)

RITE Awards				
Title	Recipient University	Amount	FAA POC	University POC
Modeling of Exposure to Pesticides in Aircraft Cabins in Support of the ASHRAE Project	University of Medicine and Dentistry of New Jersey	$50,000	C. Ruehle	S. Isukapalli
Ozone and By-Products Determination in Passenger Cabins in Support of ASHRAE Project	University of Medicine and Dentistry of New Jersey	$50,000	C. Ruehle	C. Weisel
In-Flight Project, Task 4	Kansas State University	$40,000	C. Ruehle	B. Jones
Pesticide Study: Collection of Field Studies and Model Evaluation	University of Medicine and Dentistry of New Jersey	$75,000	C. Ruehle	C. Weisel
Air Contamination Measurement Methods	Kansas State University	$75,000	C. Ruehle	B. Jones
Onboard Measurements	Harvard University	$180,000	C. Ruehle/ J. Watson	J. Spengler
Effects of Partial Pressure on Airline Passengers	Harvard University	$72,962	C. Ruehle/ J. Watson	J. Spengler
Total awarded in FY 2008: $542,962				

4.3.2 Joint COE for Advanced Materials (JAMS)

Established in 2003, the Joint COE for Advanced Materials (JAMS) 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. JAMS is lead by University of Washington and Wichita State University. The other member universities include Edmonds Community College, Northwestern University, Oregon State University, Purdue University, University of California–Los Angeles, University of Delaware, Florida International University, University of Utah, Tuskegee University, and Washington State University. For additional information, see http://www.jams-coe.org/.

Table C.6 – Grants Awarded in 2008 to the Joint COE in Advanced Materials (JAMS)

JAMS				
Title	Recipient University	Amount	FAA POC	University POC
Damage Tolerance and Durability of Fiber-Metal Laminates for Aircraft Structures	University of California-Los Angeles	$75,000	C. Davies	T. Hahn
Course Development, Maintenance of Composite Aircraft Structures	Edmonds Community College	$153,481	C. Davies	C. Schaeffer

Table C.6 – Grants Awarded in 2008 to the Joint COE in Advanced Materials (JAMS) (continued)

JAMS				
Title	Recipient University	Amount	FAA POC	University POC
Production Control Effect on Composite Material Quality and Stability	Wichita State University	$125,000	C. Davies	J. Tomblin
Development and Safety Management of Composite Certification Guidance	Wichita State University	$20,000	C. Davies	J. Tomblin
Impact Damage Formation on Composite Aircraft Structures	University of California-Los Angeles	$20,000	C. Davies	T. Hahn
Damage Tolerance Testing and Analysis Protocols for Full-Scale Composite Airframe Structures Under Repeated Loading	Wichita State University	$300,000	C. Davies	J. Tomblin
Development and Safety Management of Composite Certification Guidance	Wichita State University	$150,000	C. Davies	J. Tomblin
Environmental Factor Influence on Composite Design and Certification	Wichita State University	$275,000	L. Pham	J. Tomblin
Effect of CACRC Depot Repairs on Composite Airframe Structures	Wichita State University	$235,000	L. Pham	J. Tomblin
Aging of Composite Aircraft Structures	Wichita State University	$275,000	C. Davies	J. Tomblin
Effect of Repair Procedures Applied to Composite Airframe Structures	Wichita State University	$225,000	L. Pham	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
Certification by Analysis	Wichita State University	$150,000	A. Abamowitz	G. Olivares
Crashworthiness of Composites – Materials Dynamic Properties	Wichita State University	$100,000	A. Abamowitz	G. Olivares
Administration of the FAA Center of Excellence on Advanced Materials in Transport Aircraft Structures (AMTAS)	University of Washington	$74,458	C. Davies	M. Tuttle
Standardization of Analytical and Experimental Methods for Crashworthiness Energy Absorption of Composite Materials	University of Washington	$70,000	A. Abamowitz	P. Feraboli
Statistical Analysis Program for Generating Material Allowables	Wichita State University	$100,722	A. Abamowitz	S. Keshavanarayana

Table C.6 – Grants Awarded in 2008 to the Joint COE in Advanced Materials (JAMS) (continued)

JAMS				
Title	Recipient University	Amount	FAA POC	University POC
Certification of Discontinuous Composite Material Forms for Aircraft Structures	University of Washington	$100,000	C. Davies	M. Tuttle
VARTM Variability and Substantiation	University of Delaware	$65,000	C. Davies	D. Heider
Development of Reliability-Based Damage Tolerant Structural Design Methodology	University of Washington	$100,000	C. Davies	K. Lin
Combined Global/Local Variability and Uncertainty in Integrated Aeroservoelacticity of Composite Aircraft	University of Washington	$125,000	C. Davies	E. Livne
Damage Tolerance and Durability of Adhesively Bonded Composite Structures	Purdue University	$70,000	C. Davies	T. Siegmund
Development and Evaluation of Fracture Mechanics Test Methods for Sandwich Composites	University of Utah	$75,647	C. Davies	D. Adams
Structural Health Monitoring of Adhesively-Bonded Composites	Northwestern University	$75,000	C. Davies	S. Krishnaswamy
Advanced Materials & Manufacturing Training Innovation Center (AMMTIC)	Edmonds Community College	$463,000	C. Davies	J. Mosier
Damage Tolerance and Durability of Fiber-Metal Laminates for Aircraft Structures	University of California-Los Angeles	$75,000	C. Davies	T. Hahn
Impact Damage Formation on Composite Aircraft Structures	University of California-Los Angeles	$125,000	C. Davies	T. Hahn
Total awarded in FY 2008: $3,697,308				

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 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, University of Missouri-Rolla, University of North Carolina–Chapel Hill and Georgia Institute of Technology. For additional information, see http://www.partner.aero/.

Table C.7 – Grants Awarded in 2008 to the COE Partnership for Air Transportation Noise and Emissions Reduction (PARTNER)

PARTNER				
Title	Recipient University	Amount	FAA POC	University POC
PM and HAPs Emissions Characterization for a Gas Turbine Engine Using a Bio Fuel - Probe Stand Interface	Missouri University of Science and Technology	$20,000	C. Ma	P. Whitefield
Program Management for Aircraft Noise and Aviation Emissions Mitigation Center of Excellence	Massachusetts Institute of Technology	$385,000	L. Maurice	I. Waitz
Environmental Design Space Tool Development	Georgia Institute of Technology	$1,000,000	J. DiPardo	D. Mavris
Sonic Boom Mitigation	Purdue University	$60,000	L. Fisher	P. Davies
Outreach (formerly Noise Quest)	Pennsylvania State University	$100,000	L. Fisher	A. Atchley
Source Emission and Propagation	Pennsylvania State University	$100,000	B. Hua	A. Atchley
PM and HAPs Measurement Methodologies Development and Planning for Test Cell Measurements	Missouri University of Science and Technology	$128,000	C. Ma	P. Whitefield
Health Effects of Aircraft Noise	Purdue University	$15,000	M. Marsan	P. Davies
Implementation of Enhanced Network Restructuring Algorithms and Scenarios for Improved ATO Forecasts	Purdue University	$75,000	J. Post	D. DeLaurentis
Opportunities for Reducing Surface Emissions Through Airport Surface Movement Optimization	Massachusetts Institute of Technology	$150,000	N. Brown	J. Hansman
Investigation of Air Quality Impacts of Aviation Emissions Using CMAQ Analysis for NextGen	University of North Carolina-Chapel Hill	$299,998	M. Gupta	Arunachalam
Health Impacts of Aviation-Related Air Pollutants	Harvard University	$230,000	M. Gupta	Levy
Noise Exposure Response - Sleep Disturbance	Purdue University	$100,000	L. Fisher	P. Davies
Noise Exposure Response: Annoyance	Pennsylvania State University	$90,000	M. Marsan	V. Sparrow
Noise Exposure Response – Annoyance	Purdue University	$115,000	M. Marsan	P. Davies
Transmission of Low Frequency Noise through Double-Pane Windows	Purdue University	$100,000	B. He	K. Ming
Studying the Effects of Aircraft Exhaust on Global and Regional Climate	Stanford University	$240,000	M. Gupta	S. Lele

Table C.7 – Grants Awarded in 2008 to the COE Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) (continued)

PARTNER				
Title	Recipient University	Amount	FAA POC	University POC
Environmental Cost-Benefit Analysis of Ultra Low Sulfur Jet Fuels: Project 27	Massachusetts Institute of Technology	$235,000	M. Gupta	I. Waitz
Studying the Effects of Ultra Low Sulfur Jet Fuel on Climate and Air Quality	Stanford University	$65,000	M. Gupta	M. Jacobson
Program Management for Aircraft Noise and Aviation Emissions Mitigation Center of Excellence	Massachusetts Institute of Technology	$10,000	L. Maurice	I. Waitz
CDA Implementation in Low-through High Density Traffic	Georgia Institute of Technology	$120,000	S. Liu	J-P Clarke
Atlantic Interoperability Initiative to Reduce Emission (AIRE) CDA	Georgia Institute of Technology	$250,000	S. Liu/C. Buntin	J-P Clarke
Environmental Design Space Tool Development	Georgia Institute of Technology	$100,000	J. DiPardo	D. Mavris
Environmental Cost-Benefit Analysis of Alternative Jet Fuels	Massachusetts Institute of Technology	$30,000	W. Gillette	I. Waitz
Total awarded in FY 2008: $4,017,998				

4.3.4 COE for General Aviation Research (CGAR)

Established in 2001, the COE for General Aviation Research (CGAR) conducts safety-related R&D with application to non-commercial aviation. Embry-Riddle Aeronautical University serves as the lead member for CGAR. Core university members include Wichita State University, University of North Dakota, and University of Alaska–Fairbanks and Anchorage. For additional information, see http://www.cgar.org/.

Table C8– Grants Awarded in 2008 to COE for General Aviation Research (CGAR)

CGAR				
Title	Recipient University	Amount	FAA POC	University POC
Operational Usage Information for a General Aviation Propeller	Wichita State University	$49,650	C. Nguyen	K. Rokhaz
Development of a 3-Dimensional Radar Based Airspace Monitoring and Surveillance Instrument	University of Alaska	$118,364	J. Zvanya	G. Walker
Remote Airfield Lighting Systems	Embry-Riddle Aeronautical University	$79,965	D. Gallagher	Grant
2-Day Workshop in Support of the FAA's ADS-B Implementation Program Office	Embry-Riddle Aeronautical University	$44,287	S. Williams	S. Hampton

Table C8– Grants Awarded in 2008 to COE for General Aviation Research (CGAR) (continued)

CGAR				
Title	Recipient University	Amount	FAA POC	University POC
Operational Loads Monitoring of Agricultural Aircraft	University of North Dakota	$50,000	J. Newcomb	D. Marshall
Remote Airport Lighting Systems III	University of Alaska	$79,999	D. Gallagher	M. Inman
Year Eight, Management & Administrative Support- General Aviation Center of Excellence	Embry-Riddle Aeronautical University	$165,855	P. Sparacino	S. Hampton
Development of an Aviation Weather Database Highlighting Weather Encounters (Phase I)	Embry-Riddle Aeronautical University	$36,908	R. Stevens	M. Bazargan
Development of UAS Operational Data Collection Concept	University of North Dakota	$100,000	X. Lee	D. Marshall
2-Day Workshop in Support of the FAA's ADS-B Implementation Program Office	Embry-Riddle Aeronautical University	$146,651	S. Williams	S. Hampton
Friction Study	University of North Dakota	$174,914	R. King	T. Zeidik
UAS Emergency Flight Recovery and Termination: Technology Survey and Regulatory Gap Analysis	Embry-Riddle Aeronautical University	$91,117	X. Lee	T. Wilson
Total awarded in FY 2008: $1,137,710				

4.3.5 COE for Airport Technology (CEAT)

Established in 1995, the Center of Excellence for Airport Pavement Research initially 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 C.9 – Grants Awarded in 2008 to COE for Airport Technology (CEAT)

CEAT				
Title	Recipient University	Amount	FAA POC	University POC
Metrics and Measurement Procedures of LED Lighting Systems	Rensselaer Polytechnic Institute	$150,000	D. Gallagher	N. Narendran
Deployment and Evaluation of Avian Radars – DFW	University of Illinois – Urbana-Champaign	$250,607	R. King	E. Herricks

Table C.9 – Grants Awarded in 2008 to COE for Airport Technology (CEAT) (continued)

CEAT				
Title	Recipient University	Amount	FAA POC	University POC
Work Program FY 2008 for FAA Center of Excellence for Airport Technology (CEAT)	University of Illinois - Urbana-Champaign	$75,000	D. Brill	D. Lange
GIS Wildlife Hazard Program for the FAA Center of Excellence for Airport Technology (CEAT)	University of Illinois - Urbana-Champaign	$435,448	R. King	E. Herricks
FOD Program for the FAA Center of Excellence for Airport Technology	University of Illinois - Urbana-Champaign	$351,531	J. Patterson	E. Herricks
Deployment of Avian Radars at SEA and JFK	University of Illinois - Urbana-Champaign	$620,452	R. King	E. Herricks
Management of Deployed Avian Radars (SEA, NASWI, ORD, JFK and DFW)	University of Illinois - Urbana-Champaign	$748,122	R. King	E. Herricks
Chromaticity Boundary for Aviation White Light	Rensselaer Polytechnic Institute	$100,000	D. Gallagher	N. Narendran
Investigations of DC and AC LEDs for Airport Runway and Taxiway Lighting Systems	Rensselaer Polytechnic Institute	$150,000	D. Gallagher	N. Narendran
Deployment and Evaluation of Expanded Avian Radar Systems – DFW	University of Illinois - Urbana-Champaign	$299,809	R. King	E. Herricks
Work Program FY 2009 for FAA Center of Excellence for Airport Technology (CEAT)	University of Illinois - Urbana-Champaign	$300,000	D. Brill	D. Lange
CEAT Asphalt and Concrete Materials	University of Illinois - Urbana-Champaign	$75,000	D. Brill	D. Lange
Total awarded in FY 2008: $3,555,969				

APPENDIX D: Research, Engineering and Development Advisory Committee (REDAC)

Table of Contents

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. The FAA has established a formal process for the agency to reply to Committee recommendations. This document summarizes fiscal year 2008 Committee recommendations with the FAA responses as follows:

1. FAA Response to REDAC R&D Guidance for Fiscal Year 2010.
2. FAA Response to REDAC Recommendations on Fiscal Year 2010 R&D Budget.
3. FAA Response to REDAC Report of the Weather-ATM Integration Working Group.

In fiscal year 2009, the FAA expects to receive the Committee's recommendations on the FAA's planned research and development investments for fiscal year 2011, including detailed recommendations from the standing subcommittees.

1. FAA Response to REDAC R&D Guidance for Fiscal Year 2010.

Dr. John Hansman (Committee Chair) submitted REDAC's R&D guidance for FY 2010 to the Administrator on November 7, 2007. The agency provided the following response to the recommendations.

Subcommittee on Airports

Recommendation: Continued close cooperation between the FAA Technical Center and the Airports Cooperative Research Program (ACRP).

FAA Response: We agree that this is an important issue. The Deputy Associate Administrator for Airports, Catherine M. Lang, is the FAA member of the ACRP Board of Governors. She and the staff of the Airports Safety and Standards Office review each of the ACRP submitted topics. During this review and ACRP scoring process, they identify any topics that duplicate ongoing FAA research or topics that should more appropriately be conducted by the FAA instead of ACRP. FAA also assigns an FAA liaison to each ACRP project technical panel.

Recommendation: That the highest of priorities be placed on testing with the new large aircraft fire mock-up at Tyndall AFB in Panama City, FL, so as to gain a clearer understanding of the quantity of fire fighting agent that will be needed to successfully deal with such events should they occur. Note should be taken that commercial operations by the Airbus A380 in the United States will commence within months.

FAA Response: We agree and the testing is underway.

Recommendation: Among the many projects that the Technical Center is carrying out, the Subcommittee especially supported the proposed research tasking on:

a) Foreign Object Damage (FOD) detection radar,

b) The development of light emitting diode technology for airport lighting (cooperative effort with Rensselaer Polytechnic Institute),

c) The study of Engineered Material Arresting System material behavior due to prolonged exposure to freeze / thaw cycles,

d) Continued development of the capabilities of the pavement test facility to mimic complex wheel arrangements, and

e) Expedited design and construction of a laboratory to support the pavement research.

FAA Response: We agree and appreciate the Subcommittee's support of these important projects.

Recommendation: Among the topics that the Airport Subcommittee would like to see added to the research that is already in progress are:

a) A consideration for the Airport Technology Branch to possibly take on the most promising of the pending projects of the Innovative Pavement Research Foundation (IPRF) and the Airfield Asphalt Pavement Technology Program (AAPTP) should there be no funding approved in upcoming legislation for these programs,

b) The FAA should initiate a study of the affects of runway de-icing fluids on surface friction, and

c) The FAA should consider starting a research project on the design of the location of exit taxiways, as a possible means to reduce runway occupancy times.

FAA Response: We agree. A review is underway of these issues to determine which projects are high priorities, can be funded, and should be included in the Airport Technology Research program.

Subcommittee on Environment and Energy

The subcommittee identified the following specific issues to bring to the attention of the Administrator.

Issue 1: The subcommittee feels that developing solutions (technology/fuels, operations) to limit or mitigate environmental impacts is critical to the future of the Next Generation Air Transportation System (NextGen). The maturing of technologies will have the greatest impact on future environmental advances and is therefore the most critical component.

Recommendation: For environmental solutions to become viable, sufficient additional resources will be required. The FY09 budget as proposed in the NARP is the minimum investment required from the agency.

FAA Response: We agree that environmental issues are a constraint on growth, and we are seeking various strategies to mitigate these issues. We will carefully consider investments as we finalize the Fiscal Year 2008 budget and start building our Fiscal Year 2010 submission.

Issue 2: The OEP briefing was critical since it ties research to implementation. Research in a vacuum does not solve problems; therefore, tying research to operational implementation is absolutely essential.

Recommendation: Developing a robust R&D plan for enabling the OEP transformation is critical. It is also important that environmental concerns be identified as a major priority along with capacity, efficiency, safety, and security.

FAA Response: We agree that addressing environmental concerns is critical to enabling the OEP transformation. I have asked my staff to highlight environmental concerns and their influence on capacity.

Issue 3: The subcommittee felt that the Office of Environment and Energy needs to reevaluate its strategic priorities.

Members view NextGen efforts as equal in importance, if not more so, than efforts focused on the International Civil Aviation Organization Committee on Aviation Environmental Protection (ICAO/CAEP). While members felt that both activities are important and must be supported, emphasis should be driven by the change in importance of NextGen.

Recommendation: The subcommittee recommends that the Office of Environment and Energy consider the following priorities in its future efforts:

- **#1 Applied Solutions** such as technology development, alternative fuels, operational improvements, and maturation of the CLEEN program should be the top priority.
- **#2 Modeling** should focus on NextGen as the #1 priority; although, continued work on CAEP remains critical.
- **#3 Research on understanding** the various elements of aviation environmental challenges (climate, local air quality, noise, and water quality) continues to be critical, with climate and water quality identified as the areas that need to be accelerated.
- **#4 Research to support regulatory work** must continue, but the subcommittee felt that the other priorities listed above are more important.

Continuing to mature Centers of Excellence (COEs) and the CLEEN consortium are business priorities, not program priorities, but clearly need to continue.

FAA Response: The Office of Environment and Energy will consider the research priorities outlined by the Environment and Energy REDAC subcommittee and come up with a plan to address your recommendations. We will share this plan with the subcommittee at the next meeting on February 20-21, 2008, in Savannah, Georgia.

Issue 4: The National Airspace System (NAS) enabled by NextGen will have a number of new aircraft and systems. It is critical to determine the environmental impacts of these new aircraft and systems. Research to determine these impacts should be part of the NextGen R&D plan.

Recommendation: Ensure that determining the environmental impacts of new aircraft and systems (including developing appropriate analytical tools) is considered in building the FY10 FAA R&D budget.

FAA Response: We have to ensure we are ready to address environmental concerns associated with new aircraft and systems. The staff will consider this recommendation as it builds the Fiscal Year 2010 research and development budget.

Issue 5: The scope of the environment and energy program has grown to meet needs. Budget requests should include resources for additional personnel to address developing issues (while keeping to the principle of maintaining a lean organization).

Recommendation: Ensure that resources for additional personnel are part of future budget requests. FAA also needs a robust recruiting strategy to attract qualified personnel to execute the NextGen R&D efforts.

FAA Response: Our NextGen R&D strategy does account for additional positions to execute the efforts. Attracting qualified personnel is critical. We are augmenting our outreach activities and working with our Centers of Excellence to identify and recruit suitable candidates to help us tackle the challenges of NextGen.

Issue 6: The committee was supportive of the CLEEN implementation briefing.

Recommendation: FAA and NASA should start working the details of CLEEN, even if establishing the program is reauthorization/appropriations dependent. The subcommittee should be briefed on progress/status at Feb 2008 meeting.

FAA Response: The staff is working closely with NASA to identify a strategy to implement CLEEN, despite the uncertainty regarding reauthorization. They will brief progress to the subcommittee at the February 2008 meeting.

Subcommittee on NAS Operations

Findings:

NASA's foundational research in ATM automation technologies is addressing long-term issues in automation, but it is not clear that the FAA is tracking it or assessing its connection to their needs. NASA's human factors work should be addressing foundational issues in human-automation interaction or air-ground roles and responsibilities in the context of FAA NextGen design, and that connection was not clear from the briefings.

