Federal Aviation Administration

# NARP

# 2011 National Aviation Research Plan

May 2011

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

2011 NARP
May 2011

*The National Aviation Research Plan* (NARP) is a report of the Federal Aviation Administration to the United States Congress pursuant to 49 United States Code 44501(c). The NARP is available on the Internet at http://www.faa.gov/go/narp.

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# Executive Summary

Aviation is a vital resource for the United States. It provides opportunities for business, jobs, economic development, law enforcement, emergency response, personal travel, and leisure. It attracts investment to local communities and opens up new domestic and international markets and supply chains. As a result, the United States needs a system that leads the global aviation community – a system that responds quickly to changing and expanding transportation needs. The Federal Aviation Administration (FAA) supports this system through the introduction of new technologies and procedures, innovative policies, and advanced management practices.

The *National Aviation Research Plan* (NARP) is the 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. The NARP integrates the FAA R&D programs into a portfolio that addresses the near-, mid-, and far-term research needs of the aviation community. It uses R&D goals and performance targets to bridge requirements from the FAA's five-year strategic *Flight Plan* to the future Next Generation Air Transportation System (NextGen), and it identifies how the FAA can use its research strengths to meet these needs. This approach enables the FAA to address the current challenges of operating the safest, most efficient air transportation system in the world while building a foundation for the future system in an environmentally sound manner.

The NARP includes ten R&D goals with corresponding R&D targets for 2016 that represent a mid-point between the initial R&D plan established in 2006 and the future system envisioned for 2025. The R&D targets for 2016 are ambitious, and they challenge and encourage researchers to innovate, take risks, and seek non-traditional solutions.

This year, the NARP provides the FAA's record of accomplishment, five years of results from 2006 to 2010. It shows that the FAA did what it said it would do as responsible stewards of tax dollars by following a plan, reporting achievements, and delivering results. Next year, the NARP will present a five-year budget plan, ending in 2017, extending past the R&D targets for 2016, in continued pursuit of the R&D goals. In preparation for next year, the NARP examines the challenges in meeting the R&D targets by 2016, identifies further research needs, and establishes a basis for extending our sights beyond the current R&D targets.

In fiscal year 2012, the FAA plans to invest a total of $386,035,000 in R&D. The R&D investment spans multiple appropriations for the FAA, including $190,000,000 in Research, Engineering and Development (RE&D); $150,785,000 in Facilities and Equipment (F&E); $44,250,000 in the Airport Improvement Program (AIP); and $1,000,000 in Operations (Ops).

NO
TURN
ON RED

# Preface

Title 49 of the U.S. Code section 44501(c) requires the Administrator of the FAA to submit the NARP to Congress annually with the President's Budget. The Plan includes both applied research and development as defined by the Office of Management and Budget (OMB) Circular A-11* and involves research activities funded in four appropriation accounts: RE&D, F&E, AIP, and Ops.

The NARP is an integrated, performance-based R&D plan for the FAA with programs that go beyond air traffic operations, including unique strengths in aircraft safety, airports, commercial space transportation, environment and energy, and human factors. The NARP shows how these unique strengths support the near-, mid-, and far-term research needs of the aviation community. It aligns the FAA R&D portfolio with the goals, objectives, and performance targets in both the *Flight Plan* and the Joint Planning and Development Office (JPDO) *NextGen Integrated Plan*†. It defines ten R&D goals with performance targets and interim milestones, creating a multi-year plan, integrating program efforts, and measuring progress toward the goals.

The 2011 NARP shows how the FAA R&D programs are achieving the milestones that originally appeared in the 2006 NARP. This year, the NARP reflects on progress toward the larger, more difficult R&D performance targets for 2016, explaining the continued importance and relevance of the R&D targets, identifying the knowledge gained to date from pursuing the R&D targets, and defining the challenges in meeting the R&D targets by 2016. Examining current progress toward the R&D targets and challenges that remain forms the basis for developing out-year milestones beyond 2016 in continued pursuit of the R&D goals into 2025.

Chapter 1 provides an overview of the National Airspace System (NAS) mission, vision, and goals used to define the FAA R&D needs. It presents the relationship between the near-, mid-, and far-term planning documents of the FAA and the JPDO and explains how the FAA R&D goals support these plans and their research requirements, from the day-to-day safety, capacity, efficiency, and environmental issues of the NAS to the future NextGen.

Chapter 2 provides a master schedule and includes a high-level plan for each of the ten R&D goals. The plan aligns R&D programs under each R&D goal and integrates them to achieve the R&D performance target for 2016. Milestones identify the responsibilities of each program and provide measures of interim progress toward the R&D target. This year, the chapter identifies progress to date and challenges that remain in achieving the R&D targets by 2016.

* OMB Circular A-11, "Preparation, Submission and Execution of the Budget," July 21, 2010, section 84, page 8 (www.whitehouse.gov/OMB/circulars).
† Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004 (www.jpdo.gov).

Chapter 3 identifies the FAA R&D programs that support NextGen and shows how the programs map to the solution sets and operational improvements of the *NextGen Implementation Plan*. The FAA R&D programs that support NextGen are a subset of the R&D portfolio and budget presented in Chapter 2.

Chapter 4 provides summaries of the R&D programs; the five-year budget plan; partnership activities with other government agencies, academia, and industry; and methods used to evaluate the programs. It presents the programs and budget according to the President's budget submission for fiscal year (FY) 2012.

All appendices are included in a separate volume from the main body of the 2011 NARP. Appendix A provides a detailed description and justification for each R&D program, including the requested budget, planned accomplishments, description of activities, performance linkages, and criteria for success.

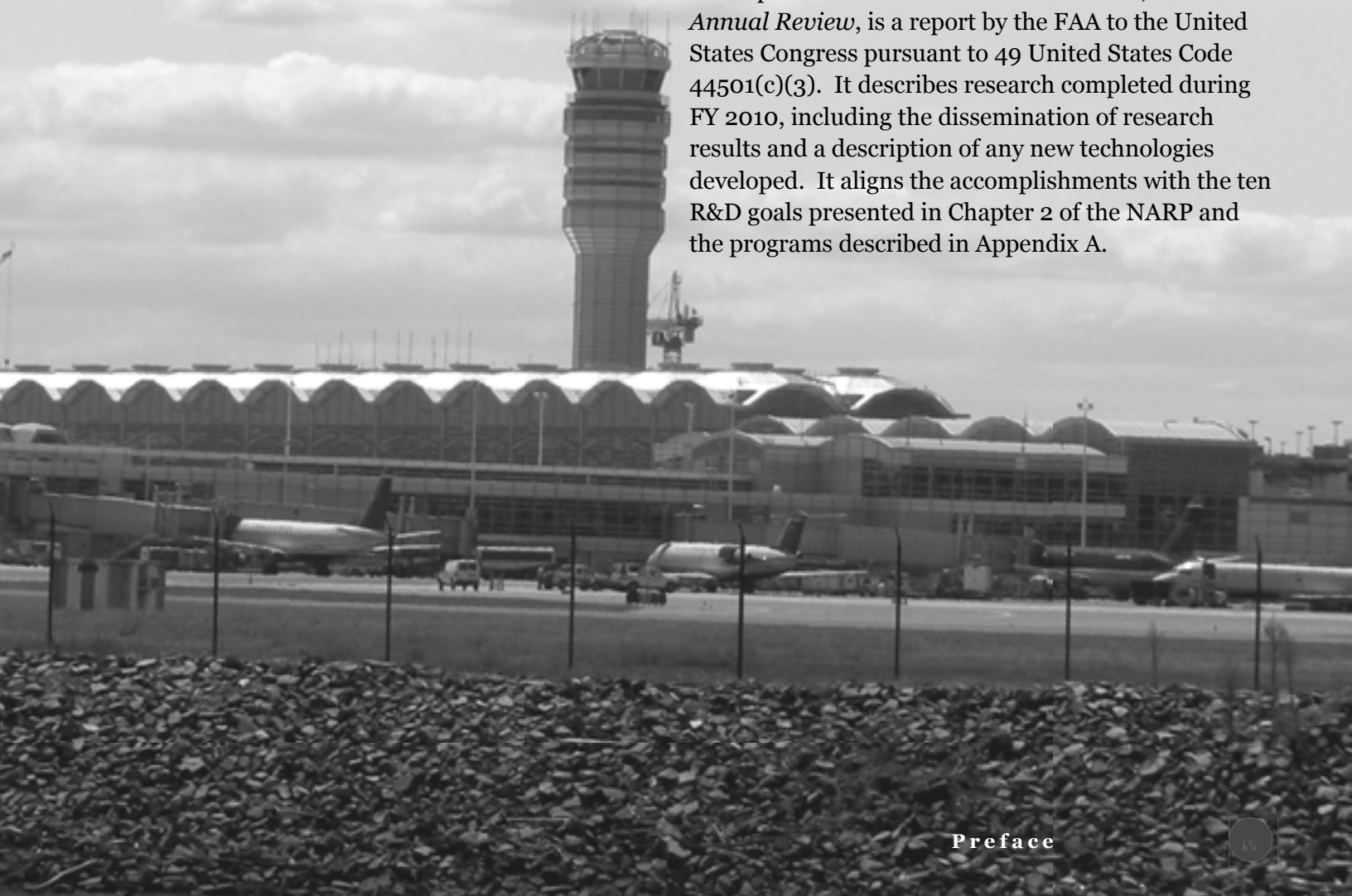
Appendix B provides detailed information on FAA partnerships with government, academic, and industry organizations. It lists information for FY 2010, including active agreements with other government agencies, cooperative R&D agreements, patents, and grants. This appendix supports the partnership section in Chapter 4.

Appendix C provides the recommendations of the Research, Engineering, and Development Advisory Committee (REDAC), listed according to the reports produced by the committee in FY 2010. The FAA response to each recommendation is included. This appendix supports the evaluation section in Chapter 4.

Appendix D shows the status of all Chapter 2 milestones in the 2011 NARP. The appendix lists any changes in the milestones aligned with the ten R&D goals in Chapter 2 to provide the reader complete transparency and maintain continuity with previous editions of the NARP.

Appendix E provides a list of acronyms and abbreviations used in the 2011 NARP appendices.

A companion document to the 2011 NARP, the *R&D Annual Review*, is a report by the FAA to the United States Congress pursuant to 49 United States Code 44501(c)(3). It describes research completed during FY 2010, including the dissemination of research results and a description of any new technologies developed. It aligns the accomplishments with the ten R&D goals presented in Chapter 2 of the NARP and the programs described in Appendix A.



# Chapter One

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

To maximize these opportunities, the United States must not only maintain, but also continue to improve upon its airspace system so that it remains responsive to its rapidly changing and expanding transportation needs while ensuring the highest level of safety. Increased mobility, higher productivity, reduced environmental impact, and greater efficiency are possible through the introduction of new technologies and procedures, innovative policies, and advanced management practices. Collaborative, needs-driven R&D is central to this process, because it enables the United States to be a world leader in its ability to move people and goods by air safely, securely, quickly, affordably, efficiently, and in an environmentally sound manner.

# Mission

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

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

The design, development, maintenance, and operation of the NAS relies on 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 contribute to regulation of the aviation industry; development, maintenance, and operation of the air traffic management (ATM) system; and 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. Department of Defense (DoD), Department of Transportation (DOT), Department of Homeland Security (DHS), Department of Commerce (DOC), FAA, National Aeronautics and Space Administration (NASA), and the President's Office of Science and Technology Policy (OSTP), is "A transformed aviation system that allows all communities to participate in the global marketplace, provides services tailored to individual customer needs, and accommodates seamless civil and military operations."*

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

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

# National Goals

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

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

# Planning Documents

The national goals challenged the FAA to support the far-term requirements to achieve NextGen and the near-term requirements to address the day-to-day safety and capacity issues of the NAS. The FAA aligns its existing plans to achieve this balance between near-term goals and NextGen by working with other agencies as part of the JPDO to plan and refine the far-term goals for NextGen and establishing an FAA office to plan the integration and implementation of NextGen. This section explains how the FAA and JPDO plans and goals are connected and how the FAA R&D portfolio supports the larger planning effort by providing research to balance the near-, mid-, and far-term needs of the aviation community.

Figure 1.1 describes the relationship between the *Flight Plan*, *NextGen Implementation Plan*, NAS Enterprise Architecture, *NAS Capital Investment Plan*, NARP, and JPDO plans. The relationship includes relative timeframes, from today to the year 2025.

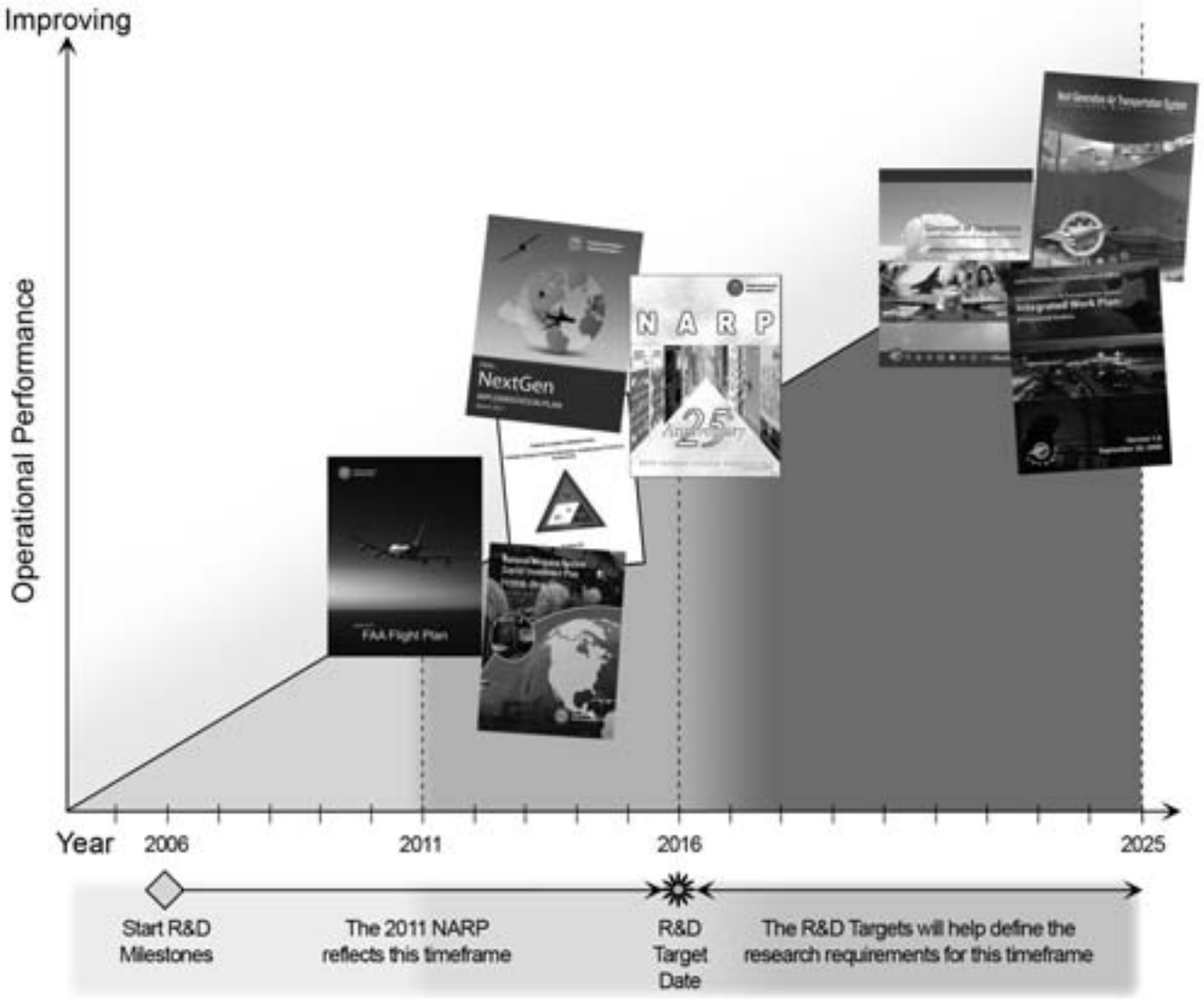



**Figure 1.1: FAA and JPDO Integrated Planning**

## Flight Plan

The *FAA 2009-2013 Flight Pla*n is the five-year strategic plan for the FAA that describes the Agency's overall near-term performance goals and objectives, including increased safety and greater capacity. Since the FAA has the day-to-day responsibility to promote the safe and efficient operation of the current aviation system, the *Flight Plan* goals and objectives drive many Agency priorities, including research. The *Flight Plan* provides the foundation for the other FAA plans, includes all FAA initiatives, and focuses on the near-term. For more information, see http://www.faa.gov/about/plans_reports/.

## NextGen Implementation Plan

The FAA's *NextGen Implementation Plan* outlines the Agency's path to deliver mid-term (2012-2018) NextGen capabilities and their associated benefits. The *NextGen Implementation Plan* lays out the Agency's vision for NextGen, identifying the goals set for technology and program deployment and the commitments made in support of that vision. The *NextGen Implementation Plan* includes all FAA initiatives for NextGen and focuses on the mid-term. Chapter 3 of the NARP provides a summary of the *NextGen Implementation Plan* and the seven solutions sets of NextGen. For more information, see http://www.faa.gov/nextgen/.

## Enterprise Architecture

The FAA Enterprise Architecture (EA) provides the overall architecture for the Agency in three parts: National Airspace System (NAS) EA, Regulatory EA, and Non-NASEA (information technology investments and business processes). The NASEA contains the systems and operational changes for the command and control of the NAS, and it provides the set of technical roadmaps describing how the current NAS will transition to NextGen, including the mid-term target architecture for 2018 and the transition strategy to achieve that architecture. It contains milestones for planning purposes but it is not used as a tool for managing NextGen implementation. The NASEA addresses the transition from the current system to NextGen and includes near-, mid-, and far-term architectures for the NAS. For more information, see https://nasea.faa.gov/.

## NAS Capital Investment Plan

The FAA *NAS Capital Investment Plan* (CIP) for Fiscal Years 2012-2016 describes the planned investments in the NAS over the next five-years for each budget line item in the F&E appropriation. The CIP is similar to the NARP in that the FAA submits both to Congress at the same time as the President's Budget. The CIP includes only FAA F&E programs, whereas the NARP addresses the entire FAA R&D portfolio. Both documents present the part of the R&D portfolio funded by the F&E appropriation. The CIP ties directly to the *Flight Plan* goals and objectives, identifies the NextGen investments funded by the F&E appropriation, and provides the NASEA roadmaps. The CIP supports the NAS modernization effort depicted in the NASEA. The CIP addresses all FAA programs funded by the F&E appropriation and focuses on the near- to mid-term. For more information, see http://go.usa.gov/aXa/.

## National Aviation Research Plan

The NARP provides the FAA's R&D plan, presents the entire FAA R&D portfolio, including NextGen R&D programs, and identifies investments planned for the next five years in four FAA appropriation accounts. The NARP is an integrated, performance-based R&D plan with goals and performance targets that support the *Flight Plan*, *NextGen Implementation Plan*, and JPDO. The R&D goals reflect the broad spectrum of the FAA R&D portfolio, including aircraft safety, airports, commercial space technology, environment and energy, weather, and human factors. The NARP presents the FAA R&D portfolio and addresses the near-, mid-, and far-term research needs of the aviation community. For more information, see http://www.faa.gov/go/narp/.

## Joint Planning and Development Office Plans

In 2003, Congress created the JPDO* to coordinate interagency planning related to NextGen. The JPDO supports the Office of the Secretary of Transportation (OST) and reports to its Senior Policy Committee, chaired by the Secretary of Transportation, and includes representatives from DoD, DOT, DHS, DOC, FAA, NASA, and OSTP. In 2004, working with industry and academia, the JPDO published the NextGen Integrated Plan, establishing the far-term system goals and objectives for NextGen in 2025. Subsequently, JPDO produced the NextGen Concept of Operations (ConOps), EA, and Integrated Work Plan (IWP). Current efforts focus on the policy required to achieve NextGen. The JPDO plans address the efforts of all NextGen participants, including FAA, in the far-term. For more information, see http://www.jpdo.gov/.

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

# Research and Development

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

## Mission

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

## Vision and Values

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 FAA has defined five R&D organizational values to enable it to better manage its programs and achieve its far-term R&D vision. These are:

- 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 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 our people to invent new aviation capabilities, and creating 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 promoting these values, the FAA will generate the maximum benefit from limited R&D resources to help achieve the national vision of a transformed aviation system.

† OMB Circular A-11, "Preparation, Submission and Execution of the Budget," July 21, 2010, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

## Goals

The FAA R&D portfolio supports both the day-to-day operations of the NAS and the development of NextGen. 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.

When developing the R&D goals, originally published in the 2006 NARP, the FAA R&D community considered the goals and performance targets of the *Flight Plan* and *NextGen Integrated Plan*, including how the two plans connect and how the strengths of the FAA R&D portfolio might help achieve the goals of these two plans.

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

Table 1.1 shows the primary relationship among the *Flight Plan* goals, FAA R&D goals, the *NextGen Implementation Plan* solution sets, and the JPDO far-term goals identified for NextGen. Each FAA R&D goal aligns with a primary *Flight Plan* goal.

## Table 1.1: Alignment of Goals

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

# Chapter Two

# Research and Development Goals

The R&D goals help align, plan, and evaluate the FAA's R&D portfolio. This chapter presents a master schedule with a high-level plan for each of the ten R&D goals.

The ten R&D goals with corresponding R&D targets were developed by considering the near-, mid-, and far-term needs of the aviation community and determining how the R&D portfolio's research strengths could be used to meet those needs. The JPDO's *NextGen Integrated Plan* provides performance targets for 2025 to increase capacity and efficiency. Applying these challenging performance targets to the *Flight Plan* reveals corresponding needs in other areas. For example, increasing capacity could generate a corresponding reduction in aviation safety and increases in fuel consumption, noise, emissions, and the number of air traffic controllers needed, resulting in operational and societal costs that might hinder capacity growth. By applying the FAA R&D portfolio strengths in aviation safety, environment, and human factors to these issues, the FAA will mitigate them, enabling the desired increase in capacity. The R&D goals and targets reflect how the strengths of the FAA R&D portfolio support both the *Flight Plan* and NextGen.

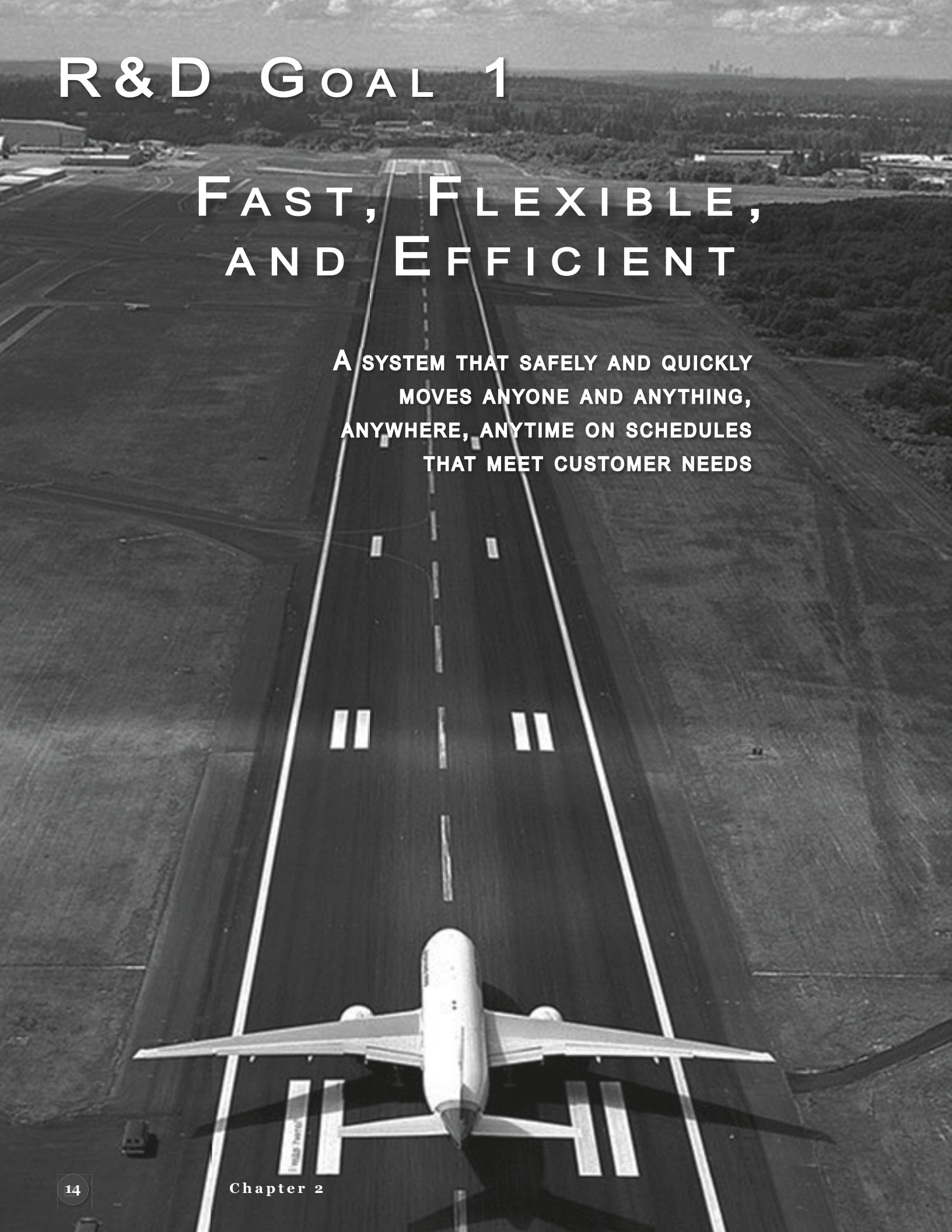
The following pages provide the plan for each of the ten R&D goals. Each R&D goal includes an R&D target for the year 2016 to help measure progress toward the R&D goal. Milestones represent detailed steps toward each R&D target and identify the contributions of each R&D program toward the R&D target. The milestones measure annual progress: checkmarks identify each completed milestone with a short paragraph on progress that describes the significance of each milestone completed in 2010. Progress reports for each R&D goal evaluate current results against the plan and identify challenges that remain in reaching the R&D target by 2016.

Table 2.1 provides a map of the R&D programs to the R&D goals and shows how the program's funding aligns with the R&D goal. The intent of this chapter is to identify contributing programs and provide assignments for delivery responsibilities, so that each program focuses on a specific, limited number of R&D goals.

# Table 2.1: Map of R&D Programs in 2012 to R&D Goals

| R&D Programs | | Goal 1 Fast, Flexible, and Efficient | Goal 2 Clean and Quiet | Goal 3 High Quality Teams and Individuals |
|---|---|---|---|---|
| Advanced Materials/Structural Safety | A11.c | | | |
| Aeromedical Research | A11.j | | | |
| Air Traffic Control/Technical Operations Human Factors | A11.i | | | 10,634 |
| Aircraft Catastrophic Failure Prevention Research | A11.f | | | |
| Aircraft Icing - Atmospheric Hazards/Digital System Safety | A11.d | | | |
| Airport Cooperative Research - Capacity | -- | 1,650 | | |
| Airport Cooperative Research - Environment | -- | | 5,000 | |
| Airport Cooperative Research - Safety | -- | | | |
| Airport Technology Research - Capacity | -- | 12,025 | | |
| Airport Technology Research - Environment | -- | | 1,500 | |
| Airport Technology Research - Safety | -- | | | |
| Airspace Management Program | 1A01E | | | |
| Center for Advanced Aviation System Development (CAASD) | 4A09A | 15,266 | | 1,367 |
| Commercial Space Transportation Safety | -- | | | |
| Continued Airworthiness | A11.e | | | |
| Environment and Energy | A13.a | | 15,327 | |
| Fire Research and Safety | A11.a | | | |
| Flightdeck/Maintenance/System Integration Human Factors | A11.g | | | Coordinate |
| Joint Planning and Development Office | A12.a | 9,847 | Coordinate | Coordinate |
| NAS Weather Requirements | 1A01D | | | |
| NextGen - Air Ground Integration Human Factors | A12.c | | | |
| NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | 1A08A | | | 10,000 |
| NextGen - Alternative Fuels for General Aviation | A11.m | | | |
| NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | 1A08D | | 15,000 | |
| NextGen - New Air Traffic Management Requirements | 1A08B | 37,000 | | |
| NextGen - Operational Assessments | 1A08F | | Coordinate | |
| NextGen - Operations Concept Validation - Validation Modeling | 1A08C | | | |
| NextGen - Self-Separation Human Factors | A12.d | | | |
| NextGen - Staffed NextGen Towers (SNT) | 1A08H | | | |
| NextGen - System Safety Management Transformation | 1A08G | | | |
| NextGen - Wake Turbulence | A12.b | 10,674 | | |
| NextGen - Wake Turbulence - Re-categorization | 1A08E | 3,000 | | |
| NextGen - Weather Technology in the Cockpit | A12.e | | | |
| NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | A13.b | | 20,523 | |
| Operations Concept Validation | 1A01C | Coordinate | | |
| Propulsion and Fuel Systems | A11.b | | | |
| Runway Incursion Reduction | 1A01A | | | |
| System Capacity, Planning and Improvement | 1A01B | | | |
| System Planning and Resource Management | A14.a | | | |
| System Safety Management | A11.h | | | |
| Unmanned Aircraft Systems Research | A11.l | | | |
| Weather Program | A11.k | 1,637 | | |
| William J. Hughes Technical Center Laboratory Facility | A14.b | | | |
| Total ($000) | | 91,098 | 57,350 | 22,001 |

| Goal 4 | Goal 5 | Goal 6 | Goal 7 | Goal 8 | Goal 9 | Goal 10 | | |
|---|---|---|---|---|---|---|---|---|
| **Human-Centered Design** | **Human Protection** | **Safe Aerospace Vehicles** | **Separation Assurance** | **Situational Awareness** | **System Knowledge** | **World Leadership** | | **Total ($000)** |
| | Coordinate | 2,605 | | | | | A11.c | 2,605 |
| | 11,617 | | | | Coordinate | | A11.j | 11,617 |
| Coordinate | | | Coordinate | Coordinate | | | A11.i | 10,634 |
| | | 1,502 | | | | | A11.f | 1,502 |
| | 1,621 | 3,783 | | | | | A11.d | 5,404 |
| 1,700 | | | | | 1,650 | | -- | 5,000 |
| | | | | | | Coordinate | -- | 5,000 |
| | 2,500 | | | Coordinate | 2,500 | | -- | 5,000 |
| | | | | | | | -- | 12,025 |
| | | | | | | | -- | 1,500 |
| | 5,504 | | | 10,221 | | | -- | 15,725 |
| | | | | | 3,000 | | 1A01E | 3,000 |
| | | 684 | | 3,646 | 1,823 | | 4A09A | 22,785 |
| | | 500 | | | 500 | | -- | 1,000 |
| | | 12,085 | | | 504 | | A11.e | 12,589 |
| | | | | | | Coordinate | A13.a | 15,327 |
| | 6,852 | 1,305 | | | | Coordinate | A11.a | 8,157 |
| 6,162 | | | Coordinate | Coordinate | | | A11.g | 6,162 |
| Coordinate | | | Coordinate | Coordinate | 4,220 | | A12.a | 14,067 |
| | | | | 1,000 | | | 1A01D | 1,000 |
| 10,545 | | | | | | | A12.c | 10,545 |
| Coordinate | | | | | | Coordinate | 1A08A | 10,000 |
| | | 2,071 | | | | | A11.m | 2,071 |
| | | | | | | | 1A08D | 15,000 |
| | | | | | | | 1A08B | 37,000 |
| | | | | | 10,000 | | 1A08F | 10,000 |
| | | | | | 10,000 | | 1A08C | 10,000 |
| | | | 9,934 | | | Coordinate | A12.d | 9,934 |
| | | | | 6,000 | | | 1A08H | 6,000 |
| | | | | | 18,000 | Coordinate | 1A08G | 18,000 |
| | | | | | | Coordinate | A12.b | 10,674 |
| Coordinate | | | Coordinate | | | | 1A08E | 3,000 |
| Coordinate | | | | 9,186 | | Coordinate | A12.e | 9,186 |
| | | | | | | Coordinate | A13.b | 20,523 |
| | | | | | 4,000 | | 1A01C | 4,000 |
| | | 3,611 | | | | | A11.b | 3,611 |
| | | | | 5,000 | | | 1A01A | 5,000 |
| | | | | | 6,000 | | 1A01B | 6,000 |
| | | | | | | 1,718 | A14.a | 1,718 |
| Coordinate | | | | | 10,027 | | A11.h | 10,027 |
| | | 3,504 | | | | | A11.l | 3,504 |
| Coordinate | 1,473 | | | 13,256 | | | A11.k | 16,366 |
| 3,777 | | | | | | | A14.b | 3,777 |
| 22,184 | 29,567 | 31,650 | 9,934 | 48,309 | 72,223 | 1,718 | | 386,035 |



# R&D Goal 1

## Fast, Flexible, and Efficient

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

## R&D TARGET

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

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 1

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| -- | Airport Cooperative Research - Capacity | AIP | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 33% of total program |
| -- | Airport Technology Research - Capacity | AIP | 12,025 | 12,150 | 12,150 | 12,150 | 12,150 | 100% of total program |
| 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 15,266 | 15,115 | 15,115 | 15,115 | 15,115 | 67% of R&D program in FY 2012 |
| A12.a | Joint Planning and Development Office | R,E&D | 9,847 | 9,561 | 9,547 | 9,668 | 9,882 | 70% of total program |
| 1A08B | NextGen - New Air Traffic Management Requirements | F&E | 37,000 | 22,000 | 22,000 | 22,000 | 22,000 | 100% of total program |
| A12.b | NextGen - Wake Turbulence | R,E&D | 10,674 | 10,283 | 10,227 | 10,340 | 10,565 | 100% of total program |
| 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 3,000 | 1,500 | 1,500 | 1,500 | 1,500 | 100% of total program |
| 1A01C | Operations Concept Validation | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.k | Weather Program | R,E&D | 1,637 | 1,531 | 1,500 | 1,505 | 1,534 | 10% of the program |
| | | **Total** ($000) | 91,098 | 73,790 | 73,688 | 73,928 | 74,396 | |

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

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

# 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 routing to increase throughput and efficiency for large, super density airports. **[COMPLETED]**

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

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

**2009**: Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication. **[COMPLETED]**

## Airport capacity

**Increase airport capacity while reducing costs.**

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

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

**2012**: Develop new standards and guidelines for runway pavement design. (Airport 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. (NextGen - Wake Turbulence) **COMPLETED**

**2013**: Modify procedures as requested to allow use of closely spaced parallel runways for arrival operations during non-visual conditions (2 to 3 airports per year per Task Force 5 recommendations and for requests from airports). (NextGen - Wake Turbulence)

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

**2009**: Develop and simulate separation procedures that vary according to aircraft capability and pilot training. (NextGen Demonstrations and Infrastructure Development) **COMPLETED**

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

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

## Wake turbulence

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

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

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

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

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

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

## Aviation weather

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

**2010**: Develop 0-8 hour advanced storm prediction algorithm. **[COMPLETED]**

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

**2011**: Demonstrate 0-8 hour advanced storm prediction algorithm.

**2013**: Transition 0-8 hour advanced storm prediction algorithm for implementation.

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

# Progress in FY 2010: Fast, Flexible, and Efficient

Increasing capacity and efficiency in the system is a cornerstone of the FAA *Flight Plan* and drives the need for NextGen. The Fast, Flexible and Efficient goal is R&D's contribution to increasing capacity and efficiency. The R&D Target is, by 2016, to demonstrate that the system will have the flexibility to handle growth in demand up to 3 times current levels and demonstrate that gate-to-gate transit time can be reduced by up to 30 percent. The R&D portfolio provides research to improve capacity and efficiency, including research in the areas of aviation weather, wake turbulence, and airports.

Over the past five years, the Airport Cooperative Research Program (ACRP) – Capacity Program has conducted research aimed at improving the ability of airports to respond to the traveling public, focusing on the ability of passengers to efficiently and effectively access airports and the airline services within them. The program has provided the planning community with information on ground access to airports to plan, design, and construct easier airport access methods. It also has studied the potential of implementing common-use systems at airports, providing information for airport and airline staff to evaluate if these systems are suitable for their respective airports.

Since 1998, the Weather Program has produced numerous enhancements in the areas of data assimilation, model physics, and resolution, including operational implementation of the Weather Research Forecast in 2006 as part of the North American Mesoscale model application. Receiving feedback from users is critical in development of capabilities that maximize capacity and efficiency. In 2009, the Weather Program produced a prototype advanced storm prediction capability to provide high-resolution thunderstorm 0-8 hour forecasts over the Northeast with an evaluation by users in a simulated operational environment.

During the last five years, NextGen – Wake Turbulence research gathered the most extensive database of aircraft wake turbulence transport and decay information in the world and applied that information to develop concepts for safely increasing the landing and takeoff capacity at airports with parallel runways spaced closer than 2500 feet apart. Research results helped implement air traffic control (ATC) procedure changes for wake turbulence mitigation and develop prototypes of ATC decision support tools, allowing greater use of airport runways during weather conditions that require instrument operations or during periods of heavy departure demand. The decision support tools for the FAA terminal automation systems allow the monitoring of wake separations between aircraft and facilitate the operational environment of the NextGen era – including TBO, Required Navigation Performance (RNP) routing in High Density operations, and Flexible Terminal operations – to meet capacity demands for air travel in the 2018 to 2025 timeframe.

## Results achieved in 2010 include:

### Situational Aircraft Separation Display Concepts:

The NextGen – Wake Turbulence Program provided concepts for situational aircraft-separation displays needed to define requirements for future enhancements to the FAA terminal automation platforms. The FAA will use these results to define ATC concepts for NextGen in the 2018 to 2025 timeframe, supporting implementation of the NextGen TBO and High Density concepts. (NextGen – Wake Turbulence)

### Advanced Storm Prediction Algorithm (0-8 hour):

About 75 percent of weather delays from April-September are caused by thunderstorms (convective weather). In addition, $22 million in injuries, fatalities, and aircraft damage per year are the result of convectively-induced turbulence. The FAA is developing an advanced storm prediction algorithm specifically to minimize delays caused by convection. In FY 2010, development extended the prototype forecast over the Continental Unites States (CONUS) and incorporated feedback from users. Additional capabilities include forecasts of precipitation and storm height with 0-2 hour 1 kilometer (5-minute update rate) and 2-8 hour 3 kilometer (15-minute update rate) with forecast and verification contours. Traffic flow managers at the Air Traffic Control System Command Center, as well as users at Air Route Traffic Control Centers, Terminal Radar Approach Control (TRACON) facilities, and several airlines evaluated this capability. Initial feedback has indicated that this new capability provides information that may enhance traffic-flow-management decision-making and thus, capacity and efficiency. The program will complete data analysis and an evaluation report in FY 2011. Future enhancements by FY 2016 will include probabilistic forecasts out to 18 hours and extend the domain over oceanic regions. (Weather Program)

### Rapid Refresh Weather Forecast Model:

In-flight icing, turbulence, convective weather, and low ceilings and visibility affect both the capacity and safety of the NAS on a daily basis. Timely and precise forecasts of these aviation-specific weather hazards require forecast models that are not only accurate and updated frequently, but also easily enhanced as research advancements become available. In 2010, development of the Weather Research Forecast (WRF) model with a 1-hour update rate was completed and transitioned to NOAA for operational implementation. Also known as the WRF-Rapid Refresh (RR), this version of the WRF model provides 13 kilometers resolution, short-range weather model forecasts out to 18 hours, as well as 1-hour background forecasts for a high frequency, three-dimensional objective analysis over all of North America. The FAA will use the WRF-RR output as input for developing aviation weather applications that produce weather hazard forecasts. Future enhancements by 2016 will include probabilistic forecasts and evolving to a global rapid refresh, updated hourly. (Weather Program)

### Multimodal Transportation in Coastal Mega-Regions:

The ACRP – Capacity Program developed integrated strategic actions to enhance decision-making to address the constrained aviation system capacity and growing travel demand in the high-density, multi-jurisdictional, multimodal, coastal mega-regions along the east and west coasts. Transportation agencies and operators, as well as public officials at the federal, state, and local levels will use the research results. (ACRP)

### Automated People Mover System at Airports:

The ACRP – Capacity Program prepared a comprehensive guidebook for planning and implementing automated people mover (APM) systems at airports. The guidebook includes a Compact Disc Read Only Memory with interactive tools designed to assist airports to plan and implement an APM system. The scope of this research includes APM systems that provide transportation on airport grounds as well as access to remote facilities (e.g., airport parking, car rental facilities, hotels, off-airport public transportation, and other related activity centers). (ACRP)

### Airport Parking Strategies:

The ACRP – Capacity Program developed a handbook that airport operators can use to assess the impacts on airport access due to constrained public and/or employee parking. For airports where constrained parking exists or is expected, the handbook provides guidance on how to quantify the impacts of potential changes in airport customer and employee access resulting from strategies such as changes in parking rates, the provision of new or improved public or private transportation services, and the introduction of remote parking facilities. The handbook allows airport operators to better understand, anticipate, and evaluate changes in airport parking strategies at airports, where constrained-parking exists or is expected. (ACRP)

### Managing Small Airports:

The ACRP – Capacity Program developed a practical, easy-to-use guidebook for managing small airports. Owners, operators, managers, and policy makers of small airports will use the guidebook. The guidebook (1) identifies fundamental management principles, (2) identifies best practices for effective use and management of resources and facilities, and (3) presents the information in an attractive, convenient format. A major element of this research is the identification of best practices that achieve safe and efficient operations while maintaining compliance with regulatory requirements and federal obligations. (ACRP)

### Airport Marketing:

The ACRP – Capacity Program developed a guidebook for small airport marketing, external communications, and public information. The guidebook describes effective airport marketing practices, provides guidance for their use, and assists airports in developing an airport marketing strategy. (ACRP)

### Performance Measurement for Airports:

The ACRP – Capacity Program produced a practical, user-friendly guidebook that: (1) assists airport management in understanding the practical benefits of a performance-measurement system; (2) identifies methods to help airports discern how well they are meeting their customer and stakeholder expectations; (3) guides the development and implementation of the most appropriate performance-measurement system; and (4) provides examples of key performance indicators, and how to incorporate them into a system. Performance-measurement systems resulting from this guidebook enhance the airport's decision-making process to improve service and efficiency. (ACRP)

**The Airport and Airline Relationship:**

The ACRP – Capacity Program developed a resource manual for airport and airline professionals that: (1) describes the current range of practices and characteristics of airport and airline relationships and their relative, underlying airport and airline business models; (2) identifies and briefly summarizes rates and charges policies and guidance; (3) identifies, compares, and contrasts airport and airline critical issues, objectives, and considerations inherent in airport and airline agreements or other business arrangements; and (4) identifies and synthesizes the trade-offs and linkages among the critical issues as they relate to common objectives for airport and airline negotiations. Airports have a complex relationship with the airlines and airport tenants particularly at larger airports. This report will provide practical guidance to airports when negotiating with airlines. It will help airports meet their obligations to the FAA to be self-sufficient yet ensure that airline fees are reasonable. Maintaining this cooperative relationship is important in this era of deregulation to ensure airlines continue to service the airport and do not affect capacity by pulling out of the airport on short notice to service airports with more attractive rates and charges. (ACRP)

The magnitude of the R&D Target represents a substantial stretch goal for researchers. Although R&D programs conduct research that will provide important improvements in capacity and efficiency, the improvements provided by these efforts will not be enough to meet the target. Measuring improvements is difficult, and the programs are working to determine how much improvement will result from the research. The Wake Turbulence Program is furthest along and plans to validate an estimated 5-10 percent improvement in capacity by 2016. During the next five years, NextGen – Wake Turbulence research will develop additional wake turbulence mitigation processes to enable NextGen-era ATC operations. It will define a solution space that accomplishes these operations with equal or increased levels of wake encounter safety and provides technology solutions that increase capacity. The Weather Program is working to improve the quality of convective weather forecasts that support aviation strategic planning at 4 and 6 hour lead-times by reducing over and under forecasting by 2 percent, while also increasing the critical success index by 1 percent. Ultimately, to achieve measurable progress towards goals, improved weather information as a result of forecast improvements will need to be translated into impacts that support enhanced ATM decision-making. By 2016, the capacity and efficiency evaluation under Goal 9 – System Knowledge plans to validate solutions that meet the forecasted demand for 2025*, that based on the current forecast, is 58 percent higher than the year 2004. This means that current efforts to increase capacity and efficiency will produce improvements, but not at the level needed to meet the R&D Target. The FAA is working to define new goals and metrics that may replace the R&D Target for this R&D Goal next year.

* Federal Aviation Administration *Terminal Arec* http://www.faa.gov/data_research/aviation/aerospace_forecasts/2010

# R&D Goal 2

# 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 (despite growth) in a cost-beneficial way, make progress toward achieving carbon neutral growth by 2020 from a 2005 baseline, and reduce uncertainties in particulate matter and non-carbon dioxide (CO2) climate impacts to levels that enable appropriate action.

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 2

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| -- | Airport Cooperative Research - Environment | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 100% of total program |
| | Airport Technology Research - Environment | AIP | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 100% of total program |
| A13.a | Environment and Energy | R,E&D | 15,327 | 14,505 | 14,293 | 14,384 | 14,677 | 100% of total program |
| A12.a | Joint Planning and Development Office | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | R,E&D | 20,523 | 19,743 | 19,623 | 19,833 | 20,263 | 100% of total program |
| 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | F&E | 15,000 | 10,000 | 10,000 | 10,000 | 10,000 | 100% of total program |
| 1A08F | NextGen - Operational Assessments | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| | | **Total** ($000) | 57,350 | 50,748 | 50,416 | 50,717 | 51,440 | |

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

# 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. (Environment and Energy; Airport Cooperative Research - Environment) **[COMPLETED]**

**2011**: Establish the relationship between aviation engine exhaust and the gases and particulate matter that are deposited in the (NextGen - Environmental Rese Aircraft Technologies, Fuels, and

**2012**: Expand noise data collection to jets and supersonic aircraft. (En and Energy)

**2012**: Initiate a project to study aircraf annoyance data and sleep distur around airports. (Airport Techn Research – Environment)

**2013**: Obtain direct measurements of h air pollutants and particulate ma update modeling tools. (Enviror and Energy)

## Threshold levels

**Determine acceptable lev emissions.**

**2010**: Develop new standards a to quantify and assess th noise and aviation emiss and Energy; Airport Coo Environment) **[COMPL**

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

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

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

**2011**: Investigate feasibility of aircraft noise and emissi (Environment and Energ

## Prediction

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

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

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

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

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

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

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

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

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

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

## Reduction techniques

**Develop noise and emission reduction methods.**

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

**2010**: Develop algorithms to optimize ground and airspace operations by leveraging communication, navigation, and surveillance technology in the short- to medium-term to optimize aircraft sequencing and timing on the surface and in the terminal area. (NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction) **[COMPLETED]**

**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) **[COMPLETED]**

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

**2013**: Identify and pursue the development of engine and airframe technologies that will be the most effective at producing environmental benefits. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

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

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

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

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

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

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

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

# Environmental Management

**Develop environmental management system for the NAS**

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

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

# Progress in FY 2010: Clean and Quiet

Both the FAA *Flight Plan* and *NextGen Implementation Plan* recognize the importance of making air transportation cleaner, quieter, and more energy efficient to support greater mobility while reducing aviation's impact on our environment. The FAA R&D portfolio supports this R&D Goal and its R&D Target: by 2016, demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (despite growth) in a cost-beneficial way, make progress toward achieving carbon neutral growth by 2020 from a 2005 baseline, and reduce uncertainties in particulate matter and non-CO2 climate impacts to levels that enable appropriate action.

Over the past five years, the FAA conducted research to reduce the impact of airports and aircraft operations on the environment, reduce aviation's energy footprint, and advance deployment of sustainable alternative fuels. In addition, the FAA conducted research to measure particulate matter and hazardous air pollutants on airports resulting from aircraft operations. It also investigated deicing and anti-icing fluids, first trying to develop alternative, more environmentally-friendly fluid formulations and then studying methods that efficiently use, treat, and dispose of the fluids.

## Results achieved in 2010 include:

**Baseline Measurement:**

One of the accomplishments of the ACRP component of the Environmental Program was gathering data and developing a robust estimate of deicing chemicals used today and determining how use may vary by geographic location and seasonal weather characteristics. In addition, the research gathered and summarized information on existing regulatory requirements that directly address the potential discharge of deicing runoff to comply with the Clean Water Act. Full implementation of these existing programs sheds important light on the potential effect of related controls and environmental threats. This information will help direct future assessment of potential environmental impacts from airfield and aircraft deicing materials. (ACRP)

**Prediction:**

One of the accomplishments of the ACRP component of the Environmental Program was improving the ability to evaluate noise generated by aircraft ground operations, allowing airport staff, airport planners, and consultants to systematically incorporate taxiway noise modeling in their evaluations when needed. This capability will increase the accuracy of airport noise modeling, thus improving chances of identifying significant noise impacts and incompatible land-uses and addressing appropriate mitigation strategies. This research will enable a joint assessment of both noise and air quality, resulting in more balanced and comprehensive decisions in airport planning. (ACRP)

### Aviation Environmental Design Tool (AEDT):

The Environment and Energy Program enhanced AEDT's integrated aviation noise, emissions, and fuel burn analysis capability and achieved major development milestones. Key improvements include new regional modeling capabilities that will enable environmental review of airspace redesign projects and representation of high fidelity weather for improved fuel burn analyses. We released two "beta" versions of AEDT to the Design Review Group (DRG) for testing and evaluation. The DRG feedback is helping improve and guide further AEDT development. These advances will enable release of the AEDT-regional model in 2011 and a public version in 2013 for integrated airport environmental analyses. These AEDT releases will ultimately replace legacy environmental analysis tools. By 2016, we will have enhanced AEDT capabilities to enable integration with NAS-wide models for NAS-wide environmental analyses and to support decision-making. (Environment and Energy)

### Assessing the Impact of Aviation:

During FY 2010, the FAA developed preliminary estimates of the impact of cruise-altitude aircraft emissions on surface air quality. Generally, researchers quantify aircraft contribution to surface air quality using aircraft emissions between the surface and 3000 feet, known as the Landing and Takeoff (LTO) cycle. However, approximately 90 percent of the aircraft fuel combustion occurs at cruise altitude, leading to the release of NOx and sulfur oxide emissions. These emissions may also potentially affect surface air quality. Results from this work helped inform the U.S. position on NOx emissions stringency at the Eighth Meeting of the International Civil Aviation Organization Committee on Aviation Environmental Protection (ICAO/CAEP) and achieve the most ambitious standards ever implemented. The FAA continues to refine its analyses to reduce uncertainties and inform U.S. policy on reducing aircraft emissions and the role of altitude emissions. (Environment and Energy)

### Algorithms to Optimize Ground and Airspace Operations:

In FY 2010, the FAA developed algorithms for optimized ground and en-route operations and plans to demonstrate these algorithms in pilot studies. In particular, researchers are demonstrating an N-control optimization algorithm for surface operations at Boston Logan airport, and we are exploring options to implement and test this algorithm in other airport settings. Researchers tested algorithms for optimized en-route procedure at the FAA Technical Center in Atlantic City. Thus, research is valuable as aircraft taxiing contributes to fuel burn and emissions at airports, and growing en-route air traffic in congested areas is a source of additional environmental impacts. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

**Drop-in Potential of Alternative Fuels:**

In FY 2010, the FAA worked with other federal agencies and stakeholders to demonstrate the feasibility and environmental benefits of drop-in alternative fuels, fuels that may reduce emissions that contribute to air quality and climate change as well as provide security and price stability for commercial aviation. FAA-funded researchers achieved a major milestone by contributing toward the approval of Fischer-Tropsch by ASTM International and establishing a framework for the approval of additional fuels, completing a groundbreaking study of life-cycle emissions of a wide range of alternative jet fuels, and making progress quantifying other sustainability aspects such as land use and water use. Work continues with ASTM to qualify additional drop-in alternative fuels with a focus on bio-blends. This work will enable availability and deployment of sustainable jet fuels by 2016. (NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics)

Over the past five years, the Environment and Energy Program has made a number of advances, such as advancing sustainable alternative aviation fuels and environmentally-friendly operational procedures that will enable us to demonstrate net reductions of significant environmental impacts and enhanced energy efficiency by 2016, which is critical to enabling NextGen goals.

We have successfully characterized aviation noise and emissions related issues and quantified associated risks that could potentially limit NextGen success. In particular, we have developed advanced models for integrated noise, emissions, and fuel burn analyses to characterize the interdependencies and tradeoffs. These tools are being used for NAS-wide environmental assessments and supporting decision-making through cost-benefit analyses. We have identified a number of mitigation solutions (e.g., advance aircraft and fuel technologies, environmentally and energy efficient operational procedures) and initiated efforts under NextGen funding to mature and implement them. NextGen funding has allowed us to initiate development of EMSs that will dynamically manage NextGen environmental goals and targets. We have also conducted research to support more stringent environmental standards and market-based measures that will supplement potential shortfalls in meeting NextGen environmental goals via technology and operations mitigation approaches.

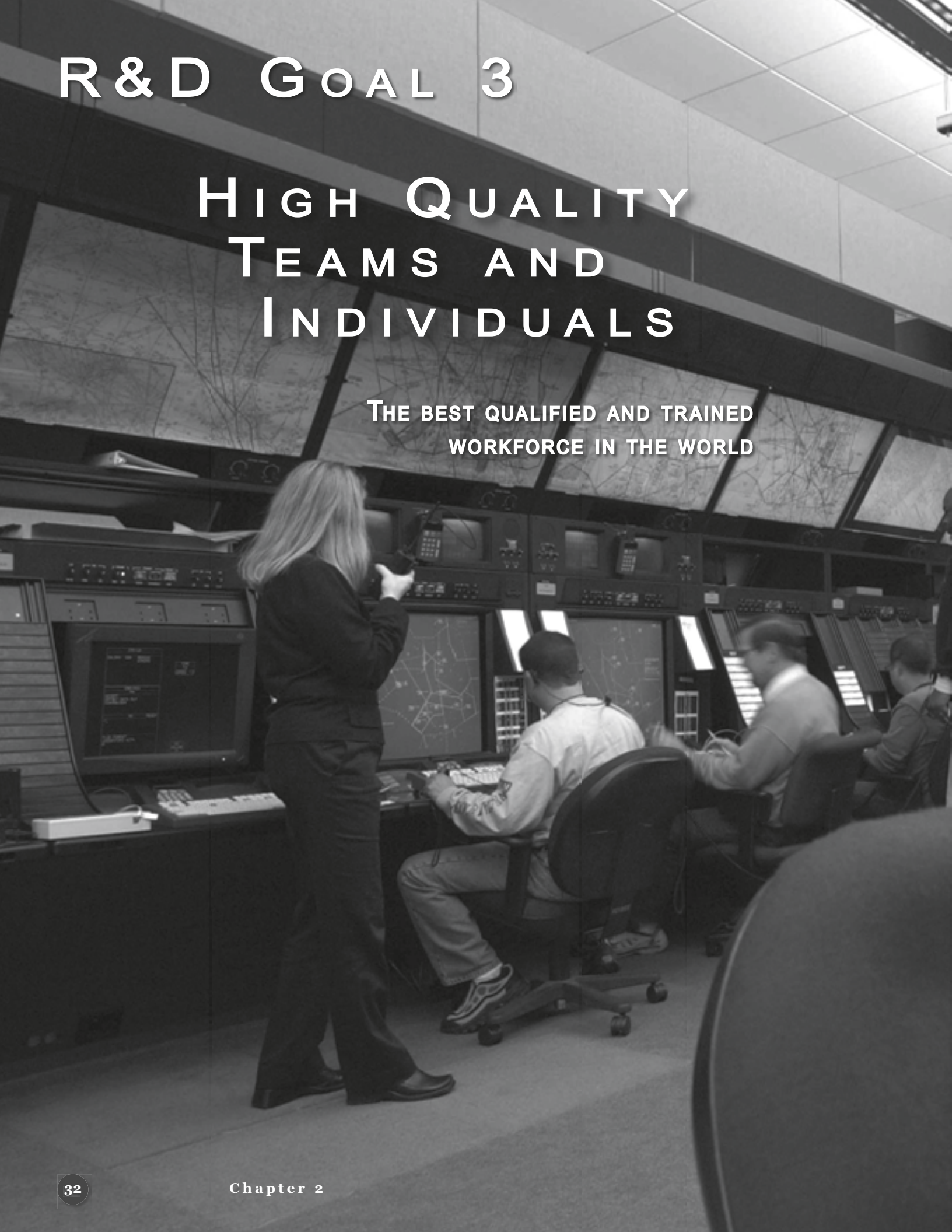
Although there has been substantial progress to date, there are still challenges that need to be addressed to achieve the 2016 R&D Target. Climate impacts of aviation need to be well quantified to inform tradeoffs among emissions and, hence, decisions to develop technologies and critical national and international policies. Characterization of aircraft non-volatile particulate emissions and their environmental impacts is another major area of continuing focus. We also need to characterize noise impacts beyond the currently defined "significant" level of 65 Day Night Level to allow effective mitigation of health and welfare impacts associated with noise exposure. We need to establish the baseline environmental performance of our current aviation system so that we can quantify the benefits and risks from NextGen solutions to inform implementation decisions. We need to demonstrate and mature additional technologies under the CLEEN program. We need to identify and accelerate deployment of sustainable fuels. We also need to conduct the research to enable NAS-wide implementation of NextGen EMS across a range of stakeholders.

The Environment and Energy program is pursuing a comprehensive integrated R&D program. We continue to work to advance our scientific understanding of aviation environmental impacts and pursue a range of mitigation solutions that will contribute towards meeting NextGen environmental goals. We have identified associated risks and are working to address and reduce them. We are on track to meet the environment and energy R&D goals and targets.

# R&D Goal 3

# High Quality Teams and Individuals

## The best qualified and trained workforce in the world



## R&D TARGET

By 2016, demonstrate improvement in ANSP efficiency (e.g., greater number of aircraft) and effectiveness (e.g., improvement of safety metrics) through automation and standardization of operations, procedures, and information.

## METHOD OF VALIDATION

The approach includes continued, incremental pursuit of efficiency gains in the cruise phase of flight and pursuit of new knowledge and results that produce efficiency gains in the arrival and departure phases. Automation and new capabilities added through implementation of operational improvements may provide incremental efficiency benefits, and there are likely interactions among these capabilities; however, human performance modeling and human-in-the-loop testing will help verify specific benefits accrued, including the effects of a mixed equipage environment. The program will examine the roles of controllers and maintainers at increased capacity levels. It will determine how to support those roles through the allocation of functions between human operators and automation, enhancing safety and minimizing the potential for human error while increasing efficiency. This goal contributes to the integrated demonstration under R&D Goal 4 - Human-Centered Design.

## FUNDING REQUIREMENTS - R&D GOAL 3

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 10,634 | 10,502 | 10,579 | 10,762 | 11,015 | 100% of total program |
| 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 1,367 | 1,354 | 1,354 | 1,354 | 1,354 | 6% of R&D program in FY 2012 |
| A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.a | Joint Planning and Development Office | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| 1A08A | NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | 100% of total program |
| | | **Total** ($000) | 22,001 | 16,856 | 16,933 | 17,116 | 17,369 | |

## INCREASE TO 130 PERCENT*

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

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

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

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

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

## SELECTION CRITERIA

**Ensure ANSPs have the aptitude and capability required to manage air traffic in the future system. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))**

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

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

## DEMONSTRATE IMPROVEMENTS IN ANSP EFFICIENCY

**Demonstrate improvements in ANSP efficiency achieved by implementation of NextGen ground automation capabilities and aircraft equipage, use of data communications, and implementation of new decision support tools and automation.**

**2010**: Define anticipated controller workload reductions due to implementation of data communications. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)) **[COMPLETED]**

**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/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)) **[COMPLETED]**

**2012**: Improve computer-human interface design to reduce information overload and resulting errors. (Air Traffic Control/Technical Operations Human Factors)

**2013**: Assess the Front Line Manager Quick Reference Guide for effectiveness in aiding ATC safety. (Air Traffic Control/Technical Operations Human Factors)

**2013**: Analyze controller roles in a strategic air traffic environment for the impact on personnel selection and training. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

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

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

**2013**: Demonstrate increased ANSP efficiencies through new procedures that allow ANSP personnel to manage and introduce routing, airspace, and equipage mix changes in the dynamic air traffic environment. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

**2014**: Provide a draft of a revised Human Factors Design Standard for human factors application to ATC system acquisition. (Air Traffic Control/Technical Operations Human Factors)

**2016**: Perform an analysis of controller roles in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

# Progress in FY 2010: High Quality Teams and Individuals

The R&D Goal of High Quality Teams and Individuals supports the goals of greater capacity and increased safety in the *Flight Plan* and for NextGen. The R&D Target is, by 2016, demonstrate improvement in ANSP efficiency (e.g., greater number of aircraft) and effectiveness (e.g., improvement of safety metrics) through automation and standardization of operations, procedures, and information.

The research program started in 2005 with the first iteration of the Future En Route Workstation (FEWS). A demonstration of FEWS followed in 2006, and the FEWS effort continued with refinements and expanded research into advanced workstation concepts. In 2006, the program initiated advanced controller workstation concepts in the tower domain. In 2007, a substantial effort in the TRACON environment for an advanced controller workstation began through enhancements of laboratory infrastructure followed by human factors concept development and high fidelity simulations. The FAA is adopting and implementing products of these research efforts in acquisition programs such as the En Route Automation Modernization (ERAM) system. Specific characteristics of FEWS are evident in various versions of ERAM that are in the acquisition or planning process. The results of tower and TRACON research similarly aided development of data communications (DataCom) during various acquisition phases. These results demonstrate that the human factors research program is focused on the concept of "research to practice" to assure that the program has a measurable and positive impact on operations.

## Results achieved in 2010 include:

### Defined Anticipated Controller Workload Reductions due to Implementation of DataCom:

In 2010, researchers completed initial investigations into application of DataCom in the TRACON domain. Researchers introduced DataCom to the workstation as a total package that may represent the 2018 environment. It included area navigation (RNAV) routes and arrival procedures in the terminal area and decision support tools that may be representative of NextGen improvements in the mid-term. Results show that DataCom can enhance controller performance (e.g., number of aircraft handled in the arrival sector) and reduce workload; however, the major improvement resulted from introduction of RNAV routes. These routes improve the utility of DataCom. When used together, RNAV routes and DataCom improve human-system performance substantially. DataCom potentially can improve the performance and utility of decision support tools by making them more accurate, which in turn decreases controller workload. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

**Defined Initial Requirements and Anticipated Efficiency Benefits for Merging and Spacing Decision Support Tools to Support Continuous Descent Approach in the Terminal Area:**

The program completed two merging and spacing efforts in the terminal environment in 2010. The first used a detailed approach to address human factors requirements for optimized profile descents and integrated arrivals and departures. This was an important step in the analysis of proposed improvements to controller tasks and culminated in the development of human-system integration requirements. The second effort was imbedded in the FEWS simulation to evaluate the proposed use of decision support tools for merging and spacing. Included was conformance monitoring for adherence to routings such as the various types of continuous descent approaches. Researchers learned that use of such tools requires that conformance monitors and other alerting functions need a very low nuisance alarm rate to build a sense of trust in the automation. They also determined that the use of support tools would only be effective if the controller perceives that the tool provides a performance benefit. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

There is a substantial challenge to meet the 2016 target of improving controller efficiency and effectiveness. The program must adequately define the effective use of automation to enhance human-system performance. As the level of automation in the NAS increases, the human factors research program will seek to address the proper roles and responsibilities of air traffic controllers in a highly automated NAS as well as specific human factors requirements for automation that augment or replace controller tasks. Off-nominal scenarios and automation failures are significant areas of concern. These will require proper identification of the anomaly, maintenance of situation awareness, and the ability of controllers to maintain safety under degraded automation modes. This R&D Target is on schedule to be met by 2016.

# R&D Goal 4

# 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, ATC productivity tools, and network-enabled collaborative decision-making to increase capacity, reduce delays, and promote safety.

## FUNDING REQUIREMENTS - R&D GOAL 4

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| -- | Airport Cooperative Research - Capacity | AIP | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 | 34% of total program |
| A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 6,162 | 6,070 | 6,107 | 6,209 | 6,354 | 100% of total program |
| A12.a | Joint Planning and Development Office | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.c | NextGen - Air Ground Integration Human Factors | R,E&D | 10,545 | 10,117 | 10,043 | 10,144 | 10,363 | 100% of total program |
| 1A08A | NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.h | System Safety Management | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.k | Weather Program | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 3,777 | 3,740 | 3,772 | 3,839 | 3,931 | 100% of total program |
| | | **Total** ($000) | 22,184 | 21,627 | 21,622 | 21,892 | 22,348 | |

# Milestones

## Roles and responsibilities

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

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

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

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

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

## Human system integration

**Define human and system performance requirements for design and operation of aircraft and ATC systems.**

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

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

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

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

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

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

## Error management

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

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

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

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

## Integrated demonstrations

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

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

# Progress in FY 2010: Human-Centered Design

The R&D Goal of Human-Centered Design supports the goal of increased safety in the *Flight Plan*. The R&D Target is, 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.

Continued improvement of human-system integration is a priority due to the lightning speed of technological advances. In 2006, the program updated the Human Factors Certification Job Aid with Part 25 Advisory Circulars (ACs) and information on design of flight deck equipment, tasks and procedures, and testing assumptions. The job aid helps the FAA and industry minimize the likelihood of design-induced human performance errors. In addition, the program developed practical customized assessment tools to help FAA certifiers and inspectors, system designers, and operators standardize and streamline evaluations of electronic flight bags (EFBs). Research continued in 2007 with expansion of the Certification Job Aid to include Part 23 flight decks. With this research complete, the tool became available to the aviation community through the Technology Transfer Program, and the program created a commercial website application to increase distribution and use. Also in 2007, the program distributed findings on simulator platform motion and its impact on pilot performance during specific maneuvers to the scientific community. In 2008, the program completed research to support an update to aerospace industry recommended practices on electronic symbols, used by industry to demonstrate means of compliance with FAA regulations. In 2009, researchers completed a study addressing non-alert symbology for Airborne Separation Assurance Systems to assist RTCA SC-186 CDTI Working Group in addressing non-concurrence in the preliminary Minimum Operational Performance Standards (MOPS) document. In addition, countermeasures to crew multi-tasking were developed and the *Aviation Maintenance Safety Action Program Maintenance Program Development* handbook was completed.

## Results achieved in 2010 include:

### Identifying Equipment Categories for Avionics in Preparation for Human Factors Evaluations of NextGen:

The FAA initiated a study to identify requirements for participating in the NextGen environment and to assess the existing fleet of U.S. air carrier aircraft and flight deck avionics to determine their capabilities in light of NextGen requirements. Current avionic systems have performance capabilities that NextGen could leverage using complex operational procedures, but system designers did not necessarily include provisions for such complex procedures when designing the user interfaces for these systems. Present research focuses on human performance concerns associated with use of existing Flight Management Systems (FMSs) and associated flight deck displays in NextGen procedures to identify mitigations and implications for aircraft certification. Data collection is complete and analysis is underway. A technical report addressing human factors issues will follow. (NextGen - Air Ground Integration Human Factors)

### Electronic Flight Bag Technologies and Interfaces:

Researchers helped the FAA address human factors issues related to EFBs and supported development of EFB-related policies and guidance. The program conducted research to understand human factors issues related to implementation and integration of EFBs in normal flight operations. Two draft checklists for use during the review of EFB installations summarize the results. Researchers also published a technical report that identifies EFB issues, provides guidelines for integration of EFBs in operations, and examines EFB related safety reports from the public Aviation Safety Reporting System and the National Transportation Safety Board (NTSB). (Flightdeck/Maintenance/System Integration Human Factors)

### Airport Map Displays:

Researchers are working to understand what additional guidance and approval criteria are needed to establish minimum standards and best practices to support flight deck integration of surface moving maps depicting ownship position. Several advanced functions are under consideration, including display of surface traffic and alerts of potential runway incursions. Researchers conducted usability evaluations of three surface moving map software applications and identified potential human factors concerns in design. They provided technical support to an evaluation of the impact of a Surface Moving Map with ownship position on a Class 2 or Class 3 EFB. They also recorded observations to identify areas that may need human factors guidance to support development of MOPS for surface conflict detection and alerting. (Flightdeck/Maintenance/System Integration Human Factors)

### Proactive Audit Approach to Support Safety Management System in Airline Maintenance and Ramp Operations (LOSA):

Researchers are proactively studying airline maintenance and ramp operations during normal situations to develop Maintenance and Ramp Line Operations Safety Audit (LOSA) processes. LOSA is a formal process where trained observers collect safety-related data on maintenance performance in a non-jeopardy environment. Information obtained via LOSA provides the maintenance organization a diagnostic snapshot of safety strengths and weaknesses. Proactive approaches, as opposed to post accident and event investigation, align with the principles of risk management and Safety Management System (SMS). The research team refined and finalized maintenance and ramp LOSA forms and procedures and assisted with creation of LOSA training materials. The team also completed tests of the forms and training materials with the assistance of industry personnel. The program will conduct a LOSA beta test with the Air Transport Association's Human Factors Committee and Alaska Airlines. (Flightdeck/Maintenance/System Integration Human Factors)

### A Multi-Disciplinary Approach to Fatigue Risk Management in Aircraft Maintenance – Near Term and NextGen Time Frame (Maintenance Fatigue):

Current maintenance fatigue management processes used by Transport Canada, Australian Civil Aviation Safety Authority, European Aviation Safety Agency, and other regulatory organizations were analyzed and best practices were selected and evaluated in a prototype Maintenance Fatigue Risk Management System (RMS). The international best practices for fatigue risk management were documented in a technical report. In addition to providing the framework for a U.S. RMS in maintenance fatigue, researchers developed prototype versions of each of the fatigue management tools proposed in the prototype system. The program will test the prototype systems against the fatigue research knowledge and the airline and maintenance operations to ensure that the systems can effectively manage maintenance fatigue. The program has also developed and distributed fatigue awareness materials, including a maintenance fatigue website, fatigue survival toolbox, hangar posters, and a maintenance fatigue newsletter. (Flightdeck/Maintenance/System 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 of incorporating synthetic vision system (SVS) features into primary-flight and/or multi-function displays. Researchers conducted a literature survey to determine existing guidelines and standards for the design and use of pictorial imaging displays, including SVS, enhanced vision system (EVS), and primary flight displays. The survey also identified available data for both display design and human performance not captured in a guideline or standard. The team conducted a literature, industry, and product review, and developed a checklist summarizing human factors issues between SVS and EVS characteristics and pilot performance. They identified a number of references, documents, and guidelines that had direct or indirect bearing on human factors considerations involved in SVS, EVS, and primary flight displays. (Flightdeck/Maintenance/System Integration Human Factors)

### Automatic Dependent Surveillance - Broadcast:

This research supports the FAA in understanding human factors issues related to use of CDTI based on ADS-B and other aircraft surveillance applications systems. At issue is the question whether symbols for CDTI should be required to match symbols used for the Traffic Alert and Collision Avoidance System (TCAS) and whether CDTI should use the same "symbol-fill" as TCAS to represent the proximity of the target in range and altitude. Additional questions concern the value of the proximate status indication to pilots. Researchers examined the proximate status indication by presenting pilots with dynamic traffic simulations with and without the proximate status indication. Preliminary findings indicated that the proximate status indication did not improve the consistency of pilot ratings of traffic threat level and did not improve the consistency of pilot ratings of their ability to acquire the target visually. Additionally, results suggest that pilots use the proximate status indication to prioritize their attention. Additional analyses are ongoing and will be presented to stakeholders in FY 2011. The FAA will consider the results in development of an update to the CDTI Technical Standard Order (TSO). (Flightdeck/Maintenance/System Integration Human Factors)

### Training for Driving Privileges on Airport Airfields:

The ACRP – Capacity Program explored information on the requirements and training for driving privileges on airport airfields, and the similarities and differences between requirements at various airports throughout the country. The report examined information on the types of training programs available to airport employees based on the employee's driving authority and access privileges. There were 175 Runway Incursions caused by vehicles in FY 2010. Each of these is a warning of a potential incident, collision with an aircraft, and loss of life. Large airports have thousands of people with driving privileges on the airport. Each of these individuals is required to have initial and annual recurrent driver training. The ACRP report will make airports aware of new techniques for driver training such as low cost driver training simulators that will improve the driver's understanding of airport signs and markings based on his/her individual airport layout. The driver training simulators will simulate low visibility conditions that are a causal factor in many of the runway incursions. (ACRP)

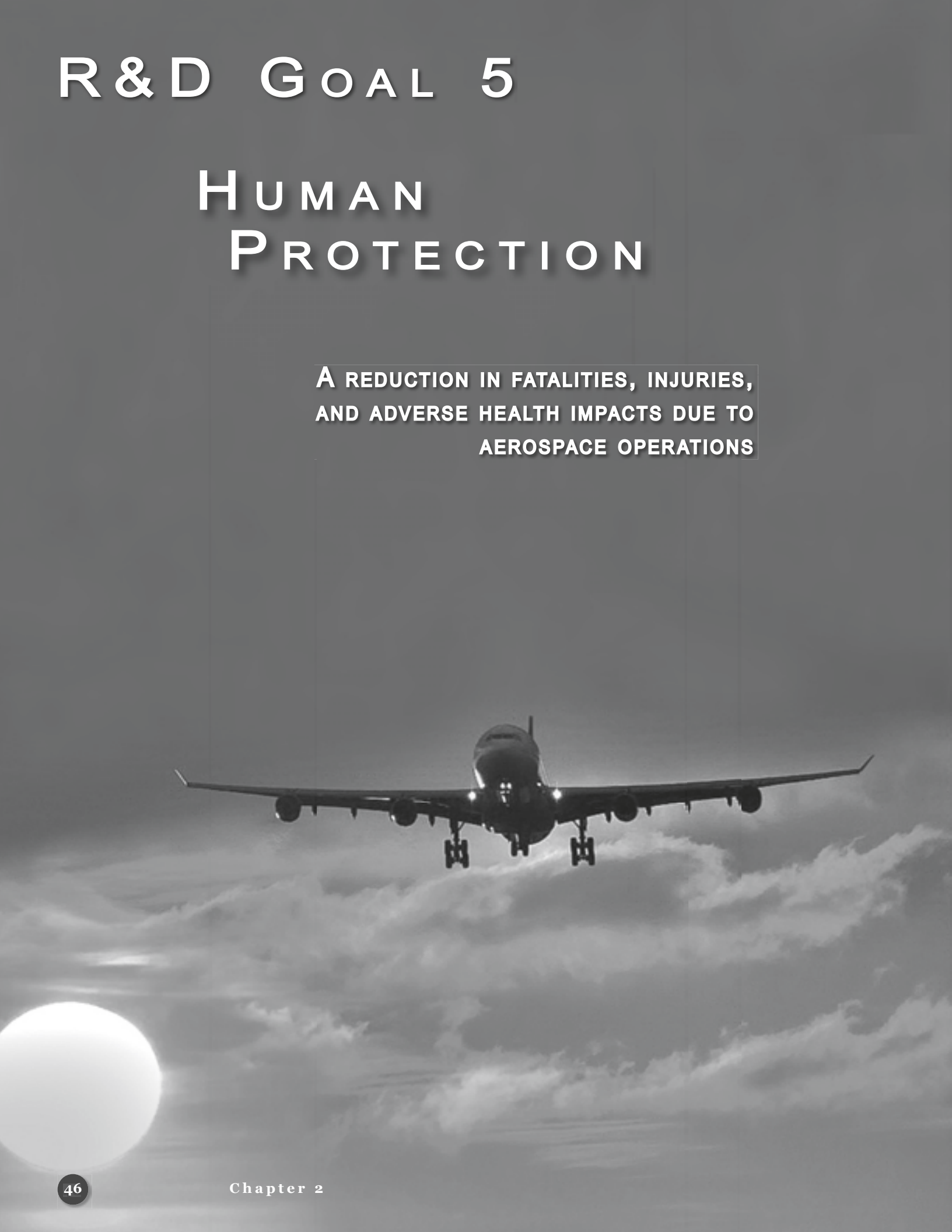
While research is on track to meet meet the FY 2016 target, the integration of air and ground capabilities poses challenges for pilots and the ANSP. Increased levels of automation and new enabling technologies that will likely transform the NAS in the future will bring new human factors challenges. Interoperability with baseline systems and refinement of procedures must accompany transitions of increasingly sophisticated automation and procedures to ensure efficient operations and to mitigate potential automation surprises. 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.

A core human factors issue is ensuring the right human operators receive the right information at the right time to make the right decisions. As NextGen advances, the environment will include an increased reliance on collaborative and distributed decision-making. The system must provide information to participants (e.g., pilots, ANSP, and airline operation centers) in a fashion that facilitates a shared understanding of phenomena (e.g., weather, wake). The system must integrate the format, content, timeliness, and presentation of that information with other information provided to decision makers and automated decision support tools. This changing environment requires a close examination of new types of human error modes to manage safety risk in the human factors domain. The FAA must develop equipment design methods, training, and procedures to decrease error likelihood and/or increase timely error detection (e.g., blunders on closely spaced parallel approaches). To achieve NextGen safety and efficiency gains, changes in roles and responsibilities will occur between pilots and ANSP and between both groups and the automation systems they use. The FAA must understand and address issues such as mode confusion, transitions, and reversions to maintain appropriate levels of situation awareness and workload.

# R&D Goal 5

# Human Protection

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



## R&D TARGET

By 2016, demonstrate a two-thirds reduction in the rate of aerospace-related fatalities and significant injuries.*

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 5

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.c | Advanced Materials/Structural Safety | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.j | Aeromedical Research | R,E&D | 11,617 | 11,420 | 11,477 | 11,662 | 11,933 | 100% of total program |
| A11.d | Aircraft Icing - Atmospheric Hazards/ Digital System Safety | R,E&D | 1,621 | 1,562 | 1,554 | 1,571 | 1,605 | 30% of total program |
| -- | Airport Cooperative Research - Safety | AIP | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 50% of total program |
| -- | Airport Technology Research - Safety | AIP | 5,504 | 5,548 | 5,548 | 5,548 | 5,548 | 35% of total program |
| A11.a | Fire Research and Safety | R,E&D | 6,852 | 6,718 | 6,744 | 6,848 | 7,006 | 84% of total program |
| A11.k | Weather Program | R,E&D | 1,473 | 1,378 | 1,350 | 1,354 | 1,380 | 9% of total program |
| | | **Total** ($000) | 29,567 | 29,126 | 29,171 | 29,482 | 29,972 | |

* This R&D Target uses the same baseline as used in the 2009 *Flight Plan*.

# 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)

**2015**: Establish validation parameters for mathematical models that can evaluate whether aircraft type designs meet requirements for evacuation and emergency response capability, in lieu of actual tests. (Aeromedical Research)

## Turbulence

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

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

**2015**: Transition turbulence forecast capability for all flight levels for implementation.

**2016**: Transition global turbulence forecast capability for implementation.

**2017**: Transition convectively-induced turbulence forecast capability for implementation.

## Hazardous weather

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

**2014**: Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content (HIWC) environments. (Aircraft Icing – Atmospheric Hazards/Digital System Safety)

## Occupant restraint

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

**2014**: 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. (Airport Technology Research - Safety)**

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

## Cabin air quality

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

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

**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.

**2014**: Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants.

**2014**: Apply and validate advanced air sensing technology for VOCs in the aircraft cabin environment.

**2015**: Develop bleed air contamination models of engine compressors and high temperature air system for effects on the health and safety of passengers and crew.

## Commercial space

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

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

## Human aeromedical safety and health risk management

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

**2012**: Assess role of airports and airlines in the spread of vector-borne diseases. (Airport Cooperative Research - Safety)

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

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

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

**2016**: Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors. (Aeromedical Research)

# Progress in FY 2010: Human Protection

Safety remains the highest priority of the Agency. The FAA *Flight Plan* has the primary goal to increase safety, achieving the lowest possible accident rate and constantly improving safety with the objective to reduce by half the rate of commercial air carrier fatalities. This R&D Goal supports the human protection element of increased safety with the R&D Target: by 2016, demonstrate a two-thirds reduction in the rate of aerospace-related fatalities and significant injuries.

Since 2006, aeromedical research has produced strategies to protect pilots and passengers by conducting medical data analysis, analyzing the effects of medications and other substances on pilots, identifying biomarkers to assess environmental stressors (fatigue, alcohol, hypoxia), developing medical certification criteria, assessing the injury potential of side-facing seats, improving airliner exit signs and passenger briefing materials, and demonstrating evacuation models. Fire and airport safety research has delivered new materials, testing procedures, and equipment that have lowered the incidence of on-board fires, mitigated the severity of fires, and provided passengers and crew with precious time to escape the consequences of post-crash fires.