The final version of the JPDO R&D Plan needs to identify priorities in research, responsible parties for conducting the research, and estimated resources and timeframes (the committee saw only working drafts of the document which were lacking these important details).

Review of FAA's ATM and Next-Gen related research by the NASOPS subcommittee has continued to be confusing by virtue of incomplete or obscure financial and research information, and providing recommendations based on the level of detail that has been presented is difficult.

Recommendation: The FAA and NASA signed a new MOU (Feb 2006) that stipulated the formation of an Executive Research Steering Committee to coordinate research and development activities between the two agencies, but this has not been implemented. It is recommended that the FAA and NASA do so.

FAA Response: Consideration is being given to establishing such a joint advisory committee. However, instead of a review committee per se, a recent proposal by the JPDO may be adapted to satisfy the intent of this recommendation. The JPDO has proposed forming FAA-NASA research transition teams. Actions have started both within the FAA and NASA to establish several teams to include the areas of Traffic Management Adviser applications, Surface Management, Dynamic Airspace Configuration, and Multi-Sector Planner. There will be a joint FAA-NASA coordinating committee that will advise and follow the activities of the respective research transition teams. The REDAC, in the appropriate subcommittees, could review this approach and then review progress once these teams are established

Recommendation: The FAA and NASA, through their roles in JPDO, should assure that the JPDO R&D plan, as coordinated through the OMB, will serve as an actionable de-facto guide to their respective research initiatives for NextGen. If the FAA wishes REDAC to weigh in on the JPDO research requirements, a formal means of review with adequate time for review and JPDO feedback should be instituted.

FAA Response: REDAC reviews the FAA NextGen research plans as part of the regular REDAC business. Any review of the JPDO R&D Plan, which contains elements of the FAA research plans, is done according to the JPDO process for this. The JPDO R&D Plan provides a high-level mapping of research needs for operational improvements with FAA NextGen implementation budget line items, as well as the R&D budget line items in the RED and ATO-Cap appropriations. In addition, for the FY09 budget request, a more detailed mapping to specific research programs is being performed for inclusion in the 2008 National Aviation Research Plan (NARP). REDAC could comment on alignment of the FAA research with JPDO's plan and gain insight with respect to gaps or misalignments in either the JPDO or FAA research planning documents.

Recommendation: FAA should continue to find ways to report on research related to NextGen in ways that are consistent with understanding both the research and the budget associated with it. Recent efforts to relate the work to the OEP solution sets appears to be a step in the right direction. Adopting a common format for reporting on research projects (similar to what had been used by the REDAC in previous years) would aid in project evaluation.

FAA Response: The new Implementation and Integration Office within ATO Operations Planning is filling positions for Solution Set Coordinators. These Solution Set coordinators are being asked to brief the appropriate REDAC subcommittees about the R&D plans within their respective solution sets. A common format suggested by the REDAC will be entertained by the FAA for such purposes.

Subcommittee on Human Factors

Finding: The committee finds that Human Factors research and human-system integration is well aligned into the ATO-P processes and supportive of the JPDO research program, as well as the Operational Evolution Partnership.

Recommendation: The subcommittee urges that the Human Factors Research and Engineering Group maintains its centrality in human-system integration research and attend to cross-cutting research issues in the ATO-P organization. Overall, the organizational structure, along with current and anticipated budgetary increases, bodes well for the appropriate level of concern for human-system integration.

FAA Response: We agree with the Subcommittee recommendation. The Human Factors Research and Engineering Group is working with ATO-P Group managers and other NextGen managers to define an integrated investment plan for NextGen and ensure human-system integration research is addressed.

Finding: There is a convergence of conditions that the subcommittee feels provides the Human Factors Research and Engineering Group with an opportunity to redefine itself at a national level within the Human Factors research community. The new organizational structures in ATO, the significant proposed increase in budget, and the likely increase in the breadth of demand for applied human factors research, given changes in NASA's roles and responsibilities in applied Human Factors research, remind the subcommittee of the opportunities and motivation provided for the National Plan for Aviation Human Factors.

Recommendation: The subcommittee recommends revisiting and updating a national Human Factors research plan with the FAA taking the lead in applied aeronautical Human Factors research to address and define current gaps in support of JPDO research requirements.

FAA Response: The FAA is asserting leadership in applied aviation Human Factors research and engineering while working with stakeholders to address evolving JPDO research requirements. The FAA Human Factors Research & Engineering Group is currently developing a NextGen research investment strategy and implementation plan for FAA investments. This activity is a critical first step towards developing a national plan for aviation human factors and is wholly dependent on the magnitude of NextGen funding beginning in FY09. We are working directly with NASA and other research organizations in government and industry to identify current research gaps and define the FAA human factors investment plan. After this initial first step is complete, the FAA will explore extending the FAA human factors plan into a national human factors research strategy.

Finding: The committee did not feel it was in a position to make a comparison, or gap analysis, between NASA's response to JPDO Next Generation research requirements in Human Factors and that work being performed by the FAA.

Recommendation: The subcommittee recommends that an interagency programmatic exchange be undertaken with respect to applied aeronautical Human Factors and that the Human Factors Research and Engineering Group take the lead in this effort.

FAA Response: The Human Factors Research and Engineering Group has already established working relationships with NASA centers and program offices and initiated technical interchange meetings at Ames and Langley research centers. We are working together with NASA program and technical leads to ensure that applied human factors research strategies are aligned and complimentary.

Subcommittee on Aircraft Safety

Recommendation: The Safety Subcommittee recommends that the FAA ensure that the OEP R&D planning timelines and the AVS R&D planning timelines are consistent.

FAA Response: The FAA concurs with the recommendation. The FAA R,E&D requirements prioritization process for the Safety portfolio is aligned with OEP planning timelines beginning for planning cycle FY2010 (which is currently in process). The Spring 2008 REDAC meeting and the REDAC subcommittee reviews have been scheduled to accommodate review of 2010 R,E&D requirements prior to providing inputs to the OEP review and planning process. Also, the AVS R&D planning timelines are consistent and aligned with the OEP R&D planning timelines. The FAA will continue efforts to improve awareness of OEP plans by all FAA personnel supporting the Safety R,E&D requirements process.

Recommendation: The Safety Subcommittee recommends that the FAA modify its safety R&D portfolio development process to clearly identify the linkage between NextGen/OEP planning activities, planning documents and any identified R&D needs, and their incorporation into the detailed AVS planning activities and the resulting R&D portfolio. The roles and engagement of AVS focal points supporting NextGen/OEP planning should be clearly articulated.

FAA Response: The FAA concurs with this recommendation. The AVS R,E&D Requirements Prioritization Process does align with NextGen plans for the planning cycle for FY2010 (which is currently in process). An emphasis on NextGen has been included in the AVS Strategic Guidance for the FY2010 R,E&D requirements. The FAA will continue efforts to improve awareness of NextGen plans by all FAA personnel supporting the Safety R,E&D requirements process.
AVS and ATO-P will review its interfaces with activities in all OEP domains and the solutions sets and implement appropriate steps to address OEP planning in the AVS R,E&D prioritization process.

Recommendation: The Safety Subcommittee recommends that the FAA begin to realign the thrust of its activities in critical research areas that will be necessary for NextGen/OEP implementation and certification of advanced technologies as soon as practicable, including FY 2008 and FY 2009 activities. In advance of detailed NextGen/OEP R&D requirements, preparatory research should be conducted as expeditiously as possible in areas such as advanced software digital systems, complex systems integration, human factors/automation, enabling enhanced crew situational awareness, and assessing potential air crew or air traffic controller responsibility changes, etc.

FAA Response: The FAA recognizes the importance of aligning its research activities in critical areas needed for NextGen/OEP implementation as soon as possible. It is essential to identify AVS NextGen R,E&D requirements necessary to implement all key NextGen technologies safely and efficiently. AVS and ATO-P will work with the appropriate JPDO Working Groups, including Aircraft Concepts, Environment, Safety, and Weather, to ensure that applicable NextGen requirements are appropriately addressed in AVS R,E&D requirements portfolio. Though there are projects funded in FY 2008 and 2009 that support the areas identified in this recommendation, the FAA will continue to review these requirements for better alignment with the NextGen/OEP plans.

Recommendation: The Safety Subcommittee recommends that the FAA make every effort to assure that F&E funding is available to sustain critical R&D capabilities, that the R&D community knows how to access F&E funding, and that needed equipment upgrades are obtained in a timely manner.

FAA Response: The FAA is conducting an assessment of the safety research facilities and will continue to examine future R,E&D facility requirements. This will include an examination of work performed to support routine certification and operations needs versus work to support R,E&D. It may be possible to support routine certification and operations work with funds in the Operations or the Facilities and Equipment (F&E) appropriations, and we will continue to explore both avenues.

Recommendation: The Safety Subcommittee recommends that the FAA ensure that critical R&D facilities, such as its fire test facilities, are identified as national assets and that they are included in the National Aeronautics R&D facilities plan to protect their long-term vitality.

FAA Response: The National Science and Technology Council is developing a National Aeronautics Research and Development Plan. This plan will address national research, development, test, and evaluation infrastructure guidelines. The FAA has a representative participating in this group. As the plan develops, the FAA will ensure that all critical FAA R&D facilities, such as the Fire Test Labs, are appropriately considered and identified.

Recommendation: The Safety Subcommittee recommends that the FAA develop clear program linkage between its environmental alternative fuels initiative and its safety-related fuels program to ensure any potential safety-related implications are identified and addressed.

FAA Response: The FAA concurs with the recommendation and will ensure that AVS, AEE, and ATO-P coordinate appropriately. Potential safety issues and implementation of environment and energy driven operational changes will be addressed accordingly.

Recommendation: The Safety Subcommittee notes the positive impact of close FAA-NASA collaboration on ASIAS, where a joint FAA-NASA roadmap was developed and implemented for research development and transition from NASA to FAA and then the private sector. The subcommittee believes other program areas will benefit from the development of similar FAA-NASA collaborative roadmaps. Therefore, the subcommittee recommends that, at a minimum, the FAA and NASA pursue joint roadmaps related to weather in the cockpit and icing R&D.

FAA Response: The FAA concurs with the recommendation. Preliminary discussions between the FAA and NASA are already underway to develop joint roadmaps for weather in the cockpit and icing R,E&D.

2. FAA Response to REDAC Recommendations on Fiscal Year 2010 R&D Budget.

Dr. John Hansman (Committee Chair) submitted REDAC's recommendations to the fiscal year 2010 R&D budget to the Administrator on March 26, 2008. The agency provided the following response to the recommendations.

Recommendation - NextGen Requirements Flow Down: Research efforts to support Next Generation Air Transportation System (NextGen) are hampered by the lack of clear requirements flow down sufficient to define the research requirements and priorities. The Joint Planning and Development Office (JPDO) Integrated Work Plan (IWP) V 0.2 is unfocused, unprioritized and does not clearly define key research questions or development goals.

FAA Response: We agree that Version 0.2 of the IWP does not provide a focused and prioritized list of clearly defined research questions or development goals. That is not the role of the JPDO or the intent of the IWP. The IWP describes the results needed to reach NextGen. It is up to the Federal and industry partners responsible for specific NextGen elements to define the activities to reach those results. These activities include developing research requirements and building a research portfolio to support NextGen. A REDAC workshop was held July 29-31 to explain the source of the NextGen research and development requirements and how these requirements are incorporated in the various research programs.

Recommendation - New Standards for New System Capabilities: A critical component of system modernization will be the development and approval of new standards and operating procedures which reflect the capabilities of the NextGen infrastructure. This has been highlighted by the REDAC focused study on Separation Standards and is emerging as an issue in ADS-B transition. In addition there appear to be near-term opportunities to improve system capability such as reduced separation standards for ILS/RNAV and RNAV/RNAV paths to adjacent and nearby airports (e.g., LGA and JFK). In order to be most effective this will require an integrated approach to connect R&D with standards development. This effort should include Office of Aviation Safety (AVS) and Air Traffic Organization (ATO) and should not be constrained by organizational barriers.

FAA Response: We agree that cross-organizational collaboration is essential to development and approval of new standards and operating procedures to take advantage of NextGen capabilities. FAA is working across the lines of business to assess separation standard methodology. In ADS-B, Aircraft Certification (AIR) is responsible for certification of the airborne sensor, and Flight Standards (AFS) is responsible for assessment of the substitution of the sensor for radar, which is followed by a determination of whether ADS-B can be assessed on the basis of comparative safety. ATO is responsible for proposal of the standard (e.g., 5 nautical miles in the Gulf of Mexico). All organizations have worked together to advance the application of new separation standards.

Similarly, Closely Spaced Parallel Operation (CSPO) is co-led by AFS and ATO-Operations Planning. AIR and Aviation Safety Analytical Services (ASA) have also been involved from the beginning. The work involves new separation standards down to 700 feet in Instrument

Meteorological Conditions. The Office of Airports also has intense interest in new technology and procedures that will lead to reduced runway separation standards. A key requirement of NextGen is increased capacity at existing airports that cannot acquire additional land because of their location or community encroachment. Construction of new airports and runways is often a ten-year process, which makes it essential to find early solutions for reducing separation standards. In addition, reduced runway separation, in some cases, may shrink the noise envelope for new runways thereby reducing the number of people impacted. ASA is reviewing the blunder assumptions. AIR is assessing mid-term NextGen technology for use in parallel stabilized approaches, with aircraft-aircraft blunder protection. ATO is also applying past wake vortex work along with current wake research efforts to affect changes in current separation standards to increase capacity. ATO is first focusing on dependent operations to Closely Spaced Parallel Runways (CSPRs) and then adding independent operations as the more complex issues (blunder, etc.) for independent operations are addressed.

The JPDO Aircraft Equipage Standing Committee is identifying standards requirements for aircraft operational capabilities to support NextGen, including trajectory based operations and CSPO. The Avionics Roadmap under development by the committee includes a standards gap analysis identifying specific standards needs for new aircraft operational capabilities. This builds on earlier work from the ATO Operations Planning Chief System Engineer for Air-Ground Integration.

Recommendation - Weather Information: Weather is a key factor influencing both the safety of flight and the performance of the NAS. The rapid growth of information distribution channels and weather products creates a dynamic environment for weather information in the cockpits and air traffic control (ATC) facilities. The Agency should encourage weather products which support pilot, controllers, and dispatchers while avoiding any adverse impacts. The REDAC supports a vigorous FAA weather research program with nodes in AVS focused on flight safety and in ATO focused on operational efficiency.

FAA Response: We agree. Weather is a key factor affecting both aviation safety and efficiency. To address this problem more effectively, the Operations Planning Service Unit created an Aviation Weather Office to perform research and development in support of FAA weather requirements. The Aviation Weather Office is managing weather research projects that support AVS and ATO sponsors. Weather Research is focused on providing improved weather nowcasts and forecasts and ensuring that all aspects of ground to air, air to air, and air to ground common weather situational awareness are addressed. The research supports increased safety and capacity goals. The FAA agrees that the primary focus for AVS is flight safety, and the primary focus for ATO is operational efficiency. ATO and AVS will continue to collaborate in the development of requirements and integration of research that effectively addresses flight safety and operational efficiency.

Recommendation - High Confidence Software Development Strategy: There is an increasing reliance on software-based system for high criticality applications both in aircraft systems and in ATC systems. The current software development and maintenance processes are cumbersome, expensive, and incomplete. The FAA is not unique in this regard as other Federal agencies and industries struggle with issues of software criticality. The REDAC suggests that this be a priority area both for FAA internal development and for inter-agency coordination.

FAA Response: We agree with the assessment of the REDAC on the importance of a software-based system both in aircraft systems and in Air Traffic Management (ATM) systems. We also agree that the development of a strategy across the appropriate Government agencies is important and will work with the appropriate agencies to develop a Government R&D strategy for high confidence software development and ensure high-level internal support for the resulting strategy. ATO will work with AVS to identify the critical challenges associated with Software and Digital Systems (SDS) development and maintenance and develop standards and guidance to help mitigate these issues.

Subcommittee on Human Factors

The subcommittee offers the following recommendations.

Recommendation: The FAA needs to develop a clear road map of NextGen Human Factors challenges which elaborates and prioritizes required human factors research per solution set. These research requirements should be linked with current and planned HFRE efforts as well as priorities for workforce training and design. Gaps and opportunities for research progress and impact on FAA mid-term capabilities should be identified with cost and schedule projections.

FAA Response: We agree with the REDAC general observation, as well as the recommendation that NextGen research requirements need to be prioritized to facilitate the development of research plans, and the JPDO is doing this. We have established the FAA NextGen Human Factors Advisory Team, co-chaired by the ATO Operations Planning, Human Factors Research and Engineering (HFRE) Group Manager (AJP-61) and the AVS Chief Scientific and Technical Advisor for Flight Deck Human Factors (AIR-100). The purpose of the team is to identify human factors research, engineering, regulatory and operational issues, and requirements across organizations affecting implementation of NextGen air and ground capabilities. The team is coordinating with other ATO, AVS, and JPDO working groups, providing a forum to support development of NextGen Human Factors research plans. Recommendations from the team will be considered by Research Engineering and Development Executive Board (REB) and the various Program Planning Teams to ensure that Human Factors R&D requirements are captured and allocated appropriately.

Recommendation: Increased hiring of experienced research managers is urgently needed to meet NextGen planning and execution challenges. Current management shortfalls are limiting the ability of the HFRE group to staff key planning and development meetings with NextGen partners.

FAA Response: Human Factors Research and Engineering (HFRE) Group has been actively engaged in recruiting and hiring and will continue to do so.

Recommendation: Increased hiring of experienced human factors research and engineering staff at the FAA Tech Center is urgently needed to address emerging, critical research challenges in air-ground integration. There is a specific need to acquire research expertise in flight deck human factors to complement the outstanding existing competency in NextGen air traffic management human factors.

FAA Response: We will pursue a strong air-ground integration capability and look to augment our air traffic management human factors competencies flight deck expertise. We will explore other air-ground resources, e.g., at CAMI and NASA, as part of an overall strategy for addressing this recommendation.

Recommendation: In order to effectively address Human Factors issues within the timetable for NEXGEN, the FAA needs to augment and leverage aggressively available Human Factors knowledge, resources, and facilities across different sectors of the aviation Human Factors research community.

FAA Response: Leveraging external expertise and facilities is a key target of the HFRE Group, but this part of the planning has been hindered because of the staffing shortfall. The HFRE Group has made progress in this area through the HF Advisory Team where National Aeronautics and Space Administration (NASA) participates, NASA Ames and Langley site visits and discussions with human factors researchers, interactions with scientists at several Department of Defense (DOD) facilities, interactions with MITRE researchers, market surveys to support NextGen human factors research, and participation in FAA/EUROCONTROL Cooperative R&D Action Plan 15 on safety and human factors.

Recommendation: Increased emphasis must be placed on computational modeling and simulation as part of formal analytic methods for NextGen systems design and evaluation.

FAA Response: We intend to use validated computational modeling and simulation as part of formal analytic methods for NextGen systems design and evaluation included in our NextGen human factors air-ground integration research plan when feasible and appropriate. Computational modeling is not suitable to all areas of human factors evaluation and there are times when there is no substitute for human-in-the-loop test and evaluation.

Subcommittee on Airports

Recommendation: The Technical Center should continue research on Foreign Object Debris (FOD) radar to accelerate development of performance standards for utilization of this new technology on airports.

FAA Response: The FAA agrees with this recommendation. Current FOD radar testing has yielded promising results using various novel technologies. Two engineers, one within the Airport Engineering Division and another in the Airport Technology R&D Branch, with a researcher from the Center of Excellence in Airport Technology (CEAT), have the task of producing a FOD radar advisory circular. Guidance is expected to be published in Fiscal Year (FY) 2009.

Recommendation: The ongoing fire research on the double-deck mockup of a new large aircraft at Tyndall Air Force Base should continue as a high priority. It is important that this research develop answers to questions if changes to the quantity requirements of fire fighting agent are needed for airports receiving new large aircraft service such as the A-380.

FAA Response: The FAA agrees with this recommendation. We place a high priority on the fire testing underway and will keep it on schedule.

Recommendation: The Subcommittee strongly supports the FY 2010 initiative to start development of a visual aid test bed facility. This will significantly increase the ability of the Technical Center to easily configure and install prototype lighting systems for testing and evaluation.

FAA Response: The FAA agrees with this recommendation. Advances in higher performance and cost-efficient lighting technologies necessitate that we continue our research and development efforts in this field. We anticipate starting work on the visual aid test bed facility in FY 2010.

Subcommittee on Aircraft Safety

Overview: Process-specific Recommendations

Note recommendations 1 and 1a are made jointly by the Aircraft Safety and NAS Ops Subcommittees.

Recommendation 1: The FAA should ensure that clear, detailed requirements for all NextGen R&D are defined and that a transparent and effective means is provided for their flow-down to R&D program planning and execution. The Subcommittees offer assistance to the FAA in developing and implementing this process.

a. Subcommittees recommend that the FAA immediately jumpstart this requirements generation process by prioritizing needs based on NextGen programmatic risk, starting with the 183 research issues listed in the NextGen Concept of Operations (ConOps), and focusing FAA research at addressing the most critical issues.

FAA Response: The FAA is providing input to the JPDO Integrated Work Plan Version 1.0. In addition, the FAA is finalizing Version 2.0 of the NextGen Implementation Plan, which is focused on the development and implementation of the near- and mid-term NextGen capabilities necessary to support the long-term goals of NextGen. With these capabilities clearly identified, the FAA will define the detailed requirements for NextGen R&D and will facilitate their flowdown to R&D program planning and execution activities. The FAA held a workshop for the REDAC in July to explain the source of the NextGen research and development requirements and how these requirements are incorporated in the various research programs.