## Results achieved in 2010 include:

**Fast Fluid Dynamics Model:**

The Airliner Cabin Environment Research (ACER) Program validated computational models of chemical air contaminants, such as volatile organic compounds, used to evaluate health and safety impacts on passengers and crew. Further study will examine the performance of these advanced models for different cabin airflow conditions. (Aeromedical Research)

**Aircraft Cabin Contaminants:**

The program developed methods to detect and analyze aircraft cabin contaminants including chemical-biological and other airborne hazards. Sampling resulted in positive detection of rhinovirus, influenza A and influenza B, and corona virus. In addition, sampling and analysis found pathogens on aircraft, including bacillus anthraces, pseudomalli, salmonella, E coli, klebsiella pnumoniae, acinetobacter baumannii, clostridium botulinum (non-human types), mycobacterium tuberculosis, rickettsia, staphylococcus aureus, and streptococcus pneumoniae. Researchers measured ozone and found it to be moderate to high on domestic flights without ozone converters. They also found elevated ozone levels on transoceanic flights equipped with ozone converters. This study helps to identify contaminants that could affect crew and passenger health and safety and will help lead to mitigation strategies. (Aeromedical Research)

### Aviation Child Restraint Certification:

Development of Child Restraint Systems (CRSs) to meet the existing aviation performance standards, TSO-C100b and Society of Automotive Engineers SAE-AS5276/1, has proven challenging. The existing test requirements call for a combination of worst-case belt anchor location, belt tension, and seat cushion properties and dimensions that were typical at the time of the original specifications. These parameters may no longer be representative of the majority of current aircraft seats. Difficulties meeting the standards based on this configuration may be inadvertently hindering the availability of CRSs with improved performance. The FAA Civil Aerospace Medical Institute (CAMI) has evaluated the test parameters to determine if revision of TSO-C100b could improve the relevancy of the tests while maintaining the same level of safety. The parameters identified for potential revision were the lap belt anchor location, seat pan dimensions, and the CRS installation procedure. The review of FMVSS-213 identified some requirements applicable to Aviation Child Safety Devices (ACSDs) not addressed by TSO-C100b or SAE AS5276/1, and some addressed by those standards but in a different way. Incorporating the applicable FMVSS-213 requirements cited in this review into the aviation standards should provide the same safety benefits for ACSDs as intended for the automotive CRSs for which the requirements were developed. Using applicable automotive requirements would also allow ACSD users to benefit from the extensive research that went into the development of those requirements. DOT report (in press) *Aviation Child Safety Device Performance Standards Review* by DeWeese R.L., et al. (Aeromedical Research)

### Performance of Evacuation Slides at Altitude:

A cooperative research program between CAMI and the aviation industry assessed the technical specifications for emergency evacuation slides and life vests that require operational capability at airport altitudes, ranging from 1,000 feet to 15,000 feet above sea level. The study's findings confirmed the regulatory language concerned with human safety. (Aeromedical Research)

### Alcohol and Drug Use in Fatal Aviation Accidents:

The study assessed alcohol and drug use in fatal aviation accidents. Data was extracted from the FAA forensic toxicology database for all pilots who died in an aviation accident from 2004 to 2008. The results of this study allow investigators to examine trends and enhance strategies to improve aviation safety. DOT report (in press) *Substances Present in Civil Aviation Pilot Fatalities from Aviation Accidents During 2004-2008* by Canfield D.V., et al. (Aeromedical Research)

### Illumination of Aircraft at Altitude by Laser Beams:

The study examined the frequency of aviation-related laser incidents by altitude of occurrence. The study analyzed 2,492 reported events during the period from 2004 to 2008. The results will aid the development of educational materials and other risk management strategies. DOT report (in press) *Illumination of Aircraft at Altitude by Laser Beams: A 5-year Study Period (2004-2008)* by Nakagawara V., et al. (Aeromedical Research)

### Medications: Postmortem Toxicological Findings:

The study analyzed the use of any medication reported by pilots during physical examinations in comparison with postmortem toxicological findings. A total of 234 cases were considered, addressing fatalities occurring during 2008. The results of this research will enhance accident investigation and medical certification decision-making processes. Abstract *Comparison between Pilot Medications Reported During their Physical Exam and CAMI's Postmortem Toxicological Findings* by Flores, K., et al. (Aeromedical Research)

### Distribution of Oxycodone in Postmortem Fluids and Tissues:

A study conducted by CAMI scientists evaluated the distribution of oxycodone, a heavily used and abused analgesic (painkiller) agent, in postmortem specimens collected from fatal aviation accidents. The study developed improved solid-phase extraction and gas chromatography/mass spectrometry methods in support of accident investigation efforts. DOT/FAA/AM-10/11, *Distribution of Oxycodone in Postmortem Fluids and Tissues* by Botch S.R., et al. (Aeromedical Research)

### Identification of Fatigue Biomarkers:

Researchers completed a study on the effects on gene expression due to 36 hours of sleep deprivation. This research effort involved collaboration with the U.S. Air Force (Brooks Air Force Base). Results identified a set of high-probability biomarkers for sleep deprivation that will support the development of Fatigue Risk Management Systems. (Aeromedical Research)

### Epoxy-Graphite Composite Aircraft:

New epoxy-graphite composite aircraft raise fire safety concerns related to hidden in-flight fire and fuel tank flammability. Research developed a new flammability test method to ensure that a composite fuselage does not present a greater risk than a conventional aluminum fuselage during a moderately severe hidden in-flight fire in an inaccessible area of the cabin. The test confirmed the availability of composite materials that prevent the spread of flames and lower the risk of uncontrollable in-flight fire. (Fire Research and Safety)

### Composite Wing Fuel Tanks:

Composite wing fuel tanks may have a greater tendency to absorb and trap heat from the sun than traditional aluminum tanks, increasing the risk of fuel tank explosions, while aluminum wing fuel tanks cool down significantly when an aircraft is airborne, causing flammable fuel vapors to condense. Research tested aluminum and composite fuel tanks under identical heating conditions and found that the composite wing tank reached much higher internal (ullage) air temperatures and fuel vapor concentrations than the aluminum tank. Using a wind tunnel to simulate typical flight speeds, research found that both the aluminum and composite wing tanks cooled down rapidly. Results showed a significant increase in flammability exposure of a composite fuel tank compared to a traditional aluminum tank. The FAA will publish a report describing these findings in early FY 2011. (Fire Research and Safety)

Results from research in aeromedical, fire, and airport safety form the basis of advisory circulars and other FAA technical and regulatory documents, appear in various scientific publications, and support the conduct of aircraft accident investigations. Aeromedical research focuses on far-term agency needs, particularly in the fields of functional genomics and bioinformatics, both offering breakthrough technologies and practices essential to the success of safety management systems that involve human operators and the predictive assessment of risk. Far-term fire safety research focuses on development of environmentally friendly and ultra-fire resistant materials and post-crash fire-fighting equipment and technologies. The combined outputs from the programs supporting this goal are on track to reach the R&D Target by 2016. With increasing demands on pilots and crew and rapid changes in aircraft size, material, and components, research in this area will become increasingly important. The challenge is to sustain these research competencies for the far-term, maintaining our nation's world-class status and laboratory capabilities in aerospace medicine, fire safety, and airport technology.

# R&D Goal 6

# Safe Aerospace Vehicles

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

## R&D TARGET

By 2016, demonstrate damage and fault tolerant vehicles and systems.

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 6

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.c | Advanced Materials/Structural Safety | R,E&D | 2,605 | 2,533 | 2,532 | 2,566 | 2,623 | 100% of total program |
| A11.f | Aircraft Catastrophic Failure Prevention Research | R,E&D | 1,502 | 1,438 | 1,425 | 1,439 | 1,470 | 100% of total program |
| A11.d | Aircraft Icing - Atmospheric Hazards/ Digital System Safety | R,E&D | 3,783 | 3,645 | 3,625 | 3,666 | 3,746 | 70% of total program |
| A11.e | Continued Airworthiness | R,E&D | 12,085 | 11,599 | 11,514 | 11,629 | 11,879 | 96% of total program |
| 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 684 | 677 | 677 | 677 | 677 | 3% of R&D program in FY 2012 |
| -- | Commercial Space Transportation Safety | OPS | 500 | 500 | 500 | 500 | 500 | 50% of total program |
| A11.a | Fire Research and Safety | R,E&D | 1,305 | 1,280 | 1,284 | 1,304 | 1,334 | 16% of total program |
| A11.m | NextGen - Alternative Fuels for General Aviation | R,E&D | 2,071 | 1,984 | 1,968 | 1,987 | 2,030 | 100% of total program |
| A11.b | Propulsion and Fuel Systems | R,E&D | 3,611 | 3,474 | 3,452 | 3,489 | 3,565 | 100% of total program |
| A11.l | Unmanned Aircraft Systems Research | R,E&D | 3,504 | 3,373 | 3,353 | 3,390 | 3,463 | 100% of total program |
| | | **Total** ($000) | 31,650 | 30,502 | 30,331 | 30,647 | 31,287 | |

# Milestones

## Engines

### Prevent engine failures.

#### In-flight icing

**2014**: Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content (HIWC) environments. (Aircraft Icing – Atmospheric Hazards/Digital System Safety)

#### Engine and component structures

**2014**: Complete a certification tool* that will predict the risk of failure of turbine engine rotor disks that may contain undetected 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) **[COMPLETED]**

**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)

**2013**: Establish required skills and develop training materials for all second level composite structures knowledge areas (maintenance, inspection, structural engineering, and manufacturing) for operational safety. (Advanced Materials/ Structural Safety)

## Systems

### Prevent accidents due to system failures.

#### Avionics

**2013**: Identify safety issues and propose mitigation approaches when software development techniques and tools are used in airborne systems. (Aircraft Icing – Atmospheric Hazards/Digital System Safety)

#### Flight controls

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

* Design Assessment of Reliability With INspection (DARWIN®)

## Unmanned aircraft

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

**2012**: Determine a set of performance characteristics and operational requirements for sense and avoid (SAA) technologies.

**2013**: Analyze data and identify potential safety implications of system performance impediments of communications latency.

**2016**: Conduct field evaluations of UAS technologies in an operational environment, including SAA, control and communications, and contingency management technologies. The documented results will be used to develop certification and airworthiness standards.

## General aviation

**Reduce GA accidents.**

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

**2016**: Develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded avgas. (NextGen – Alternative Fuels for General Aviation)

## Commercial space

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

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

**2011**: Conduct a study to provide information on the capability, limitations, and considerations for global positioning system (GPS) implementation in space launch and reentry environments, such as Space and Air Traffic Control, which will be used to help determine requirements for GPS usage and future technologies.

**2011**: Conduct a study to identify means of preventing hazards (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically hydrogen peroxide, H2O2, and nitrous oxide, N2O) used in propulsion systems in commercial space applications

**2011**: Conduct a study to provide guidance to the FAA and industry on the use of operational limitations and inspection requirements for suborbital RLVs comprised of composite materials. The results of this study will help to develop effective rules for operations and maintenance for use of composite materials, as they apply to commercial space transportation.

# Progress in FY 2010: Safe Aerospace Vehicles

Safe aerospace vehicles are essential to reaching both the FAA *Flight Plan* objective to reduce in half the rate of commercial air carrier fatalities and the JPDO NextGen goal of a two-thirds reduction in fatalities and significant injuries by 2025. The R&D Target to demonstrate damage and fault tolerant vehicles and systems by 2016 is appropriate for both plans.

Since 2006, FAA sponsored research has provided aircraft manufacturing, maintenance, and inspection sectors with handbooks, tools, prototypes, and procedures that better enable them to comply with FAA regulations. At the same time, the research has improved the knowledge base of FAA regulators regarding the use of new materials (composites, non-halon fire suppressants), new procedures (flammability tests, bonded repairs, guidance on aircraft icing, certification methods for damage tolerance and fatigue of composite airframes, guidance on operation and maintenance of composite materials for suborbital RLVs), and new technologies (unmanned aircraft systems).

## Results achieved in 2010 include:

**Certification Methods for Damage Tolerance and Fatigue of Composite Airframes:**

The program developed a public body of knowledge based on experiences gained over decades of design and operation of advanced composite structures. A working group was used to share information from the major manufacturers of structures made from these materials. The group held workshops in America, Europe, and Asia to gain insight from the experienced professionals in manufacturing, maintenance, and operations that have dealt with these structures during their operational deployment. In addition to the shared information, the research results from this program allowed updates of FAA AC 20-107 revision B and several standard industry references, including Composite Handbook 17. (Advanced Materials/Structural Safety)

**Fire Safety of Lithium Batteries:**

Lithium batteries, including lithium primary, lithium ion, and lithium polymer, have characteristic fire hazards and pose unique challenges related to their safe shipment in aircraft cargo compartments. Research found that aircraft Halon 1301 systems could extinguish lithium-ion battery fires and resulted in a recommendation that operators ship lithium ion batteries in Class C cargo compartments. More research on fireproof containers with venting capability is required for lithium ion battery shipment in the main cargo compartment of a freighter (Class E compartment), which is not required to have a halon system. Lithium primary batteries are a greater fire threat because this type of battery in thermal runaway consists of a metal fire, which halon or other common extinguishing agents cannot extinguish. Research found metal shipping containers recommended by ICAO to be very ineffective because a buildup of pressure causes the lids to deform and fail, ejecting the flammable burning batteries away from the container, which could ignite other cargo. Research is investigating new approaches for safely shipping lithium primary batteries. The FAA needs to conduct more research on lithium polymer batteries, which have far larger quantities of stored energy in one unit as compared to the more common metal cylinder batteries. In 2010, the FAA issued a Safety Alert for Operators that summarized research findings and warned operators of the dangers of lithium battery fires and the actions that can minimize these risks. (Fire Research and Safety)

### Black Box for Commercial Space Transportation Systems:

A "black box" for space systems would provide key data to designers and operators after an anomaly and help prevent a recurrence. Researchers analyzed current FAA aviation black box data collection, operational, survivability and retrieval requirements and reviewed current flight data recorders used on the NASA shuttles. Based on their extensive experience with launch vehicles, they then developed a list of data parameters that would be critical in reconstructing damage or failures of space systems. Using these results, they mapped the derived space systems black box requirements to analogs currently used for commercial aviation. They found that it is possible that current aviation black boxes can be used for first generation commercial space transport systems (specifically RLVs with low maximum velocities and brief times in space) with relatively little modification. Results were presented in the paper *"Black Box" for Reusable Launch Vehicles - Considerations and Potential Flight Test Opportunities,* at the International Association for the Advancement of Space Safety Conference in May 2010. (Commercial Space Transportation Safety)

### Engine Containment Analysis:

In 2010, the program developed a new material model for the LS-DYNA explicit finite element code used for modeling engine fragment impact in aircraft. The model will allow FAA engineers to validate proprietary tools, streamline the certification process, and help mitigate fatalities and injuries when these events occur. It is more accurate at predicting different failure modes than existing models, and the FAA/NASA/Industry LS-DYNA Aerospace Quality Control Working Group that models engine impact and failure events supports the model. In collaboration with NASA, George Washington University, Ohio State University, and the LSDYNA Aerospace Users Group, the program completed development of a failure material model for aluminum 2024 based on plastic flow stress theory. This new model takes advantage of the exponential growth of computing capabilities and leverages inexpensive computer memory by programming actual failure data for various tests. Researchers tested the model and generated the original failure surface. The model is the first to predict multiple failure modes without retuning to the new failure condition. Development and validation of the model, with regularization for aluminum and titanium, is on track for completion in 2013. (Aircraft Catastrophic Failure Prevention Research)

### Turbine Engine Rotor-burst Mitigation:

Uncontained engine failure events release high-energy fragments that can impact and disable critical systems and reduce the airworthiness of the vehicle. When multiple systems are disabled, the potential for an accident increases. System redundancy, separation, and thoughtful component location in the design of an aircraft can make significant improvement in the ability to survive one of these high-energy events. The Aircraft Catastrophic Failure Prevention Program collaborates with Naval Air Warfare Center, China Lake to support the industry by developing a multiple-engine fragment analysis process to minimize this threat. The Uncontained Engine Debris Damage Model (UEDDAM) uses existing military threat analysis tools and supports the certification process with tailored output, matching the certification package requirements in AC20-128. The UEDDAM code has been improved several times though this development based on industry feedback. In 2010, a major revision to UEDDAM was completed (Version 4.0) that allows the use of modular military codes that make UEDDAM compatible with future military code revisions. (Aircraft Catastrophic Failure Prevention Research)

**New Developments in Turbine Engine Component Risk Assessment Software:**

Over the past few decades, a number of uncontained aircraft engine failures have been traced to rare material anomalies in the rotating components of aircraft gas turbine engines. Since the occurrence rates are relatively small, a probabilistic approach is used to assess the risk of fracture including the potential risk reduction associated with non-destructive inspections. The associated risk of fracture can be predicted using DARWIN®, a probabilistic fracture mechanics software code developed by Southwest Research Institute under FAA R&D funding. A new capability for automatic generation of life contours was developed in DARWIN 7.1 for application to two-dimensional finite element models. When the user executes this option, an anomaly of one or more user-specified sizes is automatically placed at each of the nodes in the finite element model. The automatic geometry model process generates a fracture model at each anomaly location, and then the fatigue crack growth lifetime to failure is computed for each model. (Propulsion and Fuel Systems)

**Metallic Materials Properties Development and Standardization (MMPDS):**

The Metallic Materials Properties Development and Standardization (MMPDS) is an effort led by the FAA to continue the Handbook process entitled "Metallic Materials and Elements for Aerospace Vehicle Structures," (MIL-HDBK-5). The Handbook is recognized worldwide as the most reliable source for verified design allowables needed for metallic materials, fasteners, and joints used in the design and maintenance of aircraft and space vehicles. Consistent and reliable methods are used to collect, analyze, and present statistically-based aircraft and aerospace material and fastener properties. Towards this goal, the commercial version of the MMPDS-05 was released April 2010. (Continued Airworthiness)

**UAS Technology Survey:**

Research providers completed a UAS technology survey that encompassed several key technical areas: regulatory study; propulsion technology; SAA technology; command, control, and communication issues; and emergency recovery and flight termination. Each area of study included a technology status and regulatory gap analysis. Draft reports are complete and are in the publication process. (Unmanned Aircraft Systems Research)

The R&D Target to demonstrate damage and fault tolerant vehicles and systems by 2016 has already compelled researchers to push the boundaries of maintenance and inspection technologies for both metallic and composite structures and to develop new fire resistant materials and agents. Yet significant challenges remain as researchers explore prognostic and structural health monitoring systems, advancements in non-destructive inspection techniques on critical engine parts, risk assessment and risk management for small airplanes, and threats to composite aircraft structures while at the service gate and on the flight line. Introduction of UAS and commercial space vehicles into the NAS has generated two new areas of focus. One is airworthiness and operational standards for UAS. The other is effective rules for operation and maintenance of composite materials and nontraditional propellants for commercial space transportation. The key to success is collaboration with industry, academia, and other government agencies. The combined outputs from the programs supporting this goal are on track to reach the R&D Target by 2016.

# R&D Goal 7

# Separation Assurance

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

## R&D TARGET

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

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 7

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.a | Joint Planning and Development Office | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.d | NextGen - Self-Separation Human Factors | R,E&D | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | 100% of total program |
| 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| | | **Total** ($000) | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | |

# Milestones

## Surface/runway operations awareness

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

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

**2014**: Evaluate and recommend minimum display standards and operational procedures for use of 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

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

**2011**: Complete initial research to evaluate the impact and potential risks associated with use of TCAS in NextGen procedures.

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

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

## Delegated separation

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

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

**2015**: Enable reduced and delegated separation in oceanic airspace and en route corridors.

# Progress in FY 2010: Separation Assurance

This R&D Goal and R&D Target support NextGen operational improvements (OIs) while maintaining the safety and capacity goals of the *Flight Plan*. The R&D Target is to develop initial standards and procedures for self-separation by 2016.

The NextGen – Self-Separation Human Factors Program develops human factors scientific and technical information to implement NextGen capabilities, addressing human performance and coordination among pilots and ANSP, human system integration, and error management strategies. The research supports Aviation Safety (AVS) specialists who establish the standards and policies for NextGen operations, certify compliance with those standards, and assure continued operational safety once the adoption of new aircraft technologies generates procedure changes for flight crew and controllers. The research also supports NextGen OIs leading to reduced and delegated self-separation, including ADS-B enabled applications (Oceanic in-Trail Procedures (OTP), Interval Management (IM), and Closely Spaced Parallel Operations (CSPO)) and Equivalent Visual Operations (EVO), among others.

The NextGen – Self-Separation Human Factors Program, initiated in FY 2009, has defined more than two dozen research projects to support its objective, and research is scheduled to produce detailed R&D plans by the second quarter of FY 2011. These R&D plans outline the human factors efforts required for successful implementation of NextGen OIs for specific reduced and delegated separation applications. Key planned products include descriptions of research and operational experience for each of the application areas, technical information in specialized topic areas such as flight crew training for advanced NextGen flight deck automation, and identification of human factors challenges posed by the current implementation of the Navigation Reference System, a precursor system enabling trajectory operations under NextGen.

## Anticipated outputs include:

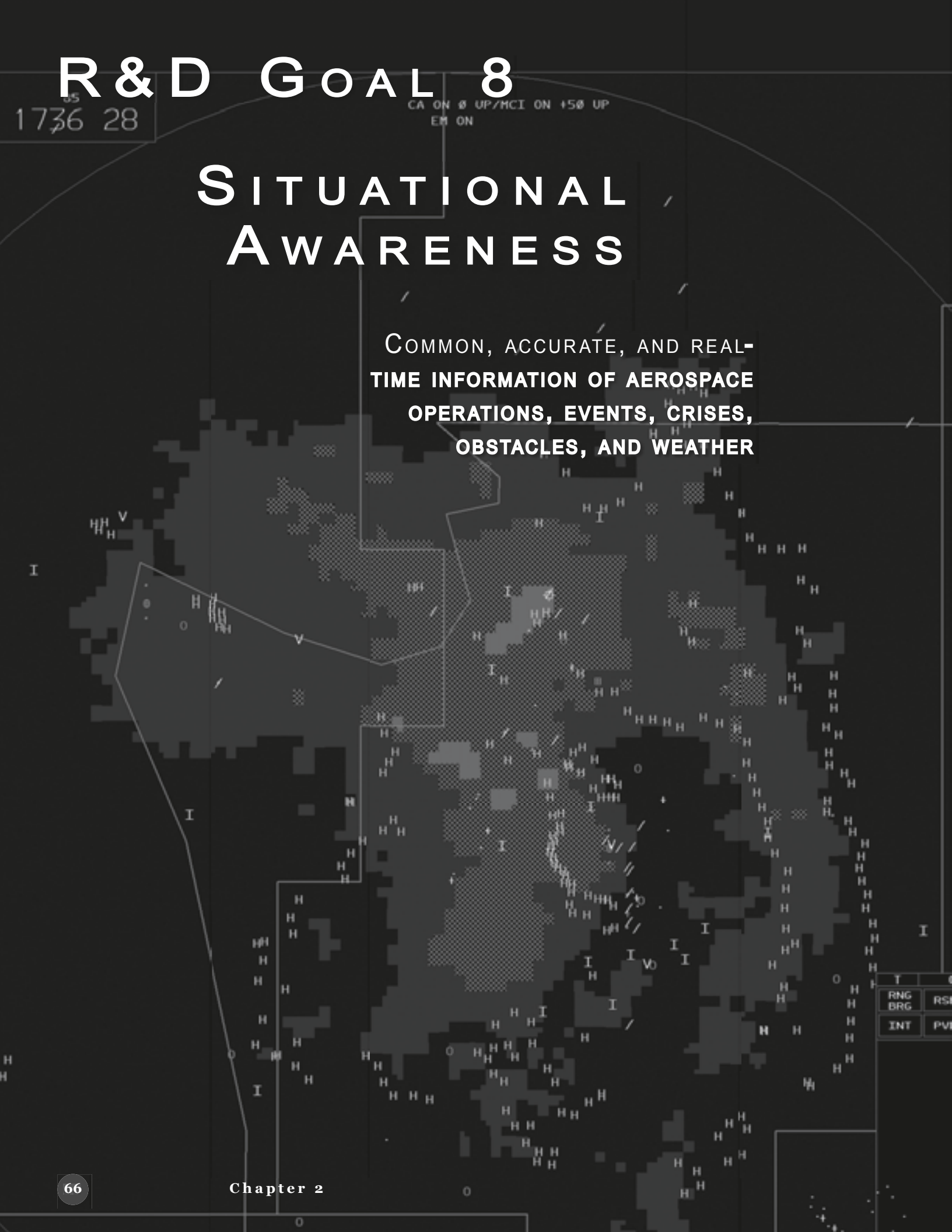
- Defining the potential impact and human factors issues due to new technologies such as enhanced vision, synthetic vision, and EFBs on separation activities
- Defining human factors technical information needed to support the development of standards, procedures, and training by FAA Flight Standards to implement plans for reduced aircraft separation and recovery to classic air traffic operations due to abnormal events
- Developing procedures and training needed to implement new roles and responsibilities for pilots and controllers during delegated separation operations
- Defining human and system performance requirements for separation activities, e.g., spacing, merging, and passing
- Developing and applying error management strategies and risk mitigation factors to reduce automation-related errors associated with enhanced separation operations
- Developing 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 determining how conformance alerts are communicated and resolved between flight deck and ground monitors, for example in TBO, and in RNAV/RNP approach and departure operations

While human factors research in the important area of self-separation is still in its challenging early stages, all projects are on a firm track toward meeting the 2016 R&D Target. Understanding the impact of new technologies on human performance and the need to develop error management strategies and associated training is on schedule. Efforts to produce detailed research plans for the ADS-B enabled applications mentioned earlier (OTP, IM, CSPO) are also on schedule. Researchers will execute the plans to produce human factors technical data that will allow the FAA to implement the NextGen OIs, enabling reduced and delegated self-separation applications.

# R&D Goal 8

# Situational Awareness

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



## R&D TARGET

By 2016, demonstrate common, real-time awareness of ongoing air operations, events, crises, and weather in all phases of flight and 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.

## FUNDING REQUIREMENTS - R&D GOAL 8

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| -- | Airport Cooperative Research - Safety | AIP | 0 | 0 | 0 | 0 | 0 | coordination only |
| -- | Airport Technology Research - Safety | AIP | 10,221 | 10,303 | 10,303 | 10,303 | 10,303 | 65% of total program |
| A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 3,646 | 3,610 | 3,610 | 3,610 | 3,610 | 16% of R&D program in FY 2012 |
| A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.a | Joint Planning and Development Office | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| 1A01D | NAS Weather Requirements | F&E | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 100% of total program |
| 1A08H | NextGen - Staffed NextGen Towers (SNT) | F&E | 6,000 | 2,000 | 2,000 | 6,000 | 6,000 | 100% of total program |
| A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 9,186 | 8,845 | 8,795 | 8,891 | 9,084 | 100% of total program |
| 1A01A | Runway Incursion Reduction | F&E | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 100% of total program |
| A11.k | Weather Program | R,E&D | 13,256 | 12,402 | 12,146 | 12,186 | 12,424 | 81% of total program |
| | | **Total** ($000) | 48,309 | 43,159 | 42,853 | 46,990 | 47,420 | |

## WEATHER SITUATIONAL AWARENESS

**Develop common situational awareness for weather.**

**Weather Information Improvements (Weather Program)**

**2010**: Develop CONUS ceiling, visibility, and flight category forecast capability. **[COMPLETED]**

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

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

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

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

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

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

**2011**: Develop NextGen mid-term concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit.

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

**2012**: Simulate and evaluate available cockpit weather technologies.

**2013**: Develop prototype weather modules for flight deck.

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

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

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

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

## Airports

**Ensure safe airport operations.**

**2010**: Develop system enhancements for runway status lights. (Runway Incursion Reduction) **[COMPLETED]**

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

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

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

## Commercial space

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

**2009**: Conduct a study to determine the need to develop a temporal wind database to support the launch of wind-weighted, unguided, suborbital rockets launched from nonfederal launch sites. **[COMPLETED]**

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

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

# Progress in FY 2010: Situational Awareness

Situational Awareness supports the FAA *Flight Plan* goals for increased safety and greater capacity and NextGen by having the R&D Target of demonstrating, by 2016, common, real-time awareness of ongoing air operations, events, crises, and weather in all phases of flight and at all types of airports by pilots and controllers. Programs in airports, weather, and runway incursion reduction support this goal.

We continue to progress toward improved situational awareness. With the advent of ADS-B, the flight deck and the controller will have the same information and view as the pilot. As equipage comes on line, imagine a sky where everyone has the same situational awareness. In 2005, the R&D program conducted successful Runway Status Lights (RWSL) operational evaluations at Dallas-Fort Worth Airport and, today, continues to refine and demonstrate the system at other airports. Airport technology research has helped set new design and installation guidance for airport visual aids, and future FAA-developed procedures for lighting systems will rely on the these new standards. Improved technology and procedures also help to maintain operational activities during periods of low-visibility and inclement weather in the airport vicinity. Weather forecasting remains a high priority for the agency as bad weather in one location has the potential to impact the entire system. Research continues to advance icing and turbulence forecasting to bring weather information into the cockpit.

## Results achieved in 2010 include:

**National Ceiling and Visibility Forecast:**

The most deadly of GA encounters results from inadvertent flight into Instrument Meteorological Conditions (IMC) by a Visual Flight Rules pilot, or a poorly prepared Instrument Flight Rules pilot, causing the most common type of weather accident. There were 21 Visual Meteorological Conditions-into-IMC accidents in 2008, of which 18 (86 percent) were fatal. Current Ceiling and Visibility work focuses on development of a probabilistic 1-10 hour forecast, updated hourly, with ceiling, visibility, and flight category known as the National Ceiling and Visibility Forecast (NCVf). In FY 2010, researchers developed a prototype NCVf system for evaluation in early FY 2011. This prototype will produce a 10-hour forecast for the Northeast CONUS. (Weather Program)

**Weather Technology in the Cockpit (WTIC):**

The program studied the feasibility of providing turbulence and icing data products directly to the cockpits of Parts 121, 135, and 91 civil aviation operators. The focus of the effort was specifically on bandwidth requirements and the suitability of communication systems currently fielded or planned to provide this data. The report detailed the initial findings of the study. The first phase of the effort investigated both the bandwidth available to weather services and the bandwidth required to provide those services. Researchers used a regional simulation methodology, modeling three regions of primary interest: the New York–Washington corridor, the Rocky Mountains, and Polar/Alaska. The study focused on four communications networks in common use (or planned for common use): ADS-B, VHF Digital Link Mode 2, Inmarsat, and Iridium. The first phase of this study has shown that providing in-flight turbulence and icing data is feasible with today's communications technology. (NextGen – Weather Technology in the Cockpit)

**Guidebook for Wildlife Hazards in Airport Environment:**

The ACRP – Safety Program developed a guidebook that managers of GA airports can use to identify, understand, and mitigate wildlife hazards to aircraft in the airport environs. This guidebook provides a primer for addressing wildlife hazards but does not fulfill Part 139 certification requirements regarding wildlife. A brief reference guide and outreach materials for aircraft/wildlife hazards at GA airports accompany the guidebook. (ACRP)

**Advisory Circulars for Visual Guidance for Pilots:**

The program completed recommendations for incorporation an AC for visual guidance cues such as runway end lighting enhancements, improved spacing of in-pavement lighting fixtures on curves and improvements in airport paint marking materials to provide pilots improved cues for situational awareness. (Airport Technology Research - Safety)

**Runway Status Lights:**

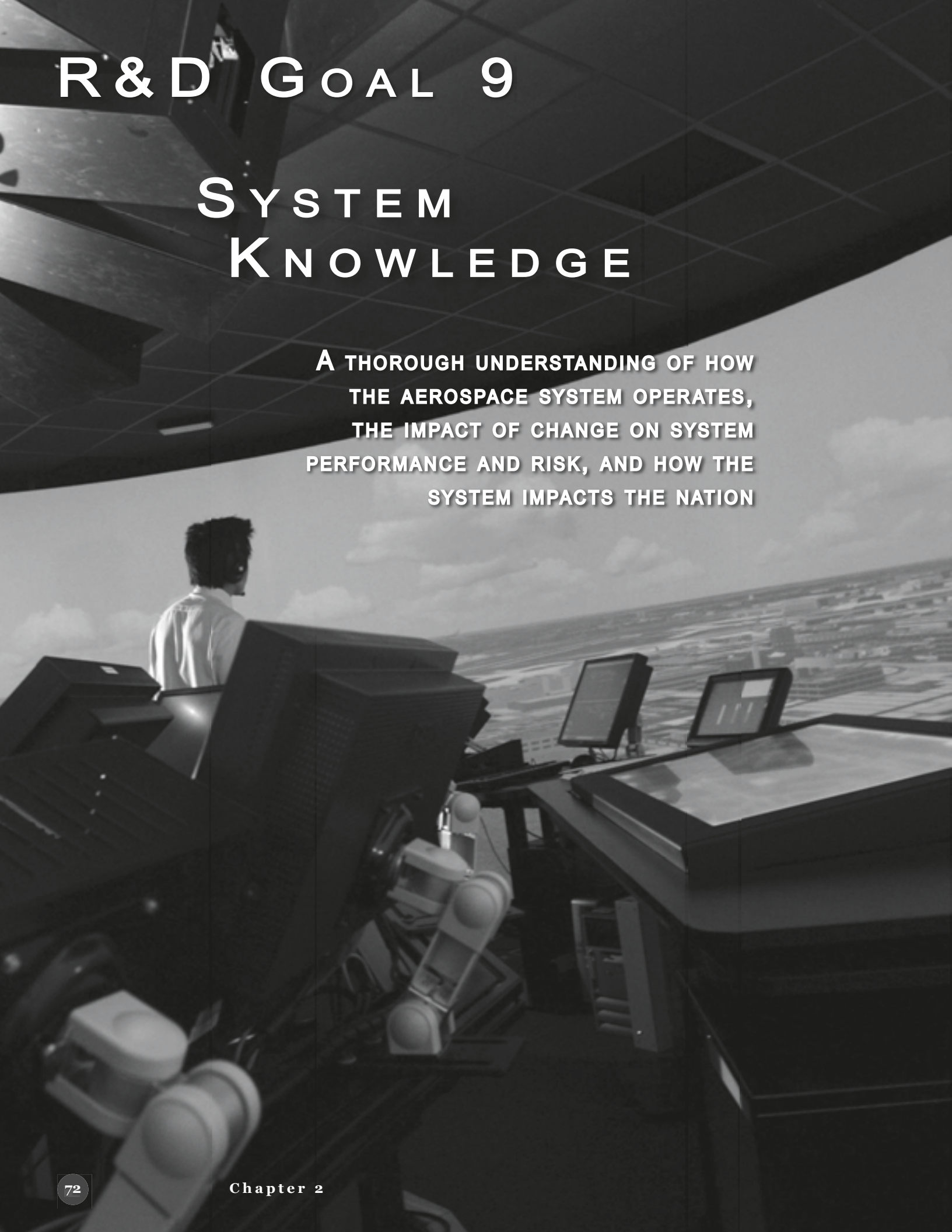
System enhancements were complete as of March 5, 2010. The lights used (Runway Intersection Lights (RIL), Takeoff and Hold Lights (THL), and Runway Entrance Lights (REL)) consist of a series of in-pavement red lights to warn pilots when it is unsafe to enter or cross a runway (REL), unsafe to take-off (THL), or unsafe to enter or cross a runway intersection (RIL). Boston is the first airport to use RIL in a prototype operational evaluation. Operational evaluation of RIL along with REL and THL started in July and will continue for three months. If the operational evaluation is successful during this timeframe, Boston Air Traffic may continue the operational evaluation until the future production RWSL system replaces them. (Runway Incursion Reduction)

Situational awareness research is producing results. Studies have shown that RWSL provides optimal defense against 65 percent of the high-hazard runway conflicts without adversely affecting runway capacity or controller workload. Additionally, initial field evaluations showed a 70 percent reduction in runway incursions on a runway equipped with RWSL. Today, periodic updates to icing and turbulence data for the entire CONUS provide significant detail for aircraft in-flight to leverage for assistance in en route re-planning. However, the data formats are very large, and the bandwidth required to transmit them exceeds even the fastest links under study. A key challenge for the future is how to condense weather data for live transmission to the cockpit. This would ensure all aircraft receive required updates in a timely and efficient manner to support pilot decision-making during adverse weather. Future studies for the NextGen-WTIC Program will add detail to existing models and review aircraft equipage architectures and reception hardware to support condensing weather data products. The program plans to validate simulation results using real hardware, define a set of system requirements, and provide a system design that includes infrastructure architecture, data-types, and software services. By 2015, Weather Program research will include development of a forecast and nowcast capability for Alaska and extend the NCVf out to 30 hours. These capabilities will provide a common real-time situational awareness by air traffic management, pilots, and dispatch, enhancing NAS safety as well as capacity. However, meeting the operational needs in the air will also require that activities occurring inside the airport terminal are streamlined for maximum efficiency. Current research into airport passenger movement and decision-making will help to reduce wait times and improve not only operational schedules, but also the passenger's travel experience. The combined outputs from the programs supporting this goal are on track to reach the R&D Target by 2016.

# R&D Goal 9

# System Knowledge

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



## R&D TARGET

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

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 9

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| A11.j | Aeromedical Research | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| -- | Airport Cooperative Research - Capacity | AIP | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 33% of total program |
| -- | Airport Cooperative Research - Safety | AIP | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 50% of total program |
| 1A01E | Airspace Management Program | F&E | 3,000 | 5,000 | 5,000 | 5,000 | 5,000 | 100% of total program |
| 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 1,823 | 1,805 | 1,805 | 1,805 | 1,805 | 8% of R&D program in FY 2012 |
| -- | Commercial Space Transportation Safety | OPS | 500 | 500 | 500 | 500 | 500 | 50% of total program |
| A11.e | Continued Airworthiness | R,E&D | 504 | 483 | 480 | 485 | 495 | 4% of total program |
| A12.a | Joint Planning and Development Office | R,E&D | 4,220 | 4,097 | 4,091 | 4,144 | 4,235 | 30% of total program |
| 1A08F | NextGen - Operational Assessments | F&E | 10,000 | 8,000 | 8,000 | 8,000 | 8,000 | 100% of total program |
| 1A08C | NextGen - Operations Concept Validation - Validation Modeling | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | 100% of total program |
| 1A08G | NextGen - System Safety Management Transformation | F&E | 18,000 | 8,000 | 8,000 | 8,000 | 8,000 | 100% of total program |
| 1A01C | Operations Concept Validation | F&E | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 100% of total program |
| 1A01B | System Capacity, Planning and Improvement | F&E | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 100% of total program |
| A11.h | System Safety Management | R,E&D | 10,027 | 9,581 | 9,489 | 9,574 | 9,776 | 100% of total program |
| | | **Total** ($000) | 72,223 | 56,616 | 56,515 | 56,657 | 56,961 | |

# 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. **[COMPLETED]**

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

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

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

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

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

## Capacity and efficiency evaluation

**Develop methods, metrics, and models to demonstrate that the modernized system can handle anticipated growth in traffic demand according to the Terminal Area Forecasts* for incremental years leading to the far-term NextGen. This evaluation will compare the modernized system with the current system using capacity and efficiency metrics.†**

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

**2011**: Demonstrate an increase in capacity and efficiency at 2018 forecasted traffic levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

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

**2013**: Demonstrate an increase in capacity and efficiency at 2021 forecasted traffic levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

**2016**: Demonstrate an increase in capacity and efficiency at 2025 forecasted traffic levels. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

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* Federal Aviation Administration *Terminal Area Forecast Summary Fiscal Years 2009-2030,* March 2010. http://www.faa.gov/data_research/aviation/aerospace_forecasts/2010-2030/

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

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

## Safety management system

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

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

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

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

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

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

## Commercial space

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

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

**2011**: Conduct a study to evaluate the adequacy of current rules and polices related to commercial space transportation, implement new rules, policy, and advisory materials, and identify barriers to industry caused by unnecessary or conflicting regulations.

**2011**: Release Commercial Space Transportation Research Road Map document, v1.0.

## Safety evaluation§

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

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

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

**2016**: Demonstrate a two-thirds reduction in the rate of fatalities and injuries.**

## Environmental assessment

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

**2009**: Develop and implement NAS-wide regional environmental analysis capability within AEDT. **[COMPLETED]**‡‡

**2010**: Implement weather effects in AEDT environmental analyses. **[COMPLETED]**

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

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

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

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

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

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

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

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

# Progress in FY 2010: System Knowledge

The R&D Target for System Knowledge is to understand the economic (including implementation) and operational impact of system alternatives by 2016. System Knowledge is important to the FAA *Flight Plan*, supporting safety and capacity goals as well as the organizational excellence objective to make decisions based on reliable data to improve overall performance and customer satisfaction. Understanding the practical effect of new alternatives is crucial to ensuring that NextGen systems function correctly, serve the appropriate needs, and provide value to the U.S. taxpayers.

Over the past five years, the operations concept validation team has conducted studies, including Big Airspace, Staffed NextGen Towers, and Multi-Sector Planner, to understand proposed NextGen systems and capabilities and to allow concepts to mature towards implementation in the NAS. These studies helped FAA understand the actual economic and operational effects of proposed concepts, often leading to new or revised system requirements that would have been unclear without the concept development and validation research. Safety research has shown that methods and metrics for measuring progress towards reducing the rate of fatalities and significant injuries are achievable. The research validated concepts through simulations, modeling, demonstrations, prototypes, field tests, and reviews among system experts.

## Results achieved in 2010 include:

### Capacity and Efficiency Evaluation:

The program conducted Staffed NextGen Tower (SNT) field demonstrations in Dallas-Fort Worth to validate the first phase of the SNT concept, documenting operational impacts and benefits of the new Multi-Sector Planner position for high altitude airspace. The demonstration showed that this new automation capability achieves the desired benefits without the need to staff a separate planning position. The program supported development of the Flow Based Trajectory Management concept by conducting real-time simulations to develop and analyze concepts and methods for handling high altitude airspace operations, and it delivered an overarching concept of operations (and related scenario description) for a wide-range of NextGen systems, explaining how the systems interrelate in the mid-term timeframe. (Operations Concept Validation)

### Point-to-Point Commercial Space Transportation in the NAS:

The safety regulatory provisions of commercial space transportation must continue to evolve and keep pace with new developments in the commercial space transportation sector, including point-to-point suborbital RLV operations. The report *Point-to-Point Commercial Space Transportation in the NAS* identifies and provides a critical examination of the safety related issues that existing and emerging ATM architectures must consider and address to provide enabling support for suborbital point-to-point operations, allowing them to occur safely and seamlessly in the NAS. The overall safety goal of commercial space transportation is to protect public health and safety. For more information, see: https://www.faa.gov/about/office_org/headquarters_offices/ast/media/point_to_point.pdf. (Commercial Space Transportation Safety)

### Implementing Weather Effects in AEDT Environmental Analyses:

The FAA successfully implemented high-fidelity weather data from multiple sources in the AEDT integrated environmental analyses tool. We have performed post-implementation validation and verification of this enhanced functionality. Inclusion of weather was necessary to develop better estimates of fuel burn and assign source location of noise and emissions based on the weather driven flight tracks. The DRG currently is testing this enhanced AEDT. (NextGen - Operational Assessments)

**Airport Surface Detection Equipment Model-X (ASDE-X) for ASIAS:**

The program designed and implemented a direct feed of ASDE-X data into ASIAS. To support integration of internal FAA databases, the FAA developed the ASDE-X Front End Processor (FEP) and Enhanced Repository System (ERS). These prototyped and validated tools use secure file transfer protocols to proactively and securely collect, process, and distribute safety related air traffic information such as ASDE-X data within the user community for aviation research. As part of the NextGen R&D Enclave, the ASDE-X FEP and ERS perform a key role by providing a comprehensive set of airport surface traffic, towered airspace traffic, and other system-safety logic information. The ERS continues to provide data to support analyses for capacity improvements and safety risk-management methodologies. (System Safety Management)

**Safety Evaluation: Reducing Fatalities:**

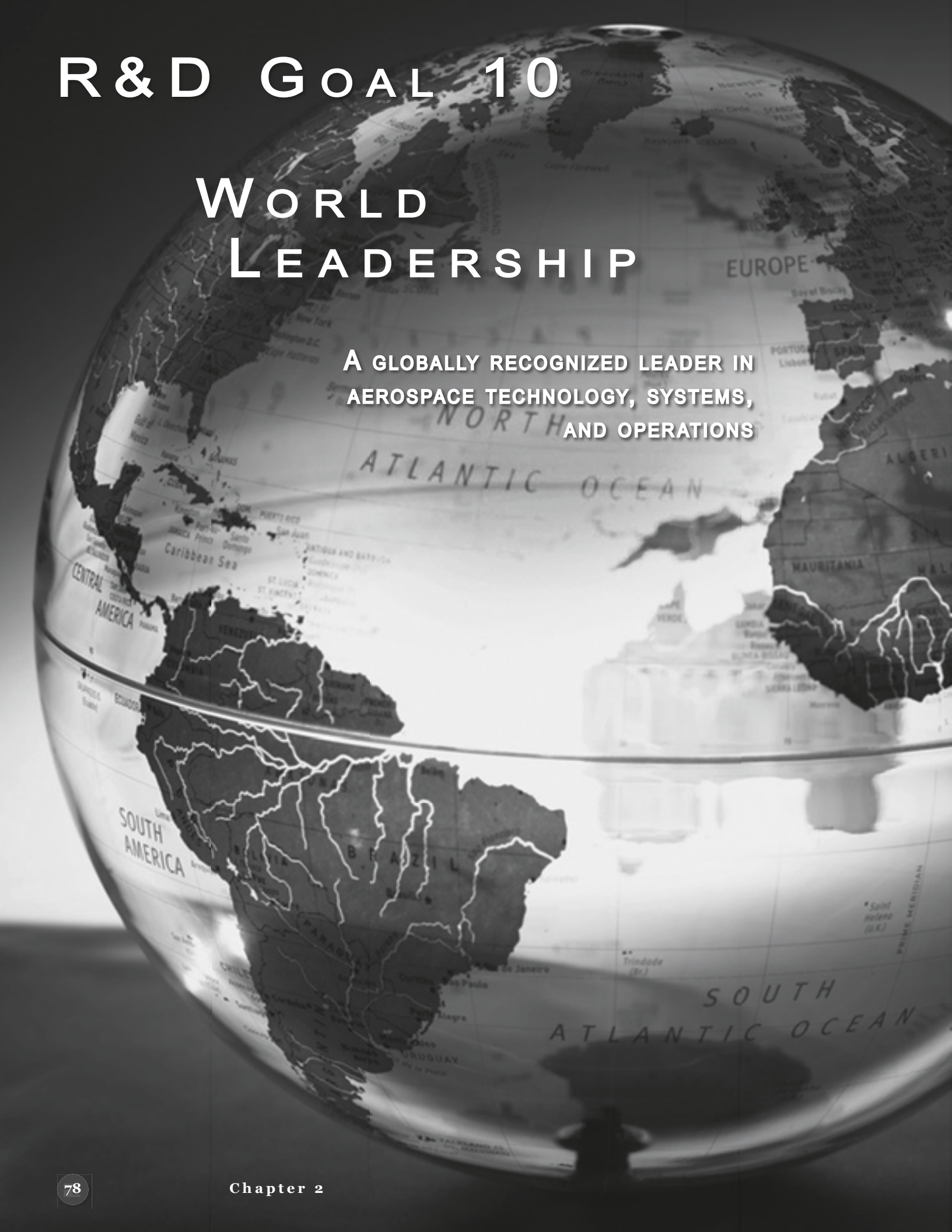
Research results in 2010 show that methods and metrics for measuring progress towards reducing the rate of fatalities and significant injuries by two-thirds in 2025 are achievable. Research focused on commercial aviation including both scheduled and nonscheduled flights of U.S. passenger and cargo air carriers and scheduled flights for regional air carriers. Researchers used NTSB databases on fatality and serious injuries and identified loss of control in flight, controlled flight into terrain, and runway excursion as the three major accidents types that contribute over 60% of total fatalities and serious injuries. Metrics (precursors or indicators) that measure the performance of each category of accidents are now available and will be further validated as soon as the 2010 NTSB safety data become available. The research focus area will expand to start exploring and analyzing the establishment of targets and tracking metrics for the GA sector. (System Safety Management)

The challenge for capacity and efficiency validation is that not all of the data exists today to allow the projection of economic and operational impact of alternatives by 2016. Research, including fast-time modeling, analysis, and human-in-the-loop simulations over the next few years, will be critical to developing a robust body of data. Additionally, while research initiatives focus on specific operational improvements and concepts, it is difficult to conduct NAS-wide benefits modeling with a level of fidelity that covers every operational improvement and interdependencies between them. The challenge is to understand the overall impact based on the integration of alternatives. First, the operational feasibility and benefits of individual alternatives must be understood, then the cumulative impact must be assessed, but that impact is based on implementation increments which are not yet known. We have a much better understanding today of data and modeling and simulation shortfalls. The program will focus on conducting more integrated fast-time and real-time simulation activities starting in 2012 to compensate for today's data shortfalls. In addition, efforts are currently underway to identify implementation increments for mid-term NextGen capabilities so that the economic and operational impacts can be based on feasible implementation packages. Future challenges in the safety evaluation include identifying metrics (precursors or indicators) that have strong correlation with fatalities and serious injuries, used to monitor and predict potential fatalities and serious injuries. The combined efforts of the programs under this goal are on track to meet the R&D Target by 2016.

# R&D Goal 10

# World Leadership

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



## R&D TARGET

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

## METHOD OF VALIDATION

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

## FUNDING REQUIREMENTS - R&D GOAL 10

The funding levels listed for years 2013 to 2016 are estimates and subject to change. Programs with zero funding listed support this goal with FAA staff resources only.

| BLI | Program Name | Budget Type | 2012 | 2013 | 2014 | 2015 | 2016 | Notes |
|---|---|---|---|---|---|---|---|---|
| -- | Airport Cooperative Research - Environment | AIP | 0 | 0 | 0 | 0 | 0 | coordination only |
| A13.a | Environment and Energy | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A11.a | Fire Research and Safety | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| 1A08A | NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.d | NextGen - Self-Separation Human Factors | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| 1A08G | NextGen - System Safety Management Transformation | F&E | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.b | NextGen - Wake Turbulence | R,E&D | 0 | 0 | 0 | 0 | 0 | coordination only |
| A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 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 | coordination only |
| A14.a | System Planning and Resource Management | R,E&D | 1,718 | 1,602 | 1,567 | 1,570 | 1,601 | 100% of total program |
| | | **Total** ($000) | 1,718 | 1,602 | 1,567 | 1,570 | 1,601 | |

# Milestones

## Management

### Manage ongoing research. (System Planning and Resource Management)

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

**2009**: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2009-2014 FAA R&D plan. **[COMPLETED]**

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

**2011**: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2011-2016 FAA R&D plan.

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

**2010**: Determine criteria for assessing the benefits of the international research collaboration. **[COMPLETED]**

**2011**: Develop a strategic mapping for international research collaboration.

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

**2016**: Determine final value of international research collaboration.

## Products

**Leverage research results.***

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

**2010**: Develop a preliminary planning version of an Aviation Environmental Design Tool (AEDT) that will allow integrated assessment of noise and emissions impact at the local and global levels. (Environment and Energy) **[COMPLETED]** [See Goal 2 under Progress for more information.]

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

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

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

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

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

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

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

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

# Progress in FY 2010: World Leadership

Increasing the safety and capacity of the global civil aerospace system continues to be at the forefront of the FAA's strategic planning. Through its World Leadership goal, the FAA's international partnerships and collaboration efforts are helping to reach the 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.

Over the past five years, the FAA has used the NARP to integrate its R&D portfolio and align its programs with the near- and far-term safety and capacity goals for the nation's air transportation system. The ten R&D goals challenge the research and development community to think far-term and work to achieve breakthroughs to support the vision of the FAA. The NARP presents the specific plan to meet measurable targets and reach toward stretch goals, which ultimately support the FAA's strategic goals. By reporting on the progress of the portfolio toward the R&D goals, the R&D Annual Review enables the FAA and the research and development community to review accomplishments under each R&D goal. The NARP explains and analyzes progress on the plan and helps identify gaps that may require additional research. The NARP and R&D Annual Review have helped FAA ensure research focus matches its strategic focus.

## Results achieved in 2010 include:

**R&D Portfolio:**

The program provided guidance on the FAA FY 2012 R&D portfolio in October 2010. The R&D Executive Board (REB) developed the proposed FY 2012 R&D portfolio between November 2009 and February 2010. The five REDAC subcommittees reviewed the portfolio in February 2010, and the full REDAC provided its final review of the FY 2012 R&D portfolio on April 21, 2010, providing comments to the FAA on May 10 2010. (System Planning and Resource Management)

**National Aviation Research Plan:**

The program prepared the NARP, allowing FAA to submit it on time to Congress in February 2010. (System Planning and Resource Management)

**Evaluation Criteria for International Research Collaborations:**

The program determined criteria for assessing the benefits of the international research collaboration. (System Planning and Resource Management)

The FAA researchers have continued to advance world leadership through multiple international collaborative efforts. Researchers have worked in cooperation with European, Asian, and North and South American partners to harmonize global air traffic management, as well as communication, navigation and surveillance standards. Through targeted outreach efforts, including technical demonstrations and exchanges, working groups, cooperative research projects, and data sharing, the agency is well within reach of meeting the world leadership R&D Target.

# Chapter Three

# Alignment with NextGen

NextGen improves our national airspace system to make air travel more convenient and dependable, while ensuring flights are as safe, secure, and hassle-free as possible. The primary goal of NextGen is to provide new capabilities that make air transportation safer and more reliable, improve the capacity of the NAS, and reduce aviation's impact on our environment.

The *NextGen Implementation Plan* is the FAA's primary outreach tool for communicating with stakeholders and aviation partners who are working with FAA to develop and deploy NextGen. The Plan provides an overview of NextGen, including a status report on the NextGen deployments, capabilities, and benefits introduced to date. The plan focuses on the mid-term system planned for 2018 and provides decision-makers in the aviation community with the most up-to-date information available on the operator and airport investments needed for NextGen benefits (Appendix A). It documents the major milestones and critical work that will be ongoing for the next four years in pursuit of the 2018 goals (Appendix B).

The *NextGen Implementation Plan* provides the FAA's plan for NextGen, and the FAA R&D portfolio supports the *NextGen Implementation Plan* with several NextGen R&D programs.

# NextGen Solution Sets

The NextGen Implementation Plan provides an overview of the FAA's ongoing transition to NextGen, explaining the agency's vision for NextGen now and into the mid-term, which is defined as 2012-2018. The plan defines the seven cross-cutting solution sets of NextGen that are summarized below.

**Initiate Trajectory-Based Operations:** The TBO solution set focuses primarily on high-altitude cruise operations in en route airspace. The TBO solution set will provide the capabilities, decision-support tools, and automation to manage aircraft movement by trajectory. This shift from clearance-based to trajectory-based air traffic control will enable aircraft to fly negotiated flight paths necessary for full Performance Based Navigation, taking both operator preferences and optimal airspace system performance into consideration.

**Increase Arrivals/Departures at High Density Airports:** The High Density Airports solution set provides capabilities that improve arrival and departure capacity for multiple airports and runways in high-demand airspace. The combination of precision procedures, decision support tools, enhanced surface management, and improved coordination and information sharing will allow for maximum usage of all runways and airspace at close-proximity airports. The High Density Airports solution set takes advantage of performance based navigation, traffic-flow management capabilities in the Collaborative Air Traffic Management (CATM) solution set, and builds on the capabilities of the Flexible Terminals and Airports solution set.

**Increase Flexibility in the Terminal Environment:** The Flexible Terminals and Airports (FLEX) solution set provides capabilities necessary to increase access to and manage the separation of aircraft in the terminal environment at and around all airports – large and small. The FLEX solution set addresses initial surface management capabilities, procedures that improve access to runways in low-visibility, and new automation that will support and maximize the use of available data to enable surface trajectory operations. These capabilities will improve safety, efficiency, and overall capacity in reduced visibility.

**Improve Collaborative Air Traffic Management:** The CATM solution set covers strategic and tactical flow management, including interactions with operators to mitigate situations when the desired use of capacity cannot be accommodated. The CATM solution set includes flow programs and collaboration on procedures that will shift demand to alternate resources (e.g. routings, altitudes, and times). The CATM solution set also includes the foundational information elements for managing NAS flights. These elements include development and management of aeronautical information, management of airspace reservation, and management of flight information from pre-flight to post-analysis.

**Reduce Weather Impact:** The Reduce Weather Impact solution set supports the integration of a broad range of weather information into air traffic decision making. In the mid-term, new operational improvements and technologies will mitigate the effects of weather resulting in safer and more efficient and predictable day-to-day NAS operations.

**Improve Safety, Security, and Environmental Performance:** Improving safety, security, and the environment is an inherent part of the FAA's overall mission and is embedded in the activities of individual programs agency-wide. This solution set involves activities directly related to ensuring that NextGen systems contribute to steadily reducing risks to safety and information security while mitigating adverse effects on the environment and ensuring environmental protection that allows sustained aviation growth.

**Transform Facilities:** The Transform Facilities (FAC) solution set focuses on capabilities that enable a network of integrated facilities designed to support the delivery of safer and more efficient operations system-wide. It enables a facilities infrastructure that supports NextGen capabilities as they are integrated into the current system and as they mature over time. Business continuity is built into the system and provides for a more resilient infrastructure, better contingency operations, and a higher degree of service. The FAC solution set includes multi-discipline laboratories and test beds to support NextGen requirements development and risk-mitigation efforts.

# FAA NextGen R&D Portfolio

The FAA NextGen R&D portfolio supports NextGen by working to increase capacity and efficiency, to reduce aviation's impact on the environment, and to improve safety. It provides concepts and technologies to enable greater capacity and efficiency in air traffic operations, including new operational concepts to increase capacity, human factors to help define the changing roles and responsibilities of pilots and controllers, weather information to enhance common situational awareness, and wake turbulence separation standards to increase capacity. It works to reduce aviation's impact on the environment using alternative fuels, new equipment and operational procedures, and more precise flight paths to make flying quieter, cleaner, and more fuel-efficient and to lessen its impact on the climate and reduce the amount of noise that communities experience. It provides proactive safety management, allowing analysis of trends to uncover problems early on, so that preventive measures are put in place before any accident can occur.

Funded by both RE&D and F&E appropriations, the FAA NextGen R&D portfolio is a subset of the FAA R&D portfolio, as reported in the NARP, and the FAA NextGen portfolio, as reported in the *NextGen Implementation Plan*. The FAA NextGen R&D portfolio represents 48 percent of the budget reported in the NARP for FY 2012, and it represents 15 percent of the FAA NextGen portfolio. The FAA R&D portfolio includes the entire RE&D contribution to NextGen, but only part of the F&E contribution to NextGen.

Table 3.1 describes how the FAA NextGen R&D portfolio supports the mid- and far-term OIs in the *NextGen Implementation Plan* solution set timelines. These *NextGen Implementation Plan* OIs are identical to the OIs displayed in the NAS Enterprise Architecture's service roadmaps, and an R&D program may support more than one *NextGen Implementation Plan* OI.

Table 3.2 provides the FAA NextGen R&D portfolio five-year budget plan by line item and appropriation.

## NextGen - System Development

The FAA maintains a System Development budget line (1A08) in the F&E appropriation to fund projects that have broad applicability across the solution sets and to NextGen overall. These projects, as described in the *NextGen Implementation Plan*, form the F&E portion of the FAA NextGen R&D portfolio. The projects are listed in Table 3.2 and summarized in Chapter 4.

## NextGen RE&D Programs

In addition to the System Development budget line item under F&E, the FAA NextGen R&D portfolio includes seven budget line items under the RE&D appropriation. The seven programs or budget line items under RE&D are listed in Table 3.2 and summarized in Chapter 4.

# Table 3.1: Mapping of FAA NextGen R&D Portfolio to the NextGen Implementation Plan

Key:
* Far-term OI/Capability (all others are Mid-term)
X Supporting NextGen R&D Activities

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

| FAA NextGen R&D Budget Lines | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NextGen - Alternative Fuels for General Aviation | NextGen - Wake Turbulence | NextGen - Air Ground Integration Human Factors | NextGen - Self-Separation Human Factors | NextGen - Weather Technology in the Cockpit | NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | NextGen - New Air Traffic Management Requirements | NextGen - Operational Concept Validation - Validation Modeling | NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction | NextGen - Wake Turbulence - Re-categorization | NextGen - Operational Assessments | NextGen - System Safety Management Transformation | NextGen - Staffed NextGen Towers | | | | | |
| A11.m | A12.b | A12.c | A12.d | A12.e | A13.b | 1A08A | 1A08B | 1A08C | 1A08D | 1A08E | 1A08F | 1A08G | 1A08H | Operational Improvements/Capabilities | Tactical | OI# | | | |
| | | | | | | | | | | | | | | Provide Full Flight Plan Constraint Evaluation with Feedback | | 101102 | Collaborative Air Traffic Management | | Solution Sets |
| | | | | X | | | | | | | | | | On-Demand NAS Information | | 101305 | | | |
| | | X | X | | | X | | | | | | | | Full Collaborative Decision Making | * | 105207 | | | |
| | | | | | | | X | | | | | | | Continuous Flight Day Evaluation | | 105302 | | | |
| | | | | | | | | | | | | | | Manage Airspace to Flow | * | 108207 | | | |
| | | | | | | | | | | | | | | Improved Management of Airspace for Special Use | | 108212 | | | |
| | | | | | | | | | | | | | | Traffic Management Initiatives with Flight Specific Trajectories | | 105208 | | | |
| | | | | | | | | | | | | | | Initial Improved Weather Information from Non-Ground Based Sensors | | 103116 | Reduce Weather Impact | | |
| | | | | X | | | | | | | | | | Automatic Hazardous Weather Alert Notification | * | 103117 | | | |
| | | | | X | | | | | | | | | | Initial Integration of Weather Information into NAS Automation and Decision Making | | 103119 | | | |
| | | | | X | | | | | | | | | | Near-real Time Dissemination of Weather Information to all Ground and Air Users | * | 103120 | | | |
| | | | | X | | | | | | | | | | Full Operational Weather Capability | * | 103121 | | | |
| | | | | | | | | | | | | X | | Enhanced Emergency Alerting | | 106202 | Safety | Security, Safety, and Environment | |
| | | | | | | | | | | | X | X | | ASIAS-Information Sharing and Emergent Trend Detection | | 109303 | | | |
| | | | | | | | | | | | | X | | Enhanced Aviation Safety Information Analysis and Sharing | | 109304 | | | |
| | | | | | | | | | | | X | X | | Improved Safety for NextGen Evolution | | 109305 | | | |
| | | | | | | | | | | | | | | Increased International Cooperation for Aviation Safety | * | 109306 | | | |
| | | | | | | | | | | | X | X | | Improved Air Safety Across Air Transportation System Boundaries | * | 109307 | | | |
| | | | | | | | | | | | X | X | | Enhanced (Automated) Aviation Safety Information Sharing and Analysis Scope and Effectiveness | * | 109308 | | | |
| | | | | | | | | | X | | X | | | Implement EMS Framework | | 109309 | Environment | | |
| | | | | | | | | | X | | X | | | Implement EMS Framework - Enhanced | * | 109310 | | | |
| | | | | | | | | | X | | | | | Environmentally and Energy Favorable En Route Operations | | 109311 | | | |
| | | | | | | | | | X | | | | | Environmentally and Energy Favorable En Route Operations - Enhanced | * | 109312 | | | |
| | | | | | | | | | X | | | | | Environmentally and Energy Favorable Terminal Operations | | 109313 | | | |
| | | | | | | | | | X | | | | | Environmentally and Energy Favorable Terminal Operations - Enhanced | * | 109314 | | | |
| | | | | | X | | | | X | | | | | Implement NextGen Environmental Engine and Aircraft Technologies | | 109315 | | | |
| | | | | | X | | | | X | | | | | Increased Use of Alternative Aviation Fuels | | 109316 | | | |
| | | | | | X | | | | X | | | | | Implement NextGen Environmental Engine and Aircraft Technologies - Enhanced | * | 109318 | | | |
| | | | | | | | | | | | | | | Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk-Based Assessment | | 109302 | Security | | |
| | | | | | | | | | | | | | | NAS-wide Sector Demand Prediction and Resource Planning | * | 105104 | Transform Facilities | | |
| | | | | | | | | | | | | | X | Remotely Staffed Tower Services | | 109402 | | | |

# Table 3.2 – NextGen R&D Funding Levels

| FY 2012 Budget Line Item | Program | 2012 Request ($000) | 2013 Planned ($000) | 2014 Planned ($000) | 2015 Planned ($000) | 2016 Planned ($000) | R&D Goal |
|---|---|---|---|---|---|---|---|
| | **NextGen - System Development Programs** | | | | | | |
| 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | 3 |
| 1A08B | NextGen - New Air Traffic Management Requirements | 37,000 | 22,000 | 22,000 | 22,000 | 22,000 | 1 |
| 1A08C | NextGen - Operations Concept Validation - Validation Modeling | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | 9 |
| 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | 15,000 | 10,000 | 10,000 | 10,000 | 10,000 | 2 |
| 1A08E | NextGen - Wake Turbulence - Re-categorization | 3,000 | 1,500 | 1,500 | 1,500 | 1,500 | 1 |
| 1A08F | NextGen - Operational Assessments | 10,000 | 8,000 | 8,000 | 8,000 | 8,000 | 9 |
| 1A08G | NextGen - System Safety Management Transformation | 18,000 | 8,000 | 8,000 | 8,000 | 8,000 | 9 |
| 1A08H | NextGen - Staffed NextGen Towers (SNT) | 6,000 | 2,000 | 2,000 | 6,000 | 6,000 | 8 |
| Planned | NextGen - Initial Operation Test & Evaluation | 100 | 0 | 0 | 0 | 0 | 9 |
| | **Total F&E** | **109,000** | **61,500** | **61,500** | **65,500** | **65,500** | |

**R&D Goals Key:**

- 1 - Fast, Flexible, and Efficient
- 2 - Clean and Quiet
- 3 - High Quality Teams and Individuals
- 4 - Human-Centered Design
- 5 - Human Protection
- 6 - Safe Aerospace Vehicles
- 7 - Separation Assurance
- 8 - Situational Awareness
- 9 - System Knowledge
- 10 - World Leadership

| FY 2012 Budget Line Item | Program | 2012 Request ($000) | 2013 Planned ($000) | 2014 Planned ($000) | 2015 Planned ($000) | 2016 Planned ($000) | R&D Goal |
|---|---|---|---|---|---|---|---|
| | **NextGen RE&D Programs** | | | | | | |
| A11.m | NextGen - Alternative Fuels for General Aviation | 2,071 | 1,984 | 1,968 | 1,987 | 2,030 | 6 |
| A12.a | Joint Planning and Development Office | 14,067 | 13,658 | 13,638 | 13,812 | 14,117 | 1,9 |
| A12.b | NextGen - Wake Turbulence | 10,674 | 10,283 | 10,227 | 10,340 | 10,565 | 1 |
| A12.c | NextGen - Air Ground Integration Human Factors | 10,545 | 10,117 | 10,043 | 10,144 | 10,363 | 4 |
| A12.d | NextGen - Self-Separation Human Factors | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | 7 |
| A12.e | NextGen - Weather Technology in the Cockpit | 9,186 | 8,845 | 8,795 | 8,891 | 9,084 | 8 |
| A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | 20,523 | 19,743 | 19,623 | 19,833 | 20,263 | 2 |
| | **Total RE&D** | **77,000** | **74,164** | **73,758** | **74,568** | **76,189** | |

| | | | | | |
|---|---|---|---|---|---|
| **Total NextGen R&D Programs** | **186,000** | **135,664** | **135,258** | **140,068** | **141,689** |

# Chapter Four

# Research Business Management

This chapter summarizes the FAA R&D portfolio according to its FY 2012 budget submission. The chapter explains what FAA is doing (programs), how much it is spending (budget), how it performs its programs (partnerships), and how well it executes its programs (evaluation).

## Sponsors

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

## Programs

Four appropriation accounts fund the R&D portfolio: RE&D; F&E; AIP; and Ops. In general, the RE&D account funds R&D programs that improve the NAS by increasing its safety, security, productivity, capacity, and environmental compatibility to meet the expected air traffic demands of the future.* R&D programs funded under the F&E account include R&D concept development and demonstration prior to an FAA investment decision. The AIP account generally funds airport improvement grants, including those emphasizing safety and security needs and capacity development; and funds grants for aircraft noise compatibility planning and programs and low emissions airport equipment. † It also funds administrative and technical support costs for the Office of Airports. The Ops account funds commercial space transportation R&D.

The programs summarized below are in the FY 2012 R&D budget request, grouped by funding account. Appendix A provides detailed information for each program, explaining the program's funding request and its planned accomplishments, providing a description of activities and performance linkages, supporting the need for the program, identifying the criteria for success, and justifying the funding requested.

## Research, Engineering and Development (RE&D)

### Fire Research and Safety (A11.a):

The program develops technologies, procedures, test methods, and fire performance criteria that can prevent accidents caused by hidden cabin or cargo compartment in-flight fires and fuel tank explosions, and can improve survivability during a post-crash fire. Fire safety focuses on near-term improvements in fire test methods and materials performance criteria, fire detection and suppression systems, fuel tank explosion protection, and identification of hazardous materials. Fire research addresses fundamental issues of combustion toxicity, the impact of flame retardant chemicals, health hazards of cabin materials, the impact of materials flammability on the initiation of in-flight fires, and post-crash survivability. Far-term research focuses on the enabling technology for ultra-fire-resistant interior materials.

### Propulsion and Fuel Systems (A11.b):

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.

### Advanced Materials/Structural Safety (A11.c):

The program ensures the safety of civil aircraft by assessing the safety implications of composites, alloys, and other advanced materials, and associated structures and fabrication techniques that can help to reduce aviation fatalities. The program also increases the ability of passengers to survive aviation accidents by developing advanced methodologies for assessing aircraft crashworthiness.

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

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

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

The program develops and tests technologies that detect frozen contamination, predict anti-icing fluid failure, and ensure safe operations in atmospheric icing conditions. The program also develops new guidelines for testing, evaluating, and approving digital flight controls, avionics, and other systems for the certification of aircraft and engines.

### Continued Airworthiness (A11.e):

The program promotes the development of technologies, procedures, technical data, and performance models to prevent accidents and mitigate accident severity related to civil aircraft failures as a function of their continued operation and usage. The program focuses on longer term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and the safety of electrical wiring interconnect systems and mechanical systems.

### Aircraft Catastrophic Failure Prevention Research (A11.f):

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. The program also uses historical accident data and NTSB recommendations to examine and investigate turbine-engine uncontainment events and other engine-related impact events.

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

The program provides the human factors research for guidelines, handbooks, advisory circulars, 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 certification of new aircraft and design or modification of equipment considers human factors.

### System Safety Management (A11.h):

The program develops risk management methods, prototype tools, technical information, and SMS procedures and practices. In addition, the program develops an infrastructure that enables the free sharing of de-identified, aggregate safety information derived from government and industry sources in a protected manner. It also conducts operational research to leverage new technologies and procedures that enhance pilot and aircraft safety during terminal operations.

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

The program emphasizes the concept of human-system integration (HSI) and safety aspects of the functions performed by air traffic controllers and technical operations personnel. The HSI concept will address the interactions between workstation design, personnel selection and training, and human error and human safety.

### Aeromedical Research (A11.j):

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

### Weather Program (A11.k):

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

### Unmanned Aircraft Systems Research (A11.l):

The program conducts research to ensure the safe integration of UAS in the NAS by providing information to support certification procedures, airworthiness standards, operational requirements, maintenance procedures, and safety oversight activities for UAS civil applications and operations. Research activities focus on new technology assessments, methodology development, data collection and generation, laboratory and field validation, and technology transfer.

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

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

### Joint Planning and Development Office (A12.a):

The program addresses far-term imbalances in aviation capacity and demand while ensuring a future operating environment that is safe, well managed, environmentally responsible, and harmonized with international standards.

### NextGen - Wake Turbulence (A12.b):

The program conducts research to increase airport runway capacity safely by reducing aircraft wake separation minima under certain conditions and to address wake turbulence restrictions in today's terminal and en route airspace and in the future NextGen airspace designs.

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

The program addresses flight deck and air traffic service provider (ATSP) integration for NextGen operational capabilities. It focuses on human factors issues that primarily affect the pilot side of the air-ground integration challenge (i.e., the challenge of ensuring that pilots receive the right information at the right time, for decision-making and collaboration with ANSP personnel to operate in the NAS safely and efficiently). Using modeling, simulation, and demonstration, the program assesses interoperability of tools, develops design guidance, determines training requirements, and verifies procedures for ensuring effective and efficient human system integration in transitions of NextGen capabilities.

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

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

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

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

### Environment and Energy (A13.a):

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

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

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

### System Planning and Resource Management (A14.a):

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

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

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

### Runway Incursion Reduction (1A01A):

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

### System Capacity, Planning and Improvement (1A01B):

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

### Operations Concept Validation (1A01C):

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

### NAS Weather Requirements (1A01D):

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

### Airspace Management Program (1A01E):

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

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

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

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

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

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

The program develops methods, metrics, and models to demonstrate that the planned system can handle the demand forecast for 2025 (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 these improvements will provide the targeted levels of capacity and efficiency.

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

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

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

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

### NextGen - Operational Assessments (1A08F):

The program conducts research and development to assess system-wide NAS performance, safety, and environmental impacts. The transition to NextGen requires the conduct of operational assessments to ensure that new capabilities include safety, environmental, and system performance considerations, enabling an integrated implementation of NextGen.

### NextGen - System Safety Management Transformation (1A08G):

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

### NextGen - Staffed NextGen Towers (1A08H):

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

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

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

## Airport Improvement Program (AIP)

### Airport Cooperative Research - Capacity:

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

### Airport Cooperative Research - Environment:

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

### Airport Cooperative Research - Safety:

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

### Airport Technology Research - Capacity:

The program provides better airport planning, designs, and improves runway pavement design, construction, and maintenance. It ensures that 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 - Environment:

This program will establish up-to-date exposure-response relationships for community annoyance and sleep disturbance in the U.S. by collecting extensive data covering a wide variety of airport types and geographic locations. The results will help guide national aviation noise policy, determinations of community noise impacts, land use guidelines around airports, and mitigation funding.

### Airport Technology Research - Safety:

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

## Operations (Ops)

### 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.

# Budget

This section provides four tables that present 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 2012. The funding levels listed for FYs 2013 to 2016 are estimates and subject to change.

Appropriation Account – Table 4.1 shows the FAA R&D budget planned for FY 2012, including the five-year plan through FY 2016, grouped by appropriation account. The previous section described the programs in each of the four appropriation types. The F&E budget in Table 4.1 includes three main line items: Advanced Technology Development and Prototyping (ATD&P), 1A01; NextGen - System Development, 1A08; and the Center for Advanced Aviation System Development (CAASD), 4A09A. The ATD&P and NextGen - Systems Development line items have several programs under them, as shown in the tables. Both the F&E and the Ops appropriations have programs that are not part of the R&D portfolio; the NARP only presents R&D.

Sponsoring Organization – Table 4.2 shows the FAA R&D budget planned for FY 2012, including the five-year plan through FY 2016, grouped by sponsoring organization. Sponsoring organizations include Aviation Safety; Air Traffic Organization; Airports; Commercial Space Transportation; and Policy, International Affairs, and Environment.

R&D Category – The FAA R&D portfolio includes both applied research and development as defined by OMB Circular A-11*. Table 4.3 shows the FAA R&D portfolio according to these categories with the percent of applied research and development for FY 2012 through 2016.

Performance Goal – Table 4.4 shows the FAA R&D budget by the performance goals defined in Exhibit II of the FAA budget request for FY 2012. The R&D programs apply to three performance goals – safety, economic competitiveness, and environmental sustainability. 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 2012.

* OMB Circular A-11, "Preparation, Submission and Execution of the Budget," July 21, 2010, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

# Table 4.1
# FAA R&D Program Budget by Appropriations Account

| Project Number | FY 2012 Budget Line Item | Program | Appropriation Account | 2012 Request ($000) | 2013 Planned ($000) | 2014 Planned ($000) | 2015 Planned ($000) | 2016 Planned ($000) | /1 |
|---|---|---|---|---|---|---|---|---|---|
| ***Research, Engineering and Development (R,E&D)*** | | | | | | | | | |
| 061-110 | A11.a | Fire Research and Safety | R,E&D | 8,157 | 7,998 | 8,028 | 8,152 | 8,340 | |
| 063-110 | A11.b | Propulsion and Fuel Systems | R,E&D | 3,611 | 3,474 | 3,452 | 3,489 | 3,565 | |
| 062-110/111 | A11.c | Advanced Materials/Structural Safety | R,E&D | 2,605 | 2,533 | 2,532 | 2,566 | 2,623 | |
| 064-110/111 | A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | R,E&D | 5,404 | 5,207 | 5,179 | 5,237 | 5,351 | |
| 065-110 | A11.e | Continued Airworthiness | R,E&D | 12,589 | 12,082 | 11,994 | 12,114 | 12,374 | |
| 066-110 | A11.f | Aircraft Catastrophic Failure Prevention Research | R,E&D | 1,502 | 1,438 | 1,425 | 1,439 | 1,470 | |
| 081-110 | A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 6,162 | 6,070 | 6,107 | 6,209 | 6,354 | |
| 060-110 | A11.h | System Safety Management | R,E&D | 10,027 | 9,581 | 9,489 | 9,574 | 9,776 | |
| 082-110 | A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 10,634 | 10,502 | 10,579 | 10,762 | 11,015 | |
| 086-110 | A11.j | Aeromedical Research | R,E&D | 11,617 | 11,420 | 11,477 | 11,662 | 11,933 | |
| 041-110 | A11.k | Weather Program | R,E&D | 16,366 | 15,311 | 14,995 | 15,045 | 15,338 | |
| 069-110 | A11.l | Unmanned Aircraft Systems Research | R,E&D | 3,504 | 3,373 | 3,353 | 3,390 | 3,463 | |
| 111-160 | A11.m | NextGen - Alternative Fuels for General Aviation | R,E&D | 2,071 | 1,984 | 1,968 | 1,987 | 2,030 | |
| 027-110 | A12.a | Joint Planning and Development Office | R,E&D | 14,067 | 13,658 | 13,638 | 13,812 | 14,117 | |
| 111-130 | A12.b | NextGen - Wake Turbulence | R,E&D | 10,674 | 10,283 | 10,227 | 10,340 | 10,565 | |
| 111-110 | A12.c | NextGen - Air Ground Integration Human Factors | R,E&D | 10,545 | 10,117 | 10,043 | 10,144 | 10,363 | |
| 111-120 | A12.d | NextGen - Self-Separation Human Factors | R,E&D | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | |
| 111-140 | A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 9,186 | 8,845 | 8,795 | 8,891 | 9,084 | |
| 091-110/111/116 | A13.a | Environment and Energy | R,E&D | 15,327 | 14,505 | 14,293 | 14,384 | 14,677 | |
| 111-150 | A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | R,E&D | 20,523 | 19,743 | 19,623 | 19,833 | 20,263 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 1,718 | 1,602 | 1,567 | 1,570 | 1,601 | |
| 011-140 | A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 3,777 | 3,740 | 3,772 | 3,839 | 3,931 | |
| | | ***R,E&D* TOTAL** | **R,E&D** | **190,000** | **183,000** | **182,000** | **184,000** | **188,000** | |
| ***Facilities & Equipment (F&E)*** | | | | | | | | | /2 |
| S09.02-00 | 1A01A | Runway Incursion Reduction | F&E | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| M08.28-00 | 1A01B | System Capacity, Planning and Improvement | F&E | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | |
| M08.29-00 | 1A01C | Operations Concept Validation | F&E | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | |
| M08.27-01 | 1A01D | NAS Weather Requirements | F&E | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | |
| M08.28-04 | 1A01E | Airspace Management Program | F&E | 3,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| | | **Subtotal** | **Line 1A01** | 19,000 | 21,000 | 21,000 | 21,000 | 21,000 | /3 |
| G1M.02-01 | 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G6M.02-01 | 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | F&E | 15,000 | 10,000 | 10,000 | 10,000 | 10,000 | |
| G1M.02-02 | 1A08B | NextGen - New Air Traffic Management Requirements | F&E | 37,000 | 22,000 | 22,000 | 22,000 | 22,000 | |
| G1M.02-03 | 1A08C | NextGen - Operations Concept Validation - Validation Modeling | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G7M.02-01 | 1A08G | NextGen - System Safety Management Transformation | F&E | 18,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| G6M.02-02 | 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 3,000 | 1,500 | 1,500 | 1,500 | 1,500 | |
| G7M.02-02 | 1A08F | NextGen - Operational Assessments | F&E | 10,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| G3M.04-01 | 1A08H | NextGen - Staffed NextGen Towers (SNT) | F&E | 6,000 | 2,000 | 2,000 | 6,000 | 6,000 | |
| | | **Subtotal** | **Line 1A08** | 109,000 | 61,500 | 61,500 | 65,500 | 65,500 | /4 |
| M03.02-00 | 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 22,785 | 22,560 | 22,560 | 22,560 | 22,560 | /5 |
| | | ***F&E* TOTAL** | **F&E** | **150,785** | **105,060** | **105,060** | **109,060** | **109,060** | |
| ***Airport Improvement Program (AIP)*** | | | | | | | | | |
| -- | -- | Airport Technology Research - Capacity | AIP | 12,025 | 12,150 | 12,150 | 12,150 | 12,150 | |
| -- | -- | Airport Technology Research - Environment | AIP | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | |
| -- | -- | Airport Technology Research - Safety | AIP | 15,725 | 15,850 | 15,850 | 15,850 | 15,850 | /6 |
| -- | -- | Airport Cooperative Research - Capacity | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Environment | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Safety | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | /7 |
| | | ***AIP* TOTAL** | AIP | **44,250** | **44,500** | **44,500** | **44,500** | **44,500** | |
| ***Operations (Ops)*** | | | | | | | | | |
| -- | -- | Commercial Space Transportation Safety | Ops | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | |
| | | ***Ops* TOTAL** | **Ops** | **1,000** | **1,000** | **1,000** | **1,000** | **1,000** | |
| | | **GRAND TOTAL** | | **$386,035** | **$333,560** | **$332,560** | **$338,560** | **$342,560** | |

Notes:
/1 The funding levels listed for years 2013 to 2016 are estimates and subject to change.
/2 The amounts shown for F&E programs reflect only R&D activities: they do not include acquisition, operational testing, or other non-R&D activities.
/3 The five programs in the ADT&P line (1A01) are combined into a single narrative write-up in Appendix A.
/4 The eight programs in the NextGen - Systems Development line (1A08) are combined into a single narrative write-up in Appendix A.
/5 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 28.2% in FY 2012 and beyond.
/6 The three programs in the Airport Technology Research line (AIP) are combined into a single narrative write-up in Appendix A.
/7 The three programs in the Airport Cooperative Research Program (AIP) are combined into a single narrative write-up in Appendix A.