Recommendation 2: The FAA and NASA should jointly develop clear and actionable integrated roadmaps spanning all NextGen-required safety R&D and other safety-related R&D. The roadmaps should identify timelines, deliverables, and decision and transition points for the R&D's insertion into infrastructure or regulatory products. Absent a more mature description of research needs, the Safety Subcommittee suggests that the 183 research issues from the ConOps be used as the basis for launching the NextGen-related roadmap process.

FAA Response: We agree. The FAA will work with NASA to develop joint R&D roadmaps wherever practicable. In fact, development of roadmaps is already underway in the areas of icing and weather-in-the-cockpit R&D.

Recommendation 3a: The Safety Subcommittee recommends that the FAA update the TCRG planning process to improve communications & transparency with stakeholders.

FAA Response: We agree with the recommendation on improving communication and transparency. The FAA concurs that improvements to the communication and transparency in AVS R&D prioritization process, including the TCRG activities, should be made wherever possible. At the end of each planning cycle, a lessons-learned review is conducted. Comments similar to the SAS recommendation were received and are being reviewed. Greater communication and more active feedback to, and between, stakeholders will be instituted to ensure greater transparency.

It is assumed that this recommendation (3a) and all subparts (3b – 3f), are meant to refer to the AVS R&D Requirements Process, as the TCRG planning processes are only a subset of the overall AVS R&D Requirements Process. Furthermore, the recommendation, with all subparts, is more broadly applicable to all the FAA RE&D planning processes, as are the responses, and will be used by the Research Executive Board to improve the processes.

Recommendation 3b: Expand the planning process to ensure the process extends beyond the AVS boundaries and into other key organizations such as ATO. The process should recognize the full slate of safety-related R&D being considered and ensure maximum synergy is developed in response to requirements.

FAA Response: We agree that R&D planning across FAA organizations would be beneficial. However, such an expansion would be more appropriately carried out under the auspices of the Research Executive Board (REB), which has representation from all FAA lines of business. The REB has the representation and authority to address this issue across the FAA, to examine research portfolios and ensure synergies between R&D programs are exercised to the greatest extent.

Recommendation 3c: Monitor the performance of program elements to agreed-upon timelines and product delivery expectations, including well-defined success criteria. Multi-year funding profiles should be developed and used to ensure programs that are performing well towards their defined success criteria remain on track. However, programs that are not achieving the necessary results should be modified, redirected, or terminated.

FAA Response: We agree. Several new initiatives are underway or being planned to address performance monitoring.

- The Research Executive Board has sponsored the development of a Performance Measurement Database that will track progress of annual R&D program goals, objectives, and accomplishments;
- The NextGen Integration and Implementation Office is developing a portfolio management process and database to track the performance of the NextGen efforts; and
- The AVS R&D Requirements Process is taking steps to implement performance monitoring. Proposed research requirements will include elements such as project milestones, performance metrics, and phased exit criteria.

A comprehensive revision of the AVS R&D Requirements Process is planned for FY 2012. This revision will address the issue of multi-year funding and will implement further steps for considering prior progress and performance in the process.

Recommendation 3d: Ensure top-level NextGen requirements are clearly flowed into the process and that well-integrated programs are developed to address them.

FAA Response: We agree. We will continue to work within the NextGen Implementation and Integration development process to develop well integrated NextGen R&D programs.

Recommendation 3e: Identify key priority safety themes based on data and clearly articulated emerging issues/areas that cut across TCRGs and other FAA organizations. Develop integrated programs constructed to make significant impact on these critical areas. Possible areas for focus include: advanced software and digital systems integration, reducing general aviation accidents related to inadvertent flight into IMC conditions, improving runway safety, or identification and assessment of emerging risks. These areas are notional, however. The FAA should conduct a thorough review to determine the actual listing of critical areas based on current data and an understanding of emerging issues and areas.

FAA Response: We agree and will conduct a thorough review to identify the critical areas based on current data and an understanding of emerging issues and areas. We suggest this as a task for a REDAC working group or for a subset of the Aircraft Safety Subcommittee. AVS will work with ATO Operations Planning, Research and Technology Development (R&TD) to establish such a study group.

Recommendation 3f: Identify key core competencies and capabilities needed for the FAA research organization. The FAA should ensure that a means is developed to advance these key core competencies and capabilities beyond the current state-of-the art. Absent a more effective means, the FAA should consider dedicating a percentage of the overall R&D budget in this area.

FAA Response: We agree that identifying core competences is an important issue; one that should be addressed at a level that deals with all research programs and organizations at the

FAA. We plan to task an independent group such as the REDAC to define what a core competency is and develop recommendations on how to develop and maintain core competencies. Part of the tasking for this independent group will include looking both in the near- and long-term, as well at what resources might be needed to maintain and advance the core competencies.

Program-specific Recommendations

Recommendation 4: The safety subcommittee recommends that the FAA immediately identify clear customers and associated requirements for the weather-related safety R&D and ensure that its program is fully aligned to these needs. Immediate adjustments should be made as necessary to the 2008–2010 weather program to ensure the program is fully aligned to customer-driven requirements and success metrics, and that actions are taken to implement its products into use.

FAA Response: We agree. Requirements for FY 2009 and beyond will be fully reviewed. All requirements will be linked to a sponsor need or removed from the portfolio. In addition, performance goals and suitable and verifiable metrics for measuring accomplishment of the goals for each requirement will be established. To ensure timely product implementation, the Aviation Weather Office will complete a process for the development and approval of weather products and their continued configuration management. This process shall be developed with the participation of all associated FAA lines of business. For example, for products intended to be airborne, or used for flight planning, this process will address AVS certification, operational, and oversight requirements.

Software and Digital Systems

Recommendation 5: The Safety Subcommittee recommends that the complex software and digital systems integration area should be significantly elevated in priority and identified as a key safety theme. The subcommittee recommends that a comprehensive and integrated program should be developed and appropriate resources allocated to springboard the FAA to a leading position in complex software and digital system safety.

FAA Response: The FAA agrees that software and digital systems is an increasingly critical area in aerospace systems requiring specialized expertise and carefully planned R&D. The Aircraft Safety R&D program, working with the JPDO Aircraft Equipage Standing Committee, will identify the key software and digital systems issues, current and anticipated in the future. Beginning immediately, the FAA will develop a comprehensive program plan, with a focus on the needed R&D, which will help position the FAA as a leader for complex software and digital systems safety.

Fatigue and Lifing-related Proposals

Recommendation 6: The Safety Subcommittee recommends that the RS-10-04 and SIM-10-02 program elements be terminated and the resources for these efforts be allocated to other efforts. The Safety Subcommittee further recommends that the FAA certification organization determine if guidance material is required for the restricted category rotorcraft community and the fixed-wing general aviation community on acceptable means of compliance related to these issues. If so, the FAA should issue this guidance to the respective communities to enable them to perform the required work.

FAA Response: The FAA notes the concerns of the Aircraft Safety Subcommittee that the FAA may be performing research that should be conducted by the rotorcraft and general aviation communities. The Aircraft Certification Service will conduct an evaluation of each requirement that fully addresses the Subcommittee's concerns. The projects may be rescoped as a result of the aircraft certification evaluation.

Subcommittee on Environment and Energy

The subcommittee identified the following specific issues as matters to bring to the attention of the Administrator.

Issue 1: The subcommittee noted that the Fiscal Year 2010 budget very clearly reflects the shifts in priorities recommended by the subcommittee to support NextGen. The program is well balanced and the right priorities and projects proposed.

Recommendation: For solutions to become viable, the subcommittee recommends that the environmental research budget grow to the levels suggested in the NARP ($35M in RE&D, $20M in ATO-Cap) by 2011.

FAA Response: The FAA recognizes that we must address environmental constraints to enable NextGen. We will make every attempt to grow our budget to the levels outlined in the 2008 National Aviation Research Plan (NARP) in 2010 and beyond, while considering other Agency and national priorities.

Issue 2: The committee feels strongly that procurement competition is crucial to ensure excellence. Members feel that the Center of Excellence (COE) process – which was competitively selected – has proven to be a successful way to perform quality research and should continue.

Recommendation: The committee recommends that, as the resources grow, the FAA ensure that performers are competitively selected.

FAA Response: The FAA agrees that competition improves the quality of research. The Continuous Low Energy, Emissions and Noise (CLEEN) Program and other new environmental initiatives are being competitively procured.

Issue 3: The subcommittee noted the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) COE had made substantial progress addressing environmental issues since its inception about four years ago.

Recommendation: The subcommittee recommends that FAA continue supporting research through PARTNER at a robust level.

FAA Response: The PARTNER COE has made substantial contributions to our efforts to understand and mitigate aviation's environmental impacts. Our plans are to continue supporting the Center at similar levels or possibly higher than we have the last few years.

Issue 4: The committee noted that there are many areas of noise research that need to be reviewed/assessed to address emerging topics and establish the research requirements to deal with these issues

Recommendation: The subcommittee recommends the FAA put together a draft of a comprehensive integrated noise research plan and brief to the subcommittee in August.

FAA Response: The FAA agrees that noise issues need to be continually reviewed and assessed, as noted in the recently released Government Accountability Office (GAO) study. FAA staff is working on a comprehensive noise research plan. The draft plan was briefed to the subcommittee in August to ensure we consider your views in the final product.

Issue 5: The subcommittee commended the Commercial Alternative Aviation Fuels Initiative (CAAFI) process and noted the tremendous progress made in alternative fuels, particularly qualification and assessing environmental impacts.

Recommendation: The subcommittee recommends the FAA continue to carefully consider the life cycle emissions/environmental impact of alternative fuels.

FAA Response: We agree that alternative fuels environmental impacts must be addressed over the whole "well to wake" life cycle. All of our alternative aviation fuels studies have included and will continue to include life-cycle assessments. We are also working with the Air Force Research Laboratory to tailor life-cycle emissions models to aviation applications.

Issue 6: The committee noted the climate aspects of the Aviation Environmental Portfolio Management Tool (APMT) are very reliant on emerging science. It is important that developers continue to incorporate the latest science and improvements that could be made as appropriate. It will be important to not treat APMT as a black box, with a need to be well aware of existing uncertainties and gaps in any uses of the tool.

Recommendation: The FAA needs to ensure the latest scientific advice and sound uncertainty analyses are incorporated into APMT. The subcommittee asked for a briefing on the peer review to date of APMT and plans to continually improve the fundamental science of APMT. The subcommittee also asked for a briefing on how uncertainties are treated.

FAA Response: We strive to always include the latest scientific insight into our models. The APMT development effort includes careful uncertainty assessments. FAA staff briefed these efforts to the subcommittee at the August 2008 meeting.

NAS Operations Subcommittee

The subcommittee offers the following overall comments.

With respect to the R&D Program in the OEP to support NextGen, the subcommittee agrees that facilitating NextGen should be a major focus of the R&D program. However, how this facilitation is being done was not clear because the R&D program elements were not clearly mapped to NextGen relevance. The linkage between the research being planned and the actual research requirements (from either the OEP or the JPDO's Integrated Work Plan (version 1)) was not clearly defined. In addition, the NextGen system analysis is not yet detailed enough to allow a quantitative evaluation of the R&D efforts. Therefore, the subcommittee thinks that the FAA cannot realistically assess R&D project relevance. From the information presented to the subcommittee, it seems that additional investment is required in analytical tools to evaluate the system design properly. Some policy decisions need to be made for NextGen progress to be made. For example, the decision about how much responsibility the air vehicle pilot will have for separation is pivotal in determining future research directions and final concepts.

The research and development plans were presented to the subcommittee for each OEP solution set. The following are specific comments for each one presented:

Recommendation:

Solution Set: Initiate Trajectory Based Operations

- The research content and funding appear appropriate for the shorter-term goals described, but the relevance to NextGen is limited to high altitude airspace.
- The Weather aspects of the described efforts are not integral to the air traffic management R&D effort, and this must be corrected.

FAA Response: Tactical Trajectory Management (TTM) is an identified step in NextGen and included in the FY 2009 budget request under the Collaborative Air Traffic Management (CATM) solution set. The FAA will determine weather information required for embedded decision making in flow related operations. In the CATM, major activities will include defining approaches to truly integrating weather into strategic flow decision support tools. If funded, the FAA will identify weather information required for embedded decision-making in flow related operations and will include defining approaches to truly integrating weather into strategic flow decision support tools. The FAA is also working with industry through the Collaborative Decision Making community's Future Concept Team (FCT) on weather integration into decision support tools for air traffic management. Currently the CDM, FCT workgroup developed limited decision support tools for a Human-In-The-Loop test in July 2008 that provided an interim solution and facilitate the integration of weather into CATM and TTM. Within the FAA Aviation Weather Office (AWO), a project has been established specifically to bring about integration of weather information into ATM tools.

Recommendation:

Solution Set: Increase Arrivals/Departures at High Density Airports

- The research content and funding appear adequate for the shorter term goals described, although some near-term gaps were noted:
    - FAA should pursue reduced separation standards for ILS/RNAV and RNAV/RNAV paths to adjacent and nearby airports, e.g., La Guardia and JFK.
    - Weather parameters for CAVS need to be defined to maximize operator benefits.

Solution Set: Increased Flexibility in Terminal Environment

- There appears to be overlap and interdependencies between solution sets that is not explicitly stated and could be overlooked. For example,
    - Enhanced Tower data link (NR7 for TBO) and Surface Management (NR2 for High Density Airports)
    - Pre-departure clearance in TBO and Pre-departure clearance in CATM
- The project to provide surface surveillance data to aircraft, ANSPs and Safety systems is very important
- Wake Project achieved early successes
    - Wake Turbulence Mitigation for Departures
    - St Louis Closely-Spaced Parallel Runway Waiver Proposal

Solution Set: Improve Collaborative ATM

- The research content and funding appear adequate for the shorter term goals described

Solution Set: Reduce Weather Impact

- (1) Weather ATM Integration research
    - Current CAASD effort should be accelerated for early field trials (2009)
    - It is unclear if air traffic managers developers are participating in decision-making tools
    - No evidence was presented of assessing required weather information requirements in terms of levels of system capability

FAA Response: In response to the recommendations regarding Weather ATM Integration Research, The Reduce Weather Impact program will start in FY 2009. The Aviation Weather Office (AWO) has already begun discussions with MITRE/CAASD to incorporate their ongoing activities into the program.

The FAA is working with industry through the CDM community's FCT, which includes air traffic managers, on weather integration into decision support teams for air traffic management. Currently the CDM, FCT workgroup developed limited decision support tools for a Human-In-The-Loop test in July 2008. Within the FAA AWO, a project has been established specifically to bring about integration of weather information into ATM tools.

The FAA, in cooperation with the JPDO and participating agencies, recently completed a Functional Analysis of the Single Authoritative Source (SAS) for ATM. The FAA is conducting Aviation Weather Requirements work to address NextGen system capability needs. Several new starts, including Reduce Weather Impacts will begin to integrate requirements into several NextGen system capabilities (e.g., CATM).

Recommendation: Legacy Aviation Weather Research Program (AWRP) efforts need to be reevaluated and reprioritized in a way to make them closer to NextGen needs and weather-ATM integration

FAA Response: In response to the recommendation regarding Aviation Weather Research Efforts, an April 2008 AWRP program management review was held to more tightly couple the program to customer-driven requirements, especially for weather-ATM integration.

Recommendation:

- New Initiatives appear good:
  - NNEW 4D Data Cube using NEO technology, to serve as the backbone of NextGen weather data
  - Weather to the Cockpit to reduce accidents; weather node

- Weather – ATM Integration needs models of how flight crews react to weather in flight
  - Collaboration with Safety Subcommittee Recommended

FAA Response: The FAA agrees that collaboration with the Aircraft Safety Subcommittee is a necessary step toward addressing the full range of equipment and operational issues relating to an aircraft-centric program such as Weather Technology in the Cockpit. The FAA is addressing the needed research in the Weather Technology in the Cockpit Program by ensuring the program addresses all aspects of the ground to air, air to air, and air to ground common situational awareness and weather integration system needs. Examples of Human Factors planned research under the FY 2009 budget submission include development of methods for cooperative use of weather information among pilots, controllers, AOCs/FOCs, and Air Traffic Operation Centers to enhance weather-related safety and efficiency decisions, and conducting an air-ground integration simulation regarding improved weather products at the controller workstation and in the cockpit to enhance safety and capacity in the NAS.

The NAS Ops Subcommittee offers the following recommendations:

Recommendation 1: The FAA should review their R&D programs for the items listed below that the subcommittee perceived as R&D Gaps. For those items that the FAA agrees are gaps, resolve how the gap will be addressed. The gap could be schedule based or resource based. In other words, the FAA may have some work being done in these areas, but it may not be of sufficient levels to meet the NextGen goals in a timely and complete fashion.

- The Subcommittee is concerned by apparent lack of the following research:

  - Probabilistic traffic flow management: Research that explores weather forecasts that both incorporate probabilistic outcomes and the anticipated impact on flows

FAA Response: The FAA's Aviation Weather Research Program is developing probabilistic forecasts as part of the development of the 4-D Weather Data Cube concept. In the FY 2009 budget submission, plans for weather impact forecasts are included as part of the weather integration into ATM NextGen Collaborative Air Traffic Management. The FAA is working with industry through the CDM community's FCT on weather integration into decision support tools for air traffic management. Under those auspices, METRON Aviation Inc. and MITRE/CAASD are both working on parts of a probabilistic flow management tool.

Recommendation 1 (Continued):

- UAS Impact on air traffic management: Research that explores the impact on controller workload, air traffic safety, flow efficiency and capacity, and potential new air traffic management procedures associated with more routine operation of UAS in controlled airspace;
- Operational requirements: Research that identifies all the activities and development needed to obtain approvals for the required NextGen policies, procedures, operations, or implementation of technology;
- Equipage: Research that defines what system performance can be accomplished at various levels of equipage and equipage mixture, and what are the barriers; and
- Policy: Research that informs policy changes necessary to achieve NextGen goals (e.g., equipage, first-come-first-served, and avionics)

FAA Response: The FAA appreciates the identification of the perceived research gaps. The FAA agrees to review the R&D programs for the gaps listed. If the FAA agrees that such gaps exist, plans to resolve the gap will be developed, which could include adding additional items to the research plan, adjusting schedules, or other forms of mitigation to lessen the impact of the gap. These reviews will be conducted according to the OEP Process. Results of these reviews will be used in the budget formulation and adjustment phases for FY 2009 and FY 2010.

The NAS Operations and the Aircraft Safety Subcommittees jointly offer the following recommendations:

Recommendation: The FAA should ensure that clear, detailed requirements for all NextGen R&D are defined and that a transparent and effective means is provided for their flow-down to R&D program planning and execution. The Subcommittees offer assistance to the FAA in developing and implementing this process.

FAA Response: A workshop for the REDAC was conducted at the end of July 2008 to explain the source of the NextGen R&D requirements and how these requirements are being incorporated in the various research programs.

Recommendation: The Subcommittees recommend that the FAA immediately jumpstart this requirements generation process by prioritizing needs, based on NextGen programmatic risk, perhaps starting with a review of the 167 research issues listed in the NextGen Concept of Operations (ConOps), and focusing FAA research at addressing the most critical issues.

FAA Response: Whether or not any additional requirements should be generated and by what process was determined at the July workshop.

3. FAA Response to REDAC Report of the Weather-ATM Integration Working Group.

Dr. John Hansman (Committee Chair) submitted REDAC's report of the Weather – ATM Working Group to the Administrator on October 4, 2007. The agency provided the following response to the recommendations.

Overarching Recommendations

A. Crosscutting Research Program

Recommendations (page 10): Initiate and fund a crosscutting research program in Air Traffic Management (ATM)/Weather Integration and insure that weather aspects are an integral part of new ATM initiatives from the beginning.

B. Leadership

Recommendation (page 10): Establish Senior Leadership oversight.

Senior leadership oversight of all major weather – ATM integration development efforts should be established to insure progress and overcome traditional resistance that has been resident in the middle management levels of the FAA.

FAA Response for A&B: We concur. The following activities, already underway, are expected to address these recommendations, at least in part.

The Vice President of Air Traffic Organization (ATO) Operations Planning has established the Aviation Weather Office to lead development of new weather capabilities and realign legacy capabilities to achieve NextGen. This office reports directly to the Vice President and is responsible for aviation weather budget formulation, program development, and the research program for all of NextGen weather services including integrating weather into ATM decision support tools . The Aviation Weather Office has developed the NextGen Network Enabled Weather (NNEW) program that is expected to start in Fiscal Year (FY) 2008 and will enable net-centric access to multi-agency weather data repositories in support of NextGen. The office has also developed a new budget line, called Reduce Weather Impact (RWI) for FY 2009 and succeeding years that will address the weather observations, forecasting, and integration needs of NextGen.

The refocused Operational Evolution Partnership (OEP), which oversees seven NextGen "Solution Sets", will help address crosscutting weather research and integration into ATM. NNEW and RWI, described above, in combination constitute one of the seven OEP solution sets. The OEP provides high-level, cross-agency management oversight of all solution sets to ensure support of NextGen objectives and plans. Within the OEP is an Impact and Implementation (I&I) Office whose job will be to ensure that all necessary coordination for NextGen capabilities occur efficiently and effectively, including weather integration capabilities. The Aviation

Weather Office will work closely with the OEP I&I office to facilitate the coordination of weather capabilities from research to field implementation.