# Table 4.2
# FAA R&D Program Budget by Sponsoring Organization

| Project Number | FY 2012 Budget Line Item | Program | Appropriation Account | 2012 Request ($000) | 2013 Planned ($000) | 2014 Planned ($000) | 2015 Planned ($000) | 2016 Planned ($000) | /1 |
|---|---|---|---|---|---|---|---|---|---|
| ***Aviation Safety (AVS)*** | | | | | | | | | |
| 061-110 | A11.a | Fire Research and Safety | R,E&D | 8,157 | 7,998 | 8,028 | 8,152 | 8,340 | |
| 063-110 | A11.b | Propulsion and Fuel Systems | R,E&D | 3,611 | 3,474 | 3,452 | 3,489 | 3,565 | |
| 062-110/111 | A11.c | Advanced Materials/Structural Safety | R,E&D | 2,605 | 2,533 | 2,532 | 2,566 | 2,623 | |
| 064-110/111 | A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | R,E&D | 5,404 | 5,207 | 5,179 | 5,237 | 5,351 | |
| 065-110 | A11.e | Continued Airworthiness | R,E&D | 12,589 | 12,082 | 11,994 | 12,114 | 12,374 | |
| 066-110 | A11.f | Aircraft Catastrophic Failure Prevention Research | R,E&D | 1,502 | 1,438 | 1,425 | 1,439 | 1,470 | |
| 081-110 | A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 6,162 | 6,070 | 6,107 | 6,209 | 6,354 | |
| 060-110 | A11.h | System Safety Management | R,E&D | 10,027 | 9,581 | 9,489 | 9,574 | 9,776 | |
| 086-110 | A11.j | Aeromedical Research | R,E&D | 11,617 | 11,420 | 11,477 | 11,662 | 11,933 | |
| 069-110 | A11.l | Unmanned Aircraft Systems Research | R,E&D | 3,504 | 3,373 | 3,353 | 3,390 | 3,463 | |
| | | **Subtotal** | **R,E&D** | **65,178** | **63,176** | **63,036** | **63,832** | **65,249** | |
| G7M.02-01 | 1A08G | NextGen - System Safety Management Transformation | F&E | 18,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| | | ***AVS* TOTAL** | | **83,178** | **71,176** | **71,036** | **71,832** | **73,249** | |
| ***Air Traffic Organization (ATO)*** | | | | | | | | | |
| 082-110 | A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 10,634 | 10,502 | 10,579 | 10,762 | 11,015 | |
| 041-110 | A11.k | Weather Program | R,E&D | 16,366 | 15,311 | 14,995 | 15,045 | 15,338 | |
| 027-110 | A12.a | Joint Planning and Development Office | R,E&D | 14,067 | 13,658 | 13,638 | 13,812 | 14,117 | |
| 111-130 | A12.b | NextGen - Wake Turbulence | R,E&D | 10,674 | 10,283 | 10,227 | 10,340 | 10,565 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 1,718 | 1,602 | 1,567 | 1,570 | 1,601 | |
| 011-140 | A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 3,777 | 3,740 | 3,772 | 3,839 | 3,931 | /3 |
| 111-160 | A11.m | NextGen - Alternative Fuels for General Aviation | R,E&D | 2,071 | 1,984 | 1,968 | 1,987 | 2,030 | |
| 111-110 | A12.c | NextGen - Air Ground Integration Human Factors | R,E&D | 10,545 | 10,117 | 10,043 | 10,144 | 10,363 | |
| 111-120 | A12.d | NextGen - Self-Separation Human Factors | R,E&D | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | |
| 111-140 | A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 9,186 | 8,845 | 8,795 | 8,891 | 9,084 | |
| | | **Subtotal** | **R,E&D** | **88,972** | **85,576** | **85,048** | **85,951** | **87,811** | |
| S09.02-00 | 1A01A | Runway Incursion Reduction | F&E | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | /3 |
| M08.28-00 | 1A01B | System Capacity, Planning and Improvement | F&E | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | |
| M08.29-00 | 1A01C | Operations Concept Validation | F&E | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | |
| M08.27-01 | 1A01D | NAS Weather Requirements | F&E | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | |
| M08.28-04 | 1A01E | Airspace Management Program | F&E | 3,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G1M.02-01 | 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | /4 |
| G1M.02-02 | 1A08B | NextGen - New Air Traffic Management Requirements | F&E | 37,000 | 22,000 | 22,000 | 22,000 | 22,000 | |
| G1M.02-03 | 1A08C | NextGen - Operations Concept Validation - Validation Modeling | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G6M.02-02 | 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 3,000 | 1,500 | 1,500 | 1,500 | 1,500 | |
| G7M.02-02 | 1A08F | NextGen - Operational Assessments | F&E | 10,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| G3M.04-01 | 1A08H | NextGen - Staffed NextGen Towers (SNT) | F&E | 6,000 | 2,000 | 2,000 | 6,000 | 6,000 | |
| M03.02-00 | 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 22,785 | 22,560 | 22,560 | 22,560 | 22,560 | /5 |
| | | **Subtotal** | **F&E** | **117,785** | **87,060** | **87,060** | **91,060** | **91,060** | /2 |
| | | ***ATO* TOTAL** | | **206,757** | **172,636** | **172,108** | **177,011** | **178,871** | |
| ***Airports (ARP)*** | | | | | | | | | |
| -- | -- | Airport Technology Research - Capacity | AIP | 12,025 | 12,150 | 12,150 | 12,150 | 12,150 | |
| -- | -- | Airport Technology Research - Environment | AIP | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | /6 |
| -- | -- | Airport Technology Research - Safety | AIP | 15,725 | 15,850 | 15,850 | 15,850 | 15,850 | |
| -- | -- | Airport Cooperative Research - Capacity | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Environment | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Safety | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | /7 |
| | | ***ARP* TOTAL** | | **44,250** | **44,500** | **44,500** | **44,500** | **44,500** | |
| ***Policy, International Affairs, and Environment (APL)*** | | | | | | | | | |
| 091-110/111/116 | A13.a | Environment and Energy | R,E&D | 15,327 | 14,505 | 14,293 | 14,384 | 14,677 | |
| G1M.02-01 | A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | R,E&D | 20,523 | 19,743 | 19,623 | 19,833 | 20,263 | |
| | | **Subtotal** | **R,E&D** | **35,850** | **34,248** | **33,916** | **34,217** | **34,940** | |
| G6M.02-01 | 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | F&E | 15,000 | 10,000 | 10,000 | 10,000 | 10,000 | |
| | | **Subtotal** | **F&E** | **15,000** | **10,000** | **10,000** | **10,000** | **10,000** | /2 |
| | | ***APL* TOTAL** | | **50,850** | **44,248** | **43,916** | **44,217** | **44,940** | |
| ***Commercial Space Transportation (AST)*** | | | | | | | | | |
| -- | -- | Commercial Space Transportation Safety | Ops | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | |
| | | ***AST* TOTAL** | | **1,000** | **1,000** | **1,000** | **1,000** | **1,000** | |
| | | **GRAND TOTAL** | | **$386,035** | **$333,560** | **$332,560** | **$338,560** | **$342,560** | |

Notes:
/1 The funding levels listed for years 2013 to 2016 are estimates and subject to change.
/2 The amounts shown for F&E programs reflect only R&D activities: they do not include acquisition, operational testing, or other non-R&D activities.
/3 The five programs in the ADT&P line (1A01) are combined into a single narrative write-up in Appendix A.
/4 The eight programs in the NextGen - Systems Development line (1A08) are combined into a single narrative write-up in Appendix A.
/5 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 28.2% in FY 2012 and beyond.
/6 The three programs in the Airport Technology Research line (AIP) are combined into a single narrative write-up in Appendix A.
/7 The three programs in the Airport Cooperative Research Program (AIP) are combined into a single narrative write-up in Appendix A.

# Table 4.3
# FAA R&D Program Budget by Research and Development Category

| Project Number | FY 2012 Budget Line Item | Program | Appropriation Account | 2012 Request ($000) | 2013 Planned ($000) | 2014 Planned ($000) | 2015 Planned ($000) | 2016 Planned ($000) | /1 |
|---|---|---|---|---|---|---|---|---|---|
| ***Applied Research*** | | | | | | | | | |
| 061-110 | A11.a | Fire Research and Safety | R,E&D | 8,157 | 7,998 | 8,028 | 8,152 | 8,340 | |
| 063-110 | A11.b | Propulsion and Fuel Systems | R,E&D | 3,611 | 3,474 | 3,452 | 3,489 | 3,565 | |
| 062-110/111 | A11.c | Advanced Materials/Structural Safety | R,E&D | 2,605 | 2,533 | 2,532 | 2,566 | 2,623 | |
| 064-110/111 | A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | R,E&D | 5,404 | 5,207 | 5,179 | 5,237 | 5,351 | |
| 065-110 | A11.e | Continued Airworthiness | R,E&D | 12,589 | 12,082 | 11,994 | 12,114 | 12,374 | |
| 066-110 | A11.f | Aircraft Catastrophic Failure Prevention Research | R,E&D | 1,502 | 1,438 | 1,425 | 1,439 | 1,470 | |
| 081-110 | A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 6,162 | 6,070 | 6,107 | 6,209 | 6,354 | |
| 060-110 | A11.h | System Safety Management | R,E&D | 10,027 | 9,581 | 9,489 | 9,574 | 9,776 | |
| 082-110 | A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 10,634 | 10,502 | 10,579 | 10,762 | 11,015 | |
| 086-110 | A11.j | Aeromedical Research | R,E&D | 11,617 | 11,420 | 11,477 | 11,662 | 11,933 | |
| 041-110 | A11.k | Weather Program | R,E&D | 16,366 | 15,311 | 14,995 | 15,045 | 15,338 | |
| 069-110 | A11.l | Unmanned Aircraft Systems Research | R,E&D | 3,504 | 3,373 | 3,353 | 3,390 | 3,463 | |
| 111-160 | A11.m | NextGen - Alternative Fuels for General Aviation | R,E&D | 2,071 | 1,984 | 1,968 | 1,987 | 2,030 | |
| 027-110 | A12.a | Joint Planning and Development Office | R,E&D | 14,067 | 13,658 | 13,638 | 13,812 | 14,117 | |
| 111-130 | A12.b | NextGen - Wake Turbulence | R,E&D | 10,674 | 10,283 | 10,227 | 10,340 | 10,565 | |
| 111-110 | A12.c | NextGen - Air Ground Integration Human Factors | R,E&D | 10,545 | 10,117 | 10,043 | 10,144 | 10,363 | |
| 111-120 | A12.d | NextGen - Self-Separation Human Factors | R,E&D | 9,934 | 9,534 | 9,464 | 9,561 | 9,767 | |
| 111-140 | A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 9,186 | 8,845 | 8,795 | 8,891 | 9,084 | |
| 091-110/111/116 | A13.a | Environment and Energy | R,E&D | 15,327 | 14,505 | 14,293 | 14,384 | 14,677 | |
| 111-150 | A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | R,E&D | 20,523 | 19,743 | 19,623 | 19,833 | 20,263 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 1,718 | 1,602 | 1,567 | 1,570 | 1,601 | |
| 011-140 | A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 3,777 | 3,740 | 3,772 | 3,839 | 3,931 | |
| | | **Subtotal** | **R,E&D** | **190,000** | **183,000** | **182,000** | **184,000** | **188,000** | |
| -- | -- | Airport Cooperative Research - Capacity | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Environment | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| -- | -- | Airport Cooperative Research - Safety | AIP | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | /2 |
| -- | -- | Airport Technology Research - Capacity | AIP | 12,025 | 12,150 | 12,150 | 12,150 | 12,150 | |
| -- | -- | Airport Technology Research - Environment | AIP | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | |
| -- | -- | Airport Technology Research - Safety | AIP | 15,725 | 15,850 | 15,850 | 15,850 | 15,850 | /3 |
| | | **Subtotal** | **AIP** | 44,250 | 44,500 | 44,500 | 44,500 | 44,500 | |
| -- | -- | Commercial Space Transportation Safety | Ops | 500 | 500 | 500 | 500 | 500 | /4 |
| | | **Subtotal** | **Ops** | **500** | **500** | **500** | **500** | **500** | |
| | | ***Applied Research* TOTAL** | | **234,750** | **228,000** | **227,000** | **229,000** | **233,000** | |
| | | ***Applied Research* PERCENT** | | **60.8%** | **68.4%** | **68.3%** | **67.6%** | **68.0%** | |
| ***Development*** | | | | | | | | | |
| S09.02-00 | 1A01A | Runway Incursion Reduction | F&E | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | /5 |
| M08.28-00 | 1A01B | System Capacity, Planning and Improvement | F&E | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | |
| M08.29-00 | 1A01C | Operations Concept Validation | F&E | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | |
| M08.27-01 | 1A01D | NAS Weather Requirements | F&E | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | |
| M08.28-04 | 1A01E | Airspace Management Program | F&E | 3,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G1M.02-01 | 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | /6 |
| G6M.02-01 | 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | F&E | 15,000 | 10,000 | 10,000 | 10,000 | 10,000 | |
| G1M.02-02 | 1A08B | NextGen - New Air Traffic Management Requirements | F&E | 37,000 | 22,000 | 22,000 | 22,000 | 22,000 | |
| G1M.02-03 | 1A08C | NextGen - Operations Concept Validation - Validation Modeling | F&E | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | |
| G7M.02-01 | 1A08G | NextGen - System Safety Management Transformation | F&E | 18,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| G6M.02-02 | 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 3,000 | 1,500 | 1,500 | 1,500 | 1,500 | |
| G7M.02-02 | 1A08F | NextGen - Operational Assessments | F&E | 10,000 | 8,000 | 8,000 | 8,000 | 8,000 | |
| G3M.04-01 | 1A08H | NextGen - Staffed NextGen Towers (SNT) | | 6,000 | 2,000 | 2,000 | 6,000 | 6,000 | |
| M03.02-00 | 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 22,785 | 22,560 | 22,560 | 22,560 | 22,560 | /7 |
| | | **Subtotal** | **F&E** | **150,785** | **105,060** | **105,060** | **109,060** | **109,060** | /8 |
| -- | -- | Commercial Space Transportation Safety | Ops | 500 | 500 | 500 | 500 | 500 | /4 |
| | | **Subtotal** | **Ops** | **500** | **500** | **500** | **500** | **500** | |
| | | ***Development* TOTAL** | | **151,285** | **105,560** | **105,560** | **109,560** | **109,560** | |
| | | ***Development* PERCENT** | | **39.2%** | **31.6%** | **31.7%** | **32.4%** | **32.0%** | |
| | | **GRAND TOTAL** | | **$386,035** | **$333,560** | **$332,560** | **$338,560** | **$342,560** | |

Notes:
/1 The funding levels listed for years 2013 to 2016 are estimates and subject to change.
/2 The amounts shown for F&E programs reflect only R&D activities: they do not include acquisition, operational testing, or other non-R&D activities.
/3 The five programs in the ADT&P line (1A01) are combined into a single narrative write-up in Appendix A.
/4 The eight programs in the NextGen - Systems Development line (1A08) are combined into a single narrative write-up in Appendix A.
/5 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 28.2% in FY 2012 and beyond.
/6 The three programs in the Airport Technology Research line (AIP) are combined into a single narrative write-up in Appendix A.
/7 The three programs in the Airport Cooperative Research Program (AIP) are combined into a single narrative write-up in Appendix A.

# Table 4.4

# FAA R&D Program Budget by Performance Goals

(Organized According to Exhibit II of the FAA FY 2012 Budget Request)

| Project Number | FY 2012 Budget Line Item | Program | Appropriation Account | FY 2012 Contract Costs ($000) | FY 2012 Personnel Costs ($000) | FY 2012 Other In-house Costs ($000) | FY 2012 Total Planned ($000) | |
|---|---|---|---|---|---|---|---|---|
| ***1. Safety*** | | | | | | | | |
| 061-110 | A11.a | Fire Research and Safety | R,E&D | 3,850 | 3,960 | 347 | 8,157 | |
| 063-110 | A11.b | Propulsion and Fuel Systems | R,E&D | 2,400 | 1,092 | 119 | 3,611 | |
| 062-110/111 | A11.c | Advanced Materials/Structural Safety | R,E&D | 1,450 | 1,054 | 101 | 2,605 | |
| 064-110/111 | A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | R,E&D | 3,504 | 1,718 | 182 | 5,404 | |
| 065-110 | A11.e | Continued Airworthiness | R,E&D | 8,656 | 3,588 | 345 | 12,589 | |
| 066-110 | A11.f | Aircraft Catastrophic Failure Prevention Research | R,E&D | 1,070 | 395 | 37 | 1,502 | |
| 081-110 | A11.g | Flightdeck/Maintenance/System Integration Human Factors | R,E&D | 2,617 | 3,318 | 227 | 6,162 | |
| 060-110 | A11.h | System Safety Management | R,E&D | 7,330 | 2,427 | 270 | 10,027 | |
| 082-110 | A11.i | Air Traffic Control/Technical Operations Human Factors | R,E&D | 4,241 | 6,019 | 374 | 10,634 | |
| 086-110 | A11.j | Aeromedical Research | R,E&D | 5,183 | 6,145 | 289 | 11,617 | |
| 041-110 | A11.k | Weather Program | R,E&D | 15,342 | 768 | 256 | 16,366 | |
| 069-110 | A11.l | Unmanned Aircraft Systems Research | R,E&D | 2,307 | 1,110 | 87 | 3,504 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 848 | 17 | 12 | 877 | |
| 011-140 | A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 892 | 1,443 | 60 | 2,396 | /1 |
| 111-160 | A11.m | NextGen - Alternative Fuels for General Aviation | R,E&D | 2,003 | 40 | 28 | 2,071 | /1 |
| | | **Subtotal** | **R,E&D** | **61,693** | **33,094** | **2,733** | **97,521** | |
| S09.02-00 | 1A01A | Runway Incursion Reduction | F&E | 5,000 | 0 | 0 | 5,000 | |
| | | **Subtotal** | **F&E** | **5,000** | **0** | **0** | **5,000** | |
| -- | -- | Airport Technology Research - Safety | AIP | 13,984 | 1,741 | 0 | 15,725 | |
| -- | -- | Airport Cooperative Research - Safety | AIP | 3,750 | 1,250 | 0 | 5,000 | |
| | | **Subtotal** | **AIP** | **17,734** | **2,991** | **0** | **20,725** | |
| -- | -- | Commercial Space Transportation Safety | Ops | 1,000 | 0 | 0 | 1,000 | |
| | | **Subtotal** | **Ops** | **1,000** | **0** | **0** | **1,000** | |
| | | ***1. Safety* TOTAL** | | **85,427** | **36,085** | **2,733** | **124,246** | |
| ***2. Economic Competitiveness*** | | | | | | | | |
| 027-110 | A12.a | Joint Planning and Development Office | R,E&D | 10,938 | 2,869 | 260 | 14,067 | |
| 111-130 | A12.b | NextGen - Wake Turbulence | R,E&D | 9,492 | 943 | 239 | 10,674 | |
| 111-110 | A12.c | NextGen - Air Ground Integration Human Factors | R,E&D | 9,978 | 414 | 153 | 10,545 | |
| 111-120 | A12.d | NextGen - Self-Separation Human Factors | R,E&D | 9,362 | 408 | 164 | 9,934 | |
| 111-140 | A12.e | NextGen - Weather Technology in the Cockpit | R,E&D | 8,234 | 775 | 177 | 9,186 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 490 | 10 | 8 | 507 | |
| 011-140 | A14.b | William J. Hughes Technical Center Laboratory Facility | R,E&D | 515 | 833 | 34 | 1,382 | /1 |
| | | **Subtotal** | **R,E&D** | **49,009** | **6,252** | **1,036** | **56,295** | /1 |
| M08.28-00 | 1A01B | System Capacity, Planning and Improvement | F&E | 6,000 | 0 | 0 | 6,000 | |
| M08.29-00 | 1A01C | Operations Concept Validation | F&E | 4,000 | 0 | 0 | 4,000 | |
| M08.27-01 | 1A01D | NAS Weather Requirements | F&E | 1,000 | 0 | 0 | 1,000 | |
| M08.28-04 | 1A01E | Airspace Management Program | F&E | 3,000 | 0 | 0 | 3,000 | |
| G1M.02-01 | 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | F&E | 10,000 | 0 | 0 | 10,000 | |
| G1M.02-02 | 1A08B | NextGen - New Air Traffic Management Requirements | F&E | 37,000 | 0 | 0 | 37,000 | |
| G1M.02-03 | 1A08C | NextGen - Operations Concept Validation - Validation Modeling | F&E | 10,000 | 0 | 0 | 10,000 | |
| G7M.02-01 | 1A08G | NextGen - System Safety Management Transformation | F&E | 18,000 | 0 | 0 | 18,000 | |
| G6M.02-02 | 1A08E | NextGen - Wake Turbulence - Re-categorization | F&E | 3,000 | 0 | 0 | 3,000 | |
| G7M.02-02 | 1A08F | NextGen - Operational Assessments | F&E | 10,000 | 0 | 0 | 10,000 | |
| G3M.04-01 | 1A08H | NextGen - Staffed NextGen Towers (SNT) | F&E | 6,000 | 0 | 0 | 6,000 | |
| M03.02-00 | 4A09A | Center for Advanced Aviation System Development (CAASD) | F&E | 22,785 | 0 | 0 | 22,785 | |
| | | **Subtotal** | **F&E** | **130,785** | **0** | **0** | **130,785** | /2 |
| -- | -- | Airport Technology Research - Capacity | AIP | 10,285 | 1,740 | 0 | 12,025 | |
| -- | -- | Airport Cooperative Research - Capacity | AIP | 3,750 | 1,250 | 0 | 5,000 | |
| | | **Subtotal** | **AIP** | **14,035** | **2,990** | **0** | **17,025** | |
| | | ***2. Economic Competitiveness* TOTAL** | | **193,829** | **9,242** | **1,036** | **204,105** | |
| ***4. Environmental Sustainability*** | | | | | | | | |
| 091-110/111/116 | A13.a | Environment and Energy | R,E&D | 12,658 | 2,025 | 644 | 15,327 | |
| 111-150 | A13.b | NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics | R,E&D | 18,655 | 1,378 | 490 | 20,523 | |
| 011-130 | A14.a | System Planning and Resource Management | R,E&D | 323 | 6 | 4 | 334 | |
| | | **Subtotal** | **R,E&D** | **31,636** | **3,409** | **1,138** | **36,184** | /1 |
| G6M.02-01 | 1A08D | NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction | F&E | 15,000 | 0 | 0 | 15,000 | |
| | | **Subtotal** | **F&E** | **15,000** | **0** | **0** | **15,000** | |
| -- | -- | Airport Technology Research - Environment | AIP | 1,500 | 0 | 0 | 1,500 | |
| -- | -- | Airport Cooperative Research - Environment | AIP | 3,750 | 1,250 | 0 | 5,000 | |
| | | **Subtotal** | **AIP** | **5,250** | **1,250** | **0** | **6,500** | |
| | | ***4. Environmental Sustainability* TOTAL** | | **51,886** | **4,659** | **1,138** | **57,684** | |
| | | **GRAND TOTAL** | | **331,142** | **49,986** | **4,908** | **386,035** | |

Notes:

/1 System Planning and Resource Management is considered part of Mission Support for the R,E&D program and is pro-rated across the three goal areas as follows: Safety at 51.1 percent; Economic Competitiveness at 29.5 percent; and Environmental Sustainability at 19.54 percent. William J. Hughes Technical Center is considered part of Mission Support; it is pro-rated between Safety at 63.4 percent and Mobility at 36.6 percent.

/2 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 28.2% in FY 2012 and beyond. Many R&D programs apply to more than one goal area; however, for budgeting purposes most programs are included in only one goal area. The amounts shown for F&E programs reflect only R&D activities: they do not include acquisition, operational testing, or other non-R&D activities.

# Partnerships

The FAA enhances and expands its R&D capabilities by working with other government, industry, and academic organizations using a variety of acquisition tools, such as cooperative agreements, grants, and contracts. These research mechanisms help leverage resources and 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 cooperative agreements, such as memoranda of understanding/agreement (MOU/MOA) and international agreements. 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.

### Memoranda of Understanding/Agreement

Memoranda of Understanding/Agreement support joint research activities between departments or agencies. 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 under a broader MOU. An MOA may include interagency agreements (IAs), written agreements between FAA and other agencies, in which FAA agrees to receive from, or exchange supplies or services with, the other agency. Appendix B lists current FAA MOUs, MOAs, and IAs.

### Joint Planning and Development Office

The JPDO provides government-wide planning and coordination for NextGen. The JPDO members include the DoD, DOT, DHS, DOC, FAA, NASA, and OSTP. 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/.

## National Science and Technology Council

The National Science and Technology Council (NSTC), established by Executive Order 12881 on November 23, 1993, is a cabinet-level Council and the principal means within the executive branch to coordinate science and technology policy across the diverse entities that make up the federal research and development enterprise. Chaired by the President, the NSTC includes the Vice President, the Director of OSTP, Cabinet Secretaries, and Agency Heads with significant science and technology responsibilities, and other White House officials. For more information, see http://www.whitehouse.gov/ostp/nstc/.

## Global Earth Observation System of Systems

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

## The U.S. Global Change Research Program

The U.S. Global Change Research Program (USGCRP) began as a presidential initiative in 1989. It was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101-606), which called for "*a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.*" Thirteen federal departments and agencies participate in the USGCRP including DOT. The FAA contributes by assessing and identifying potential measures to reduce fuel consumption and greenhouse gas emissions and by conducting research to support USGCRP Goal 2, leveraging research with other U.S. Government agencies to reduce uncertainties surrounding aviation emissions and their effect on climate change. For more information, see http://www.globalchange.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. FAA does this through the following mechanisms:

### Cooperative Research and Development Agreements

A Cooperative Research and Development Agreement (CRDA) is collaborative in nature and allows FAA to share facilities, equipment, services, intellectual property, personnel, and other resources with private industry, academia, or state and local government agencies. Appendix B provides a list of active CRDAs for FY 2010. For more information, see http://www.faa.gov/go/ttp/.

### Contracts and Cooperative Agreements

The FAA awards contracts and cooperative agreements 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 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 properties are inventions, including those protected by patents. Appendix B provides a list of current 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:

### 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. For more information, see http://u2.princeton.edu/~jup/.

### Aviation Research Grants

Public Law 101-508 Section 9205 authorizes the FAA to establish research grant programs that encompass a broad spectrum of aviation research activities. These programs encourage and support innovative and advanced research with potential benefit to the FAA mission. All colleges, universities, and other non-profit research institutions qualify for research grants. This FAA program also supports the long-term growth of the aviation industry by encouraging academic institutions to establish and nurture aviation research programs that increase the talent-base in aviation. Appendix B provides a summary of grants issued in FY 2010. For more information, see http://www.tc.faa.gov/logistics/grants/.

### Air Transportation Centers of Excellence

Public Law 101-508 Section 9209 authorizes the Administrator to establish and operate air transportation centers of excellence (COEs). Through these collaborative, long-term, cost-sharing partnerships, government, academia, and industry teams leverage their resources to advance the technological future of the nation's aviation community. The FAA operates six COEs through cooperative agreements with academic institutions to assist in mission-critical research in the areas of commercial space transportation, airliner cabin and inter-modal transport environment, advanced materials, noise and emissions mitigation, general aviation, and airport technology. Appendix B provides a summary of COE activities. For more information, see http://www.faa.gov/go/coe/.

### 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 aviation safety and ATM modernization programs and to leverage research activities that harmonize operations and promote a seamless and safe air transportation system worldwide.

### EUROCONTROL

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

### AIRE

Established in 2007, the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) provides a foundation for cooperation between the FAA and the European Commission on research to aid the environment while making air transportation more efficient. In addition to facilitating cooperation among aviation authorities, AIRE also involves industry partners, such as aircraft manufacturers, operators, and providers of aviation navigation services. In total, 1,152 flights contributed to the framework of AIRE. Analysis of the data collected show that 400 tons of CO2 could be saved which corresponds to the annual CO2 emission of 100 passenger cars. For more information, see http://www.ec.europa.eu/transport/air/environment/aire_en.htm/.

### Transport Canada

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

### ASPIRE

The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) was established February 18, 2008 as a partnership, with initial partners FAA, Airservices Australia, and Airways New Zealand; and demonstration partners SEAC Tahiti and Airports Fiji. The partnership seeks to reduce the impact of aviation on the environment in the Asia and South Pacific regions through technological innovation and best practice air traffic management. It includes demonstrations and implementation of key NextGen technologies and practices, including reduced separation, more efficient flight profiles, and tailored arrivals. Initial results based on the current and “ideal flight” trajectories for selected 806 city pair flights show an average of 5.5% fuel burn benefit. For more information, see http://www.aspire-green.com/.

# Evaluation

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

## Internal Portfolio Reviews

The FAA R&D portfolio receives continuous internal review to ensure that it meets customer needs, high quality standards, and management excellence.

### Process Improvements and Quality Management

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

### Program Planning Teams

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

### R&D Executive Board

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

### Joint Resources Council

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

## External Portfolio Reviews

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

### Research, Engineering, and Development Advisory Committee

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

During 2010, the REDAC held two committee meetings and ten subcommittee meetings and produced two reports. Appendix C provides the recommendations from these reports and the Agency responses. For more information, see http://go.usa.gov/aQW/.

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

## Commercial Space Transportation Advisory Committee

Established in 1984, the Commercial Space Transportation Advisory Committee (COMSTAC) advises the FAA Administrator and the U.S. Department of Transportation on matters relating to the U.S. commercial space transportation industry, including R&D activities. Currently, the Committee has twenty-two members. The Administrator recommends members to the Secretary of Transportation,
Each member serves a two-year term. Members represent commercial launch providers of expendable and reusable launch vehicles, rocket propulsion, commercial launch site operations, satellite manufacturing and operations, space policy and education, space law, insurance and finance, state government and economic development, space advocacy, and space business and technical associations. The COMSTAC provides annual recommendations for commercial space transportation R&D projects and periodically reviews FAA commercial space R&D reports and activities.

During 2010, the COMSTAC held two full committee meetings and eight working group meetings. Committee produced two sets of recommendations at its May 2010 meeting. The first set focused on export controls and advocated support for the White House's "four singles" approach, which would create a single coordinating agency, a single list, a single licensing agency, and a single information technology system. The second set supported the Commercial Crew Development Program and advocated licensing for commercial human spaceflight activities. For more information, see http://www.faa.gov/about/office_org/headquarters_offices/ast/advisory_committee/.

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

The ACRP Oversight Committee announced their FY 2011 projects in August 2010. The 30 projects will examine different research areas that target near-term solutions to problems facing airport operators and industry stakeholders, such as the Airports Council International. These projects include development of airport performance metrics, low cost practices to reduce airport carbon footprint, airport development under oil price uncertainty, and assessment of the risks of runway safety areas and existing airfield separation standards. For more information, see http://www.trb.org/ACRP/Public/.

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*FAA Headquarters, Washington, DC*

# Acronyms and Abbreviations

| | |
|---|---|
| AC | Advisory Circular |
| ACER | Airliner Cabin Environment Research |
| ACRP | Airport Cooperative Research Program |
| ACSD | Aviation Child Safety Device |
| ADS-B | Automatic Dependent Surveillance-Broadcast |
| AEDT | Aviation Environmental Design Tool |
| AIP | Airport Improvement Program Appropriation |
| AIRE | Atlantic Interoperability Initiative to Reduce Emissions |
| ANSP | Air Navigation Service Provider |
| APM | Automated People Mover |
| APMT | Aviation Environmental Portfolio Management Tool |
| ASDE-X | Airport Surface Detection Equipment Model-X |
| ASIAS | Aviation Safety Informati and Sharing |
| ASPIRE | Asia and South Pacific Ini Reduce Emissions |
| ASTM | American Society for Test Materials |
| ATC | Air Traffic Control |
| ATD&P | Advanced Technology an Development and Prototy |
| ATM | Air Traffic Management |
| ATSP | Air Traffic Service Provid |
| AVS | Aviation Safety |
| CAASD | Center for Advanced Avia Development |
| CAEP | Committee on Aviation E Protection |
| CAMI | Civil Aerospace Medicine |
| CDTI | Cockpit Display of Traffic |
| CIP | Capital Investment Plan |
| CLEEN | Continuous Lower Energ and Noise |
| CO2 | Carbon Dioxide |
| COE | Center of Excellence |
| COMSTAC | Commercial Space Transportation Advisory Committee |
| ConOps | Concept of Operations |
| CONUS | Continental United States |
| CRDA | Cooperative Research an Development Agreement |
| CRS | Child Restraint System |
| CSPO | Closely Spaced Parallel Operations |
| DARWIN | Design Assessment Of Reliability With Inspection |
| DataCom | Data Communications |
| DHS | U.S. Department of Homeland Security |
| DOC | U.S. Department of Comr |
| DoD | U.S. Department of Defer |
| DOT | U.S. Department of Transportation |
| DRG | Design Review Group |
| EA | Enterprise Architecture |
| EFB | Electronic Flight Bag |
| EMS | Environmental Management System |
| ERAM | En Route Automation Modernization |
| ERS | Enhanced Repository System |
| EUROCONTROL | European Organization for the Safety of Air Navigation |
| EVO | Equivalent Visual Operations |
| EVS | Enhanced Vision System |
| F&E | Facilities and Equipment Appropriation |
| FAA | Federal Aviation Administration |
| FAC | Transform Facilities |
| FEP | Front End Processor |
| FLEX | Flexible Terminals and Airports |
| FMS | Flight Management System |
| FEWS | Future En Route Work Station |
| FY | Fiscal Year |
| GA | General Aviation |
| GEOSS | Global Earth Observation System of Systems |
| GPS | Global Positioning System |
| HIWC | High Ice Water Content |
| HSI | Human-System Integration |
| HUMS | Health and Usage Monitoring System |
| IA | Interagency Agreement |
| ICAO | International Civil Aviation Organization |
| IM | Interval Management |
| IMC | Instrument Meteorological Conditions |
| IWP | Integrated Work Plan |
| JPDO | Joint Planning and Development Office |
| JRC | Joint Resources Council |
| LOSA | Line Operations Safety Audit |
| LTO | Landing and Takeoff |
| MMPDS | Metallic Materials Property Development and Standardization |
| MOA | Memorandum of Agreement |
| MOC | Memorandum of Cooperation |
| MOPS | Minimum Operational Performance Standards |
| MOU | Memorandum of Understanding |

| | |
|---|---|
| NARP | National Aviation Research Plan |
| NAS | National Airspace System |
| NASA | National Aeronautics and Space Administration |
| NASEA | National Airspace System Enterprise Architecture |
| NCVf | National Ceiling and Visibility Forecast |
| NEO | Net Enabled Operations |
| NextGen | Next Generation Air Transportation System |
| NSTC | National Science and Technology Council |
| NOAA | National Oceanic and Atmospheric Administration |
| NOx | Nitrogen Oxide |
| NTSB | National Transportation Safety Board |
| OI | Operational Improvement |
| OMB | Office of Management and Budget |
| Ops | Operations Appropriation |
| OST | Office of the Secretary of Transportation |
| OSTP | Office of Science and Technology Policy |
| OTP | Oceanic in-Trail Procedures |
| R&D | Research and Development |
| RE&D | Research, Engineering and Development Appropriation |
| REB | Research and Development Executive Board |
| REDAC | Research, Engineering, and Development Advisory Committee |
| REL | Runway Entrance Lights |
| RIL | Runway Intersecting Lights |
| RLV | Reusable Launch Vehicle |
| RMS | Risk Management System |
| RNAV | Area Navigation |
| RNP | Required Navigation Performance |
| RR | Rapid Refresh |
| RWSL | Runway Status Lights |
| SAA | Sense and Avoid |
| SAE | [illegible]notive Engineers |
| SMS | Safety Management System |
| SNT | Staffed NextGen Towers |
| SVS | Synthetic Vision System |
| TBO | Trajectory-Based Operation |
| TCAS | [illegible] Collision Avoidance System |
| TF5 | Task Force 5 |
| THL | Takeoff and Hold Lights |
| TRACON | [illegible] Approach Control Facility |
| TRB | Transportation Research Board |
| TSO | Technical Standard Order |
| UAS | Unmanned Aircraft System |
| UEDDAM | Uncontained Engine Debris Damage Model |
| USGCRP | U.S. Global Change Research Program |
| U.S. | United States |
| VOC | Volatile Organic Compound |
| WRF | Weather Research Forecast |
| WTIC | Weather Technology in the Cockpit |

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

www.faa.gov/go/narp

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Federal Aviation Administration

# 2011
# National Aviation Research Plan (NARP)

# Appendices

**A - Program Descriptions**
**B - Partnership Activities**
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**D - NARP Chapter 2 Milestone Status**
**E - Acronyms and Abbreviations**

**May 2011**

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

# Appendix A: Program Descriptions

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**Detailed Justification for**

# A11.a Fire Research and Safety

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – Fire Research and Safety**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.a Fire Research and Safety | $7,799,000 | $8,157,000 | +$358,000 |

For FY 2012, $8,157,000 is requested for Fire Research and Safety. Major activities and accomplishments planned with the requested funding include:

Fire Safety Improvements:

- Complete tests in engine fire simulator to determine the fire extinguishing effectiveness and performance criteria for novel, environmentally friendly dry powder agent.
- Develop a cost-effective halon (an ozone depleting and global warming chemical) replacement system for hand-held extinguishers.
- Evaluate the effectiveness and safety (toxicity) of hand-held extinguishers discharging contaminated halon.
- Determine the capability of existing airline hazardous materials containers for preventing the hazards of a lithium battery fire from spreading outside of the containers.
- Study novel agents and systems for the suppression of cargo fires in freighter aircraft.
- Develop improved next generation burner test method for the fire worthiness of power plant components.

Fire Safety Research:

- Extend the FAA ThermaKin burning model to two-dimensions to predict flame spread on cabin materials and composite fuselage structure.
- Conduct reduced-scale fire tests to calibrate cabin fire model.
- Test and evaluate developmental environmentally-friendly, ultra-fire resistant materials.

For FY 2012, research continues to focus on in-flight fire safety in both freighter (all cargo) and passenger-carrying aircraft. In freighter aircraft, work will continue on the development of a practical and cost-effective fire detection and suppression system. Also, the safe transport of lithium batteries will be emphasized by the evaluation of available agents/systems to extinguish lithium battery fires and the development of a fire-hardened container to ship lithium batteries. This work supports proposed rulemaking by the Pipeline and Hazardous Materials Safety Administration (PHMSA), in consultation with FAA, to improve the fire safety aspects of the transportation of lithium batteries.

In passenger carrying aircraft, FAA will continue work on extinguishment or suppression of in-flight fires in fire-prone areas. Because of deadlines proposed by the International Civil Aviation Organization (ICAO), more full and large-scale tests will be conducted on engine, hand-held, and cargo compartment applications to replace halon with practical and effective agents that are environmentally acceptable in terms of ozone depletion and global warming. Also, recent discovery of contamination in recycled halon will require testing to determine the effect on extinguishment effectiveness and safety (toxicity).

The FAA will also continue its research on the improvement of existing flammability tests and the development of new tests for novel applications of materials that may impact fire safety. A next generation oil burner will be adapted for power plant component fire tests because the existing antiquated burner produces variable results, and a replacement propane burner has been shown to produce conditions that are less severe than required. Proper fire

tests and performance criteria are needed for structural composite fuselages, such as the new Boeing 787, and for the novel application of fire resistant magnesium alloys in seat structure and possibly other cabin applications.

## 2. What Is This Program?

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. We provide industry with state-of-the-art safety products and information as a result of our research and produce publications and government-owned patents on new materials, fire test instrumentation, and analytical methodologies.

The program develops technologies, procedures, test methods, and fire performance criteria that can prevent accidents caused by hidden cabin or cargo compartment in-flight fires and fuel tank explosions, and improve survivability during a post-crash fire. Fire safety focuses on near-term improvements in fire test methods and materials performance criteria, fire detection and suppression systems, and aircraft fuel tank explosion protection. Fire research addresses fundamental issues of combustion toxicity, the impact of flame retardant chemicals on the fire and health hazards of cabin materials, and the impact of materials flammability on the initiation of in-flight fires and post-crash survivability.

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 (REDAC) – These representatives from industry, academia, and other government agencies annually review the program's research activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure 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 and jointly funded university research on ultra fire resistant materials.
- National Transportation Safety Board (NTSB) – 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) – FAA works with PHMSA to cooperatively develop requirements/guidelines for the safe transport of hazardous materials (current focus is on lithium batteries).
- International Civil Aviation Organization (ICAO) – FAA provides expertise on the development of a mandate by ICAO to require the replacement of halon in civil aviation by specific dates.

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 international regulatory authorities.

- Consortia with Fortune 100 companies to share research and development costs for new fire-resistant materials.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Fire Safety Improvements:

- Determined the effectiveness of cost-effective available fire suppression agents/systems against cargo container fires in freighter aircraft.
- Evaluated the effectiveness of current fire extinguishing agents against lithium battery fires.
- Provided comprehensive guidance on lithium battery fire safety in passenger items and aircraft systems.
- Determined the effectiveness and safety of approved and developmental halon replacement agents for the extinguishment of cabin fires with hand-held extinguishers.
- Standardized the new composite flammability test method for in-flight fire resistance.
- Developed a flammability test method for seat structure (e.g., magnesium alloy), if warranted.
- Determined and compared the fuel tank flammability envelope for candidate alternative fuels and Jet A fuel.

Fire Safety Research:

- Evaluated the combustion characteristics of adhesives used in the construction of aircraft cabins in support of FAA/industry effort to obtain regulatory relief by demonstrating similarity of fire performance.
- Extended the FAA thermal-kinetic burning model (ThermaKin) to one-dimensional burning of layered and structural composite materials.

Performance Linkages

Fire Research and Safety is an in-house program that supports the DOT'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.

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 materials; new fire tests for novel material applications such as composite fuselage structure and magnesium seats; high energy lithium battery fire safety; supporting the replacement of halon, in FAA-required fire extinguishing systems; and new or improved fire detection and extinguishment systems. Long term research will be conducted to support near term improvements and develop the enabling technology for a fireproof aircraft cabin.

The following goals directly support the ultimate strategic goals of in-flight fire prevention, fuel tank explosion prevention, and improved post-crash fire survivability:

- By FY 2012, define composite fuselage fire safety design criteria.
- By FY 2013, define performance criteria for cargo containers for the safe shipment of lithium batteries.
- By FY 2014, use full-scale cabin fire models to demonstrate the effects of material improvements and substitutions on post-crash fire survivability and the likelihood of in-flight fires.
- By FY 2014, determine viable and environmentally safe agents/systems to replace halon in cargo compartment fire suppression systems.
- By FY 2016, demonstrate the effectiveness of an integrated fire suppression system using nitrogen available from a fuel tank inerting system.

## 3. Why Is This Particular Program Necessary?

The consequences of fire in commercial aviation are great – the large loss of life in accidents either caused by fire (in-flight fire and explosions) or as a consequence of fire (post-crash fire), and the destruction of the aircraft. It is an

awesome challenge to prevent accidents caused by in-flight fire or fuel tank explosions and to improve survivability by mitigating the effects of a post-crash fire when one considers the following: the passengers are in a densely populated and confined space; the wings are laden with tens of thousands of gallons of flammable jet fuel; the cabin is furnished and lined with plastic materials; tens of miles of wiring and cable are routed behind the cabin walls, ceiling and floor; and below the floor in the cargo compartment is flammable passenger luggage and cargo. To prevent or mitigate the effects of fire, the majority of the research is directed toward the development of new or improved fire tests for interior materials and cost-effective fire extinguishing systems.

FAA fire safety research is largely driven by accidents, NTSB recommendations, new technology, new fire threats, and environmental concerns. In the 1980's and early 1990's the emphasis was on improved post-crash fire survivability. However, three catastrophic accidents in the 1990's have driven research priorities over the past decade: ValuJet (1995, 110 fatalities), TWA 800 (1995, 230 fatalities) and Swiss Air (1998, 229 fatalities). Currently, fire safety research is addressing destructive freighter fires and the continuing threat of in-flight fire (e.g., over 800 incidents of odor and smoke in 2006); structural composite fuselage fire resistance (e.g., B787) and other proposed new interior materials such as magnesium alloys; fuel tank flammability in composite wings; the growing threat of lithium batteries in cargo shipments, passenger personal electronic devices and in aircraft emergency power systems; and the need for environmentally-acceptable and practical replacements for halon extinguishing agents.

## 4. How Do You Know The Program Works?

Over the past 25 years, every major improvement in aircraft fire safety that has been implemented by FAA through the regulatory and advisory process was a product of this program. Over that time period a recent analysis of world-wide accidents has shown that the probability of dying in an aircraft fire has been reduced (improved) by a factor of three. The most recent examples of these regulatory products are (1) in-flight fire resistant thermal acoustic insulation (effective 9/2/05), (2) explosion prevention fuel tank inerting systems (effective 9/19/08), and (3) burnthrough resistance thermal acoustic insulation (effective 9/2/09). The future benefit of the first two rules was projected by FAA to be the prevention of two to three catastrophic aircraft accidents, which would have caused many hundreds of fatalities.

Almost all of the work is conducted in-house by internationally recognized experts in aircraft fire safety and research. The FAA operates the world's most extensive aircraft fire test facilities. The vast majority of the work is directed toward the improvement by FAA fire safety regulations. In addition, FAA certification engineers receive training in these facilities on the material flammability test standards developed by this program that are now FAA regulations. 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 online at http://www.fire.tc.faa.gov/reports/reports.asp) highlighting research results that have led to major improvements in aircraft safety. In addition, the results of FAA's research is often published in peer-reviewed scientific journals, presented at technical conferences, and/or discussed at technical workshops.

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure that FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

Modest reductions would delay plans to build burners for six laboratories and conduct round robin tests to establish the reproducibility of the burners.

**Detailed Justification for**

# A11.b Propulsion and Fuel Systems

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – A11.b Propulsion and Fuel Systems**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.b Propulsion and Fuel Systems | $3,105,000 | $3,611,000 | +$506,000 |

For FY 2012, $3,611,000 is requested for Propulsion and Fuel Systems. Major activities and accomplishments planned with the requested funding include:

- The probabilistic design for rotor integrity (PDRI) program will continue to address material and manufacturing anomalies that can increase the risk of failure of critical rotating turbine engine parts by advancing the probabilistically-based turbine engine rotor design and life management code found in the Design Assessment of reliability with Inspection (DARWIN™) in order to enhance its predictive capability. These enhancements map directly to future advisory circulars (ACs) planned by the Engine and Propeller Directorate (ANE) and benefits will accrue in the form of a reduced risk of engine failures and fewer accidents, which in turn will lead to fewer injuries and fatalities.
- The PDRI program will also 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.
- The cold dwell fatigue program will continue to develop a design methodology for use by industry to prevent cold dwell fatigue in turbine rotor disks and will continue to develop a technique to assess the risk of cold dwell fatigue in the current aircraft fleet.
- Continue the enhancement of the DARWIN™ probabilistic rotor design code.
- Develop a plan with stakeholders for propulsion malfunction detection and reporting requirements in NextGen and also propulsion malfunctions on unmanned aircraft systems (UAS) to assess safety risks.

## 2. What Is This Program?

FAA issues certification standards and ACs and reviews the specifications and practices recommended by recognized technical societies (American Society for Testing and Materials (ASTM) International, Society of Automotive Engineers (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.

The Propulsion and Fuel Systems 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.

Propulsion malfunction events in the NextGen environment with decreased aircraft separation may result in aircraft trajectory deviations. Propulsion system monitoring and possibly adaptive controls will be investigated to mitigate potential incursions. Also, unmanned aircraft systems (UAS) will be assessed for safety risks associated with engine malfunctions.

The Propulsion and Fuel Systems Program works with the following industry and government groups:

- 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 the program's research projects support new rulemaking and development of alternate means of compliance for existing rules.
- The Aerospace Industries Association (AIA) – working subcommittees on rotor integrity and rotor manufacturing.

Propulsion and Fuel Systems Program R&D partners include:

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

In FY 2011, major activities and accomplishments planned with the requested funding include:

Turbine Engine Research

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

Performance Linkages

The main research area within the Propulsion and Fuel Systems Program is to ensure the structural integrity and durability of critical rotating engine parts in turbine engines throughout their service life. This research is providing analytical tools to meet the requirements of AC 33.14-1, "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 goals of the focused research endeavors are:

- By FY 2013, 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 2014, develop a certification tool that will predict the risk of failure of rotor disks containing material and manufacturing anomalies.
- By FY 2014, perform analysis of propulsion malfunctions in the NextGen environment and on UAS to assess safety risks.

## 3. Why Is This Particular Program Necessary?

In spite of a history of safe turbine engine operation in commercial aviation, the threat of an engine failure is always present and the potential consequences are enormous – the large loss of life in accidents and the destruction of the aircraft. Although they are few, accidents such as United Airlines Flight 232 on July 19, 1989 in Sioux City, Iowa, and the Delta Airlines 1288 on July 6, 1996 in Pensacola, Florida are noteworthy because they were caused by the failure of turbine engine components that caused catastrophic loss of life and aircraft. Turbine engine research is conducted to study the causes of failures and determine how to prevent them in the future.

FAA Propulsion and Fuel Systems research, conducted in conjunction with the manufacturers, has shown that the primary inherent failure modes in these accidents result from the presence of material and manufacturing anomalies that can degrade the structural integrity of high energy turbine rotors. The primary failure mode of the Sioux City accident was a fatigue crack that originated from an undetected titanium alloy melt-related defect. From the research the FAA made recommendations related to the improvement of titanium metallurgical quality, nondestructive inspection, and turbine rotor structural design and lifing standards. The research has yielded a

probabilistically-based damage tolerance design code (DARWIN™) to determine the risk of fracture of turbine engine rotor disks containing undetected material anomalies which is used by all the major engine manufacturers. The goal of the research continues to be the prevention of turbine engine related accidents.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

A reduction would result in a delay of several months in the start of development of a new fleet risk assessment module for the DARWIN™ code.

A further reduction would delay development of a new fleet risk assessment module for the DARWIN™ code until FY 2013.

**Detailed Justification for**

## A11.c Advanced Materials/Structural Safety

### 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – Advanced Materials/Structural Safety**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.c Advanced Materials/Structural Safety | $4,935,000 | $2,605,000 | -$2,330,000 |

For FY 2012, $2,605,000 is requested for Advanced Materials/Structural Safety. Major activities and accomplishments planned with the requested funding include:

Advanced Materials

- Continued work to expand developments in composite training with the initial emphasis on levels of safety awareness for structural engineering and manufacturing.
- Study for the types of threats to composite aircraft structures while at the service gate and on the flight line.
- Documenting of accepted certification methodology for damage tolerance and fatigue, including full-scale test and analysis protocols for repeated loads and damage threats.
- Development of training and conduct workshops to review progress in damage tolerance, adhesive joints, and maintenance.
- Evaluation of safety of new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures.

Structural Safety

- Continued development of analytical modeling protocols and methodologies of aircraft structures crash conditions for certification use.
- Continued development of standards and methods to characterize dynamic properties of composite material systems.
- Continued support of new rulemaking and guidance development for Part 25 composite and metallic aircraft crashworthiness for structural substantiation certification.

Advanced Materials

The program will continue to focus on damage tolerance and fatigue issues of composite structures, including the assessment of impact damage threats (e.g., in-flight hail, ground vehicle collisions), and the aging of composite materials. Composite control surfaces degradation on transport airplanes will be explored and linked to aircraft safety issues. Quality control procedures will be studied for adhesive joints. Important field variables will be evaluated for bonded and bolted repairs. Properties of new materials and applications, which are used in primary aircraft structures, will be studied and evaluated. Safety awareness trainings in structural engineering for advanced composite materials have been developed and provided to related workforce. Work will continue supporting the composite safety awareness training development for a manufacturing course.

Structural Safety

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.

## 2. What Is This Program?

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

FAA establishes rules for the certification of safe and durable materials for use in aircraft construction. While the rules are the same for composite or metal structures, different behavioral characteristics of structural materials call for different means of compliance. Although Advisory Circular (AC) 20-107B, "Composite Aircraft Structure," has been published, advances in technologies and materials require periodic updates and expansion of the AC. The FAA Chief Scientific and Technical Advisor disseminates current technical information developed in this program to regulatory personnel through technical reports, handbooks, guidance, policy, and related training courses. 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

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. 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).

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. In addition, the Advanced Materials/Structural Safety Program helps FAA achieve its strategic goals in international leadership and organizational excellence by providing a developmental basis in aircraft certification guidance and training in all areas of study that can be used throughout the world.

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 – set priorities to: develop technologies, conduct data analysis for current aircraft, and anticipate problems related to future aircraft.
- The Aviation Rulemaking Advisory Committee – this FAA committee and its subcommittees help to ensure the effectiveness of the agency's rulemaking by identifying R&D requirements and priorities, providing guidance for the update of documents, such as AC 20-107B and encouraging industry's full participation in implementing new rules.
- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee – representatives from industry, academia, and other government agencies annually review the program's activities.
- Technical Community Representative Groups – FAA representatives apply formal guidelines to ensure the program's research projects support new rule making and development of alternative means of compliance for existing rules.
- The Advanced Materials/Structural Safety Program benefits from a close working relationship with the Joint Center of Excellence for Advanced Materials and Structures led by Wichita State University and the University of Washington. The research performed under this program is leveraged by the monetary and intellectual contributions of its partners including many major commercial aviation companies.

Advanced Materials

- FAA sponsors, with the cooperation of other government agencies and industry, a primary, authoritative handbook (Composite Materials Handbook 17) facilitating the statistical characterization data of current and emerging composite materials. This international reference tool is the best available data and technology source for testing and analysis, and also includes guidance on data development, design, inspection,

manufacturing and product usage. On recommendations by regulatory guidance, material data contained in this handbook are acceptable for use in the certification process. The FAA research is also coordinated with SAE standards organizations for advanced materials (e.g., Committee P-17 for composite materials specifications and the Commercial Aircraft Composite Repair Committee (CACRC), ASTM, and Society for the Advancement of Material & Process Engineering).

- Interagency Advanced Structures Working Group, which consists of FAA, NASA and the DoD agency, was established in FY 2010. This working group will coordinate all current and future advanced composite research programs between federal agencies to ensure effective research efforts by interchanging information, identifying and filling technical gaps, and avoiding duplication.

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.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Advanced Materials

- Generated composite material dynamic properties important to crashworthiness.
- Provided next level of support data and guidelines to the FAA Office of Aviation Safety for AC 20-107B.
- Worked with industry to develop consensus for a damage tolerance and fatigue certification protocol.
- Continued work to expand developments in composite training with the initial emphasis on levels of safety awareness for structural engineering and manufacturing.
- Continued studies for the types of threats to composite aircraft structures while at the service gate and on the flight line.
- Documented accepted certification methodology for damage tolerance and fatigue, including full-scale test and analysis protocols for repeated loads and damage threats.
- Developed training and conducted workshop to review progress in damage tolerance, adhesive joints, and maintenance.
- Continued to evaluate safety of new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures.

Structural Safety

- Developed analytical modeling techniques of aircraft crash conditions.
- Reviewed the need for off-axis analysis capabilities to assist in certification of structures for crashworthiness.
- Continued developing analytical modeling protocols and methodologies of aircraft structures crash conditions for certification use.
- Developed standards and methods to characterize dynamic properties of composite material systems.
- Initiated benchmarking industry analysis and test practices to support new rulemaking and guidance development activity for Part 25 composite and metallic aircraft crashworthiness structural substantiation certification.

<u>Performance Linkages</u>

Advanced Materials/Structural Safety supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. 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.

The goals of the focused research endeavors are:

- By FY 2012, assess the risks and technical issues associated with severe blunt impact (e.g., ground service vehicle collisions).
- By FY 2012, establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.
- By FY 2012, quantify critical sandwich panel degradation mechanisms (e.g., disbonding, fluid ingression, freeze/thaw).
- By FY 2013, develop criteria for damage tolerance assessments of stiffened laminated composite structures.
- By FY 2013, generate methodology for demonstrating aircraft structure crashworthiness certification by analysis.
- By FY 2014, evaluate field bonded and bolted repair practices to update related guidance and training for composite aircraft structures.
- By FY 2014, evaluate the ability of models to predict off-axis and multiple terrain impacts.
- By FY 2015, evaluate existing and emerging bonded airframe technology to update guidelines and standards.
- By FY 2016, develop standards and methods to characterize dynamic properties of composite material systems.
- By FY 2016, generate background documentation on acceptable industry practices in structural analysis and testing to substantiate aircraft crashworthiness of primary composite structures supporting new rules and guidance.

## 3. Why Is This Particular Program Necessary?

The use of new materials, processes and forms on aircraft continues to push the knowledge base for certification and provides safe aircraft for civilian applications. This has been accelerated in the last decade due to the rapid expansion of the use of them in increasingly large structures. Dominating the rapid expansion has been the use of fiber reinforced polymers to provide lighter, fuel efficient airframe components including, in recent applications, full fuselage barrels and wings. The understanding of these emerging technologies is paramount to assuring the safety of the civil aviation and the flying public. The current certification process for many advanced materials and structures were established for smaller, less critical components and service conditions. As the current certification protocols are applied to the larger structures, uncertainty exists in the applicability which has to be demonstrated for these aircraft products. In addition to operational issues, these changes in materials, construction methods and processes have altered the response of these structures to dynamic crash events. The difference in structural characteristics needs to be understood and incorporated in certification and operational plans to assure safety for new aircraft that incorporate these advances.

FAA Advanced Materials and Structural Safety research requirements are driven by industry advancements in construction of airframes and related components presented for certification. The FAA must assure that the changes maintain an equivalent or improve the level of safety compared to that achieved with currently operational aircraft. Requests from the Aircraft Certification Offices and from the aircraft manufacturers seeking Type Certification approval are major influences that shape research requirements, as the FAA seeks to evaluate the safety of planned new concepts using advanced materials, processes and forms. Additional requirements are developed from assessments of existing techniques, protocols, and service histories of previous advanced products to determine if modifications are required for the ever expanding materials, processes, and forms that are being introduced on civil aircraft. The National Transportation Safety Board review of accidents (AA587, R22, etc.) involving these structures

provides additional focus for the information and research required to understand these emerging technologies. Currently the program is researching the damage tolerance and fatigue of composite structures; bonded structures; maintenance and repair of composite structures; aging and environmental effects; dynamic component damage tolerance and fatigue of composite structures; and the structural response in dynamic crash conditions.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction in funding to the Advanced Materials/Structural Safety Program would decrease funds to the work done in Environmental and Aging Effects for Composite Structures. It would result in an extension of the schedule of approximately four months.

**Detailed Justification for**

## A11.d Aircraft Icing - Atmospheric Hazards/Digital System Safety

### 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – Aircraft Icing - Atmospheric Hazards/Digital System Safety**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.d Aircraft Icing - Atmospheric Hazards/Digital System Safety | $4,482,000 | $5,404,000 | +$922,000 |

For FY 2012, $5,404,000 is requested for Aircraft Icing - Atmospheric Hazards/Digital System Safety. Major activities and accomplishments planned with the requested funding include:

Aircraft Icing – Atmospheric Hazards

- Reduce Accidents During Flight In Glaciated, Mixed-phase and Supercooled Large Drop (SLD) Icing Conditions
  - Continue experimental work on the physics of engine icing in high ice water content (HIWC) environments.
  - Continue development of methods to test engines in simulated HIWC environments.
- Reduce Accidents During Flight In 14 CFR Part 25, Appendix C Icing Conditions
  - Continue research on aerodynamic effects of ice on 3-D lifting surfaces.
- Reduce Accidents During Takeoffs In Icing Conditions
  - Continue the development of improved methods for simulation of ice pellet and mixed conditions for determination of fluid failure and holdover times and allowance times.
  - Continue evaluation of Remote Onboard Ground Ice Detection System (ROGIDS) for pre-takeoff contamination check and other applications, including data package for Society of Automotive Engineers (SAE) spec and advisory material.

Digital System Safety

- Continue Software Development Techniques and Tools, such as verification of adaptive systems.
- Complete development process technology and criteria task on data integrity.
- Continue to evaluate systems considerations for complex intensive systems.
- Continue Onboard Network Security and Integrity, such as Phase 6 onboard network security and integrity effort for insuring consistency with aircraft safety and certification.
- Continue airborne electronic hardware (AEH) Techniques and Tools, such as AEH design assurance.
- Continue COTS Technology in Complex and Safety-Critical Systems, such as obsolescence and life cycle maintenance of avionics.

Researchers will continue to refine laboratory methods to determine anti-icing fluid holdover times and allowance in a variety of environmental conditions, including new mixed conditions. Investigation of the enhancement and validation of icing simulation methods, with an emphasis on engine testing in HIWC conditions, will continue. Researchers will continue to evaluate software development techniques and tools, onboard network security and integrity, AEH techniques and tools, and COTS technology in Complex and Safety-Critical Systems.

## 2. What Is This Program?

FAA establishes rules for the certification and operation of aircraft that encounter icing conditions as well as rules for the use of digital systems. The agency uses the research results to generate Advisory Circulars (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.

The Aircraft Icing - Atmospheric Hazards/Digital System Safety 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) and ice crystal 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 HIWC environments from 1988 to 2003. A current collaborative research effort addresses this issue.

The program will develop new guidelines for testing, evaluating, and approving digital flight controls, avionics, and other systems for the certification of aircraft and engines. 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 system 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.

The Aircraft Icing - Atmospheric Hazards/Digital System Safety 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 Aircraft Icing - Atmospheric Hazards/Digital System Safety Program.
- The Aerospace Industries Association Ice Crystal Consortium – this is a private sector working group that coordinates ice crystal ground facility research testing with the FAA.
- SAE G-12 Aircraft Ground Deicing Committee– 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 Technology Committee – this subcommittee assists in establishing guidance and standards for icing test and simulation methods.
- Radio Technical Commission for Aeronautics (RTCA) – members of this U.S. Federal Advisory Committee and its special committees (SC) help to ensure the effectiveness of the agency's rulemaking in aviation areas, such as digital systems.
- Certification Authorities Software Team – a group of international certification software and AEH specialists who collaborate and make recommendations to regulatory authorities for digital systems.
- John A. Volpe National Transportation Systems Center – the Center is leading cyber security research in aeronautical system security that supports the onboard network security and integrity goal.

The program maintains a number of cooperative relationships:

- NASA Glenn Research Center - includes various cooperative efforts on aircraft icing activities.
- Transport Canada - based on an international agreement on research on aircraft ground deicing issues.
- Environment Canada - based on an international memorandum of cooperation for research on in-flight icing conditions.

- National Research Council of Canada - based on an international memorandum of cooperation for research on engine and airframe icing.
- Australian Bureau of Meteorology - partner in field campaign in Darwin, Australia to obtain data in HIWC environments.
- Aerospace Vehicle Systems Institute - cooperative industry, government, and academia venture for investigation and standardization of aerospace vehicle systems.
- NASA Langley Research Center – includes cooperative efforts on digital systems.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Aircraft Icing – Atmospheric Hazards

- Reduced Accidents During Flight In Glaciated, Mixed-phase and SLD Icing Conditions
  - Continued experimental work on the physics of engine icing in HIWC environments.
  - Developed data and methods supporting the evaluation of aircraft engines for operation in HIWC environments.
  - Continued development of methods to test engines in simulated HIWC environments.
- Reduced Accidents During Flight In 14 CFR Part 25, Appendix C Icing Conditions
  - Continued research on aerodynamic effects of ice on 3-D lifting surfaces.
- Reduced Accidents During Takeoffs In Icing Conditions
  - Continued the development of improved methods for simulation of ice pellet and mixed conditions for determination of fluid failure and holdover times and allowance times.
  - Continued evaluation of ROGIDS for pre-takeoff contamination check and other applications, including data package for SAE spec and advisory material.

Digital System Safety

- Software Development Techniques and Tools
  - Continued to determine alternative software assurance approaches and completed the investigation into reverse engineering.
  - Evaluated development process technologies and criteria, such as data integrity.
  - Continued to evaluate systems considerations for complex software intensive systems, such as System Architecture Virtual Integration.
- Onboard Network Security and Integrity: Completed Phase 5 onboard network security and integrity effort for insuring consistency with aircraft safety and certification.
- AEH Techniques and Tools: Continued to evaluate AEH techniques and tools, such as AEH design assurance.
- COTS Technology in Complex and Safety-Critical Systems: Continued to evaluate COTS technology, such as obsolescence and life cycle maintenance of avionics.

<u>Performance Linkages</u>

Aircraft Icing - Atmospheric Hazards/Digital System Safety supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. 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 airframes and engines can safely operate in atmospheric icing conditions and while using digital systems. The goals of the focused research endeavors are:

Aircraft Icing - Atmospheric Hazards

- By FY 2012, complete fundamental research work on ice crystal accretion studies to determine physical parameters of importance and modeling schemes for ice accretion formation mechanisms inside engine compressors.
- By FY 2013, complete analysis of the ice crystal cloud properties from field campaign and provide ice crystal cloud parameters in a format that will allow for their evaluation as an updated engineering standard for convective weather ice crystal icing conditions.
- By FY 2014, develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated HIWC environments.

Digital System Safety

- By FY 2012, identify certification issues, including security vulnerabilities introduced by network connectivity to multiple aircraft systems, and potential mitigation techniques.
- By FY 2012, develop COTS electronic hardware reliability prediction tools and techniques for the latest generation of the COTS electronic components.
- By FY 2013, identify safety issues and propose mitigation approaches when software development techniques and tools are used in airborne systems.
- By FY 2014, identify safety issues and propose mitigation approaches when airborne electronic hardware techniques and tools are used in airborne systems.

## 3. Why Is This Particular Program Necessary?

Aircraft Icing-Atmospheric Hazards

Aircraft icing due to the freezing of supercooled water on aircraft surfaces is a continuing concern in all realms of aviation, due to the insidious nature of icing problems for takeoff, cruise, holding, and landing. Fatal accidents fall into two major categories: takeoff accidents due to failure to properly de-ice or anti-ice prior to takeoff, and accidents due to accretion of ice while in-flight. The latter class affects all phases of flight, but particularly holding and approach and landing. Since 1980, takeoff icing accidents have claimed many hundreds of fatalities, while in-flight icing accidents have claimed at least 200 fatalities. Icing problems due to flight in ice crystals in HIWC environments were not fully recognized as posing a serious safety hazard until recent years. Although ice crystals bounce off aircraft surfaces, when ingested into engine cores and pitot tubes, the crystals have resulted in serious events. The FAA, working with industry, has identified 140 ice crystal turbine engine power loss events in reviewing 16 years of recent data (a power-loss event is a surge, stall, rollback, or flameout of one or more engines). There were also 11 total power loss events from flameout and 1 forced landing due to ice crystals. The FAA has also received recent feedback on pitot tube ice crystal events where the probe stopped working.

Digital System Safety

The goal of the Software and Digital Systems (SDS) research is to improve and maintain manned and unmanned aircraft safety and prepare for the FAA's Next Generation Air Transportation System by conducting research in the area of advanced, airborne digital systems (software-based and programmable logic-based), such as fly-by-wire flight controls, navigation and communication equipment, autopilots, and other aircraft and engine functions. Software and digital systems are concerns in aviation due to the large quantity of aircraft computer software code and AEH used to implement the software code. Also, the field of digital systems continues to change rapidly and is becoming increasingly more complex and pervasive within aircraft. More importantly, the effect of software and AEH upon the ultimate safety of the aircraft in which this equipment resides is yet to be fully determined. The SDS Program focuses the research on areas that will help prevent normal equipment failures (faulty software code and AEH) and abnormal equipment failures through security vulnerabilities exposed by cyber security threats. This research supports the aircraft certification process that includes work to assure digital systems function properly and safely. The results of the research are technical data, reports, compliance methods, verification methods, and certification techniques that can be used to develop policy, guidance, and training materials, and to enforce aircraft continued airworthiness. The research assists both the FAA and industry in meeting their safety objectives. Although there have been no aircraft accidents directly attributable to the failure of software or AEH, it is prudent to take research and development actions that will prevent such accidents.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction in Aircraft Icing-Atmospheric Hazards would slow preparations for testing in the Office of National d'Etudes et de Recherches Aérospatiales F1 Tunnel anticipated in FY 2013. In Digital Systems Safety, this reduction would remove the FAA funding contribution to the Systems Architecture Virtual Integration research and cause the FAA to be an observer only.

**Detailed Justification for**
## A11.e Continued Airworthiness

### 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – Continued Airworthiness**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.e Continued Airworthiness | $10,944,000 | $12,589,000 | +1,645,000 |

For FY 2012, $12,589,000 is requested for Continued Airworthiness. Major activities and accomplishments planned with the requested funding include:

- Complete assessment on surveyed corrosion data for transport aircraft and on feasibility of using data from accelerated corrosion testing to determine applicability of the probabilistic risk analysis approach.
- Continue to lead the Metallic Materials Properties Development and Standardization (MMPDS) steering group in updating the metallic materials properties handbook.
- Continue damage tolerance and durability research for emerging structural technologies to ensure safety, support maintenance, and support future FAA policies and guidance.
- Enhance FAA's Full-scale Aircraft Structural Test and Evaluation facility capabilities and demonstrate residual strength of panels fabricated from advanced materials.
- Develop Health and Usage Monitoring Systems (HUMS) database for commercial rotorcraft operations in order to assess its application in usage credit determinations.
- Continue to develop technical data on regulatory issues for ongoing fly-by-wire and fly-by-light working groups.
- Continue to develop data to support a specification for industrial ultrasonic forging inspection.
- Complete the evaluation of thermal acoustic technology as an inspection technique for engine disks.
- Complete an assessment of the performance of infrared inspection spectrometry to identify and quantify environmental damage of composite structures.
- Complete research on basic envelope protection. Technical data will support development of FAA guidance and policies for general aviation autopilot systems.
- Continue research to assess the performance of prognostic and health monitoring systems that are in use or under development for transport airplanes.
- Continue research to develop enhanced models of full stall departure characteristics for transports.

The FY 2012 funding request will support Continued Airworthiness Program research requirements that contribute to FAA's aviation safety goal. The program will continue to focus on providing data and analysis on developing technologies, technical information, procedures, and practices that help ensure the safety of aircraft systems and structures in the civil aviation fleet. Research will continue on:

- Development of certification processes for HUMS systems for rotorcraft, with emphasis on the processes related to validation of usage credits.
- Tracking the development of prognostic and health monitoring methods for complex flight critical systems and structures of commercial aircraft.
- Development and evaluation of risk assessment and risk management methods for the continued operational safety of small airplanes, with the methods extended to transport aircraft structures.

- Flight controls and mechanical systems, focusing on assisting pilots with advanced displays and systems to avoid hazards in both transport category and general aviation airplanes.
- Investigation of nondestructive inspection techniques for critical engine components.
- Nondestructive inspection of structures will continue to develop methods and technologies to assure the long term safety of metallic, composite, and bonded structures. In light of the increased use of composites in the latest transport models, the focus will be on composite structures for both in-production and in-service aircraft.

## 2. What Is This Program?

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

The Continued Airworthiness Program promotes the development of technologies, procedures, technical data, and performance models to prevent accidents and mitigate accident severity related to civil aircraft failures as a function of their continued operation and usage. The program is focused on long-term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft; continued safety of aircraft engines; development of inspection technologies; and safety of electrical wiring interconnect systems (EWIS), flight control systems, and mechanical systems.

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

- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee (REDAC) – 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 the program's research projects support rulemaking and the development of guidance for means of compliance with 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.

The Continued Airworthiness Program activities are closely coordinated with industry, the National Aeronautics and Space Administration (NASA), and the Department of Defense (DoD). FAA maintains interagency agreements with NASA, U.S. Army, U.S. Navy, U.S. Air Force, the Department of Energy, and the Forest Service. DoD and NASA have co-sponsored 12 joint Aircraft Airworthiness and Sustainment Conferences with FAA (formerly known as Aging Aircraft Conference).

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

- 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 repairs and emerging structural technologies.

In FY 2011, major activities and accomplishments planned with the requested funding include:

- Completed a study of safe life and risk-based fleet management for small airplane continued operational safety.
- Continued damage tolerance and durability research for emerging structural technologies to ensure safety, support maintenance, and support future certification policies and guidance.
- Continued to lead the MMPDS steering group in updating metallic materials properties handbook.

- Continued research to develop rotorcraft data that provide guidance for the certification of HUMS for usage credits.
- Developed technical data on regulatory issues for ongoing fly-by-wire and fly-by-light working groups.
- Continued research to develop the potential of advanced or emerging nondestructive inspection (NDI) techniques for critical engine components.
- Assessed advanced inspection systems to perform large-area inspection of composite airplane components.
- Provided technical guidance on pilot rudder usage, design, and training issues.
- Developed enhanced models of full stall departure characteristics for transport airplanes.
- Assessed damage detection technologies for inspecting remote or inaccessible aircraft areas.
- Developed monitoring of machining processes to prevent manufacturing-induced surface anomalies on critical engine components.
- Developed functional, safety, and certification information for advanced flight displays to meet the Next Generation Air Transportation System (NextGen) trajectory management needs.
- Continued research on minimum performance criteria and certification requirements for automatic envelope protection and automation systems for general aviation.
- Conducted research to develop technical data to evaluate and assess commercial aircraft health monitoring systems for certification and continued airworthiness requirements.
- Developed technical data for standards on NextGen electrical power systems and components.

Performance Linkages

The Continued Airworthiness Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. The goal of the Continued Airworthiness Program is to understand and develop methods to counter the effects of age and usage on the airworthiness of an aircraft over its lifetime, including potential effects of modifications and repairs. The program conducts research in developing technologies and processes, and assesses current practices in order to eliminate or mitigate the potential failures related to aircraft aging, thereby reducing the number and severity of accidents. The research also supports development of methodologies for both inspection and maintenance protocols to assure the continued airworthiness of advanced composite aircraft.

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

- By FY 2012, assess performance of an advanced inspection system for identifying environmental damage of composite structures, such as by chemical, ultraviolet, and water ingress.
- By FY 2013, 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 detect defective bonds as well as determine the actual strength of the bond.
- By FY 2013, develop technical data on rotorcraft that provide guidance for certification of HUMS for usage credits.
- By FY 2013, develop a predictive methodology for damage tolerance risk assessment and risk management for continued operational safety of small airplanes.
- By FY 2014, provide technical data to develop guidelines for implementing structural health monitoring in commercial transport category airplanes

## 3. Why Is This Particular Program Necessary?

The Continued Airworthiness Research Program came into existence as a direct result of accident involving an Aloha Airlines Boeing 737 in 1988. The aircraft experienced an explosive decompression during flight that tore off a large section of the top of the fuselage. The research program that subsequently developed was called the Aging Aircraft Program because that structural failure was connected with the aircraft's age and its large number of takeoff-landing cycles. The program's research scope grew to address causes of subsequent accidents. For instance, aircraft engines were included as a result of a 1989 United Airlines DC-10 crash caused by an uncontained engine failure, and electrical systems were added as a result of a 1998 Swiss Air MD-11 crash most likely caused by wire arcing. Today, the breadth of the research has grown to include safety of transport and small airplanes as well as rotorcraft. The program title was changed to Continued Airworthiness to better match the FAA's aircraft regulatory language regarding "Continuing Airworthiness." The technical scope of the research includes inspection and maintenance of structures and engines, structural integrity of fixed wing aircraft and rotorcraft, and flight controls and electrical systems. The focus is on the continuing safety of all aircraft (new and in-service) throughout their lifetime.

The current research program is based on requirements developed by the FAA Office of Aviation Standards. The requirements reflect the need of the regulatory office for technical data and information to support regulatory activities or for possible solutions to real world questions and problems. For example, the inspection of composite, metallic, and bonded structures in an accurate and reliable way is challenging. The program's research looks at improved inspection technologies and procedures, as well as quantifiable measures to describe the accuracy. A research output might be a feasibility demonstration of an inspection technology, a characterization of new inspection methods and procedures, or a proposed inspection standard for the aviation industry. There is almost always cooperation and sometimes even partnerships with aircraft manufacturers, systems manufacturers, air carriers, and academic researchers. A similar description can be applied over the full range of research areas within the Continued Airworthiness program. In certain areas the partners include NASA and elements of the DoD. Finally, the research program provides a core technical competency as well as a unique test facility to serve the interests of FAA and the safety of flying public.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction in funds to the Continued Airworthiness program would slow down parts of the maintenance and inspection program by three months, particularly affecting the FY 2012 research goal to assess performance of an advanced inspection system for identifying environmental damage of composite structures, and would thereby raise a risk of missing the research goal milestone.

**Detailed Justification for**

# A11.f Aircraft Catastrophic Failure Prevention Research

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Aircraft Catastrophic Failure Prevention Research**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.f Aircraft Catastrophic Failure Prevention Research | $1,545,000 | $1,502,000 | -$43,000 |

For FY 2012, $1,502,000 is requested for Aircraft Catastrophic Failure Prevention Research. Major activities and accomplishments planned with the requested funding include:

Engine Uncontainment Research

- Continue FAA/NASA/industry sponsored quality control program for modeling aircraft problems in manufacturers-supported finite-element code (referred to as LS-DYNA).
- Continue development of new material model for titanium in LS-DYNA.
- Continue collaboration with the Naval Aviation Weapons Center (NAWC) China Lake to maintain the Uncontained Engine Debris Assessment Damage Model (UEDDAM) code.

Research will continue on the NASA/FAA/industry program for modeling aircraft engine failures in LS-DYNA. The FAA, NASA, and academia will continue to evaluate improved material models and incorporate them into LS-DYNA upon acceptance by the Aerospace Users Group. Users' guidelines and training will continue to be developed and made available through George Washington University.

Additional research will continue on developing a generalized damage and failure model with regularization for titanium materials impacted during engine failure events. Also, research will continue on material characterization tests to support development of damage and failure models for aircraft materials.

## 2. What Is This Program?

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 Advisory Circulars to outline acceptable means for meeting these rules. The program's objective is to ensure safe aircraft operation in the National Airspace System (NAS).

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. The program also uses historical accident data and National Transportation Safety Board (NTSB) 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.

The program collaborates with a broad cross section of the aviation community, including:

- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee (REDAC) – 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 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 rulemaking. Members of the subcommittee and full committee identify research requirements, priorities, and provide guidance for the update of documents such as AC 20-128, and encourage industry's full participation in implementing new rules.

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 LS-DYNA 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 Aerospace Industries Association (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.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Engine Uncontainment/Containment Research

- Continued FAA/NASA/industry-sponsored quality control program for modeling aircraft problems in LS-DYNA – a primary output of this work on impact analysis supports Fan Blade Certification to improve safety by developing and implementing better analytical technology into the certification process.
- Completed testing of titanium necessary to populate the material failure map of LS-DYNA material model MAT224.
- Continued collaboration with NAWC China Lake to maintain the Uncontained Engine Debris Damage Assessment Model (UEDDAM) code.

Performance Linkages

The Aircraft Catastrophic Failure Prevention Research Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. 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 LS-DYNA Aerospace Users Group, FAA is working with industry to establish standards for finite element analysis and guidance for use in support of certification. The goal of the focused research endeavors is:

- By FY 2013, develop and verify a generalized damage and failure model with regularization for aluminum (MAT 224) and titanium materials impacted during engine failure events.

## 3. Why Is This Particular Program Necessary?

The threat of catastrophic failure in commercial aviation is always present and the potential consequences are great – the large loss of life in accidents and the destruction of the aircraft. It is an awesome challenge to prevent accidents caused by catastrophic failure. Over the years, this research program has supported the FAA to improve regulations and advisory material related to uncontained engine failure, loss of flight controls, propulsion malfunction plus inappropriate crew response, and fuel tank explosion.