For the first time the FAA has created a Weather Research Program Planning Team (PPT) that cuts across all FAA elements to establish FAA-wide weather research priorities. The three principal operational Service Units in ATO and both Flight Standards and Aircraft Certification in AVS are represented on the PPT. The Vice President of Operations Planning is participating in an executive level policy board to address cross-agency weather investments regarding NextGen. The board consists of executive level representatives from the FAA (Chair of the OEP Review Board), the National Weather Service (NWS), the Department of Defense (DOD), and the Joint Planning and Development Office (JPDO).

Recommendation (page 10): Establish REDAC monitoring.

The REDAC should be directed to annually monitor weather-ATM integration initiatives to ensure adequate progress.

FAA Response: We concur. The FAA will brief the REDAC on weather/ATM integration research initiatives on a mutually agreed-upon schedule. Briefings have been and will continue to be provided to the Subcommittee on Aircraft Safety and to the NAS Operations Subcommittee on the Weather Research Program.

Recommendation (page 11): Revitalize joint advisory committee reviews of FAA and NASA joint research such as weather-ATM integration.

FAA and NASA should hold joint meetings of their advisory committees and include the identification of current and future cross agency research opportunities in support of integrating advanced aviation weather and air traffic management tools. Furthermore, a Memorandum of Understanding (MOU) or Agreement of Understanding (AOU), between FAA and NASA, and encompassing weather and ATM research, may be needed to clearly elucidate the needed connection between these agencies.

FAA Response: We concur. However, it is our understanding that that National Aeronautical and Space Administration (NASA) no longer has an active advisory committee. Consideration is being given to implementing a JPDO proposal for the formation of FAA-NASA research technology transition teams. One such team could be established for Weather-ATM integration. The FAA is already discussing development of a joint roadmap with NASA for weather-in-the-cockpit research.

C. Requirements Process

Recommendation (page 11): Develop requirements for weather ATM integration participation within the AWRP.

FAA Response: We concur. Integration managers in ATO Operations Planning are being staffed to address this recommendation. The Aviation Weather Office, which has the overall responsibility for weather requirements in the FAA, is working with each of the operational Service Units to align their requirements with FAA-wide and NextGen requirements including integration of weather into decision support tools. In concert with the JPDO, the Aviation Weather Office is planning integration workshops for early 2008. In addition, FAA has tasked MITRE to support integration of weather information into ATM decision support tools.

Weather – Air Traffic Management Integration

Near Term: IOC 2010

A. Assessments of Avoidable Delay

Recommendation (1) (page 13): Research is needed to identify and quantify avoidable delay.

Quantitative research studies of "avoidable" delay, should be conducted each year, based on significant summer or winter storm events, to identify opportunities to reduce delay and to evaluate the performance of weather – ATM integration capabilities as they are developed and fielded.

Recommendation (2) (page 13): ATM/TFM/AOC/FOC Involvement is needed.

Operational user feedback on the feasibility of the ATM strategies developed by the automatic planner described in Section 4 should be provided.

FAA Response for 1 & 2: We concur. FAA/ATO has developed and implemented the Weather Impacted Traffic Index (WITI) as a macro metric for correlating weather and NAS performance (e.g., delays) on a daily basis. Further work is planned for FY 2008 to extend WITI to evaluate the effectiveness of weather information in reducing avoidable weather delays. Additional funding for metrics development has been requested in subsequent fiscal years.

System-wide modeling and analysis capability is in development in the ATO Operations Planning, Performance Analysis and Strategy Office. The model is planned for testing in FY10. The Director of that office will be responsible for tracking and reporting on this research.

The FAA concurs that industry involvement is an important factor in determining NAS performance. There is robust coordination on all aspects of NAS performance, both internally and externally, through various stakeholder entities including Air Traffic Control Association, Air Traffic Management Advisory Committee Requirements and Procedures Sub-group, and ATA. This coordination will continue through FY 2009 and the foreseeable future.

B. Translating Weather Data into ATC Impacts

Recommendation (page 15): Expand research on the translation of convective weather impacts into ATC impacts so that this information can be used to effectively support decision making.

Research should be conducted to address the following elements:

a. Improve the models for convective weather impacts, e.g., route blockage and airspace capacity.
b. Determine if pilot thresholds for weather conditions that lead to deviations can be reduced, since unexpected deviations around storm regions in high density airspace can lead to prolonged, unnecessary route closures.
c. Determine if the data link transfer of ground derived weather and ATC domain information (spatial boundaries acceptable for maneuvering) to the pilot achieve a more consistent pilot response to convective weather.
d. Determine if the airspace usage differs between various en route facilities [e.g., the Jacksonville Center (ZJX) appears to have very different procedures for convective weather ATM than many of the ARTCCs in the Northeast].
e. Develop models for storm impacts on arrival and departure flows in both en route and terminal airspace.

FAA Response: We concur. FAA has work underway and is planning FY 2008 research with MIT/ Lincoln Labs on the translation of convective weather impacts into Air Traffic Control (ATC) impacts. We plan to continue work on the Route Availability Planning Tool (RAPT) to improving route blockage models for convective weather. We are initiating development of a new convective forecast product called Consolidated Storm Prediction for Aviation (CoSPA) as the authoritative source for convective forecasts for standalone use and for integrating into NextGen decision support tools. However, additional work to translate weather into ATC impacts will be required. The FAA will review ZJX procedures to determine if these are a best practice that should be expanded and institutionalized. Any effective decision making must involve the pilot, thus the Office of Aviation Safety will be part of the process to define the research.

C. Improved Weather Input into Collaborative Traffic Flow Management

Recommendation (page 17): Develop a six-eight-ten hour convective forecast for strategic flow management decisions with automatically generated and updated forecasts of flow impacts.

This should be a joint program between the AWRP and the TFM R & D programs with involvement by representatives of the CDM Weather Team

FAA Response: We concur. Considerable research will be required to address this recommendation.

On the convective forecast side of this recommendation, the FAA has issued draft requirements to NWS for extension in FY 2008-2009 of the Collaborative Convective Forecast Product (CCFP) to 8 hours and beyond. CoSPA described in the response to Recommendation 8, is intended to fill this forecast gap for the longer term but will require significant scientific development.

On the flow impact side of the recommendation, FAA recognizes the problem and is evaluating how to bridge the gap around the use of weather information in the automation programs to address this gap. Specific programs are yet to be defined but are essential to addressing the fundamental concern expressed by REDAC that weather information be effectively used in NAS operations.

Recommendation (page 17): Improve the Traffic Management interaction with AOC/FOCs during weather impacts.

Develop collaborative TFM systems that allow operators to better manage risks in meeting their own business objectives. Specifically, collaborative TFM systems should be developed that give operators the following capabilities:

- Enable visibility into probabilistic TFM weather mitigation strategies through robust TFM data feeds for integration into their own internal systems via CDMnet and eventually System Wide Information Management (SWIM).
- Electronically pre-negotiate multiple trajectory options with Traffic Managers.
- Select viable route/altitude/delay options during severe weather impacts.
- Integrate and ingest ATC-approved trajectories onto the flight deck for execution consistent with their own corporate infrastructure, business objectives and regulatory requirements.
- Expand collaboration to include flight deck capabilities and decision making tools consistent with NextGen and within the corporate infrastructure, business objectives and regulatory requirements of the operator.

FAA Response: We concur. The FAA CDM Future Concepts Team is working on ways to improve interaction with customers and place more responsibility for flight operations with the AOC/FOCs. We recognize that while pre-negotiated routes are advantageous to system operations and efficiency, the interaction between the flight crew and air traffic controllers is a critical input to tactical routing determinations and flight operations. The Collaborative Air Traffic Management (CATM) solution set of the OEP involves integrating weather into decision support tools that will lead to improved traffic management interaction.

D. Weather Information and Pilot Decision Making

Recommendation (page 18): Initiate a research program to develop procedures and guidance on the integration of weather and airspace congestion information for preflight and in-flight decision making tools.

The program should include the following objectives:

- Develop appropriate rule sets for weather avoidance decision making in both non congested and, highly congested airspace.

- Develop ways to incorporate the same rule set into preflight, cockpit, AOC/FOC, and ATM decision support tools.
- Develop methods to integrate or display current and forecast weather impact to flight profile, airspace congestion information, and weather decision support information in preflight and cockpit systems to enable greater shared situational awareness and improved collaborative decision making.
- Conduct research on the direct, machine to machine, information transfer among cockpit, FOC, and ATM computing systems and determine whether this will facilitate consistent and expeditious decision making. This will place the users more "over the loop" than "in the loop" with respect to weather decision making.

FAA Response: The FAA agrees that airspace congestion and weather information should be integrated to provide greater shared situational awareness and improved collaborative decision making between pilot, dispatcher, and ATM. In fact, one goal of the weather in the cockpit research program sponsored by AVS is focused on shared situational awareness between the pilot, the dispatcher, and ATM. Information on the airspace congestion and weather and participation of ATO are vital pieces of reaching shared situational awareness. FAA's planned research program for FY 2009 and beyond includes weather-in-the-cockpit and flight planning automation components that will address this recommendation.

E. Integrating Weather Impacts with Airport Surface and Terminal Management Systems

Recommendation (page 20): Expand the use of route availability tools to integrate airport and terminal area weather data and ATM tools.

Expand the deployment of integrated tools, such as route availability, to additional airports and terminal regions to improve NAS performance at the largest airports impacted by convective activity.

FAA Response: We concur. The FAA is looking at the applicability of expanding Route Availability Planning Tool (RAPT), an integrated planning tool, to other airports outside of the New York metro region. Assuming the identification of a positive business case, our plans are to develop, evaluate, and implement the capability at other locations. The FAA is also exploring ways to integrate RAPT into TFM processes including Departure Flow Management (DFM) and Departure Sequence Program (DSP) and making it en route capable. The OEP solution set "Reduce Weather Impact" states that weather information will be incorporated into decision support tools in multiple domains.

Recommendation (page 20): Conduct research on enhancing the Traffic Management Advisor (TMA) to achieve a weather sensitive arrival planning tool.

FAA Response: We concur. TMA currently integrates forecast winds, temperatures, and pressure derived from the Rapid Update Cycle (RUC) model in determining its output. The FAA is currently working on ways to integrate TMA data into TFM. For the FY 2009 budget submission, the FAA proposes research to extend TMA to the top 50 OEP airports, develop integration architecture for TMA, and link TMA arrival schedule and TFMS Monitor alert.

Recommendation (page 20): Integrate RAPT, ITWS, DFM, and TMA with surface management systems to provide a singular terminal management tool spanning departures, arrivals, and surface movement. Consider common use by air traffic and operators for collaborative decisions.

FAA Response: We concur. The FAA is currently looking at the feasibility of integrating RAPT into DFM and DSP. Initial work would begin in late FY 2008. This would be one of the first steps to the larger recommendation identified in the recommendation. As part of NextGen, the FAA will be developing an integrated arrival/departure and surface traffic manager to improve decision making and flow management. The decision support tools will effectively manage high-capacity arrival and departure flows in the presence of various weather conditions. The initial availability is estimated in 2016. These new tools will be made available to both air traffic and external users for making collaborative decisions as prescribed in the CATM solution set.

Recommendation (page 20): Support CDM and other efforts to provide meaningful and integrated terminal and TRACON specific weather forecast information.

FAA Response: We concur. ATO System Operations recently led a CDM effort to identify requirements for TRACON-specific weather forecast information. The effort will continue, working to possible implementations within the CDM framework.

Consistent with JPDO and OEP reduce weather impact solution set sponsored activities we expect network-enabled operations based 4-D Weather Data Cube to provide specific weather forecasts for terminal and TRACON applications.

Mid Term IOC 2015

F. Adaptive Integrated ATM Procedures for Incremental Route Planning

Recommendation (page 24): Develop Weather Impact Forecasts versus Time (for different planning horizons).

Develop weather forecasting capabilities that incorporate representations of the uncertainties associated with different weather phenomenon for different planning horizons. This should be included in the research recommended in Section 6 B, translating weather into ATM impacts.

FAA Response: We concur. The FAA is developing weather impact forecasts as part of the development of the 4-D Weather Data Cube concept and the use of probabilistic forecasts. In the FY 2009 budget submission, plans for weather impact forecasts are included as part of weather integration into ATM in NextGen Collaborative Air Traffic Management.

Recommendation (page 24): Develop Adaptive ATM/TFM Procedures.

Develop TFM procedures that are adaptive, and that take advantage of changes in uncertainty over time. These procedures should incorporate distributed work strategies that match the locus of control for a specific decision with the person or group that has access to the knowledge, data, motivation and tools necessary to effectively make that decision. Such adaptive procedures require an integrated approach to strategic planning and tactical adaptation.

FAA Response: We concur. Adaptive ATM/TFM procedures have been identified as a necessary step to NextGen. A task has been submitted in the FY 2009 budget request for this effort. Included in the Collaborative Air Traffic Management (CATM) solution set of the OEP, one of the key benefits is that decision makers will have more information about relevant issues, and improved automation tools. Decisions will be made more quickly, required lead times for implementation will be reduced, responses will be more specific, and solutions will be more flexible to change.

Recommendation (page 24): Manage at the Flight Level.

Take advantage of trajectory-based management so that control actions and their impacts can be more directly and precisely localized at the points in the system where they are required to deal with a given scenario. In particular, this means that tools and procedures need to be developed to adaptively manage at the flight level instead of traffic flows, and that the air traffic management user does not need detailed meteorology experience.

FAA Response: We concur. The execution of “tactical ATM procedures” for weather avoidance will be supported by enhancements in the En route Automation Modernization (ERAM)/TFM evolution, namely, the receipt by ERAM of flow-constrained area definitions from TFM and the receipt and execution by ERAM of aircraft-specific reroutes from TFM. In En Route, Traffic Flow Management will send flow-constrained area definitions and reroutes, which will be used by automation. With automation executing aircraft specific reroutes, procedures and training will be developed to ensure controllers do not override automated decisions. This capability is a candidate for future ERAM releases. Also further research into tactical reroutes calculated by
En Route automation is in the concept exploration phase by Mitre Inc.

For NextGen, trajectory management is an integral part of trajectory-based operations along with trajectory planning and execution and is addressed in the FAA’s FY 2009 budget submission NextGen – Trajectory-Based Operations. Any effective decision making must involve the pilot, thus AVS will be part of the process to define the research.

Recommendation (page 24): Translate weather information and forecasts to parameters relevant to decision support tools.

Develop decision support tools that translate the implications of probabilistic weather forecasts into the decision parameters that are relevant to the application of particular TFM procedures and in a way that the air traffic management user does not require significant meteorological training.

FAA Response: We concur. The Reduce Weather Impact solution set plans to develop objectively indexed weather information (observations and forecasts) that can be translated into impacts on specific aircraft types and configurations.

Recommendation (page 25): Develop human-centered designs.

Develop human-centered designs for these decision support tools that enable their users to understand the current state of the relevant parts of the NAS, and that support these users in understanding the basis and implications of recommendations generated by their decision support tools that automatically generate options for users to consider.

FAA Response: We concur. We recognize the need to look at human factors issues around automated decision making for weather situations and the importance of pilot, controller, and dispatcher decisions and capabilities. As part of human centered design research, human factors researchers are developing guidance on displays and techniques as part of the FY 2009 budget submission.

Recommendation (page 25): Develop tools and automation enabling operations and implementation.

Develop computer-supported communication tools and automated decision support tools that enable effective coordination and collaboration in this distributed work system, and that enable timely implementation of the decisions that are made.

FAA Response: We concur. Development and implementation of tools and automation enabling operations is an expected outcome of the FAA's FY 2009 Collaborative Air Traffic Management (CATM) investments and pre-implementation engineering. Any effective decision making must involve the pilot, thus AVS will be part of the process to define the research. Additionally, as part of human centered design research, human factors will evaluate and develop guidance on automation tools used by pilots, dispatchers, and ATM.

G. Weather Impacts and Tactical Trajectory Management

Recommendation (page 25): Implement Tactical Trajectory Management with integrated weather information.

Develop a highly automated advanced Tactical Trajectory Management (TTM) decision support capability integrated with convective weather and turbulence to decrease controller and pilot workload, and increase safety. This would be a mostly automated system. This capability would assist the controller in a shared severe weather separation responsibility with the pilot.

FAA Response: We concur. Tactical Trajectory Management has been identified as a necessary step to NextGen and is included in the FY 2009 budget request under the CATM solution set. The FAA will determine weather information required for embedded decision-making in flow related operations. CATM covers both strategic and tactical interactions with the users—whether airborne or on the ground. Also in the CATM, major activities will include defining approaches to truly integrating weather into strategic flow decision support tools. Under New ATM Requirements in the FY 2009 budget submission research will develop requirements to integrate weather data into automated trajectory management system.

Recommendation (page 26): Investigate the human factors issues (communication, information display, safety nets, cognitive complexity, and mental workload) associated with new paradigms for tactical trajectory management.

FAA Response: We concur. The FAA recognizes the importance of human factors in assessing new paradigms for tactical trajectory management. Tactical trajectory management decisions involve the pilot, dispatchers, and ATM; thus, the FAA will develop a coordinated research program in this area.

The FAA plans new research to:

- Conduct an analysis of human performance benefits in terms of safety and capacity when using enhanced weather products, such as storm movement and turbulence, at the en route controller's workstation; and
- Assess communication and display issues in use of NextGen weather information supporting collaborative ATM.

H. Airspace Designs for Weather Impacts

Recommendation (page 27): Airspace designs should enable route flexibility during adverse weather conditions.

If the vision of 4D trajectories is to become a reality, the airspace must be designed to support seamless adjustments of the route of flight in all four dimensions, as required by weather impacts.

The development of ATM decision support tools must be done jointly with the weather research community so that decisions will adequately address impacts of adverse weather. Foundational efforts that reach across the disciplines of airspace design, weather translation into ATM impact and ATM decision support are required to achieve effective integration.

FAA Response: We concur. Airspace design has been identified as a necessary early step to NextGen. We recognize that en route and terminal automation capabilities and project plans will require re-engineering to support new airspace design. The FY 2009 budget submission includes in the CATM solution set, weather integration into ATM and will include development of methods to adjust TFM/TMI needs as weather conditions evolve.

Recommendation (page 27): Investigate the human factors issues associated with the dynamic reconfiguration of airspace, including issues associated with information display, training, and cognitive complexity.

FAA Response: We concur. Human factors associated with dynamic reconfiguration of airspace are addressed in the FAA's FY 2009 budget submission under NextGen CATM. Included in this research is analysis of human performance benefits in terms of safety and capacity when using enhanced weather products, such as storm movement and turbulence, at the en route controller's workstation and developing guidance on displays and techniques.

IOC Post 2015

I. Advanced Weather ATM Integration Concepts

Recommendation (page 28): Develop methods which combine the use of both probabilistic and deterministic forecasts and observations, to maximize throughput using multiple dynamic flight lanes or "tubes" in weather impacted areas.

FAA Response: We concur. The FAA is collaborating with NASA on use of dynamic flight lanes. The "Reduce Weather Impact" solution set will determine how probabilistic weather forecasts and other probabilistic weather information can be developed for use by NAS decision makers. As both research areas mature they can be developed into an integrated capability.

Recommendation (page 29): Develop methods to transition from a probabilistic trajectory or flight envelope to a 4D trajectory which is useable for separation and safety assurance. Establish an independent bi-annual review of this work to determine the potential benefits and costs to aviation.

FAA Response: We concur. The FAA is collaborating with NASA on research in this area. Trajectory based operations are addressed in the NextGen – Trajectory Based Operations solution set of the OEP. The OEP and JPDO will be reviewing progress and anticipate future review by REDAC.

Recommendation (page 29): Conduct research into replacement of surrogate weather indicators such as radar reflectivity with reflectivity with actual indicators such as turbulence, icing, lightning, or wind shear, and an estimate of ATM impact. For example, radar reflectivity can be translated into ATM impact by estimated airspace pilots will avoid and the associated airspace capacity loss.

FAA Response: We concur. FAA has some work underway and is planning FY 2008 research with MIT/ Lincoln Labs on the translation of convective weather impacts into ATC impacts. However, additional work to translate weather into ATC impacts will be required.

Recommendation (page 29): Develop methods to use gridded and scenario based probabilistic weather data for ATM decision making.

Develop methods to translate deterministic and probabilistic convective forecasts to ATM impact for use in network based capacity estimate models.

Determine the reduction in capacity of an airspace region due to convective weather using a network model.

FAA Response: We concur. The Reduce Weather Impact solution set will determine how probabilistic weather forecasts and other probabilistic weather information can be developed for use by NAS decision makers. As both research areas mature, they can be developed into an integrated capability. The CATM solution set plans to use gridded and scenario based probabilistic weather data for ATM decision making.

Recommendation (page 30): Investigate the human factors issues associated with the integration of such probabilistic modeling into decision support tools.

FAA Response: We concur. Examples of human/system integration research associated with the integration of probabilistic modeling into decision support tools planned in the FY 2009 budget submission will include:

- Identifying requirements for collaborative ATM in use of probabilistic weather information by pilots and controllers;
- Completing a preliminary cognitive task analysis supporting common information between pilots and controllers in use of probabilistic weather information; and
- Developing guidance to the weather program to enhance usability of forecasting products for pilot decision making.

Human Factors Considerations for Integrated Tools

Recommendation (page 31): Develop advanced information sharing and display concepts for the design of integrated decision-support tools.

Develop strategies for information representation and display that enable people to maintain situation awareness regarding weather and traffic impacts, develop shared mental models, and evaluate inputs to the decision process provided by technology.

Of particular importance is the need to conduct research on strategies for representing, integrating and displaying probabilistic information about uncertainty regarding weather and traffic constraints and its predicted impacts as a function of look-ahead time. Equally important is the need to research new strategies for risk management that make use of such information. Research on the effective use of probabilistic information by ATC, TFM and FOCs is a major challenge that needs to commence in the near term in order to obtain short term benefits and to enable more powerful solutions in the longer term. This research needs to consider human factors as well as technology development challenges.

FAA Response: We concur. Examples of Human Factors research included in the FY 2009 budget submission are:

- Developing standards and guidance for design approval of weather decision support for cockpit use including integration of weather information with existing Communication-Navigation-Surveillance/ATM information on multi-function displays;
- Conducting an analysis of human performance benefits in terms of safety and capacity when using enhanced weather products, such as storm movement and turbulence, at the en route controller's workstation; and
- Conducting an air-ground integration simulation regarding improved weather products at the controller workstation and in the cockpit to enhance safety and capacity in the NAS.

Integrated decision-support tools involve the pilot, dispatchers, and ATM; thus, the FAA will develop a coordinated research plan in this area.

Recommendation (page 31): Develop new approaches and strategies for effective distributed decision making and cooperative problem solving.

Develop effective strategies and technologies (decision support and communication tools) to enable distributed decision making to address the interaction of weather and traffic constraints, and to adaptively respond to situations as they evolve. This requires consideration of cognitive complexity, workload, and the ability of people to develop and maintain necessary levels of skill and expertise. It requires consideration of the need to design a resilient system that provides effective safety nets. And it requires system engineering decisions concerning when to design the system to provide coordination as a result of the completion of independent subtasks and when to design the system to support collaboration in order to ensure that important interactions occur.

Develop technologies that support cooperative problem solving environments that allow people to work interactively with decision support technologies and with each other to assess situations as they develop, and to interactively generate and evaluate potential solutions.

FAA Response: We concur. Examples of Human Factors planned research under the FY 2009 budget submission will include developing methods for effective cooperative use of weather information among pilots, controllers, AOCs/FOCs, and Air Traffic Operation Centers to enhance weather-related safety and efficiency decisions, and conducting an air-ground integration simulation regarding improved weather products at the controller workstation and in the cockpit to enhance safety and capacity in the NAS.

Distributed decision making and cooperative problem solving involves the pilot, dispatchers, and ATM; thus, the FAA will develop a coordinated research plan in this area.

Recommendation (page 32): Develop methods for implementing human-centered designs for decision-support tools.

Develop effective procedures and technologies to ensure effective communication and coordination in the implementation and adaptation of plans in this widely distributed work system that includes meteorologists, traffic managers, controllers, dispatchers, ramp controllers and pilots.

FAA Response: We concur. We recognize the need to look at human factors issues around automated decision making for weather situations and the importance of pilot, controller, and dispatcher decisions and capabilities. As part of human centered design research, human factors researchers are developing guidance on displays and techniques as part of the FY 2009 budget submission. Decision-support tools involve the pilot, dispatchers, and ATM; thus, the FAA will develop a coordinated research plan in this area.

Implications on Air Navigation Service Providers

A. Training on New Integrated Tools

Recommendation (page 33): Proactively enable new training on integrated tools.

The FAA and aviation industry should proactively develop training curricula for controllers, traffic managers, pilots, dispatchers, and weather personnel which cover

- The new roles and responsibilities in the use of supporting technologies.
- The roles, responsibilities and expectations of other decision makers with whom each group must interface.
- The training doctrine, developed in concert with the integrated tools development, leveraging that real-world experience to maximize early benefits and refinements.
- The training cadre, deployed to all major new facilities as the tools are deployed, to both assist in training and to maximize early benefits and identify problems.

The resulting procedures and rules must be translated into controlling documents such as the Federal Air Regulations (FARs), the Airman Information Manual (AIM), Air Traffic Manuals, Flight Manuals, and Aircraft Manuals.

FAA Response: We concur. Two separate components of FY 2009 budget submission support adequate understanding of functions and limitations of automation and decision aids. This will incorporate training of Air Traffic Service Providers (ATSP), pilots, and dispatchers designed to ensure adequate understanding of functions and limitations of automation and decision aids important to ensuring efficiency and effectiveness in different ATSP roles and positions.

B. Best Practices in Weather Mitigation

Recommendation (page 34): Identify best weather practices of air traffic facilities and train these practices system wide.

Identify facilities with superior performance and develop best practices guidance for use by other facilities. Do not limit benchmarking to NAS facilities only. Seek global examples and new visions of innovative weather management techniques.

Develop and train ARTCC and TRACON ATC and TFM staff on "best practices" during the introduction and first five years of all new weather and weather-ATM integrated tools

Establish metrics which compare alternative processes.

FAA Response: We concur. The FAA currently performs an end-of-season review of the collaborative decision making process used by Traffic Flow Management concerning the use of the Collaborative Convective Forecast Product (CCFP).

In the FY 2009 budget submission, the FAA will initiate field research to examine how aviation weather information is used today for collaborative decision making and identify best practices at ATC facilities (En Route, TRACON, ATCT, ATCSCC) and AOC/FOCs.

Implications on Airline and Flight Operation Centers

Recommendation (page 35): Ensure strong industry participation in CDM and NextGen concept development and implementation and consider expanding industry participation on review boards.

Industry must have voice and buy-in to future developments to ensure that internal corporate infrastructure and business systems can support, blend with and interact effectively with the NAS service provider systems.

Joint development of these systems is possibly the key component of a successful future capability

FAA Response: We concur. The FAA strongly encourages industry participation because it is a cornerstone of the Collaborative Decision Making and NextGen development processes. The FAA will continue participation in RTCA, ATMAC, OEP Working Sub-Group, JPDO ANSP, Aircraft, and Weather Working Groups, and other Ad-hoc groups including the CDM Weather Evaluation Team (WET).

Implications on FAA and NextGen Enterprise Architecture

Recommendation (page 36): Ensure that direct ATM automation-weather integration is a key focus of the development of OEP/NAS Enterprise Architecture operational and technical views for the transition to NextGen.

To achieve the capacity and safety goals for NextGen, weather and ATM automation developments must become aligned and focused to define the operational and system views for the evolution to highly automated weather impact analysis and solution-generation system, where the human operators are no longer the "glue" for trajectory level decisions. This is a necessary and fundamental shift from today where weather display and human interpretation is the norm. The resultant operational and technical views must be reflected in the OEP and companion NAS EA in order to enable timely investment decision on deploying these needed integrated automation-weather capabilities. This information must also be (constantly) coordinated with NextGen concept and EA development to ensure consistency.

<u>FAA Response:</u> We concur. Within the OEP is an Impact and Implementation (I&I) office tasked with ensuring that all necessary coordination for NextGen capabilities occurs efficiently and effectively, including weather integration capabilities. ATO Operations Planning has been restructured to better plan and manage the implementation of NextGen. The establishment of the FAA Aviation Weather Office is key to managing the development and integration of weather from the provider of weather information into ATM. The Aviation Weather Office will work closely with the OEP I&I office to facilitate the coordination of weather capabilities from research to field implementation. The integration of weather information into decision support is one of the highest priorities in the Collaborative Air Traffic Management solution set of the OEP and part of the FY 2009 budget submission.

Implications on FAA Aviation Weather Research Program

<u>Recommendation (page 37):</u> Support for the AWRP should be increased beyond previous levels.

Support for the AWRP should be increased to enable further improvements in the 0-8 hour forecast time frame, and to allow the weather research community to enter into joint collaborations with the automation research community in integration of weather information into ATM DSS. Additionally, the FAA ATO-P organization should reexamine the R&D goals for AWRP in light of the needs of NextGen.

Support for the National Ceiling and Visibility Program should be restored. Related efforts to support and benefit individual sectors of the industry should be prioritized and addressed. For example:

1. Development of the Helicopter Emergency Medical Evacuation System (HEMS) tool.
2. Rewriting FAR 121 limitations regarding Ceiling and Visibility such as FAR 121.619 (also know as the “1, 2, 3 Rule” for alternate fuel specifications

<u>FAA Response:</u> Partial concurrence. The FAA supports continuation of the Aviation Weather Research Program. During its existence as the premier national aviation weather research program, it has matured numerous capabilities in operational use today in both government and the private sector, including enhanced models, Web-based flight planning tools, as well as hazardous aviation weather products such as icing, turbulence, convection and ceiling and visibility. Not all of these capabilities meet FAA regulatory standards. While there is a need for continued improvement in science of aviation weather, there is an equally great need to ensure the full integration of scientific developments into operational use and alignment with NextGen.

FAA weather research also supports development of specifications, standards, and other regulatory and guidance materials that will support the development, certification, and operational implementation of such scientific developments.

FAA currently supports both the National Ceiling and Visibility Program and the Helicopter Emergency Medical System tool for their safety and capacity benefits.

However, the FAA does not support rewriting any part of the 14 CFR Part 121 of the Federal Aviation Regulations related to limitations regarding ceiling and visibility. For the specific example mentioned, i.e., Part 121.619 (the 1, 2, 3 rule), alternate fuel specifications, the current rule is safe and the FAA has no data to substantiate a change when destination weather is less than required to meet the rule. FAA recognizes that as advanced weather technologies are implemented into operations, associated rulemaking may be necessary to support the implementation. FAA will continue to work with all stakeholders to identify potential rulemaking requirements as early as possible.

Recommendation (page 38): Conduct research to develop improved methods of sensing turbulence taking advantage of a multi-sensor approach using radar, profilers, anemometers, satellite imagery, GPS, and instrumented aircraft to improve the forecasting and now casting of convective and non-convective turbulence.

FAA Response: We concur. FAA weather in the cockpit research is currently developing standards for the performance of turbulence detection systems. Continued research in this area includes development of guidelines for automatic reporting of turbulence. FAA weather research is developing technology for ground-based detection of turbulence and turbulence forecasting. The FAA is continuing to perform research in this area. The potential to improve turbulence detection by combining aircraft based measurements and auto reporting data with the ground based network will also be examined by the FAA.

APPENDIX E: Alignment of FAA NextGen R&D Programs

This appendix is composed of a set of tables and figures showing how FAA R&D supports NextGen. The FAA NextGen R&D programs are a subset of the FAA R&D goals, targets, and milestones listed in Chapter 2. This appendix describes how the NextGen R&D milestones support the mid-term Operational Improvements (OIs) in the *FAA's NextGen Implementation Plan* (*NGIP*) and the far-term OIs in the *JPDO Next Generation Air Transportation System Integrated Work Plan: A Functional Outline* (*IWP*)[1] in eight of the ten FAA R&D goals. In the 2009 portfolio, two goals, Human Protection and Safe Aerospace Vehicles, are focused on near-term agency needs and are not supported by any of the NextGen R&D programs. In many cases, an FAA NextGen R&D milestone supports more than one NextGen capability or OI and more than one solution set. There is one solution set, Transform Facilities, that has no NARP NextGen R&D milestones mapped to it since the solution set has matured beyond the research phase.

There is a table for each FAA R&D goal. The table provides detailed information about the NextGen mapping for those OIs supported by one or more of the FAA NextGen R&D milestones. Although, as shown, the NARP NextGen R&D milestones support a relatively small number of mid-term OIs from the *NGIP*, the same R&D milestones support a much larger set of the far-term OIs from the *IWP*. As mentioned in Chapter 3, this is not unexpected. The bulk of the R&D funding for NextGen will not start until FY09. Given the substantial lead time (5-10 years) required to complete the R&D milestones before they can contribute to implementing new capabilities, the R&D planned to start in FY09 will not be completed in time to impact the mid-term (2012-2018) OIs in the *NGIP*. However, in the far-term, there is significant mapping between the FAA NextGen R&D milestones and the OIs in the *IWP*. The *IWP* itself is aligned with the mid-term *NGIP*.

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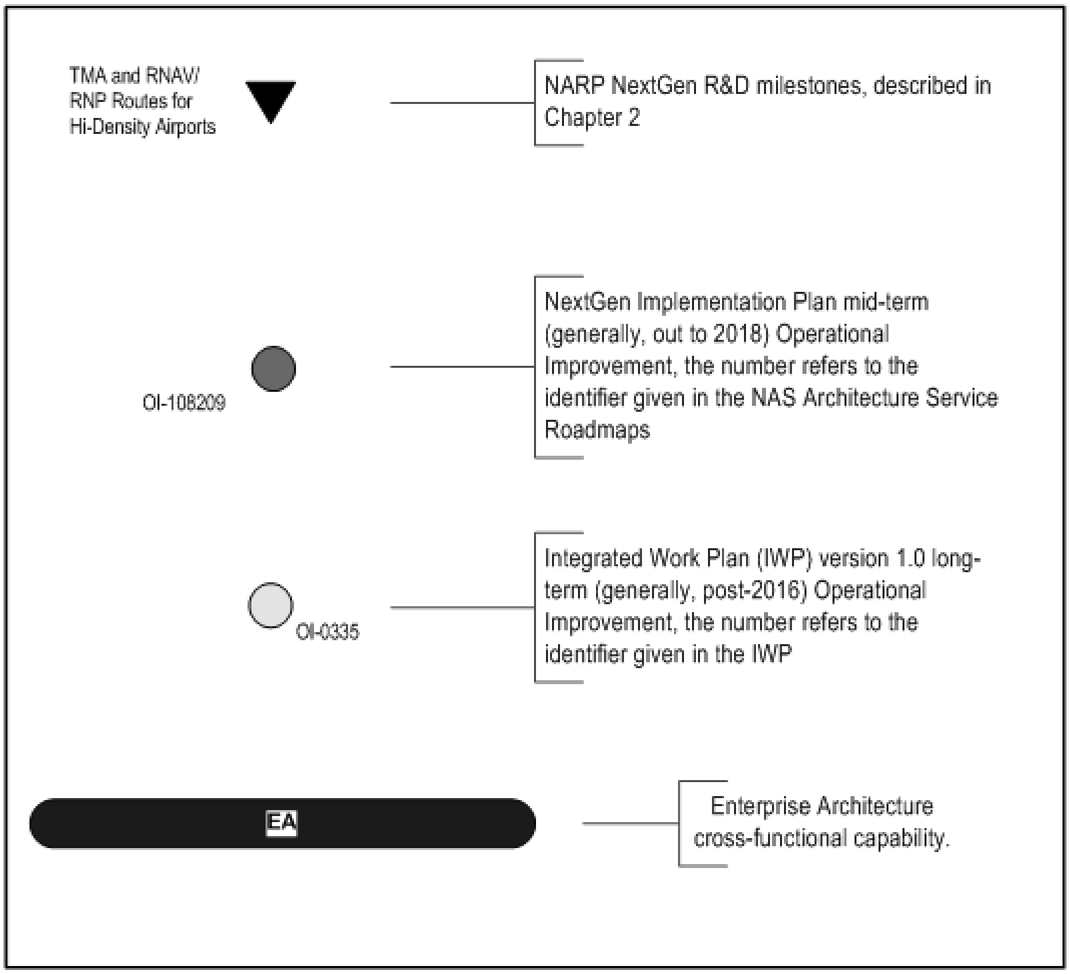
[1] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Work Plan: A Functional Outline* (http://www.jpdo.gov/iwp.asp).

The following key for the tables is provided to help the reader under the content within these mapping tables.



Mapping of NARP NextGen R&D Milestones

Following is the key to the solution set names used in this appendix:

TBO	Initiate Trajectory Based Operations
HD	Increase Arrivals/Departures at High Density Airports
FLEX	Increase Flexibility in the Terminal Environment
CATM	Improve Collaborative ATM
RWI	Reduce Weather Impact
SSE (Safety)	Increase Safety, Security, and Environmental Performance, Safety subset
SSE (E)	Increase Safety, Security, and Environmental Performance, Environmental Performance subset

<table>
<tr><td colspan="5">NARP R&D Goal</td></tr>
<tr><td colspan="5">2.1 - Fast, Flexible, and Efficient: A system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs.</td></tr>
<tr><td colspan="5">NARP R&D Target</td></tr>
<tr><td colspan="5">By 2016, demonstrate that the system can handle growth in demand up to 3 times current levels while reducing gate-to-gate transmit time by 30 percent.</td></tr>
<tr><td>NARP Activity Group</td><td>Year</td><td>NARP Milestone</td><td>NextGen Impl. Plan Solution Set OIs</td><td>IWP Far-term OIs (Post-2016)</td></tr>
<tr><td rowspan="2">Activity 1.1: Demonstrate super density operations.</td><td>2009</td><td>Demonstrate the addition of convective weather (current and forecast) into Traffic Management Advisor (TMA) to increase throughput and efficiency for large, super density airports (NextGen Demonstrations and Infrastructure Development).</td><td>N/A</td><td>Net-Enabled Common Weather Information - Level 2 (2021, IOC: 2018); Net-Enabled Common Weather Information - Level 3 Full NextGen (2022, IOC: 2022).</td></tr>
<tr><td>2010</td><td>Demonstrate greater throughput in congested, domestic, en route airspace using point-in-space metering linked to RNAV/RNP routes (NextGen Demonstrations and Infrastructure Development).</td><td>HD: Time Based Metering using RNAV and RNP Route Assignments (104123)</td><td>Trajectory-based Management Level 2 (0358, IOC: 2018); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="4">Activity 1.2: Demonstrate trajectory-based operations.</td><td rowspan="2">2009</td><td rowspan="2">Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication (NextGen Demonstrations and Infrastructure Development).</td><td>TBO: Automation Support for Mixed Environments (102137).</td><td rowspan="2">N/A</td></tr>
<tr><td>HD: Time Based Metering using RNAV and RNP Route Assignments (104123).</td></tr>
<tr><td>2011</td><td>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 (NextGen Demonstrations and Infrastructure Development).</td><td>TBO: Automation Support for Mixed Environments (102137).</td><td>Delegated Separation - Pair-wise Maneuvers (0356, IOC: 2022); Trajectory-based Management Level 2 (0358, IOC: 2018); Delegated Separation - Oceanic (0359, IOC: 2022).</td></tr>
<tr><td>2013</td><td>Demonstrate trajectory-based operations in mixed-equipage, high altitude airspace with actual aircraft and procedures (NextGen Demonstrations and Infrastructure Development).</td><td>N/A</td><td>Trajectory-based Management Level 2 (0358, IOC: 2018); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).</td></tr>
</table>

NARP R&D Goal				
2.1 - Fast, Flexible, and Efficient: A system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post-2016)
Activity 1.2: (continued)	2015	Demonstrate auto-negotiations between flight automation and ground automation without human initiation (NextGen Demonstrations and Infrastructure Development).		
Activity 3: Separation Standards	2009	Develop and simulate separation procedures that vary according to aircraft capability and pilot training (NextGen Demonstrations and Infrastructure Development).	TBO: Delegated Responsibility for Separation (102118); Automation Support for Mixed Environments (102137).	Delegated Separation - Pair-wise Maneuvers (0356, IOC: 2022); Delegated Separation - Oceanic (0359, IOC: 2022); Delegated Separation - Complex Procedures (0363, IOC: 2025).
Activity 4: Wake Turbulence	2010	Determine pilot and air navigation service provider (ANSP) situational aircraft separation display concepts required for implementation of the NextGen "Trajectory Based Operation" and "High Density" concepts (Wake Turbulence[NG]).	TBO: Reduced Horizontal Separation Standards - 3 mi. (102117); Delegated Responsibility for Separation (102118); NextGen Oceanic Procedures (102136). HD: Improved Operations to Closely Spaced Parallel Runways (102141); Wake Vortex Incorporated into Flow (102142).	Reduce Separation in High Density terminal <3 mi (0348, IOC: 2025); Integrated Arrival/Departure and Surface Traffic Management (0331, IOC: 2018); Independent Parallel or Converging Approaches in IMC (0334, IOC: 2017); Dependent Multiple Approaches in IMC (0335, IOC: 2017); WTMD: Wind-Based Wake Procedures - Dynamic Wind Procedures (0402, IOC: 2018); Wake Turbulence Mitigation for Arrivals - Dynamic Wind Procedures (0403, IOC: 2020); Efficient Metroplex Merging and Spacing (0338, IOC: 2018); Integrated Arrival/Departure and Surface Traffic Management for Metroplex (0339, IOC: 2022); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).
	2011	Refine the boundaries of the current 6 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).		

[NG] The Wake Turbulence Program contains funding for both core research and NextGen research. Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the core program resources.

NARP R&D Goal				
2.1 - Fast, Flexible, and Efficient: A system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post-2016)
Activity 4 (continued)	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 (Wake Turbulence[NG]).	N/A	
	2013	Complete development of ANSP wake separation standards that better use aircraft flight characteristics and information concerning surrounding weather conditions (NextGen - Wake Turbulence – Re-categorization).		
	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).		

[NG] The Wake Turbulence Program contains funding for both core research and NextGen research. Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the core program resources.