The Aircraft Catastrophic Failure Prevention Research Program is largely driven by accidents and incidents, but also by NTSB recommendations, new technology, and industry focus groups focused on accident reduction. This program was initiated after the 1989 DC-10 Crash landing at Sioux City, Iowa. The major thrust of the program started in engine containment and uncontained engine failures mitigation. The second focus area historically has been propulsion system malfunction plus inappropriate crew response which the program has supported since the original

Aerospace Industries Association (AIA) group started meeting in 1996. (Note: beginning in FY 2012, propulsion malfunction research is being shifted into Propulsion and Fuel Systems Program (Congressional budget line a11.b.)) These two areas are top drivers of propulsion system initiated accidents today. The Aircraft Catastrophic Failure Prevention Research Program has worked closely with the Aviation Rulemaking Advisory Committee, AIA focus groups, Department of Defense (DoD), NASA and academia to leverage existing work and develop data, analytical methods, and processes that make up the foundation for improved policy, regulation and advisory material. Some of the benefits to the FAA, other government agencies, and industry partners, and the public are as follows:

- Develop aircraft material models that improve the state of the art and better represent impacts from engine failures to allow for standardized certification by analysis and increased safety.
  - By 2014, it is planned to complete verification of new material model for aluminum and titanium and by 2016, Inconel 718 material.
- Collaborate with NASA to establish an aircraft material database to be used by industry in aircraft modeling of engine contained and uncontained failures.
  - In 2011, aluminum and titanium material characterization testing was completed and by 2014, Inconel 718 is planned to be completed.
- FAA/NASA/Industry Quality Control Aerospace Working Group is developing aerospace guidelines for dynamic modeling used in engine containment design, bird strikes, uncontained engine debris, etc. which will benefit both industry and the FAA in evaluating new aircraft designs.
- Continue development of the UEDDAM model with inputs from industry and DoD. DoD is currently using the UEDDAM analysis for new aircraft designs to mitigate uncontained engine debris damage.
- Published over 50 technical reports documenting testing, data, and improved analytical methods.

If this program was not funded, important working groups making tremendous progress to come together and standardize critical safety analysis procedures would cease. The research team has developed knowledge of the work and is a primary contributor to technology improvement. FAA must maintain an active presence in safety related development as it is often an area of little return on investment to the manufacturers, making it an area where our investment provides direct safety benefit to the public.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the NAS and works to ensure that FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality RE&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction will cause the program to reduce their staff and delay completion of the material model validation by one to three months.

**Detailed Justification for**

# A11.g Flightdeck/Maintenance/System Integration Human Factors

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 –Flightdeck/Maintenance/System Integration Human Factors**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.g Flightdeck/Maintenance/System Integration Human Factors | $7,128,000 | $6,162,000 | -$966,000 |

For FY 2012, $6,162,000 is requested for Flightdeck/Maintenance/System Integration Human Factors Program. Major activities and accomplishments planned with the requested funding include:

- Report on literature review to assess the state of the art in scenario modeling and execution for jet upset prevention, detection and recovery.
- Complete analysis of Aviation Safety Reporting System (ASRS) and NTSB accidents and incidents related to surface moving maps and Capstone 3 airline data highlighting human factors certification issues.
- Provide human factors evaluation checklist of human factors display issues for aircraft certification engineers, test pilots, and human factors specialists to ensure human factors display issues with multi-function displays are identified during the certification approval process supporting compliance to Technical Standard Order (TSO) C113 and Advisory Circular 25-11A.
- Provide analyses and human factors recommendations for unmanned aircraft system control station vision systems to ensure safe and effective operator performance.
- Analyze the effects of imperfect Automatic Dependent Surveillance-Broadcast (ADS-B) generated traffic information including the loss of traffic targets and the depictions of such information to the pilot and report out technical results.

Research will continue in the following areas:

- Develop human factors input for Flight Standards and Aircraft Certification to develop design, evaluation and operational approval guidance for ADS-B enabled implementations.
- Assist Aircraft Certification in identifying, assessing, and remediating human performance issues involving electronic flight bags, moving map displays and multi-function displays.
- Support the Unmanned Aircraft Program Office by providing human factors recommendations for the design and operation of unmanned aircraft systems control stations.
- Provide technical information for the certification of advanced auto pilots and related automation technologies in general aviation (GA) airplanes, which may include research on systems mode awareness, energy state management, and distraction.

## 2. What Is This Program?

The Flightdeck/Maintenance/System Integration Human Factors Program provides the research foundation for FAA guidelines, handbooks, orders, advisory circulars (ACs), Technical Standards Orders (TSOs), 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.

The Flightdeck/Maintenance/System Integration Human Factors Program helps achieve 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 approving new aircraft and new aircraft systems.
- 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 and human-system task/performance requirements associated with transitioning to new technologies and National Airspace System (NAS) operations.

Program researchers work directly with colleagues in FAA, other government agencies, academia, and industry to support the following research and development (R&D) programs and initiatives:

- The National Aeronautics and Space Administration's (NASA) Aviation Safety Program.
- The FAA's Voluntary Safety Program Office initiatives including Advanced Qualification Program, Flight Operations Quality Assurance, and Aviation Safety Action Program.
- 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's 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.

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.
- Department of Defense 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 such as 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 (SAE) G-10 subcommittees – FAA participates on all of the Society's subcommittees involving human factors to adapt their findings to aviation standards, guidelines, etc.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Information Management and Display

- Completed instrument procedures design research project addressing charting and depiction of performance-based navigation procedures and produce draft report.
- Completed usability assessment of surface moving maps that display ownship position in surface operation report.
- Updated human factors guidance for electronic flight bag certification, operational approval, and training based on performance data.
- Developed guidance to address human factors issues associated with using synthetic and enhanced vision to support equivalent visual operations.

Human-Centered Automation

- Developed human factors guidance for ADS-B equipment certification and operational approval.
- Developed human factors guidance for the evaluation and approval of electronic flight bags, multi-function displays, and surface moving maps.

- Compiled and analyzed human factors issues with advanced autopilots and related automation technologies in GA airplanes.
- Developed report reflecting results of an industry study on automation issues with Transport Category Airplanes as part of a Performance Based Operations Aviation Rule-Making Committee (PARC) team activity.

Human Performance Assessment

- Tested and fielded the Maintenance Line Operations Safety Audit (LOSA) safety audit tool for maintenance and ramp operations that will evaluate a maintenance organization's effectiveness.
- Delivered and implemented guidance materials, tools, and administrative process to manage and/or regulate aircraft maintainer fatigue.
- Provided human factors guidance for the operation of unmanned aerial systems (UAS) within the NAS.
- Completed research study to identify human factors issues that are contributing to very light jet incidents.

Selection and Training

- Validated training for visual approaches for low-time pilots to improve flight path and energy management.
- Developed guidance and training material to improve consistency of safety team decisions.
- Continued development of international standards for simulator fidelity.

Performance Linkages

The Flightdeck/Maintenance/System Integration Human Factors Program supports the DOT Strategic Goal of Safety by reducing transportation related injuries and fatalities on commercial air carriers and in GA.

The goals of the focused research endeavors are:

- By 2013, develop human factors guidance material to support certification of cross regulatory display work including alerting, multi-function displays, moving maps, and electronic flight bags (EFB) which can host a variety of applications.
- By 2013, develop human factors guidance material for the certification of UAS automation including guidance for control station design and pilot training.
- By 2013, develop pilot system interface and human factors guidance for current and proposed autopilot and flight management automation systems used in single pilot GA airplanes.
- By 2014, provide human factors guidance material for FAA Certification and Flight Standards personnel to evaluate traffic displays and traffic applications/operations that use ADS-B technology.
- By 2014, develop training guidelines for jet upset prevention, detection and recovery.
- By 2015, develop human factors criteria and guidelines for approving head-up displays and head-mounted displays.

## 3. Why Is This Particular Program Necessary?

Human error continues to be a major contributor to aircraft accidents and incidents both in commercial and general aviation. This research program has, over the years, identified human factors issues and developed training, mitigation, and guidance material used by government and industry to address problem areas. For example, Crew Resource Management (CRM) research supported the development of an FAA Advisory Circular as well as training for air carriers. The research program has provided substantial support for the FAA's Voluntary Safety Programs. One of these programs, the Line Operations Safety Audit, is a direct result of our research and is now mandated by ICAO as a worldwide safety monitoring requirement for airlines.

The human factors research program continues to focus on the needs of pilots, inspectors and aircraft maintainers. Flight deck design and operational practices are experiencing a revolution in digital avionics, enabling new head up displays, surface moving maps, electronic flight bags, advanced controls, communications, navigation, surveillance systems, and tools for aircraft system management. With these advances come important human performance and

human factors implications which must be understood and the appropriate guidance material developed for policy, procedures, operations and training. Our research supports the development of these products. History has taught us that the introduction of new automation to the flightdeck has resolved some human error tendencies but also introduced new ones. One goal of current research is to try to be proactive in identifying error tendencies and thereby enhance the safe and effective introduction of new technologies and procedures into the NAS.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

Any current or future reduction in funding to the Flightdeck/Maintenance/System Integration Human Factors Program would result in a delay of project delivery within the FY 2012 new start to conduct research that will support the development of certification requirements and operational approval criteria for head-up and head-mounted displays.

**Detailed Justification for**
## A11.h System Safety Management

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – System Safety Management**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.h System Safety Management | $12,698,000 | $10,027,000 | -$2,671,000 |

For FY 2012, $10,027,000 is requested for System Safety Management. Major activities and accomplishments planned with the requested funding include:

Risk Management Decision Support

- Continue to demonstrate a two-third reduction in the rate of fatalities and injuries through the development of an analytical method and associated metrics.
- Initiate development of transport airplane risk analysis evaluative metrics.

Aviation Safety Information Analysis and Sharing (ASIAS)

- Demonstrate a working prototype of network-based integration of information extracted from diverse, distributed sources.
- Continue to develop an advanced infrastructure and laboratory for conducting and sharing analysis tools and aggregated safety information.
- Continue development of automated tools to monitor databases for potential safety issues.
- Conduct safety analytical studies and safety assessments using ASIAS and other safety aviation data.
- Expand ASIAS to other domains (e.g., general aviation, rotorcraft, corporate, and military).

Operational Safety Oversight of the National Airspace System (NAS) through ASIAS

- Continue development of a user interface and trend analysis capability for equipment performance.
- Test the equipment module for facility performance.
- Develop user guide to facilitate use by air traffic safety inspectors.
- Initiate development, integration of function points, and testing of an Air Traffic Control (ATC) module, which integrates air traffic databases and permits prognostic trend analysis of air traffic safety performance for operational oversight.

Terminal Area Safety

- Investigate issues concerning the connection of required navigation performance (RNP)/performance based navigation (PBN) paths with global position landing system indicators for terminal area operations using human-in-the-loop simulations.
- Complete analysis of contributing factors and develop models for operational landing performance of selected aircraft make/model/series to improve the safety and capacity in terminal areas.
- Enhance advance simulator software models for stalls based on actual and/or wind tunnel-derived aircraft performance data. This research is performed within the context of developing models of unusual attitude encounters outside the normal operating envelope.
- Conduct research to investigate the operational procedures and the technical limitations of using enhanced vision system/synthetic vision system, and to establish the level of credit allowed by the FAA for the

equipment availability on an aircraft. This research is performed within the context of cockpit-centric navigation technologies.

ASIAS - Via the ASIAS project, researchers, with support from other government agencies, e.g., NASA, industry, and academia, will continue to develop innovative, advanced tools and methods that will extract relevant knowledge from copious amounts of disparate safety information. Development will continue on safety metrics and vulnerability discovery capabilities. Using ASIAS and other aviation safety data, analytical and directed studies to identify safety issues and verify mitigation and safety enhancements will continue.

Operational Safety Oversight of the NAS through ASIAS - Research continues and extends the work initiated in 2011 that expanded ASIAS to include facility performance data. In 2012, research advances the integration of facilities databases and develops modules for active monitoring of facilities' performance and their impact on NAS safety. Using experience and infrastructure developed for integrating the facility database into ASIAS, additional research will be conducted to develop modules for the integration of air traffic safety data for prognostic analysis.

Terminal Area Safety - Researchers will analyze operational data, develop models, and evaluate new navigation technologies to ensure FAA maintains a desired level of safety while accommodating the need for more efficient use of the terminal area. Research activities will provide the ability for advanced flight simulators to be more realistic for evaluating and training stall recognition and recoveries outside the normal operating envelope to improve the safety of terminal operations.

## 2. What Is This Program?

The System Safety Management Program will develop an infrastructure that enables the free sharing and analysis of de-identified safety information that is derived and protected from government and industry sources. In addition, the program provides 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 also conducts operational research and analysis to maintain or improve safety and to improve terminal area efficiency.

The System Safety Management Program develops risk management methods, prototype tools, technical information, and safety management system procedures and practices that will improve aviation safety. In addition, the program will develop an infrastructure that enables the free sharing of de-identified, aggregate safety information that is derived from government and industry sources in a protected, aggregated manner. It also conducts operational research to leverage proposed new technologies and procedures that may enhance pilot and aircraft safety during terminal operations.

The program encourages broad industry and government participation across all projects, including:

- 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 the program's research projects support new rulemaking and the development of alternative means of compliance with existing rules.
- The Joint Planning and Development Office 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 (CAST) – an FAA/industry collaborative effort to develop and implement data-driven safety initiatives.

The Program partners with industry, academia, and other governmental agencies, including:

- The Civil Aviation Authority of the Netherlands to conduct joint research on aviation system safety initiatives via a Memorandum of Cooperation.
- Technical expertise from air carriers to provide industry reviews and recommendations regarding safety and efficiency of terminal area operations as well as air carriers' cooperation with data sharing agreements and

governance models that allow for the free sharing of aviation data in accordance with approved voluntary safety information sharing agreements.

- Center of Excellence for General Aviation Research, via grants, to increase data and tools available for cooperative general aviation safety analyses among industry stakeholders.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Risk Management Decision Support

- Continued to demonstrate a two-third reduction in the rate of fatalities and injuries through the development of an analytical method and associated metrics.

ASIAS

- Developed 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.
- Continued to develop an advanced infrastructure and laboratory for conducting and sharing analysis tools and aggregated safety information that allows industry stakeholders to perform standardized data analysis and limited vulnerability discovery on diverse sets of data.
- Continued to 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.
- 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.

Operational Safety Oversight of the NAS through ASIAS

- Completed development of a facility/equipment operations module that includes a collection of business objects that provides a view of NAS equipment maintenance functions, combined with ASIAS/ATC baselined data, specific to NAS safety oversight.
- Initiated development of a user interface and trend analysis capability that monitors NAS equipment operations with respect to failures, risk, and other off-nominal occurrences.

Terminal Area Safety

- Completed an evaluation air traffic and flight procedures for terminal area operations using pilot-in-the-loop flight simulator.
- Continued testing procedures and requirements to identify RNP/ PBN constraints related to terminal area operations.
- Developed models for the landing distance performance of selected aircraft make/model/series using standard operating practices.
- Continued developing wake encounter models for the advanced flight simulators.
- Identified new cockpit centric navigation technologies and data for the development of new procedures to enhance the safety and capacity within the terminal area.

Performance Linkages

The System Safety Management Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. 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. The goals of the focused research endeavors are:

- 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 limited vulnerability discovery on a wide variety of diverse sets of data.
- By 2012, develop a user interface and trend analysis capability that monitors NAS equipment performance with respect to failures, risk, impact on ATC and other off-nominal occurrences.
- By 2013, develop a user interface and trend analysis capability that monitors NAS ATC operational safety with respect to risk and other off-nominal occurrences for use by FAA field and headquarters safety inspectors to more economically identify facilities with higher safety risks.
- By 2014, complete the compilation of risk analysis data and/or statistical data into a format best suited for efficient use in transport airplane risk analysis.
- By 2015, demonstrate a two-thirds reduction in the rate of fatalities and injuries.*
- By 2015, expand ASIAS system safety analysis to other domains (e.g., general aviation, rotorcraft, corporate, military).
- By 2017, enhance vulnerability assessment capabilities of discovery, identification, and evaluation of safety risks not currently known to the aviation community.

To reduce the risk for passengers and crews and enhance the traffic control process in terminal area operations, human-in-the-loop (pilot/controller) simulations, evaluations, and operational flight data analysis will be conducted.

- 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 safety and capacity of the terminal area.
- By 2012, 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.
- By 2014, determine the amount of credit granted for synthetic or enhanced vision system installation and the level of operations that can be approved in lieu of airport infrastructure.
- By 2015, distribute a validated and portable wake mathematical model for use in simulator training.

## 3. Why Is This Particular Program Necessary?

The System Safety Research Program has two primary goals. First, the program is designed to identify and analyze emerging threats in a cooperative nature with the aviation industry. Working cooperatively with aviation stakeholders provides the ability to analyze trends across the aviation community that is much more effective than monitoring individual airlines. Thus, the aviation community and FAA must have regular access to safety information to move toward a risk-based safety management approach. By creating a safety baseline and benchmarks, the program will produce products that regularly monitor safety enhancements to ensure the incorporation of new capabilities does not impact current levels of safety. Therefore, the program has direct impact in several areas that affect the incorporation of new technologies, NextGen capabilities, and evolution of the National Airspace System. Also, the program responds to several Government Accountability Office studies that call for the FAA to collect better data and improve its effort to identify and address safety issues. For FY 2012, development will continue on the working ASIAS prototype, a new air traffic control module will be developed, and analytical studies and safety assessments using ASIAS and other safety aviation data will be conducted. An initiative to develop transport airplane evaluative metrics will be initiated.

* The two-thirds reduction in the rate of aviation fatalities and injuries is based on a 2004 baseline.

The second major goal is to identify and mitigate the risks associated in the terminal area operations. This effort aims to provide solutions to the airport capacity problem so that maximum benefits for both safety and efficiency can be realized. It supports the FAA's goal of Increased Safety as stated in objectives 1 and 2 to reduce fatal accidents, and the goal of Increased Capacity as stated in objective 1 to meet projected demand, which are identified by the Flight Plan 2009-13. Furthermore, the research efforts also support the FAA's NextGen efforts to enhance the efficiency of the national airspace system, especially for the performance based navigation initiatives. For FY 2012, research will include an evaluation of air traffic and flight procedures for terminal area operations by using human-in-the-loop flight and air traffic simulator, the development of models of unusual attitude encounters outside the normal operating envelope, and the identification of new, cockpit-centric navigation technologies and data for the development of new procedures to enhance safety and capacity within the terminal area.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

The FAA is conducting research in support of continued operational safety of transport category airplanes. The next phase, entitled Transport Airplane Risk Analysis Evaluative Metrics, requires developing the supporting statistically derived data. This will prolong the research and delay delivery of hazard and risk analysis information that would be useful for FAA aircraft certification engineers.

**Detailed Justification for**

# A11.i Air Traffic Control/Technical Operations Human Factors

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Air Traffic Control/Technical Operations Human Factors**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.i Air Traffic Control/Technical Operations Human Factors | $10,302,000 | $10,634,000 | +$332,000 |

For FY 2012, $10,634,000 is requested for Air Traffic Control/Technical Operations Human Factors. Major activities and accomplishments planned with the requested funding include:

Advanced Air Traffic Systems

- Continue development of a human factors design standard for Air Traffic Control (ATC) displays that is harmonized with the color vision testing used during controller selection.
- Continue development of an ATC symbology and style guide to aid the efficient development of ATC display details.
- Continue work on a revised Human Factors Design Standard that can be cited as a design requirement during ATC system procurements.

Individual and Team Performance

- Report on the effectiveness of the ATC Quick Reference Guide for supervisor best practices.
- Continue the Preventive Maintenance Tasks Vulnerable to Human Error study that seeks to identify and prevent human errors resulting in ATC system outages.
- Perform fatigue research measuring the effectiveness of fatigue risk management interventions that are scheduled for implementation.

Advanced Technical Operations Systems

- Continue to evaluate user manuals and other multi-media documentation in the Technical Operations domain.

Personnel Selection and Training

- Continue longitudinal validation of ATC selection instruments.
- Document the effectiveness of a selection battery to place controllers by option and match skills to optimal placement.
- Continue a study of controller entry and retirement age.
- Conclude development of potential approaches to increase the efficiency of air traffic controller training and staffing.

## 2. What Is This Program?

The Air Traffic Control/Technical Operations (ATC/TO) Human Factors Program provides leadership and products to motivate National Airspace System (NAS) evolution to ensure the system's human component will safely and reliably perform to meet the flying public's needs. Outputs include:

- Air traffic workstations and concepts that increase workforce productivity by identifying key workload factors that must be mitigated to enable the humans in the system to manage the future NAS traffic flow.

- Human reliability analytical tools and methods to assess and mitigate the potential for human error.
- Assessments of the effectiveness of fatigue-risk-management strategies.
- Air Traffic Organization (ATO) safety culture transformation through research in the TO community to identify effective interventions to move the ATO toward a "Just Culture."
- Future controller and maintainer personnel selection criteria to enhance screening process efficiency and effectiveness.
- Guidelines and standards for design of computer-human interfaces used in TO.

The ATC/TO Human Factors Program supports FAA strategic goals for increased safety and greater capacity by developing research products and promoting the use of those products to meet the future demands of the aviation system. The human factors research program for FY 2012 will emphasize the concept of human-system integration (HSI) and safety aspects of the functions performed by air traffic controllers and technical operations personnel. The HSI concept will address the interactions between workstation design, personnel selection, training, and human error/safety. The ATC/TO Human Factors Program generates requirements for human interface characteristics of future air traffic and technical operations (maintainer) workstations and enhances our understanding of the role that system design plays in mitigating human error, including operational errors, runway incursions, and errors that result in NAS equipment outages. Additionally, researchers are developing methods to select new air traffic controllers and maintainers so that the applicant screening process is valid, reliable, and fair, and also to improve HSI in the maintenance arena to increase reliability and availability of the NAS.

The research program works to improve system safety by:

- Developing:
  - Organizational changes to transform the technical operations ATO safety culture.
- 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 controllers and maintainers.

The program works to improve the ATC and TO contributions to system capacity by:

- Developing:
  - Integrated workstations that allow TO specialists to meet increased availability and service demand.
  - Methods to assess the value of proposed changes to workstations to determine if human-in-the-loop performance is enhanced.
  - Advanced 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:
  - HSI in a manner that allows controllers and pilots to cooperatively manage traffic loads as cockpit technology and air traffic workstations are more closely connected to efficiently move NAS air traffic.
  - Allocation and sharing of roles and responsibilities between controllers and pilots as technology evolves to meet future demands.

The ATC/TO Human Factors Program receives requirements from its internal FAA sponsoring organizations (primarily the following FAA ATO ATC/TO research groups) and collaborates with national and international research organizations:

- 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.

- Individual and Team Performance Requirements Group – ATO Safety, En Route, Terminal, Technical Operations and System Engineering service units participate to identify human performance research needs involving fatigue, safety culture, human error hazard identification, age, operational errors, runway incursion prevention, and supervisor practices.
- Advanced Technical Operations Systems Requirements Group – The Technical Operations, En Route, and Terminal service units recommend NAS infrastructure operational and maintenance research, including ATC systems maintenance displays, controls, and maintainability features specifications.
- Personnel Selection and Training Requirements Group – ATO Technical Training and Development, Human Resources, FAA Academy, Workforce Services, Office of Aerospace Medicine, Administration and Talent Management, and the Financial Services groups address personnel selection and training, including the ability to successfully screen applicants for controller positions.
- Collaborative research with the National Aeronautics and Space Administration includes human factors areas such as the measurement of fatigue risk management effectiveness.
- Collaboration with EUROCONTROL, including joint development of a Human Reliability Assessment Tool, participation in semi-annual Air Traffic Management (ATM) seminars, and leadership of an Action Plan 15 Safety workgroup to identify ATM human factors issues.
- Cooperative research agreements are in place with Massachusetts Institute of Technology, Georgia Institute of Technology, St. Louis University, Ohio State University, and The American Institutes for Research.

The FY 2011 President's Budget requested $10,475,000 for Air Traffic Control/Technical Operations Human Factors. Major activities and accomplishments to be achieved in FY 2011 with the requested funding include:

Advanced Air Traffic Systems

- Initiated a human factors standard for safety alert information to users of tower ATC displays.
- Initiated revisions to the Human Factors Design Standard for the application of human factors design criteria to new systems and equipment.

Individual and Team Performance

- Expanded the application of human error reporting and reduction research for transformation of the ATO safety culture.
- Assessed the effectiveness of controller fatigue mitigation strategies.

Advanced Technical Operations Systems

- Reviewed human factors requirements for a standard graphical user interface on maintenance work stations and system displays used by maintainers.
- Continued development of human factors information requirements for remote maintenance monitoring.

Personnel Selection and Training

- Applied a new training effectiveness evaluation methodology for new tower simulator systems.
- Tested an occupational test of controller color vision.

Performance Linkages

- 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.

## 3. Why Is This Particular Program Necessary?

The primary purpose of the ATC system is to prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic. Decisions are made by thousands of human operators and involve tens of thousands of aircraft as they use the services of airport towers, approach control facilities, en route air traffic control

centers, the FAA System Command Center, and many airline operation centers. The safety and performance of the National Airspace System (NAS) is directly linked to the performance of these human operators. Within this complex system, from time-to-time, accidents and incidents still happen, often repeating the same sequence of events played out many times before. As a result, we are often left with the regrettable truth that there are very few "new" accidents, just different players. Among the most complex problems facing aviation today are those involving human error. To achieve quantifiable improvements in aviation safety and capacity, increasing emphasis is being placed on the human operator and those involved with the safe and efficient conduct of flight (e.g., supervisors, air traffic controllers, maintenance technicians). Enhancing safety will require a reduction in human error and increasing capacity will involve the development of techniques and tools that increase controller efficiency. The human issue will be made even more complex as a large percentage of the agency's controllers become eligible to retire within ten years. With total losses expected to exceed 10,000, FAA must develop effective recruitment, selection, and training procedures to ensure those who are hired have the necessary knowledge, skills, and abilities to be successful.

FAA Human Factors R&D for ATC/TO is motivated by a need to reduce the potential for human error and increase the efficiency of ATC operations. To meet these challenges, the FAA is focused on integrating the human into the development cycle. The major areas of human system integration are in effective workstation design, human error reduction, effective and fair personnel selection, and efficient training. The need for air traffic services is growing and the requirement to include the human component in the development of the NAS is being addressed by this research program.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure that FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development Program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

The requested funding level covers slightly over half the research requirements identified by the sponsors in the ATO. A reduction will require the cancellation of major elements such as the Human Factors Design Standard used during acquisition programs to reduce human factors risk. A further reduction will require cancellation of the Human Factors Design Standard for Display Symbology and reduce the funding available for the completion of a study regarding Preventive Maintenance Tasks Vulnerable to Human Error.

**Detailed Justification for**
# A11.j Aeromedical Research

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Aeromedical Research**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.j Aeromedical Research | $10,378,000 | $11,617,000 | +$1,239,000 |

For FY 2012, $11,617,000 is requested for Aeromedical Research. Major activities and accomplishments planned with the requested funding include:

The Civil Aeromedical Institute (CAMI) Aeromedical Research Program

- Analysis and distribution of zolpidem, a prescription medication used for the short-term treatment of insomnia, in postmortem specimens from aviation accident fatalities.
- Report on the effects of exposure to combustion gases (CO and hydrogen cyanide) in support of investigation of aviation accidents involving fire/smoke.
- Develop procedure to validate potential biomarkers by special biochemical methods. These biomarkers will assist in identifying fatigue and other aviation stressors.
- Provide guidance for measuring and estimating radiation exposure during commercial aerospace activities and develop instructional materials on radiation exposure to humans during commercial aerospace travel.
- Examine and model aviation accidents in Alaska over time. The model will provide a way of assessing risk within the Alaskan aviation community.
- Evaluate the performance of current aircrew oxygen regulators installed on commercial aircraft.
- Report on the review of all fatal and high profile accidents to determine reporting accuracy of medical certification applications and provide insight on possible corrective measures.
- Assess the vision performance effects of pilots exposed to non-ionizing radiation (ultraviolet, visible, near/mid-infrared) from natural and artificial sources and develop guidance material.

Airliner Cabin Environment Research (ACER) Program

- Collect baseline data for volatile organic compound (VOC) contaminants on loaded aircraft filters.
- Create prototype sensor network with select bleed air sensors for demonstrating feasibility of system to detect simulated contaminants.
- Detail investigation of what is generated during a bleed air event.
- Report that documents chemical reaction kinetics of high temperature degradation of aircraft engine oil and hydraulic fluids.
- Support regulatory, certification, and operations for existing Aviation Rulemaking Committees.

CAMI Aeromedical Research Program

Research will continue on identifying, assessing, and developing improved evacuation equipment and evacuation aids, such as lighting, aural way-finding systems, and symbolic information media. Emergency evacuation issues frequently arise during accidents, where scenarios develop that cannot be simulated during certification. Identifying these factors in the absence of accidents can be difficult, but is essential to prevent death and injury. Improvements in systems to inform passengers and crew about emergency issues and prepare occupants to speed evacuation will directly improve safety and take advantage of improvements in other areas such as fire safety.

Research will be ongoing to develop and maintain analytical tools, empirical data and scientific expertise to support regulatory actions, standards development, accident investigations, and enhanced safety of airplane interior arrangements and emergency equipment and operations. Emergency evacuation issues frequently arise during accidents in which scenarios develop that cannot be simulated during certification. Conversely, proposed changes to aircraft and/or operations often suggest that reductions in evacuation efficiency will likely result as a consequence. Analytical tools and empirical data are needed to confirm the effects of such identified factors, using accident histories and findings in the technological literature, as well as empirical data and analyses derived from experimentation. Work on injury criteria for obliquely oriented seats will continue to determine the injury mechanisms and human impact tolerance levels and methods of predicting occupant injuries in obliquely facing seats during a survivable crash. Techniques will be developed to use advanced occupant models to accurately simulate human response to impact and predict potential injuries for all impact vectors and occupant sizes. Dynamic testing and occupant injury assessment have been required for seats in newly certified aircraft since the adoption of Title 14 of the Code of Federal Regulations (CFR) Part 25, 25.562, and similar regulations in Parts 23, 27, and 29 (1). The occupant injury criteria contained in those regulations are primarily focused on protecting the occupant from forward and vertical impacts. This research is required since the biomechanics of side impacts differ significantly from forward or vertical impacts.

Research on prevention of injuries that impede egress will also continue in FY 2012. Human impact tolerance levels and methods for predicting occupant unconsciousness and leg injuries that can occur during a survivable crash will be determined and enhanced means of mitigating injury causing mechanisms for the brain and leg will be investigated. The CAMI impact sled and anthropometric test dummies will be utilized to perform this research.

Airliner Cabin Environment Research Program

In the areas of aircraft cabin environments, evaluation of aircraft cabin for exposure to pesticides, volatile organic compounds, semi volatile organic compounds, assessment of potential polybrominated diphenyl ethers exposure will continue in FY 2012. Models of engine oil and hydraulic fluid chemical kinetics, simulated bleed air events, experimental characterization of bleed air and recirculation air purification technologies will continue in support of research on purification of environmental control systems air supplies.

## 2. What Is This Program?

Agency outputs proceed from the FAA Office of Aviation Medicine, specifically, 1) CAMI and 2) the National Air Transportation Center of Excellence 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.

The Aeromedical Research Program supports FAA's 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 (a) Evacuation and egress of humans from aerospace craft, (b) Dynamic protection and safety of humans on aerospace craft, and (c) 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
- 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

Airliner Cabin Environment Research Program was formulated in response to issues raised in a 2002 National Research Council Report regarding the airliner cabin environment and the health of passengers and crew during normal and events outside the normal operational envelope and continued public and congressional concern. The airliner cabin environment research addresses public, aircrew, and congressional concerns regarding these issues, including, contaminant transport, ozone (including chemical reactivity of aircraft cabin interiors), pesticides (residual and sprayed), contaminants that may be carcinogenic, additives in hydraulic and lubricating fluids in aircraft engines and auxiliary power units and identified as possible neurological toxins in crew members. The Airliner Cabin Environment Research program also conducts R&D on cabin air quality sensors; advanced environmental control systems; and on chemical and biological agents, and disinfection techniques and processes. The research is primarily conducted by the National Air Transportation Center of Excellence for Research in the Intermodal Transport Environment (RITE).

The Airliner Cabin Environment Research Program supports FAA's Flight Plan goal for Increased Safety by: Developing and testing adaptive environmental control techniques to enable a safe and healthy cabin air environment including during in-flight incidents; Validating software tools and methods to mitigate possible air contamination incidents during flight and ground operations; Developing advanced 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 (a) evidence-based development of appropriate policy, regulations, and guidelines to maximize safety and health from the cabin air quality environment and (b) 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.

Both the CAMI and ACER Aeromedical Research Programs support numerous DOT and FAA organizations, public laws, customers, and stakeholders including: the Executive Office of the President, National Science and Technology Council, Office of Management and Budget, Office of Science & Technology Policy, European Aviation Safety Authority, Transport Canada, World Health Organization, and the Department of Health and Human Services.

CAMI has established a professional relationship with over 90 organizations and 55 committees, including holding fellowships and other leadership positions. These scientific, medical, academic, and bioengineering relationships include working in partnership on a multitude of efforts with these organizations, including Cooperative Research and Development Agreements and advisory groups. RITE has over 30 industry partners participating in the research and development effort. RITE researchers and Office of Aerospace Medicine staff members collaborate with leading organizations associated with aerospace medicine, aviation health, airliner cabin environment, and safety.

In FY 2011, major activities and accomplishments planned with the requested funding include:

CAMI Aeromedical Research Program

Aeromedical Systems Analysis

- Provided incidental medical findings and injury description and injury mechanisms analysis to support the development of prevention and mitigation strategies: Aerospace Accident Injury and Autopsy Data System (AAIADS).

- Conducted a risk assessment of selective serotonin reuptake inhibitors use in civil aviation.

Accident Prevention and Investigation

- Quantified the effects and impact of fatigue in aviation using gene-expression research.
- Determined the usefulness of blood from aviation accidents as an RNA source for gene-expression analysis.
- Determined the prevalence of psychotropic drugs in pilot fatalities from civil aviation accidents.
- Assessed unapproved medications found in fatally injured pilots involved in homebuilt-aircraft accidents.
- Correlated the incidence of quinine positives in aircraft fatalities with elevated serotonin metabolite ratios.

Protection and Survival

- Developed methods to qualify replacement elements for worn seat cushions used in energy-absorbing seats.
- Developed mathematical prediction of emergency evacuation performance.
- Conducted the performance evaluation of inflatable emergency equipment for ditching scenarios.

Aviation Physiology

- Calculated galactic cosmic radiation dose rates in the atmosphere at altitudes above 60,000 feet.
- Developed a Windows version of the CARI program.
- Evaluated and developed oxygen system guidelines for high-altitude aircraft.

Airliner Cabin Environment Research Program

- Provided scientific knowledge base on medical effects of combined exposures to carbon monoxide, carbon dioxide, and ozone from mild hypoxic conditions associated with reduced air pressures.
- Evaluated toxicological aspects of cabin environmental (air) quality: development of reference laboratory to support aircraft cabin air contaminants analysis.
- Validated computational models of air contaminants, VOCs; biological and viral contaminants to evaluate health impacts on passengers and crew.

Performance Linkages

The Aeromedical Research Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation.

The goals of the focused research endeavors are:

CAMI Aeromedical Research Program

- By 2014, establish design criteria for restraint systems that protect occupants at the highest impact levels the aircraft structure can sustain.
- By 2015, establish validation parameters for mathematical models that can evaluate whether aircraft type designs meet requirements for evacuation and emergency response capability, in lieu of actual tests.
- By 2015, incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control.
- By 2015, develop advanced methods to extract aeromedical information for prognostic identification of human safety risks.
- By 2015, develop a methodology to compile, classify, and assess aviation-related injuries, the mechanisms that resulted in these injuries, and their relationship to autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic testing: AAIADS.

- By 2016, apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors.

Airliner Cabin Environment Research Program

- By 2013, develop advanced data and mathematical models for cabin-air-purification systems.
- By 2015, establish design criteria for aircraft-cabin-air-quality-sensing systems.
- By 2015, demonstrate advanced methods to remove contaminants from bleed-air and non-bleed-air ventilation systems.

## 3. Why Is This Particular Program Necessary?

The human components of aviation systems are simultaneously the strongest and the weakest links in aerospace safety. Thus, the Aeromedical Research Program conducts research to maximize the strengths of the human link and minimize inherent human weakness to prevent accidents and improve safety and health in both commercial and general aviation aircraft. The Aeromedical Research Program combines three major efforts: Aerospace Medical Research that is focused on the medical aspects of aircraft accident investigation and pilot medical certification, Crash Survival and Cabin Evacuation Research to ensure post crash survival and Cabin Environment Research focused on airliner occupant health and safety.

The Aerospace Medical Research Program investigates and analyzes injury and death patterns in civilian flight accidents and incidents to determine their cause and develop preventive strategies. This research supports FAA regulatory and medical certification processes that develop safety and health regulations covering all aerospace craft occupants and their flight environments. A new aspect of the Aerospace Medical Research program combines toxicological and medical aspects of all fatal and high priority aircraft accidents to provide accident investigators, medical certification managers and researchers with near real time data to rapidly identify issues and support for safety information systems.

The Crash Survival and Cabin Evacuation Research Program recommends and develops equipment, technology, and procedures for optimal (a) evacuation and egress of humans from aerospace craft and (b) the crash protection and safety. National Transportation Safety Board reports show the survivability of commercial aircraft accidents including serious accidents is quite high – greater than 94 percent; thus, research to ensure occupants can survive crash impact and safely evacuate the aircraft is essential. The implementation of this research was evidenced by the successful water evacuation of all occupants in U.S. Airways Flight 1549.

The Airliner Cabin Environment Research Program supports FAA's Flight Plan goal and Congressional requests for research to ensure airliner occupant safety and security by developing and testing adaptive environmental control techniques to enable a safe and healthy cabin air environment including during in-flight incidents. This research develops advanced scientific models and experimental data on airborne and surface transmission of existing and emerging infectious diseases within aircraft and develops evidence-based hazard identification and risk management criteria guidelines to maximize safety and health in the air transportation system in response to infectious disease. This program will provide data and systems for air quality incident identification to alert crew to potential problems and provide signals to the environmental control system for appropriate response.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

The Aeromedical Research program is principally an in-house effort; 84 percent of FY 2012 funds are assigned for CAMI to address: (a) aeromedical PCB&T (50+ full-time government employees, $7.125 M), (b) $1.094 M baseline laboratory operating costs, and (c) $1.550 M to conduct specialized Fire and Cabin Safety research; thus the CAMI aeromedical FY 2012 non-PCB&T funds total $2,644. A reduction in funding will extend research time to assess bleed air quality on commercial aircraft and to identify oil-based contaminants, air contaminants from cabin materials, hydraulic fluid, and other toxins in the aircraft cabin that affect the safety and health of airline crewmembers and the flying public (FY 2012 Major Activity in the Airliner Cabin Environment Research Program).

**Detailed Justification for**
## A11.k Weather Program

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Weather Program**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.k Weather Program | $16,789,000 | $16,366,000 | -$423,000 |

For FY 2012, $16,366,000 is requested for the Weather Program. Major activities and accomplishments planned with the requested funding include:

- Develop advanced storm prediction probabilistic forecast capability.
- Develop initial Current Icing Product (CIP) algorithm for Alaska.
- Update high ice water content (HIWC) algorithm to support FY 2012 field program.
- Evaluate rapid refresh ensemble with 3 km Continental United States (CONUS) and Alaskan nests at National Centers for Environmental Prediction (NCEP).
- Transition turbulence forecast capability including mountain-waves for implementation.
- Test and assess CONUS ceiling, visibility, and flight category 1-3 hour forecast capability.
- Test and implement observation trending and locale specific data capability to Helicopter Emergency Medical Services (HEMS) weather tool.
- Develop volcanic ash concept of operations and initial set of functional and performance requirements.
- Develop verification techniques and approaches that assess research capabilities in support of the Research Transition process.
- Develop Terminal Area Icing Weather Information System concept design documents including description of operational use.
- Conduct research field program using high ice water content and particle size measurement instrumentation.