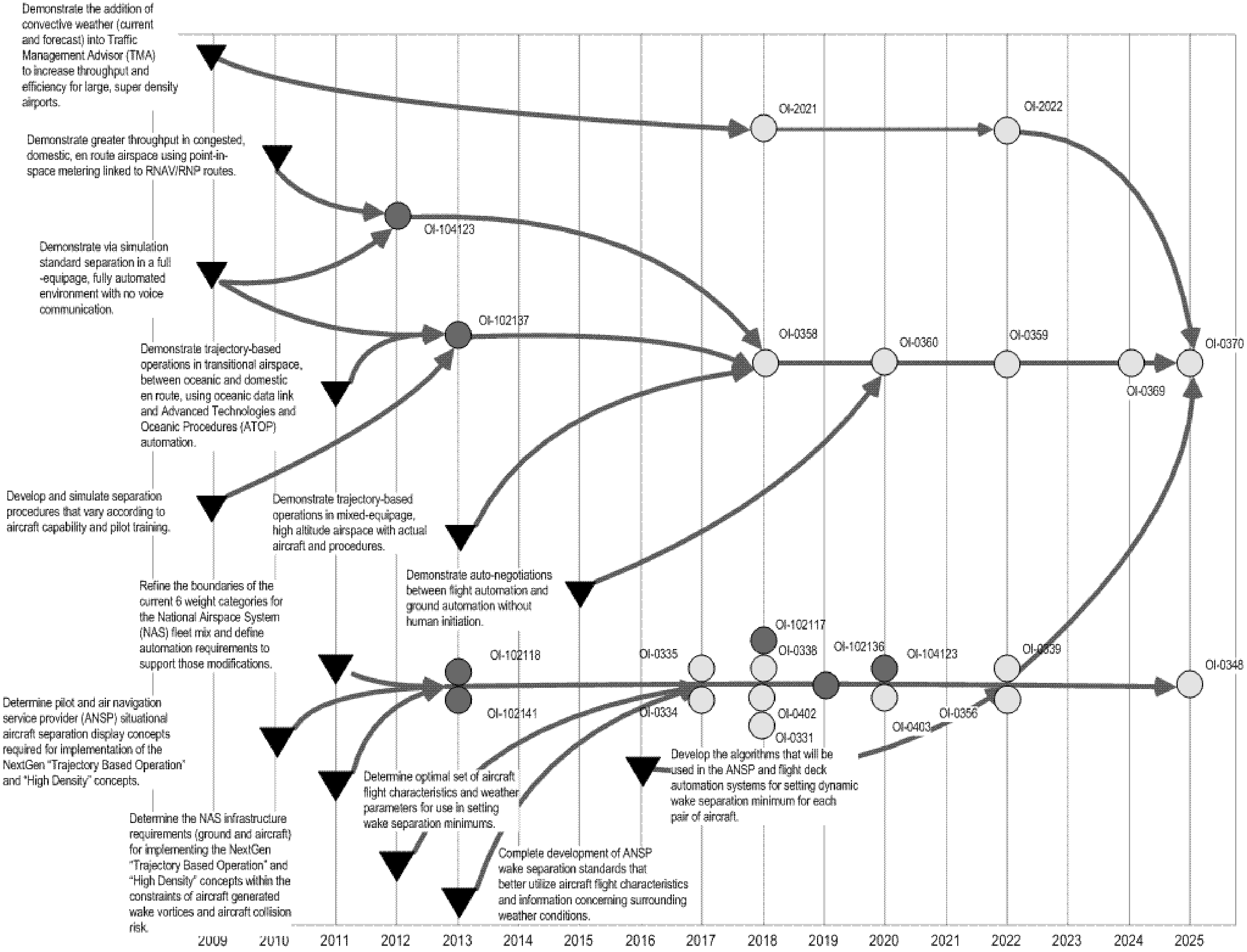


Figure E-1: Goal 2.1 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal				
2.2 - Clean and Quiet: A reduction of significant aerospace environmental impacts in absolute terms.				
NARP R&D Target				
By 2016, demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (to enable three times capacity) in a cost-effective way, and reduce uncertainties in particulate matter and climate impacts to levels that enable appropriate action.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 1. Measure current level of aviation related noise and emissions.	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).	SSE (E): National EMS Supports Integrated Environmental Performance; NGATS [NEXTGEN] Operational Initiatives that Reduce Environmental Impacts (FAA Enterprise Architecture).	Environmental Management System (EMS) Framework Level 2 (6020, IOC: 2018); Implement NextGen Environmental Engine and Aircraft Technologies - Level 2 (6023, IOC 2021)
	2012	Expand noise data collection to very light jets and supersonic aircraft (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics).		
Activity 2. Determine acceptable levels of noise and emissions.	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).	SSE (E): National EMS Supports Integrated Environmental Performance; NGATS [NEXTGEN] Operational Initiatives that Reduce Environmental Impacts (FAA Enterprise Architecture).	Implement NextGen Environmental Engine and Aircraft Technologies - Level 2 (6023, IOC 2021); Implement EMS Framework - Level 2 – (6020, IOC 2018)
	2011	Determine how aviation generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics).		

NARP R&D Goal				
2.2 - Clean and Quiet: A reduction of significant aerospace environmental impacts in absolute terms.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 3. Develop models to predict the impact and benefits of changes.	2011	Complete development of first generation ground plume model for aircraft engine exhaust (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics).	SSE (E): National EMS Supports Integrated Environmental Performance; NGATS [NEXTGEN] Operational Initiatives that Reduce Environmental Impacts (FAA Enterprise Architecture).	Implement EMS Framework - Level 2 – (6020, IOC 2018)
	2014	Update environmental assessments models to incorporate new noise metrics (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics).		
Activity 4. Develop noise and emission reduction methods.	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).	N/A	Environmental Management System (EMS) Framework Level 2 (6020, IOC: 2018); Trajectory-based Management Level 2 (0358, IOC: 2018); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).
	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).	SSE (E): National EMS Supports Integrated Environmental Performance; NGATS [NEXTGEN] Operational Initiatives that Reduce Environmental Impacts (FAA Enterprise Architecture).	Environmentally and Energy Favorable En Route Operations - Level 2 (6022, IOC 2020); Implement NextGen Environmental Engine and Aircraft Technologies - Level 2 (6023, IOC 2021)
	2012	Identify and pursue the development of engine and airframe technologies that will be the most effective at producing environmental benefits (NextGen - Environmental and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction).		

NARP R&D Goal				
2.2 - Clean and Quiet: A reduction of significant aerospace environmental impacts in absolute terms.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 4 (continued)	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 - Environmental and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction).	N/A	Trajectory-based Management Level 2 (0358, IOC: 2018); Environmentally and Energy Favorable Terminal Operations - Level 2 (6021, IOC 2020); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020);Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).
	2013	Establish engine design sensitivities by measuring particles emitted from combustor engine systems (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics).	SSE (E): National EMS Supports Integrated Environmental Performance; NGATS [NEXTGEN] Operational Initiatives that Reduce Environmental Impacts (FAA Enterprise Architecture).	Environmentally and Energy Favorable En Route Operations - Level 2 (6022, IOC 2020); Implement NextGen Environmental Engine and Aircraft Technologies - Level 2 (6023, IOC 2021)
	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 - Environmental and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction).	N/A	Environmentally and Energy Favorable En Route Operations - Level 2 (6022, IOC 2020); Environmental Management System (EMS) Framework Level 2 (6020, IOC: 2018); Trajectory-based Management Level 2 (0358, IOC: 2018); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).

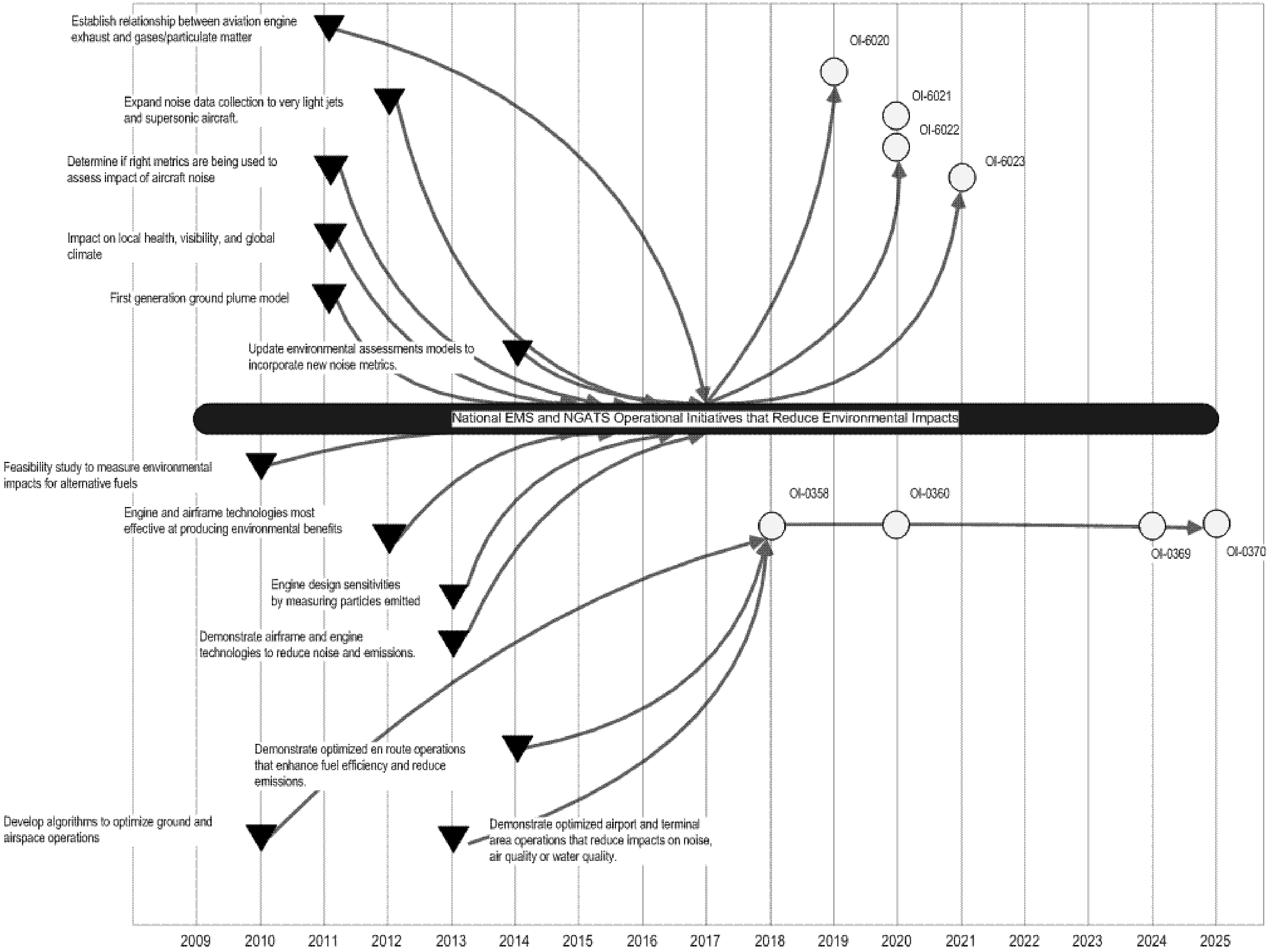


Figure E-2: Goal 2.2 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal

2.3 - High Quality Teams and Individuals - The best qualified and trained workforce in the world.

NARP R&D Target

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

NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 2. 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.	2010	Define anticipated ANSP workload reductions due to implementation of data communications (NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).	TBO: Expanded Conflict Resolution via Data Communications (104105). HD: Use Data Messaging to Provide Flow and Taxi Assignments (104208).	Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).
	2010	Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	HD: Integrated Arrival/Departure Airspace Management (104122); Time Based Metering using RNAV and RNP Route Assignments (104123).	Independent Parallel or Converging Approaches in IMC (0334, IOC: 2017); Dependent Multiple Approaches in IMC (0335, IOC: 2017); WTMD: Wind-Based Wake Procedures - Dynamic Wind Procedures (0402, IOC: 2018); Wake Turbulence Mitigation for Arrivals - Dynamic Wind Procedures (0403, IOC: 2020); Efficient Metroplex Merging and Spacing (0338, IOC: 2018).
	2013	Redefine ANSP roles in a strategic air traffic environment for en route and terminal domains (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	N/A	Delegated Separation - Complex Procedures (0363, IOC: 2025).
	2013	Demonstrate collaborative air traffic management efficiencies enabled by common situation awareness between flight operators and ANSP (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	CATM: Full Collaborative Decision Making (105207).	

NARP R&D Goal				
2.3 - High Quality Teams and Individuals - The best qualified and trained workforce in the world.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 2 (continued)	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 (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	TBO: Flexible Airspace Management (108206). CATM: Manage Airspace as Trajectories (102302).	Independent Parallel or Converging Approaches in IMC (0334, IOC: 2017); Dependent Multiple Approaches in IMC (0335, IOC: 2017); WTMD: Wind-Based Wake Procedures - Dynamic Wind Procedures (0402, IOC: 2018); Wake Turbulence Mitigation for Arrivals - Dynamic Wind Procedures (0403, IOC: 2020); Efficient Metroplex Merging and Spacing (0338, IOC: 2018).
	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 (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	CATM: Full Collaborative Decision Making (105207).	Independent Parallel or Converging Approaches in IMC (0334, IOC: 2017); Dependent Multiple Approaches in IMC (0335, IOC: 2017); WTMD: Wind-Based Wake Procedures - Dynamic Wind Procedures (0402, IOC: 2018); Wake Turbulence Mitigation for Arrivals - Dynamic Wind Procedures (0403, IOC: 2020); Efficient Metroplex Merging and Spacing (0338, IOC: 2018).
	2016	Redefine the ANSP role in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur (NextGen - Air Traffic Control/Operations Human Factors - Controller Efficiency).	N/A	Delegated Separation - Complex Procedures (0363, IOC: 2025).

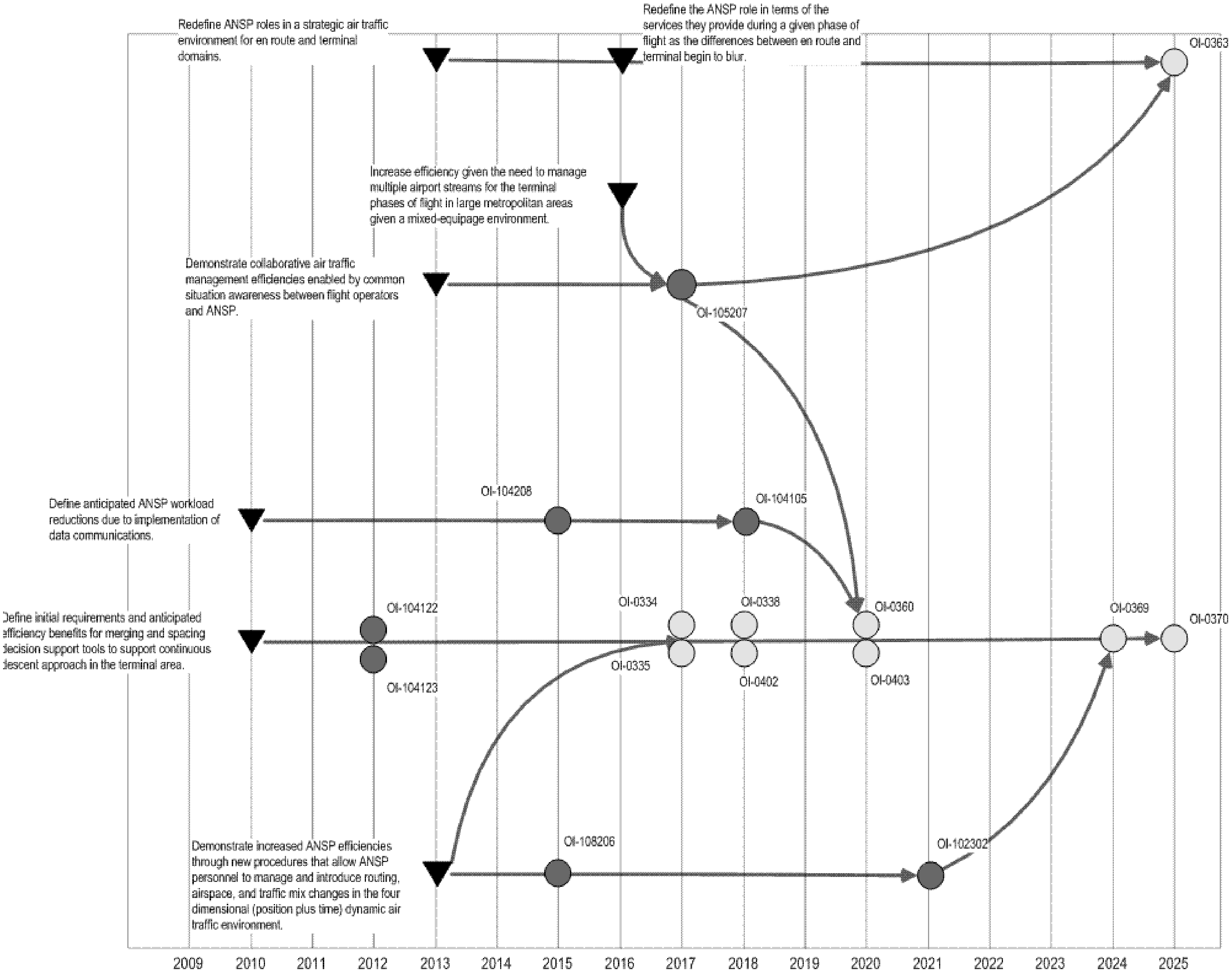


Figure E-3: Goal 2.3 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal

2.4 - Human-centered Design: Aerospace systems that adapt to, compensate for, and augment the performance of the human.

NARP 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.

NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 1. Define the changes in roles and responsibilities between pilots and controllers and between humans and automation required to implement NextGen.	2010	Develop initial taxonomy describing the relationship between human pilots/ATC and associated automated systems (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).	N/A	Delegated Separation - Pair-wise Maneuvers (0356, IOC: 2022); Trajectory-based Management Level 2 (0358, IOC: 2018); Delegated Separation - Oceanic (0359, IOC: 2022); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Self-separation Airspace (0362, IOC: 2022); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).
	2012	Complete initial research to evaluate and recommend pilot-ATC procedures for negotiations and shared decision making NextGen activities (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).	TBO: Delegated Responsibility for Separation (102118); NextGen Oceanic Procedures (102136); Tactical Trajectory Management (104121).	
	2015	Complete research to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).	HD: Full Surface Traffic Management with Conformance Monitoring (104206). CATM: Full Collaborative Decision Making (105207).	
Activity 2. 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).	N/A	Trajectory-based Management Level 2 (0358, IOC: 2018)
	2011	Initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations (NextGen Air Ground Integration).		

NARP R&D Goal				
NARP R&D Goal				
2.4 - Human-centered Design: Aerospace systems that adapt to, compensate for, and augment the performance of the human.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 2 (continued)	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).		
	2015	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).		
Activity 3. Develop and apply error management strategies, mitigate risk factors, and reduce automation-related errors.	2012	Complete research to develop methods to mitigate mode errors in use of NextGen equipment (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).	N/A	N/A
	2013	Develop initial guidance on training methods to support detection and correction of human errors in near- to mid-term NextGen procedures (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).		
	2015	Complete research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency and Air Ground Integration).		

<table>
<tr><th colspan="5">NARP R&D Goal</th></tr>
<tr><td colspan="5">2.4 - Human-centered Design: Aerospace systems that adapt to, compensate for, and augment the performance of the human.</td></tr>
<tr><td>NARP Activity Group</td><td>Year</td><td>NARP Milestone</td><td>NextGen Impl. Plan Solution Set OIs</td><td>IWP Far-term OIs (Post 2016)</td></tr>
<tr><td rowspan="4">Activity 4. Conduct incremental and full mission demonstrations to increase the likelihood of successful implementation of research results.</td><td rowspan="2">2013</td><td rowspan="2">Demonstrate the transition of self-separation responsibility to pilots (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Operations Human Factors - Air/Ground Integration).</td><td>TBO: Delegated Responsibility for Separation (102118); NextGen Oceanic Procedures (102136); Tactical Trajectory Management (104121).</td><td rowspan="4">Delegated Separation - Pair-wise Maneuvers (0356, IOC: 2022); Trajectory-based Management Level 2 (0358, IOC: 2018); Delegated Separation - Oceanic (0359, IOC: 2022); Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Self-separation Airspace (0362, IOC: 2022); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).</td></tr>
<tr><td rowspan="2">HD: Full Surface Traffic Management with Conformance Monitoring (104206).</td></tr>
<tr><td rowspan="2">2015</td><td rowspan="2">Functional demonstration – demonstrate integrated pilot and controller functional capabilities (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Operations Human Factors - Air/Ground Integration).</td></tr>
<tr><td>CATM: Full Collaborative Decision Making (105207).</td></tr>
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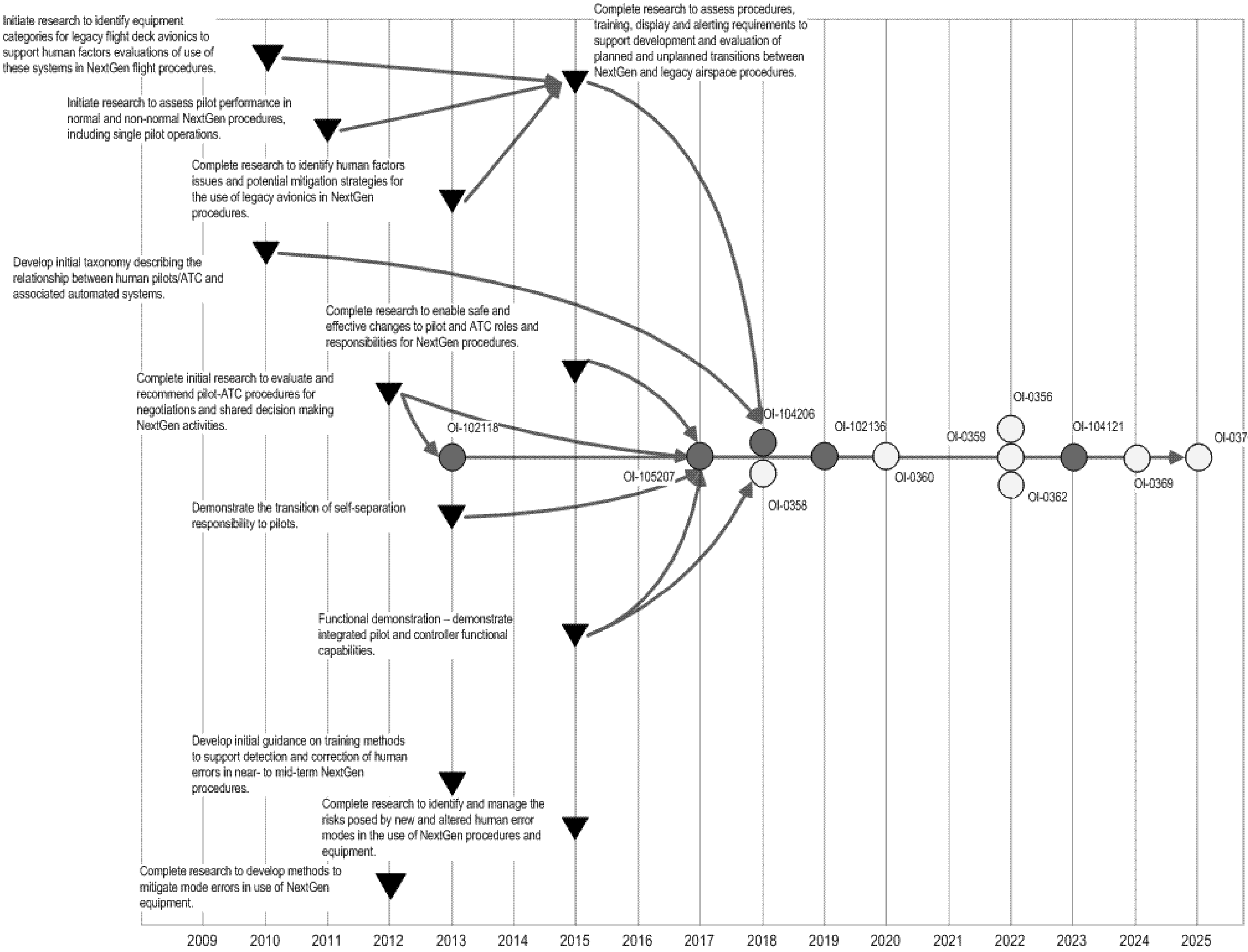
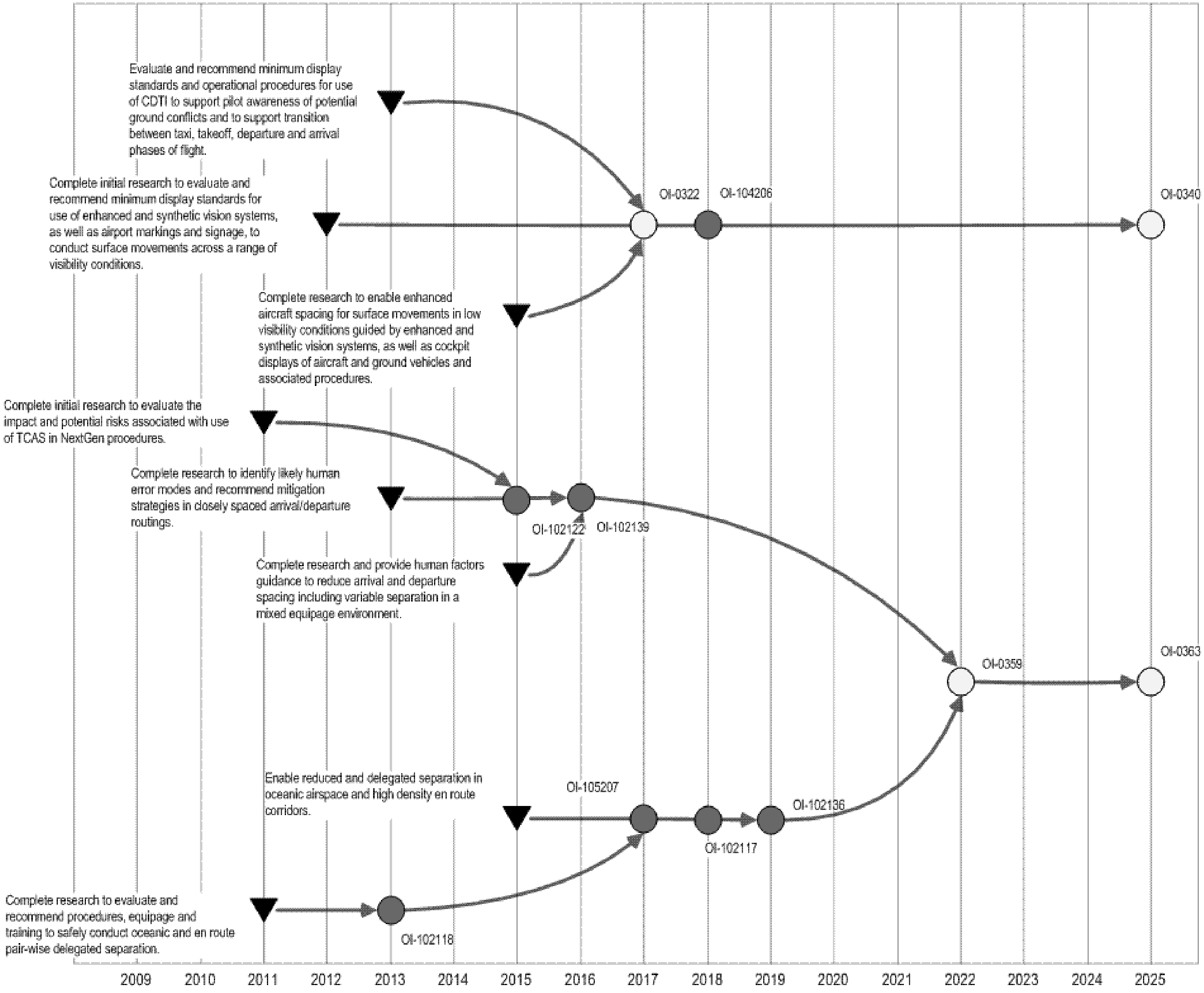


Figure E-4: Goal 2.4 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal				
2.7 - Self-Separation - No accidents and incidents due to aerospace vehicle operations in the air and on the ground.				
NARP R&D Target				
By 2016, develop initial standards and procedures for self-separation.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 1. Level 1 - Surface/runway operations awareness.	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 (NextGen - Self Separation).	HD: Full Surface Traffic Management with Conformance Monitoring (104206).	Low-Visibility Surface Operations (0322, IOC: 2017); Near-Zero-Visibility Surface Operations (0340, IOC: 2025).
	2013	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, departure and arrival phases of flight (NextGen - Self Separation).		
	2015	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 (NextGen - Self Separation).		
Activity 2. Level 2 - Reduced separation	2011	Complete initial research to evaluate the impact and potential risks associated with use of TCAS in NextGen procedures (NextGen - Self Separation).	TBO: Use Aircraft-provided Intent Data to Improve Conflict Resolution (102122).	N/A
	2013	Complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings (NextGen - Self Separation).	HD: Use Aircraft-provided Intent Data to Improve Flow and Conflict Resolution (102139).	Delegated Separation – Oceanic (0359, IOC: 2022).
	2015	Complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment (NextGen - Self Separation).		Delegated Separation - Complex Procedures (0363, IOC: 2025).

NARP R&D Goal				
2.7 - Self-Separation - No accidents and incidents due to aerospace vehicle operations in the air and on the ground.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 3. Level 3 - Delegated Separation	2011	Complete research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation (NextGen - Self Separation).	TBO: Reduced Horizontal Separation Standards - 3 mi. (102117); Delegated Responsibility for Separation (102118); NextGen Oceanic Procedures (102136).	Delegated Separation – Oceanic (0359, IOC: 2022).
	2015	Enable reduced and delegated separation in oceanic airspace and high density en route corridors (NextGen - Self Separation).	CATM: Full Collaborative Decision Making (105207).	Delegated Separation - Complex Procedures (0363, IOC: 2025).



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, departure and arrival phases of flight.

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.

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.

Complete initial research to evaluate the impact and potential risks associated with use of TCAS in NextGen procedures.

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

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

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

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

Figure E-5: Goal 2.7 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal				
2.8 - Situational Awareness: Common, accurate, and real-time information of aerospace operations, events, crises, obstacles, and weather.				
NARP R&D Target				
By 2015, demonstrate common real-time awareness of ongoing air operations, events, crisis, and weather at all types of airports by pilots and controllers.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 1.2 - Demonstrate weather in the cockpit: Policy and guidance.	2010	Develop concepts and requirements for the provision, integration, and use of weather information in the cockpit (NextGen - Weather Technology in the Cockpit).	RWI: Full Operational Weather Capability (103121); Automatic Hazardous Weather Alert Notification (103117); Near-real-time dissemination of weather information to all ground and air users (103120).	Net-Enabled Common Weather Information - Level 2 (2021, IOC: 2018); Net-Enabled Common Weather Information - Level 3 Full NextGen (2022, IOC: 2022).
	2010	Simulate and evaluate available cockpit weather technologies (NextGen - Weather Technology in the Cockpit).	CATM: On Demand NAS Information (103305).	
	2012	Develop prototype weather technology in the cockpit capability (NextGen - Weather Technology in the Cockpit).		
	2014	Simulate, test, and evaluate fully-integrated cockpit use of NextGen operational concepts, including WTIC (NextGen - Weather Technology in the Cockpit).		
	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 in the Cockpit).		
	2015	Develop design approval guidance for hardware and software standards, archiving weather data, and operational approval of new products and products from non-government vendors (NextGen - Weather in the Cockpit).		

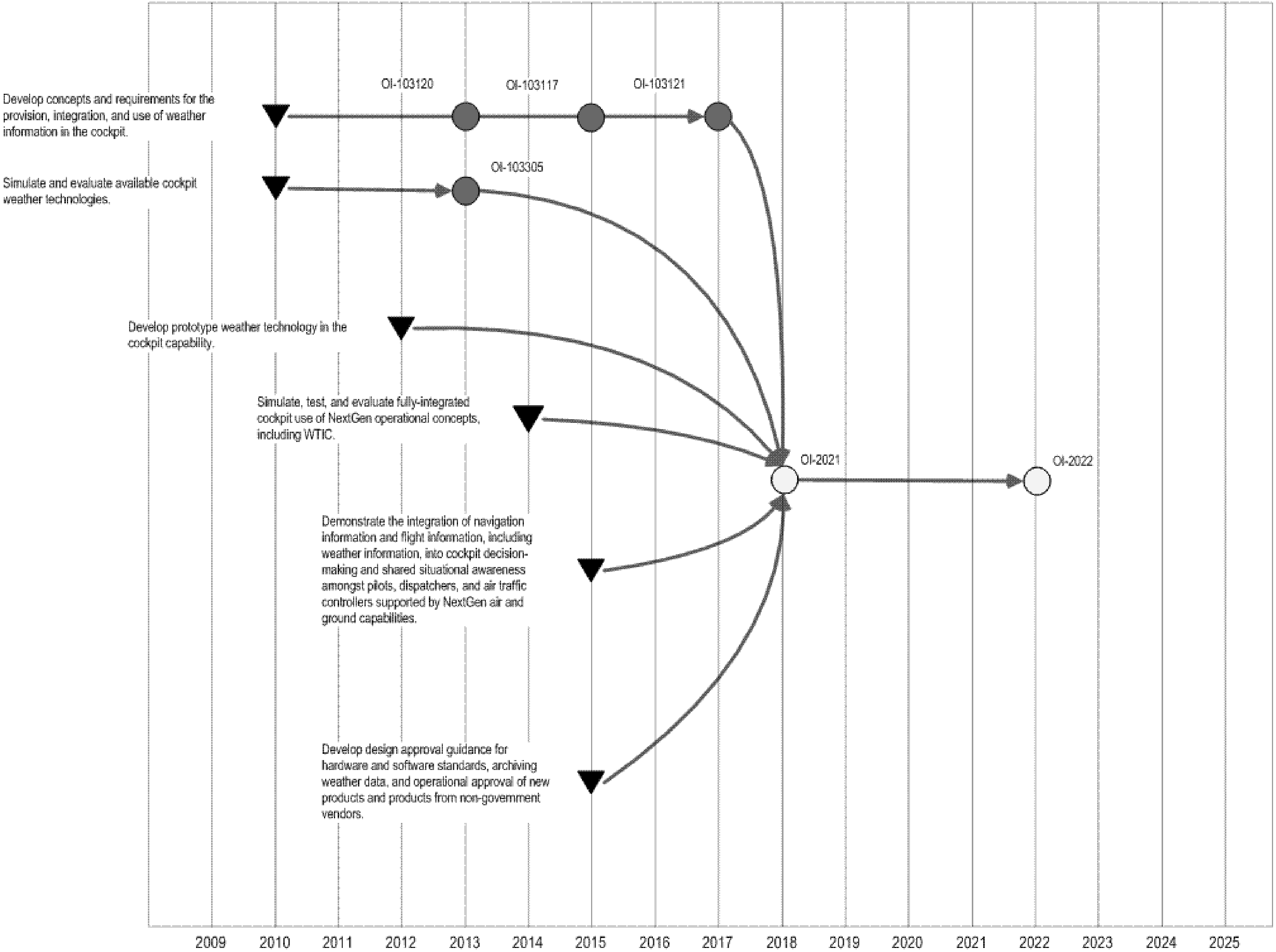

Develop concepts and requirements for the provision, integration, and use of weather information in the cockpit.
OI-103120
OI-103117
OI-103121
Simulate and evaluate available cockpit weather technologies.
OI-103305
Develop prototype weather technology in the cockpit capability.
Simulate, test, and evaluate fully-integrated cockpit use of NextGen operational concepts, including WTIC.
OI-2021
OI-2022
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.
Develop design approval guidance for hardware and software standards, archiving weather data, and operational approval of new products and products from non-government vendors.
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

Figure E-6: Goal 2.8 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

<table>
<tr><td colspan="5">NARP R&D Goal</td></tr>
<tr><td colspan="5">2. 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.</td></tr>
<tr><td colspan="5">NARP R&D Target</td></tr>
<tr><td colspan="5">By 2016 understand economic (including implementation) and operational impact of system alternatives.</td></tr>
<tr><td>NARP Activity Group</td><td>Year</td><td>NARP Milestone</td><td>NextGen Impl. Plan Solution Set OIs</td><td>IWP Far-term OIs (Post-2016)</td></tr>
<tr><td rowspan="3">Activity 1.1 - 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.</td><td>2009</td><td>Evaluate current information protection and assurance models and potential conflicts with privacy and consumer advocacy groups (System Safety Management Transformation).</td><td rowspan="3">SSE (Safety): Aviation Safety Information Analysis and Sharing (FAA Enterprise Architecture).</td><td rowspan="3">Increased Safety Information Sharing and Analysis Scope and Effectiveness (3109, IOC: 2020).</td></tr>
<tr><td>2012</td><td>Validate the Net Enabled Operations (NEO) Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders (System Safety Management Transformation).</td></tr>
<tr><td>2013</td><td>Complete the Aviation Safety Information Analysis and Sharing (ASIAS) pre-implementation activities, including concept definition, with other JPDO member agencies, participants, and stakeholders (System Safety Management Transformation).</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="2">Activity 2 - Safety Management System: Produce guidelines for developing processes and technologies to implement a safety management system.</td><td>2011</td><td>Develop proof of concept for NextGen including a safety management system prototype to implement on a trial basis with selected participants that involve a cross-section of air service providers (System Safety Management Transformation).</td><td>SSE (Safety): Safety Management Systems (FAA Enterprise Architecture).</td><td rowspan="2">Improved SMS Standards and Effectiveness (3108, IOC: 2020).</td></tr>
<tr><td>2014</td><td>Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across the NextGen (System Safety Management Transformation).</td><td>SSE (Safety): Fully Institutionalized National Aviation Safety Policy and Continuous Safety Improvement Culture (FAA Enterprise Architecture).</td></tr>
</table>

NARP R&D Goal				
2. 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.				
Activity 4 - Develop methods, metrics, and models top demonstrate that the system can handle growth in demand up to 3 times current levels. (In support of Goal 2.1 milestones.)	2011	Demonstrate capacity increase to 166% current levels (NextGen - Operations Concept Validation - Validation Modeling).	Refer to research goals 2.1 "Fast, flexible, and efficient".	Refer to research goals 2.1 "Fast, flexible, and efficient".
	2013	Demonstrate capacity increase to 230% current levels (NextGen - Operations Concept Validation - Validation Modeling).		
	2016	Demonstrate capacity increase to 300% current levels (NextGen - Operations Concept Validation - Validation Modeling).		
Activity 5 - 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 3 times current levels. (In support of Goal 2.2 milestones.)	2009	Demonstrate no environmental constraints at 130% capacity (NextGen - Environment and Energy - Validation Modeling).	Refer to research goals 2.2 "Clean and quiet".	Refer to research goals 2.2 "Clean and quiet".
	2011	Demonstrate no environmental constraints at 166% capacity (NextGen - Environment and Energy - Validation Modeling).		
	2013	Demonstrate no environmental constraints at 230% capacity (NextGen - Environment and Energy - Validation Modeling).		
	2016	Demonstrate no environmental constraints at 300% capacity (NextGen - Environment and Energy - Validation Modeling).		

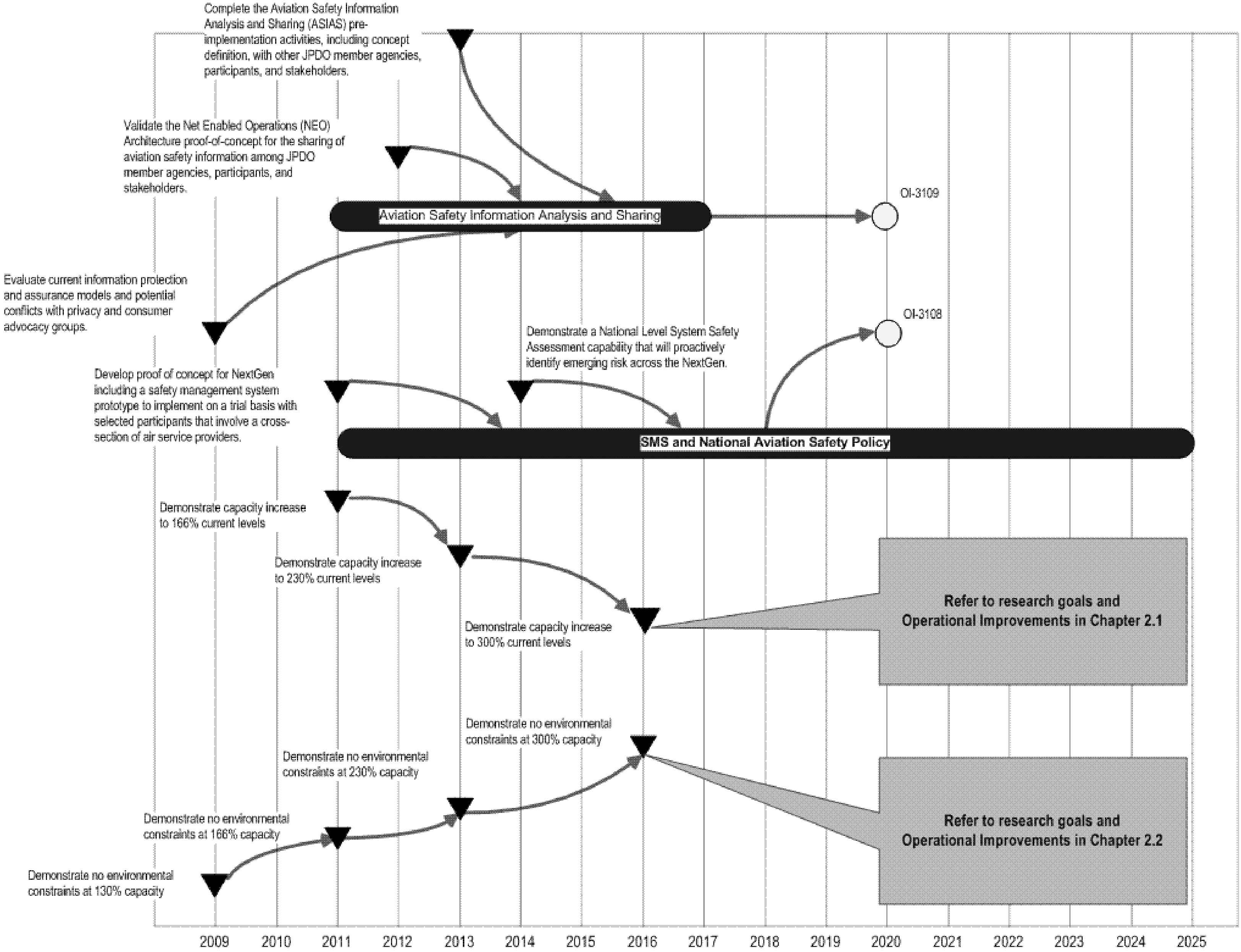


Figure E-7: Goal 2.9 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

NARP R&D Goal				
2.10 - World Leadership: A globally recognized leader in aerospace technology, systems, and operations.				
NARP 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.				
NARP Activity Group	Year	NARP Milestone	NextGen Impl. Plan Solution Set OIs	IWP Far-term OIs (Post 2016)
Activity 2. Leverage research results.	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 (NextGen - System Safety Management Transformation).	SSE (Safety): Aviation Safety Information Analysis and Sharing (FAA Enterprise Architecture).	Increased Safety Information Sharing and Analysis Scope and Effectiveness (3109, IOC: 2020).
	2013	Complete development of ANSP wake separation standards that better use aircraft flight characteristics and information concerning surrounding weather conditions. (Wake Turbulence[NG]).	HD: Wake Vortex Incorporated into Flow (102142).	Reduce Separation in High Density terminal <3 mi (0348, IOC: 2025); Integrated Arrival/Departure and Surface Traffic Management (0331, IOC:2018); Efficient Metroplex Merging and Spacing (0338, IOC: 2018); Integrated Arrival/Departure and Surface Traffic Management for Metroplex (0339, IOC: 2022).
	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).	RWI: Full Operational Weather Capability (103121) HD: Wake Vortex Incorporated into Flow (102142)	WTMD: Wind-Based Wake Procedures - Dynamic Wind Procedures (0402, IOC: 2018); Wake Turbulence Mitigation for Arrivals - Dynamic Wind Procedures (0403, IOC: 2020).
	2016	Demonstrate improvement in air navigation service provider 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 Controller/Technical Operations Human Factors - Controller Efficiency).	TBO: Expanded Conflict Resolution Advisories via Data Communication (104105).	Automation-assisted Trajectory-based Management Level 3 (0360, IOC: 2020); Self-separation Airspace (0362, IOC: 2022); Delegated Separation - Complex Procedures (0363, IOC: 2025); Automation-assisted Trajectory-based Management Level 4 (0369, IOC: 2024); Trajectory-based Management Level 5 Full Gate-to-gate (0370, IOC: 2025).

[NG] The Wake Turbulence Program contains funding for both core research and NextGen research. Those activities noted with the superscript NG indicate those funded with NextGen resources, while those without notation indicate those funded with the core program resources.

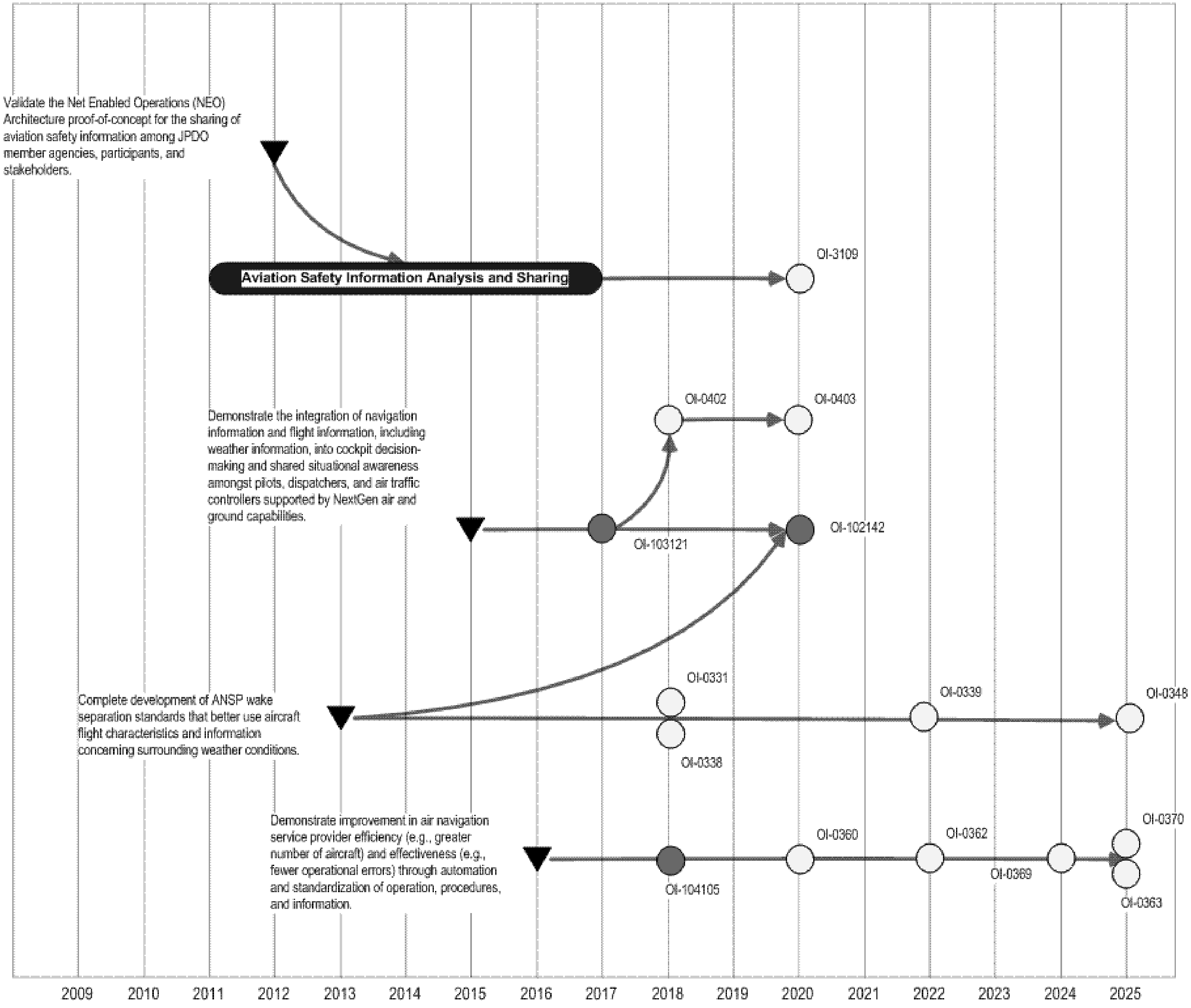


Figure E-8: Goal 2.10 Linking of FAA NextGen R&D Activities to Far-term Operational Improvements

APPENDIX F: Abbreviations and Acronyms

Acronym	Full Term
0-9	
3-D PAM	Three-Dimensional Path Arrival Management
4-D TBO	Four-Dimensional Trajectory Based Operations
4-DT	Four-Dimensional Trajectory
A	
AAAE	American Association for Airport Executives
AAIADS	Aerospace Accident Injury and Autopsy Data System
AA-IADS	Aircraft Accident/Injury and Autopsy Data System
AAM	Office of Aviation Medicine
AC	Advisory Circular
ACCRI	Aviation Climate Change Research Initiative
ACES	Airspace Conflict Evaluation Simulator
ACF	Aeronautical Charting Forum
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
ADDS	Aviation Digital Data Service
ADS-B	Automatic Dependent Surveillance - Broadcast
AEC	Aviation Emissions Characterization
AEDT	Aviation Environmental Design Tool
AEH	Airborne Electronic Hardware
AGHME	Aircraft Geometric Height Measurement Element
AI	Aeronautical Information
AIA	Aerospace Industries Association
AIDL	Aircraft Intent Description Language
AIM	Airspace and Aeronautical Information Management
AIM	Aviation Integrated Modeling
AIM	Aeronautical Information Management
AIP	Airport Improvement Program
AIR	American Institute for Research
AIRE	Atlantic Interoperability Initiative to Reduced Emissions
AIXM	Aeronautical Information Exchange Model
AMC	Aerospace Medical Certification
AME	Aviation Medical Examiner
ANSP	Air Navigation Service Provider

Acronym	Full Term
ANT	Automated NextGen Tower
AOC	Aircraft/Airline Operations Center
AOC	Airport Cooperative Research Program (ACRP) Oversight Program
APEX	Aircraft Particle Emission eXperiment
APMT	Aviation Portfolio Management Tool
APU	Auxiliary Power Unit
AQP	Advanced Qualification Program
ARAC	Aviation Rulemaking Advisory Committee
ARFF	Aircraft Rescue and Fire Fighting
ARP	Aerospace Recommended Practice
ARTS	Automated Radar Terminal System
ASAP	Aviation Safety Action Program
ASDE-X	Airport Surface Detection System – Model X
ASEB	Aeronautics and Space Engineering Board
ASIAS	Aviation Safety Information and Analysis Sharing
ASPIRE	Asia and South Pacific Initiative to Reduce Emissions
ASR	Alkali-Silica Reactive
ASR	Airport Surface Radar
ASRS	Aviation Safety Reporting System
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATC	Air Traffic Control
ATCOV	Air Traffic Color Vision Test
ATCT	Air Traffic Control Tower
ATD	Anthropomorphic Test Device
ATD&P	Advanced Technology Development and Prototyping
ATM	Air Traffic Management
ATMP	Air Tour Management Plan
ATO	Air Traffic Organization
ATOP	Advanced Technologies and Oceanic Procedures
ATO-P	Air Traffic Organization - NextGen and Operations Planning
ATP	Airline Transport Pilots
AT-SAT	Air Traffic Selection and Training
ATSP	Air Traffic Service Provider
avgas	Aviation Gasoline
AVS	Office of Aviation Safety
AVSI	Aerospace Vehicle Systems Institute

Acronym	Full Term
B	
BA	Big Airspace
BA/C	Big Airspace/Collocated Condition
BA/N	Big Airspace/Non-collocated Condition
BOMV	Buffer Oriented Micro-architectural Validation
C	
C3	Control, Command, and Communication
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAASD	Center for Advanced Aviation System Development
CAEP	Committee on Aviation Environmental Protection
CAMI	Civil Aerospace Medical Institute
CANSO	Civil Air Navigation Services Organization
CARB	California Air Resources Board
CAST	Certification Authorities Software Team
CAST	Commercial Aviation Safety Team
CATM	Collaborative Air Traffic Management
CAVS-S	Cockpit Display of Traffic Information Assisted Visual Separation
CC	Continuous Commissioning
CC5	Construction Cycle Five
CCSP	Climate Change Science Program
CDA	Continuous Descent Approach/Arrival
CDC	Centers for Disease Control
CDTI	Cockpit Display of Traffic Information
CEH	Complex Electronic Hardware
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulations
CHI	Computer Human Interface
CIP	Capital Investment Plan
CIP	Current Icing Product
CLEEN	Continuous Low Energy, Emissions and Noise
CLEQ	CAMI Life Experiences Questionnaire
CNS	Communications, Navigation, and Surveillance
CO_2	Carbon Dioxide
COA	Certificate of Authorization
CoE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
ConOps	Concept of operations (or operational concept)
CONUS	Continental United States

Acronym	Full Term
CoSPA	Consolidated Storm Product for Aviation
COTS	Commercial Off-The-Shelf
CRC	The Coordinating Research Council
CRD	Concept and Requirements Definition
CRDA	Cooperative Research and Development Agreement
D	
DARWIN	Design Assessment of Reliability With INspection
DataComm	Data Communications
DESIREE	Distributed Environment for Simulation, Rapid Engineering, and Experimentation
DFW	Dallas/Fort Worth International Airport, Texas
DHS	Department of Homeland Security
DIWS	Digital Imaging and Workflow System
DNL	Day-Night-Level
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DPE	Designated pilot examiner
D-RVSM	Domestic Reduced Vertical Separation Minimum
DSA	Detect, Sense and Avoid
DSR	Display System Replacement
E	
EA	Enterprise Architecture
EDA	En Route Descent Advisor
EDS	Environment Design System
EDMS	Emissions and Dispersion Modeling System
EDS	Environmental Design Space
EFB	Electronic Flight Bag
EFG	Economic and Financial Group
EFVS	Enhanced Flight Vision Systems
E-IPT	Environmental Integrated Product Team (now EWG)
ELV	Expendable Launch Vehicle
EMAS	Engineered Materials Arresting System
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
ERAM	En Route Automation Modernization
ERDC	US Army Engineer Research and Development Center
ETBE	Ethyl Tertiary Butyl Ether
EUROCONTROL	European Organization for the Safety of Air Navigation

Acronym	Full Term
EVS	Enhanced Vision System
EWG	Environmental Working Group
EWIS	Electric Wiring Interconnect Systems
F	
F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layered Design
FACT	Future Airport Capacity Task
FAROS	Final Approach Runway Occupancy Signal
FASTGEN	Fast Shot-Line Generator
FAST™	Fatigue Avoidance Scheduling Tool
FEA	Federal Enterprise Architecture
FEWS	Future En Route Workstation
FFRDC	Federally Funded Research and Development Center
FFS	Full fight simulator
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Field Condition
FMC	Flight Management Computer
FMS	Flight Management System
FOD	Foreign Object Debris
FOQA	Flight Operations Quality Assurance
FPT	Flourescent Penetrant Inspection
FRM	Flammability Reduction Means
FSS	Flight Service Specialists
FSIMS	Flight Standards Information Management System
FSW	Friction stir welded
F-T	Fischer-Tropsch
FTWS	Future Terminal Workstation
FY	Fiscal Year
G	
GA	General Aviation
GAO	U.S. Government Accounting Office
GEOSS	Global Earth Observation System of Systems
GIAA	Airport Improvement Program
GPRA	Government Performance and Results Act of 1993
GPS	Global Positioning System
H	
HAP	Hazardous Air Pollutant

Acronym	Full Term
HCAS	Hazard Categorization and Analysis System
HCFC	Hydrochloroflourocarbon
HCS	Host Computer System
HDA	High Density Airport
HEPA	High Efficiency Particulate Air
HERSA	Human Error Safety Risk Assessment
HFACS	Human Factors Analysis and Classification System
HFC	Hydroflourocarbon
HFDS	Human Factors Design Standard
HFIX	Human Factors Intervention Matrix
HITL	Human in the Loop
HRET	High Reach Extendable Turret
HUMS	Health and Usage Monitoring Systems
I	
I&I	Integration and Implementation
IA	Interagency Agreement
ICAO	International Civil Aviation Organization
ICCAIA	International Coordinating Council of Aerospace Industries
iCMM®	Integrated Capability Maturity Model
IDRP	Integrated Departure Route Planner
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMA	Integrated Modular Avionics
IMC	Instrument Meteorological Conditions
INM	Integrated Noise Model
IOSA	International Air Transport Association Operational Safety Audit
IPRF	Innovative Pavement Research Foundation
IRB	Investment Review Board
ITS	Intelligent Training Systems
IWP	JPDO Next Generation Air Transportation Systems Integrated Work Plan: A Functional Outline
J	
JAMS	The Joint Center of Excellence for Advanced Materials and Structures
JFK	John F. Kennedy International Airport, New York
JPDO	Joint Planning and Development Office
JPE	Joint Planning Environment
JRC	Joint Resources Council

Acronym	**Full Term**
L	
LCGS	Low-Cost Ground Surveillance
LCSS	Low-Cost Surface Surveillance
LED	Layered Elastic Design
LED	Light emitting diode
LIDAR	Light Detection and Ranging
LOSA	Line Operations Safety Audit
LTO	Landing and Takeoff Cycle
LWE	Liquid Water Equivalent
M	
M&S	Merging and Spacing
MAF	Microprocessor Approval framework
MAF	Microprocessor Approval Framework
MAGENTA	Modeling System for Assessing Global Noise Exposure
MIA	Minimum Instrument Flight Rules (IFR) Altitude
MIT	Massachusetts Institute of Technology
MMIR	Maintenance Malfunction Information Reporting
MMPDS	Metallic Materials Properties Development and Standardization
MMPI	Minnesota Multiphasic Personality Inventory
MOA	Memorandum of Agreement
MoC	Memorandum of Cooperation
MON	Motor octane numbers
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MPS	Minimum performance standard
MVA	Minimum Vector Altitude
N	
NAAQS	National Ambient Air Quality Standard
NAPA	National Academy of Public Administration
NAPTF	National Airport Pavement Test Facility
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	U.S. National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NAT	North Atlantic
NATO	North Atlantic Treaty Organization
NATPRO	National Air Traffic Professionalism Program
NAWC	Naval Air Warfare Center

Acronym	Full Term
NCP	National Airspace System Change Proposal
NDI	Nondestructive Inspection
NEIS	Net Enabled Information Sharing
NEO	Net Enabled Operations
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
Nextor	National Center of Excellence for Aviation Operations Research
NGIP	NextGen Implementation Plan
NGL	NextGen Laboratory Team
NLA	New Large Aircraft
NOSS	Normal Operations Safety Survey
NOTAM	Notice to Airmen
NO_X	Nitrogen Oxide
NPARDRI	National Plan for Aeronautics Research and Development and Related Infrastructure
NRC	National Research Council
NSS	NAS Strategy Simulator
NT	NextGen Towers
NTDA	NEXRAD Turbulence Detection Algorithm
NTSB	U.S. National Transportation Safety Board
NWEC	NextGen Weather Evaluation Capability
NWS	National Weather Service
O	
OAM	Office of Aerospace Medicine (FAA)
OBIGGS	Onboard inert gas generation system
OCS	Obstruction Clearance Surface
OE	Operational Error
OEP	Operational Evolution Partnership
OI	Operational Improvement
OMB	U.S. Office of Management and Budget
OOT	Object-Oriented Technology
OPD	Optimized Profile Descent
Ops	Operations
OSED	Operational Suitability and Environmental Description/Operational Services and Environment Description
OST	Office of Science & Technology Policy
OSTP	Office of Science and Technology Policy
P	
PAM	Path Arrival Management

Acronym	Full Term
PAPI	Precision Approach Path Indicator
PAPR	Powered Air Purifying Respirator
PARC	Performance-Based Operations Aviation Rule-Making Committee
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PATM	Performace-based Air Traffic Management
PBPK	Physiologically-based pharmacokinetic
PCPSI	Pilot-Controller Procedures and Systems Integration
PDARS	Performance Data Analysis and Reporting System
PDP	Pavement Deicing Product
PEPC	Pre-Employment Processing Center
PF	Personality Factor
PHA	Preliminary Hazards Assessment
PHMSA	Pipeline and Hazardous Materials Safety Administration
PITT	Propulsion Indications Task Team
PM	Particulate Matter
PV	Performance verification
PVT	Psychomotor Vigilance Task
R	
R&D	Research and Development
R,E&D	Research, Engineering and Development
RDHFL	Research Development & Human Factors Laboratory
REB	FAA R&D Executive Board
REDAC	Research, Engineering and Development Advisory Committee
REL	Runway Entrance Light
RF	Radius-To-Fix
RIL	Runway Intersection Light
RIRP	Runway Incursion Reduction Program
RITA	U.S. Research and Innovative Technology Administration
RITE	Research in the Intermodal Transportation Environment
RMA	Regional Airline Association
RNAV	Required Area Navigation
RNP	Required Navigation Performance
RPI	Relative Position Indicator
RSA	Runway Safety Area
RTCA	Radio Technical Commission for Aeronautics (f.k.a.)
RWI	Reduce Weather Impact
RWSL	Runway Status Light

Acronym	Full Term
S	
SAE	Society of Automotive Engineers
SAGE	System for Assessing Aviation Global Emissions
SBIR	Small Business Innovation Research
SBS	Surveillance and Broadcast Services
SCPI	System Capacity, Planning and Improvement
SDAT	Sector Design and Analysis Tool
SDP	Service Delivery Point
SEMP	Systems Engineering Management Plan
SESAR	Single European Sky ATM Research
SFO	San Francisco International Airport
SIS	Scientific Information System
SLD	Supercooled Large Droplet
SME	Subject matter expert
SMP	Strategic Management Process
SMS	Safety Management System
SNT	Staffed NextGen tower
SO2	Sulfur Dioxide
SOAP	Sustained Operations Assessment Profile
SoC	System on a Chip
SPK	Synthetic Paraffinic Kerosene
SRMP	Sustainable Range Management Plans
SSO	Spatial Standard Observer
SSS	Stanford Sleepiness Scale
STARS	Standard Terminal Automation Replacement System
STL	St. Loius International Airport
SUA	Special Use Airspace
SVS	Synthetic Vision Systems
SVS	Synthetic Vision System
SwRI	Southwest Research Institute
T	
TA	Tailored Arrival
TARGETS	Terminal Area Route Generation, Evaluation, and Traffic Simulation
TAWS	Terrain awareness and warning system
TBO	Trajectory Based Operations
TCAS	Traffic Collision and Avoidance System
TCP	Tricresyl Phosphate
TCRP	Transit Cooperative Research Program

Acronym	Full Term
TERPS	Terminal Instrumentation Procedures
TFM	Traffic flow management
TGF	Target Generator Facility
ThermaKin	Thermal-Kinetic Burning Model
THL	Takeoff Hold Light
TMA	Traffic Management Advisor
TMI	Traffic Management Initiative
TMM	Testing Maturity Model
TO	Technical Operations
TOD	Top Of Descent
TODDS	Tower Operations Digital Data System
TRACON	Terminal Radar Approach Control
TRB	U.S. Transportation Research Board
TRL	Technology Readiness Level
TSO	Technical Standard Order
U	
UAS	Unmanned Aircraft System
UCF	University of Central Florida
UEDDAM	Uncontained Engine Debris Damage Assessment Model
UI	User Interfaces
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
V	
VAS	Visual analogue mood scale
VDRP	Voluntary Disclosure Reporting Program
VFR	Visual Flight Rules
VHP	Vapor Hydrogen Peroxide
VHP	Vaporized hydrogen peroxide
VLJ	Very Light Jet
VMC	Visual Meteorological Conditions
VRR	Voice Recognition and Response
W	
WAAS	Wide Area Augmentation System
WAFS	World Area Forecast Services
Wake Re-Cat	Wake Turbulence -- Re-Categorization Project
WBAT	Web Based Application Tool
WJHTC	William J. Hughes Technical Center Laboratory Facility
WRF	Weather Research and Forecast

Acronym	Full Term
WTIC	Weather Technology in the Cockpit
WTMA	Wake Turbulence Mitigation for Arrivals
WTMD	Wake Turbulence Mitigation for Departures