The Weather Program will continue to develop and enhance forecast and nowcast capabilities to support DOT safety strategic goal, FAA Flight Plans goals of greater capacity and increased safety, and meet NextGen requirements. This will include applied research in naturally occurring atmospheric hazards including turbulence, severe convective activity, icing, and restricted visibility. In FY 2012 additional turbulence forecast capabilities are being developed to enhance en route safety and capacity, an advanced probabilistic storm prediction capability is being developed to enhance terminal and en route capacity, an in-flight icing capability for Alaska is being developed to enhance safety especially for general aviation, a ceiling visibility 0-12 hour capability is being developed to enhance en route safety especially for general aviation, and a volcanic ash dispersion ensemble forecast capability is being developed with NOAA to enhance en route safety and capacity. Additionally in FY2012, modeling capability via a rapid refresh ensemble will be evaluated that will provide enhanced icing, ceiling and visibility, turbulence, and convective forecasts for the CONUS and Alaska. This will include evaluating the ensemble using CONUS and Alaska nests, where a nest is a smaller, specific area in a large domain that is analyzed in greater detail to resolve weather structures that may contain potentially hazardous weather. Capabilities developed are transitioned to National Weather Service (NWS), FAA, and industry weather systems.

Additionally the HEMS weather tool will be enhanced to provide additional altitude and location specific data to increase safety and the FAA will be collaborating with NASA on a field program to develop measurement technology and forecast capability of high ice water content conditions which are a critical safety hazard.

## 2. What Is This Program?

The Weather Program provides new and improved weather products that support legacy National Airspace System (NAS) systems, NOAA/NWS, and near-term NextGen capabilities as well as enablers necessary for mid-term and far-term benefits. Weather products are enhanced by upgrading algorithms for existing NAS platforms such as the Weather and Radar Processor, and the Integrated Terminal Weather System. The NWS platforms also use the algorithms developed. Research is an integral element in providing the advanced forecast and nowcast information that can be integrated into aviation decision-support tools. This information will be transitioned by the FAA's Reduce Weather Impact (RWI) portfolio to accomplish this. The information will be developed in accordance with the NextGen Network Enabled Weather dissemination standards. This will allow universal access to weather information through net-centric capabilities.

The Weather Program will develop advanced forecast capabilities consistent with the operational improvements specified in the NextGen Integrated Work Plan (IWP) and the FAA NextGen Implementation Plan. To support transition of these advanced capabilities to operations, the Weather Program will utilize evaluations of these scientific advancements to verify their performance. These advanced capability requirements for NextGen include the following:

- Advanced convective weather forecast - high-resolution, deterministic and probabilistic 0 to 12+ hour forecasts of convection for air traffic management (ATM) to enhance capacity.
- Hourly (nowcasts) and 0- to 18-hour probabilistic forecasts of turbulence for use by ATM, Aviation Operations Centers (AOC), and the pilot in the cockpit to enhance safety and capacity.
- Hourly (nowcasts) and 0- to 12-hour probabilistic forecasts for in-flight icing, including its severity for use by ATM, AOC, and the pilot in the cockpit for preflight planning to enhance safety and capacity.
- Analysis and 0- to 12-hour probabilistic forecasts of ceiling, visibility, and flight category for use by ATM, AOC, and the pilot in the cockpit, and to support estimation of capacity resources at airports as well as increased general aviation safety.

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.

The Weather Program supports NextGen goals via applied research and development of the advanced forecast capabilities detailed in the NextGen Integrated Work Plan (IWP) and the FAA NextGen Implementation Plan. Efforts undertaken in collaboration with the NOAA and the National Aeronautics and Space Administration (NASA) increase FAA's ability to provide the operational improvements required for NextGen. These improvements include short-term and mid-term forecasts of naturally occurring atmospheric hazards, such as turbulence, severe convective activity, icing, and restricted visibility. Improved forecasts enhance flight safety, reduce air traffic controller and pilot workload, enable better flight planning, increase productivity, and enhance common situational awareness.

The Weather Program works within FAA, industry, and government groups to ensure its priorities and plans are consistent with user needs. This is accomplished through:

- Guidance from the Joint Planning and Development Office (JPDO) NextGen initiative and the NextGen Integration and Implementation Office within FAA.
- Guidance from the FAA Research, Engineering and Development Advisory Committee.

- Inputs from the National Aviation Weather Initiatives, which are strongly influenced by other NAS drivers including "Safer Skies" and Flight Plan Safety Objectives.
- Inputs from the aviation community, such as the annual National Business Aircraft Association /Friends/Partners in Aviation Weather Forum; JPDO; RTCA; and scheduled public user-group meetings.
- Close collaboration with FAA organizations internal to the Agency such as the Air Traffic Organization Oceanic and Off-Shore Programs Office and various FAA Aviation Safety Offices.

The Weather Program collaborates with the Department of Commerce (DOC) 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).
- NOAA laboratories (convective weather, turbulence, volcanic ash, modeling, weather radar techniques, quality assessment/verification).
- Massachusetts Institute of Technology's Lincoln Laboratory (convective weather).
- NOAA's NCEP Aviation Weather Center (in-flight icing, convective weather, turbulence, ceiling and visibility) and Environmental Modeling Center (modeling).
- NASA Research Centers (in-flight icing, turbulence, satellite data).
- Universities (modeling).
- Airlines, port authorities, cities (user assessments).

In FY 2011, major activities and accomplishments planned with the requested funding include:

- Developed CONUS 0-8 hour advanced storm prediction capability including lightning proxy.
- Integrated Canadian weather radar information into the High-Resolution Rapid Update National 3D Radar Mosaic.
- Completed Forecast Icing Product and CIP severity Weather Research & Forecast (WRF)/Rapid Refresh (RR) transition.
- Completed prototype HIWC algorithm in support of NASA trial field program.
- Tested 3km High-Resolution Rapid Refresh WRF model at NOAA.
- Completed turbulence forecast capability for WRF rapid refresh transition.
- Developed prototype CONUS ceiling, visibility, and flight category 1-3 hour forecast capability.
- Conducted QA evaluations, utilizing Network-Enabled Verification System of weather research capabilities to support the research transition process.
- Implemented FAA approved products for operational use within the NAS.
- Evaluated liquid water equivalent system for measurement of freezing rain, freezing drizzle, snow & ice pellets and the ability to distinguish between them.

Performance Linkages

The Weather Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation as well as the FAA Flight Plan Goals of greater capacity and increased safety. Research is on-going to provide weather observations, warnings, and forecasts that are more accurate, accessible, and efficient, and to meet current and planned regulatory requirements. The goals of the focused research endeavors in support of the NextGen weather operational improvements are:

- By FY 2012, in support of segment-one: develop timely and accurate deterministic and an initial set of probabilistic aviation weather forecasts for operational use by ATM, dispatchers, and pilots.
- By FY 2018, in support of NextGen mid-term requirements: increase maturity of probabilistic forecasting; using integrated ground, airborne, and satellite weather observation information in real-time for operational use by ATM, dispatchers, and pilots.
- By FY 2025, in support of NextGen far-term requirements: enhance accuracy of net-enabled deterministic and advanced probabilistic weather forecast information for integration into NAS decision support tools and dissemination in real-time from a single authoritative source for operational use by ATM, dispatchers, and pilots.

## 3. Why Is This Particular Program Necessary?

Weather has been identified as a causal factor for 70 percent of delays and 20 percent of accidents as cited in "The Mission Need Statement for Aviation Weather (#339)". The identified shortfalls are in the areas of weather detection and forecasting as well as product creation and dissemination. These shortfalls are also in line with the NextGen Integrated Work Plan (IWP) requirements and Weather Functional Requirements documents. The National Airspace System (NAS) is a complex system whose safe and efficient operation is dependent on the accurate nowcast and forecast of aviation weather conditions. The FAA's Flight Plan for 2009-2013 cites objectives for greater capacity by reducing the impacts of adverse weather on the operational capacity of the NAS and increasing aviation safety by reducing the number of accidents associated with hazardous weather conditions. Since demand is anticipated to rise sharply during this timeframe, weather impact mitigation is critical to meet that demand.

The Weather Program R&D, while driven by the FAA Flight Plan as well as the NextGen Weather Operational Improvements, is also influenced by NTSB and Research, Engineering, and Development Advisory Committee recommendations. Accidents have also driven the weather program; as an example the Roselawn Halloween accident (American Eagle, 68 fatalities, 1994) led to the capability to forecast the location, severity, and probability of in-flight icing conditions with sufficient accuracy to allow proactive planning of previously denied airspace to uncertified aircraft. Improvements to forecast and nowcast capabilities as a result of the development of in-flight icing, turbulence, ceiling and visibility, and convective weather algorithms have been transitioned into operational or experimental use and have led to improved short-term and mid-term forecasts of these naturally occurring atmospheric hazards. There have been an average of 400 weather-related accidents (general aviation, air taxi, and air carrier) per year, over the 10-year period ending in 2006, resulting in $1.46B (fatalities, injuries, aircraft damage) as well as 42,000 air carrier delay hours in 2008, resulting in $200M in delay costs. Continued evolution of improved nowcasting and forecasting algorithms with applicability to achieving higher aviation safety and capacity during hazardous weather is needed. The key is to be able to provide high quality weather nowcasts and forecasts uniquely designed to allow for rapid and effective decision making by traffic managers, air traffic control, and air crews to proactively select safe and optimal reroutes. In the view of the Joint Planning and Development Office, and as espoused in the NextGen Concept of Operations, weather is an essential element to be integrated into TFM safety and capacity management tools.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A funding reduction would delay completion of the NextGen requirement for a turbulence probabilistic forecast for all flight levels.

**Detailed Justification for**

# A11.l Unmanned Aircraft Systems Research

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Unmanned Aircraft Systems Research**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.l Unmanned Aircraft Systems Research | $3,467,000 | $3,504,000 | +$37,000 |

For FY 2012, $3,504,000 is requested for Unmanned Aircraft Systems Research. Major activities and accomplishments planned with the requested funding will include:

Sense and Avoid (SAA)

- Determine performance characteristics and operational requirements for SAA technologies.
- Continue FAA-United States Air Force (USAF) joint flight tests to study on-board SAA technology.
- Identify the barriers for systems and equipment providing equivalent SAA capabilities.

Control and Communications (C2)

- Define UAS control and communication system performance requirements such as latency, availability, integrity and security and critical fly-by-wireless certification challenges.

Minimum Requirements for UAS Control Stations

- Complete development of information to support the definition of minimum human factors requirements for UAS control stations by recommending compensatory strategies in equipment design and training to minimize the impact of the pilot's inability to directly sense data from the aircraft and its immediate environment.
- Define certification criteria for new automated functions to ensure that UAS automation meets an equivalent level of safety to manned aircraft.
- Identify information required for decision-making and execution of operational changes.

UAS Maintenance and Repair Issues

- Identify the UAS technology developments currently underway for small UAS to establish a central repository of historical data used to track continuous airworthiness of life-limited components.
- Determine the requirements that the FAA, other government agencies, and industry may have for evaluation of equipment and systems that are peculiar to UAS and how they are analyzing this equipment and systems.

Safety Management System (SMS) and System Safety Criteria

- Use Causal-Model for Air Transport Safety (CATS) to conduct causal analysis of SAA encounters in the NAS with a focus on interaction of visual flight rule (VFR) aircraft and instrument flight rule (IFR) traffic.
- Study SAA 14 CFR requirements for VFR-IFR encounters by using interim results from CATS analysis.

The FY 2012 funding request will support the UAS program, particularly in research areas of UAS technologies which directly impact the safety of the NAS. The program will focus on sense and avoid; command, control and communications; and UAS ground station requirements that will enable operation of UAS in the NAS within the 14 CFR regulatory framework.

## 2. What Is This Program?

Researchers are developing methodologies and tools to establish regulatory standards on UAS design and performance characteristics while operating in the NAS. They are evaluating technologies, conducting laboratory and field tests, performing analyses and simulations, and generating data to support standardization of UAS civil operations. New standards are being implemented to establish UAS certification procedures, airworthiness standards, operational requirements, inspection and maintenance processes, and safety oversight responsibilities. Policies and guidance materials are also being published to provide FAA certification engineers and safety inspectors with the knowledge and tools they need to ensure the safe integration of UAS into the NAS.

The UAS Research Program supports FAA efforts in Next Generation Air Transportation System (NextGen) implementation by studying safety implications of new aircraft operational concepts and technology to the NAS and supporting the development of new and modified regulatory standards to support these new technologies. The program's research activities focus on new technology assessments, methodology development, data collection and generation, laboratory and field validation, and technology transfer.

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:

- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee – These representatives from industry, academia, and other government agencies annually review program activity, progress, and plans.
- Technical Community Representatives Groups – FAA representatives apply formal guidelines to ensure the program's research projects support rulemaking and the development of guidance for means of compliance with rules.
- Department of Defense (DoD) – the DoD is the largest UAS user requesting expanded access to the NAS. The FAA collaborates with DoD through Memoranda of Understanding (MOU) and Interagency Agreements to leverage resources and implement new technologies for civil applications.
- Other entities include the Department of Homeland Security (DHS), DOC, NASA, state government agencies, and independent organizations that use UAS for national security, earth science and oceanic studies, and commercial applications.
- The Joint Planning and Development Office (JPDO) – the JPDO has identified UAS integration to NAS and new aircraft technology as one of the emerging challenges to the nation's air transportation system. In particular, the NextGen-related research will be coordinated with the JPDO Aircraft Working Group activities in support of aircraft equipage requirements and necessary enablers to fully utilize NextGen capabilities.
- RTCA Special Committee 203 (Unmanned Aircraft Systems) – members of this special committee will help to ensure the effectiveness of the agency's rulemaking by recommending Minimum Aviation System Performance Standards (MASPS) for UAS, C2 Systems, and SAA Systems.
- FAA Air Transportation Centers 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 – conduct joint research on UAS initiatives via an MOC.
- Cooperative Research and Development Agreement (CRDA) with industry to jointly study UAS regulatory compliance issues, e.g., type design, airworthiness, operation, maintenance, and repairs.

For FY 2011, major activities and accomplishments planned with the requested funding include:

Sense and Avoid

- Continue to evaluate a UAS SAA system including considerations for civil certification of logic implementations for UAS collision avoidance and separation assurance.
- Determined performance characteristics and operational requirements for SAA technologies. Included will be the development and evaluation of specific SAA technologies including both airborne and ground-based systems in compliance of regulatory requirements (airworthiness and flight operations).

- Continued FAA-USAF joint flight tests to study on-board SAA technology.

Control and Communications

- Continued to identify potential safety implications of system performance impediments of communications latency.
- Continued development and evaluation of UAS C2 technologies and performance requirements (e.g., data link requirements, C2 spectrum bandwidth estimates, latency and availability, communication with ATC, and interactions with other NAS users) to ensure operational safety with consideration of current regulatory basis for aviation.
- Identify and make recommendations on communications performance standards for difference classes of airspace, phases of flight, and system architecture (e.g., line of sight (LOS) and SATCOM relay).

Safety Management System

- Performed risks analyses to determine impacts of specific hazards, mitigation strategies, recommended approaches, safety measurements, and oversight requirements.
- Initiated the collection of UAS operational data and performed analyses to develop technical information required to support establishment of regulatory standards.

Minimum Requirements for UAS Control Stations

- Develop information to support the definition of minimum human factors requirements for UAS control stations by recommending compensatory strategies in equipment design and training to minimize the impact of the pilot's inability to directly sense data from the aircraft and its immediate environment
- Define certification criteria for new automated functions to ensure that UAS automation meets an equivalent level of safety to manned aircraft.
- Identify information required for decision-making and execution of operational changes

UAS Maintenance and Repair Issues

- Identify the UAS technology developments currently underway in small UAS to establish a central repository of historical data used to track continuous airworthiness of life-limited components
- Determine the requirements that the FAA, other government agencies, and industry may have for evaluation of equipment and systems that are peculiar to UAS and how they are analyzing this equipment and systems.

Performance Linkages

The Unmanned Aircraft Systems Research Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. 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 multiple research areas: system safety; SAA; C2; contingency management (i.e., lost-link logic and procedures, diverts, emergency landings, and flight termination); certification and airworthiness standards; and maintenance and continuing airworthiness. 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. ATC voice and data communications architectures and requirements necessary to support UAS operations in the NAS, as well as the necessary safety procedures for contingency management of UAS, will be researched. A system safety approach based on regulatory framework was initially developed to identify the potential hazards, perform risk assessments, and evaluate mitigation strategies for safe operations in the NAS. The goals of the focused research endeavors are:

- By FY 2012, determine a set of performance characteristics and operational requirements for SAA technologies.
- By FY 2013, analyze data and identify potential safety implications of system performance impediments of communications latency.

- By FY 2013, identify the UAS technology developments currently underway to establish a central repository of historical data for maintenance and repairs and determine the requirements that the FAA, other government agencies, and industry may have for evaluation of equipment and systems that are peculiar to UAS.
- By FY 2015, identify and make recommendations on how communications performance standards will vary among different classes of airspace and phases of flight, considering both a LOS and SATCOM-relay type architecture.
- By FY 2016, conduct field evaluations of UAS technologies in an operational environment, including SAA, C2, and contingency management technologies. The documented results will be used to develop certification and airworthiness standards.

## 3. Why Is This Particular Program Necessary?

Safe integration of UAS into the NAS poses substantial technical challenges not only to the FAA, but also to the aviation industry as a whole. UAS uses the most advanced technologies to achieve certain operational capabilities far exceeding the expectations of current NAS users. These unique capabilities have demonstrated its potentials of commercial applications as well as scientific research needs. Data from the recently completed UAS technology survey initiated within the UAS Research Program shows that integrating UAS in the NAS will potentially affect the entire NAS due to the various sizes of UAS (less than a foot up to the size of a commercial jet), wide ranges of maximum take-off weight (less than a pound to the weight of a large jet), large performance disparities in reference to the existing certificated aircraft, and capabilities of operating in all classes of airspace (even the ones weighing less than 100 pounds are capable of operating in Class A airspace), which could potentially disrupt normal aircraft traffic flow and induce unknown safety hazards while interacting with other NAS users.

The FAA UAS Research Program has initiated a system approach with focus on safety. It applies the SMS principle based on the existing regulatory framework, i.e. Title 14 Code of Federal Regulations, which ensures the common safety baselines, enforces the mandatory safety requirements, and allows technology-driven solutions. It is a safety-focused, technology-driven, and NextGen evolution-guided approach. Research activities within the UAS Research Program will generate technical information to support development of policies, guidance materials, and advisory circulars on utilizing advanced technologies to demonstrate regulatory compliances while operating UAS in the NAS. UAS-specific technical issues, such as "sense and avoid", control and communications with air traffic controls, and emergency response requirements, will also be studied in reference to certifications and operational requirements. It will also be an integral part of the NextGen development.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the NAS and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction in funding will delay research in the safety management system, sense and avoid, control and communications, and control station research areas.

**Detailed Justification for**

# A11.m NextGen – Alternative Fuels for General Aviation

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – NextGen – Alternative Fuels for General Aviation**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A11.m NextGen – Alternative Fuels for General Aviation | $0 | $2,071,000 | +$2,071,000 |

For FY 2012, $2,071,000 is requested for NextGen – Alternative Fuels for General Aviation. Major activities and accomplishments planned with the requested funding include:

- Evaluate the performance of a fleet representative, naturally aspirated engine on ultra-low lead fuels.
- Evaluate the impact on the general aviation (GA) fleet from the reduction and eventual removal of lead from aviation gasolines.
- Evaluate the safety and performance of high compression engines on unleaded, mid-octane aviation alkylate fuel.

Research will focus on the feasibility of reducing high-octane lead additives in aviation gasoline and how that will impact fleet performance and certification. Test data and laboratory analyses of ultra-low lead fuels will be used to determine the certification and safety impact of reducing lead in aviation fuel as a temporary measure to reduce ambient lead emissions. This research will include the investigation of increased aromatic limits in the low lead fuel for octane enhancement and its impact on other safety critical performance metrics.

The assessment of the impact on safety and operating performance from the use of the traditional 100Low Lead (100LL) aviation gasoline (avgas) without lead will continue. Research will also continue on evaluating high-octane, quasi-drop-in fuels.

Research will continue to support the development of test methods needed to evaluate the performance, safety, durability, and operability of unleaded avgas containing high aromatic or biomass derived compounds. This work will supplement the Aircraft Fuel System Materials Task Force (ASTM TF) work of developing a fuel qualification protocol for aviation and compression ignition fuel and additives qualification to ensure deviations to the current specification properties and fit-for-purpose properties ensure safety of aviation fuels. FY 2012 research will also address development of new engine, rig, and laboratory test methods necessary to evaluate fuels which differ from traditional hydrocarbon, refinery based fuels. Planning will begin for the addition of new test capabilities and tools to the laboratory to conduct full envelope testing of turbocharged aircraft engines. The data from that testing will be used to update the current detonation advisory circular The capability to measure lead emissions from GA engines is also planned to be added.

Additionally, research will also examine technologies that could be used to modify the GA legacy piston engines to run on significantly reduced octane unleaded fuels. Test data will be collected from GA engines on the effects of variations in fit-for-purpose property deviations from current aviation gasoline specification to the fuel qualification protocol from the ASTM TF for Otto Cycle fuels at ASTM International.

## 2. What Is This Program?

This program will update or create new certification standards and Advisory Circulars (ACs) that promote continued 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 related to alternative fuels for GA aircraft, and reviews the specifications and practices recommended by recognized technical societies like ASTM International and SAE International.

The intended outcome is to lessen aviation environmental impacts to air and water from operation of GA aircraft by enabling the industry to provide safe, secure, and renewable fuels.

The NextGen - Alternative Fuels for General Aviation Program works with the following industry and government groups:

- Aircraft Safety Subcommittee of the Research, Engineering and Development Advisory Committee (REDAC) – 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 the program's research projects support new rulemaking and development of alternate means of compliance with existing rules.
- The Coordinating Research Council (CRC) Unleaded Aviation Gasoline Development Group – representatives from ExxonMobil, ConocoPhillips, Chevron, BP, Cessna, Hawker Beechcraft, Teledyne Continental Motors, and Lycoming Engines facilitate two-way transfer of technology between government and industry to benefit all participants.
- Environmental Protection Agency (EPA).
- Aerospace manufacturers.
- Aerospace repair stations and maintenance organizations.
- Aerospace industry associations, such as the General Aviation Manufacturers Association (GAMA) and the National Business Aviation Association.
- Aircraft user groups, such as the Aircraft Owners and Pilots Association and the Experimental Aircraft Association.
- Private, commercial, government, and military operators.
- International airworthiness authorities.
- Standards development groups, such as ASTM International.
- Academia and national laboratories.

Partnerships include:

- CRC Unleaded Aviation Gasoline Development Group – includes ExxonMobil, ConocoPhillips, Chevron, BP, Cessna, Hawker Beechcraft, Teledyne Continental Motors, and Lycoming Engines; this group facilitates two-way transfer of technology between government and industry to benefit all participants.
- General Aviation Manufacturers Association - Future Avgas Strategy and Transition Plan (GAMA FAST) – includes engine and airframe original equipment manufacturers; this group is developing a plan for the introduction of unleaded fuel to replace 100LL and assess the impact on the current fleet of aircraft and engines.
- ASTM International Standard Practice for Evaluating the Compatibility of Proposed Fuel or Additives with Aviation Otto Cycle Fuels and ASTM TF –the group is developing the alternative aviation piston fuel protocol for Aircraft Fuel System Materials (ASTM) specification approval and is researching how changes from current specification and fit-for-purpose properties will impact safety.

In FY 2011, major activities and accomplishments planned with the requested funding include:

- Published a detailed research plan to address alternative fuels for GA aircraft that is coordinated with EPA, GAMA, CRC, and the GA community and that addresses continued safe operation of aircraft, reduction and eventual elimination in the use of lead as an additive, and alternative fuel certification.
- Began initial feasibility activities, including economic feasibility, environmental impacts, and assessment of potential for GA aircraft reduced, unleaded, and renewable alternative fuels.
- Began engine and laboratory testing on ultra-low lead fuels to address the feasibility of near-term reduction in lead levels in aviation gasoline as a temporary measure to reduce leaded aviation emissions.

- Began engine and laboratory testing on mid-octane, unleaded aviation alkylate as an input to initial safety and performance impact on the legacy fleet from potential for removal of lead from aviation gasoline.
- Began engine test data and laboratory characterization of high-octane, quasi-drop-in, unleaded fuels to replace 100LL avgas.

Performance Linkages

The NextGen – Alternative Fuels for General Aviation Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities on commercial air carrier and general aviation. The FAA will work with the GA community and the Environmental Protection Agency to evaluate the safety, environmental impact, and performance of alternatives to conventional GA fuel. Near-term research will evaluate the safety and performance of reduced lead and drop-in unleaded fuels and develop qualification and certification methodologies for those fuels.

Longer term research will evaluate the safety and performance of quasi-drop-in and biomass derived alternative fuels and support development of qualification and certification methodologies for those fuels. Longer term research includes simulated altitude and emissions investigation of biomass derived and high aromatic based fuels. Longer term research will also focus on providing data and a knowledge base to industry stakeholders and certification officials on the effects to the safety of the legacy fleet from deviation of the current specification and fit-for-purpose fuel properties. This research will also evaluate new technologies to ensure safe operation on significantly reduced octane fuels by the legacy fleet. The goals of the focused research endeavors are:

- By FY 2012, complete feasibility assessment of near-term reduction in the current lead levels in avgas on GA aircraft and engine safety, performance, certification methodologies as a temporary measure toward full lead removal, assessment of removal of lead from aviation alkylate and use of the remaining mid-octane conventional fuel.
- By FY 2013, complete feasibility assessment of the use of high aromatic additives for octane enhancement and assessment of the use of biomass derived fuels regarding the impact on GA aircraft and engine safety, performance, certification methodologies.
- By FY 2013, establish capability to measure lead emissions from piston engines operating on ultra-low lead and low lead fuels.
- By FY 2014, complete analyses to extrapolate lead emissions over GA fleet.
- By FY 2014, develop methodology and acquire tools for altitude capability to enhance existing capabilities to evaluate high-output, turbocharged engine performance across the entire operating envelope, including high altitude, high and low temperature, and high and low humidity conditions.
- By FY 2015, complete testing to be used to update FAA AC 33.47, regarding detonation testing equipment, analyses, safety margin, and altitude determination.
- By FY 2016, develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded avgas.
- By FY 2017, complete test engine emission evaluation of existing biomass derived and high-aromatic, high-octane fuels.
- By FY 2017, determine feasibility of engine technologies to enable high-compression engines in legacy fleet to safely operate on significantly reduced octane fuels.

## 3. Why Is This Particular Program Necessary?

While energy efficiency and local environmental issues have traditionally been primary drivers of aeronautics innovation, the current and projected effects of aviation emissions on our global climate is a serious long-term environmental issue facing the aviation industry. Aside from their associated health and welfare impacts, aviation emissions are a considerable challenge in terms of community acceptance of aviation activities and this challenge is anticipated to grow.

In the GA piston engine arena, there is a need to find a replacement for current leaded avgas (100LL). The replacement fuel should perform as well as 100LL in general aviation (GA) piston engines. This unleaded high octane replacement fuel must not cause any accidents and should be a seamless, transparent change to the GA community.

Research will evaluate and characterize new alternative fuel formulations that will have protected the environment while sustaining growth in air transportation.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

A reduction would result in a decrease in funding to the NextGen - Alternative Fuels for General Aviation Program and could delay the empirical testing of assessments needed to produce hard data for the determination of certification impact and safety assessment of whether the near term reduction in lead content of aviation gasoline could meet the estimated EPA target.

**Detailed Justification for**

# A12.a Joint Planning and Development Office

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – Joint Planning and Development Office**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A12.a Joint Planning and Development Office | $14,407,000 | $14,067,000 | -$340,000 |

For FY 2012, $14,067,000 is requested for Joint Planning and Development Office (JPDO). Major activities and accomplishments planned with the requested funding include:

Planning and Agency/Industry Alignment

- Develop NextGen Portfolio Analysis that recommends the alignment of resources within the federal government and U.S. industry to develop and implement the Next Generation Air Transportation System (NextGen) in the most expedient and cost-effective manner.
- Coordinate and facilitate the transfer of technologies from aeronautics research programs and direct research that will result in achieving NextGen.

Systems Integration and Transformation Analysis

- Establish standards and application for Net Enabled Weather information exchange for integration into air transportation management decision making.
- Develop policy recommendation for key architectural decisions including level of automation and aircraft system vs. ground system responsibility for separation assurance.
- Continue to refine research plans, which will describe research and supporting activities required to drive implementation decisions to effect the NextGen transformation.
- Develop Integrated Surveillance governance to facilitate robust multi-agency information sharing requirements, engineering analysis, prototype demonstrations, and implementation planning.

JPDO will continue to:

- Report progress and maintain NextGen National Integrated Plan's Enterprise Architecture, Concepts, and Integrated Work plan.
- Continue to define benefits of NextGen concepts through modeling and simulation.
- Continue to refine Life-cycle cost estimates for NextGen through collaboration with partner agencies and industry.
- Continue to support Senior Policy Committee decision-making by refining NextGen Policy agenda.
- Continue to coordinate and develop multi-agency NextGen Budget Portfolio.
- Continue enhancement of Enterprise Architecture and Multi-agency Integrated Work Plan.

## 2. What Is This Program?

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.

As the steward of NextGen, JPDO seeks to address long-term imbalances in aviation capacity and demand. At the same time, it seeks to ensure 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 DOT current strategic goal of Economic Competitiveness and Safety.

The JPDO is truly a collaborative enterprise. Employees from the National Aeronautics and Space Administration (NASA) and the Departments of Transportation, Commerce, Defense (DoD), and Homeland Security (DHS) 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. 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

Major activities and accomplishments planned with the requested funding include:

Planning and Agency/Industry Alignment

- Continued to refine research plans, which will describe research and supporting activities required to drive implementation decisions to effect the NextGen transformation.
- Continued modeling planned improvements to test their efficacy in accomplishing NextGen goals.
- Continued enhancement of Enterprise Architecture and Multi-agency Integrated Work Plan in response to the outcome of demonstrations, research, changes in agency budgets, etc.
- Facilitated the transfer of technologies from research programs that are ready for implementation (e.g., NASA and the Department of Defense) to the federal agencies with operational responsibilities and to the private sector, as appropriate.

Systems Integration and Transformation Analysis

- Risk adjusted NextGen 2025 definition including capabilities, benefits, and cost.
- Established analysis to mitigate research and development risk for 2025. Specifically:
  - Unmanned Aircraft Systems (UAS) and other advanced technologies that will lead to NAS integration.
  - Trajectory Based Operations.
- Developed Information Sharing Standards, Models, Technologies for Aviation Weather Community Interest.
- Established an Intergovernmental Integrated Surveillance Memorandum of Understanding and implement an initial operational capability by 2012.

<u>Performance Linkages</u>

FY 2012:

- Enhance the NextGen planning information to reflect:
  - Integration of net-enabled weather into automation decision making;
  - Enhanced operational scenarios that describe information sharing and procedures between flight/ airline operations;
  - NextGen trajectory-based flight processing, including air navigation service provider, flight operations center, and flight crew roles & responsibilities.
- Continue development of an interagency, Integrated Surveillance capability including:
  - Initial information sharing operation
  - Enterprise Architecture, Concept of Operations, and funding profile.

- Continue coordination of network–enabled information sharing standards for participating agencies & organizations including multi-agency governance processes.
- Continue to coordinate and conduct demonstrations that will test operational concepts, address operational challenges, and provide alternatives for architectural trade-offs.
- Continue to refine NextGen planning information: Concept of Operations (ConOps), Enterprise Architecture (EA), and Integrated Work Plan (IWP).

FY 2013-2015:

- Continue research and development to support all NextGen capabilities.

FY 2016 and Beyond:

- Continue development to support all NextGen capabilities
- Identify alternatives as a result of needed research that may be immature.

## 3. Why Is This Particular Program Necessary?

The nation's air transportation system has slowly evolved into one that has become brittle, inflexible to change, and grounded in antiquated policy, technology and business practices. The system is no longer scalable. The United States aviation system must transform itself and be more responsive to the tremendous social, economic, political and technological changes that are evolving worldwide.

In Public Law 108-176 Congress recognized the need to do business differently. To ensure this change occurs, Congress created the Joint Planning and Development Office established by the Department of Transportation within the Federal Aviation Administration will manage the work related to the NextGen.

The JPDO provides the multi-agency governance structure that guides the development of the nation's air transportation system of 2025. The JPDO together with partner agencies defines the capabilities and mechanisms that build new capacity to accommodate a wide range of customers and address an even wider spectrum of issues. These include increasing mobility for private, commercial, civil, & military aviation, airport and airspace capacity that is adaptable to unforeseen changes in traveler and shipper needs, and capacity increases that are balanced within safety and security guidelines.

The JPDO maintains the plan and provides biennial reporting on the progress that participating agencies make in transforming the air transportation management system into a space-based system capable of avoiding future capacity gridlock regardless of weather conditions.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

Any current or future reduction would result in a decrease in funding to technology transfer and would reduce activities by one third and also the enterprise architecture by one quarter.

**Detailed Justification for**

## A12.b NextGen – Wake Turbulence

### 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – NextGen - Wake Turbulence**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A12.b NextGen - Wake Turbulence | $10,631,000 | $10,674,000 | +$43,000 |

For FY 2012, $10,674,000 is requested for NextGen - Wake Turbulence. Major activities and accomplishments planned with the requested funding include:

- Continue to maintain and add to the world's most extensive aircraft wake transport data base for use in new air traffic control procedure development and assessments of wake encounter risk associated with those new procedures.
- Obtain RTCA agreement on weather observation parameters to be transmitted from aircraft –vital to the development of dynamic wake separation processes.
- Continue to incorporate wake transport and decay as well as aircraft navigation performance analysis results into FAA wake-encounter risk models.
- Initiate development of wake turbulence mitigation processes/procedures to support the NextGen era time based en-route operational environment.
- Continue development of wind forecast algorithm and its information needs for use in the Wake Turbulence Mitigation for Single Runway (WTMSR) air traffic control decision support tool.
- Continue cooperative development with European Organization for the Safety of Air Navigation (EUROCONTROL) of NextGen/SESAR of ground and aircraft based situation display concepts relative to wake separation constraints required for implementation of the NextGen/SESAR concepts for air routes and airport approach/departure paths.
- Evaluate reports of wake turbulence encounters as part of the FAA Safety Management System assurance process for changes to Air Traffic Control (ATC) procedures.
- Continue to conduct experiments, analyses, and aviation community forums to define, in terms of a wake turbulence hazard, what is an unacceptable level of wake turbulence for an encountering aircraft.
- Continue development of modeling tools to evaluate system-wide safety risk associated with the NextGen pair-wise separation concepts.
- Provide engineering and analysis support to develop airport-specific procedure modifications to enable dependent instrument approaches to an airport's closely spaced parallel runway (CSPR).
- Continue development of wake turbulence transport and decay modeling tools for use in evaluating proposed, trajectory-based, operational concepts.
- Provide wake turbulence evaluation support in determining wake separation standards for new aircraft being introduced into the NAS.

In FY 2012, FAA must continue its development of the capabilities needed to enable aircraft separation processes supportive of NextGen shared separation and dynamic spacing in super density operations. These capabilities are highly dependent on technologies that accurately predict aircraft tracks, the track/decay of their generated wake vortices and the provision of this information to pilots and controllers. Some aspects of the NextGen Concept of Operations are dependent upon the aircraft being a participant in efficient, safe air traffic control processes that would minimize the effects of required wake turbulence mitigation on the flow of air traffic in all weather and visibility conditions. The NextGen - Wake Turbulence Program's research will result in enhanced technology assisted

processes for safely mitigating aircraft wake encounter risks while optimizing capacity, for all flight regimes, including the effects of weather.

## 2. What Is This Program?

The NextGen -Wake Turbulence Program conducts applied research to improve, in terms of flight efficiency and safety, aircraft-separation processes associated with today's generalized and static air navigation service provider (ANSP) wake-turbulence-mitigation-based separation standards. As an example, during periods of less than ideal weather and visibility conditions, implementation of an ANSP decision support tool that adjusts required wake separations based on wind conditions would allow ATC to operate 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 2012 will continue work begun in FY 2008 to address the feasibility and benefit of a wake avoidance decision support capability for the flight deck.

The program provides the research to achieve near-term objectives of increasing airport runway capacity by reducing aircraft wake separation minima under certain conditions. The program also provides the research and analysis to answer the Next Generation Air Transportation System (NextGen)-era questions of:

- What wake turbulence mitigations will be required in implementing Trajectory-Based Operations?
- How can more aircraft be accommodated in high-demand airspace (terminal and en-route) and still be safe in terms of wake turbulence?

In FY 2012, NextGen - Wake Turbulence Program will continue its NextGen near- and mid-term research agenda, addressing wake turbulence restrictions in today's terminal and en route airspace and in the future NextGen airspace designs. Program outcomes include:

- Increasing runway capacity in instrument meteorological conditions and capacity for more flights in high-usage airspace, and
- Providing more capacity-efficient wake separations to aircraft with the same or reduced safety risk.

The program addresses the needs of the FAA Air Traffic Organization 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 training and implementation issues are addressed in the program's research from the start.

Customers:
Pilots;
ANSP personnel;
Air carrier operations; and
Airport operations.

Stakeholders:
Joint Planning and Development Office;
Commercial pilot unions;
FAA ANSP unions;
Other International Civil Aviation Organization (ICAO) air navigation service providers; and
Aircraft manufacturers

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:

- John A. Volpe National Transportation Systems Center
- The Center for Advanced Aviation System Development
- The National Aeronautics and Space Administration (NASA) Langley Research Center (NASA-sponsored research)
- The European Organization for the Safety of Air Navigation (EUROCONTROL) and associated research organizations (coordination and shared research)

- Massachusetts Institute of Technology's Lincoln Laboratory
- National Center of Excellence for Aviation Operations Research
- National Institute of Aerospace
- CSSI, Incorporated

In FY 2011, major activities and accomplishments planned with the requested funding include:

- Provided engineering and analysis support to develop airport-specific procedure modifications to enable dependent instrument approaches to an airport's CSPR.
- Continued data collection to determine the characteristics of wake vortices generated by departing and arriving aircraft. Emphasis is on collecting data on wake generated by Boeing 757 and heavier aircraft. Data is being 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.
- Evaluated reports of wake turbulence encounters as part of the FAA SMS assurance process for changes to ATC procedures.
- Developed initial wake separation standards to be applied to the new Boeing 747-800 series aircraft

Performance Linkages

The NextGen - Wake Turbulence Program supports the DOT strategic goal of Economic Competitiveness by maximizing economic returns on transportation policies and investment on average daily airport capacity.

The following illustrate some target milestones:

- By FY 2012, determine the National Airspace System (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.
- By FY 2013, develop as requested, airport specific instrument meteorological conditions (IMC) CSPR approach procedures that would insure wake safety and increase IMC capacity of the CSPR.
- By FY 2016, develop the algorithms that would be used in the ANSP and flight deck automation systems (if required) for setting and monitoring dynamic wake separation minimum between aircraft and surrounding aircraft.

## 3. Why Is This Particular Program Necessary?

Wake turbulence research has provided and will continue to provide the data, analysis, models and aircraft wake turbulence information collection systems that are needed to "bring to market" wake mitigation standards, procedures, and processes that allow safe but more capacity efficient aircraft to aircraft wake separations. The research program has produced the airport specific procedure and safety analyses to bring a new air traffic control wake mitigation procedure into everyday operation at the Seattle – Tacoma International Airport and an impending implementation at the Memphis airport. Seattle is currently getting up to 8 more arrival operations per hour (when compared to its former wake mitigation procedure) when weather forces it to switch to using only instrument approaches to its runways. The NextGen - Wake Turbulence Program is continuing to facilitate implementations of this procedure at Newark, Cleveland and Boston. These airports will have a similar operational improvement as Seattle.

The NextGen – Wake Turbulence Program has produced validated concepts for applying aircraft performance characteristics and runway crosswind information to reduce the required wake mitigation separations applied to aircraft arriving to and departing from an airport's runways. These research products have been transitioned into the FAA F&E projects: Wake Re-Categorization, Wake Turbulence Mitigation for Departures, and Wake Turbulence Mitigation for Arrivals. These F&E projects, when implemented, will provide air traffic control with decision support tools that will allow them to safely reduce the wake separations between aircraft when crosswinds blow the wakes out of the way of trailing aircraft. The reduced wake separations equate to more airport operations per hour when the airport is busiest.

The requested FY2012 NextGen - Wake Turbulence Program will expand the crosswind based wake mitigation concept from its use on closely spaced parallel runways to an application on single runways – potentially providing an air traffic control decision support tool that will allow more operations at an even greater number of the nation's busiest airports. The Program will also research how the NextGen era aviation system capacity enabling concepts (Trajectory Based, Flexible Terminal) can be implemented without being severely limited by wake mitigation constraints.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

A reduction would impact the FAA's progress in developing the WTMSR concept feasibility prototype. It is planned to modify the FAA terminal automation development laboratory platform at the FAA William J Hughes Technical Center to prototype the decision support tool functionality of the WTMSR concept. A reduction in funding slows the pace of the prototype development, delaying its completion by three months.

**Detailed Justification for**

## A12.c NextGen – Air Ground Integration Human Factors

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – NextGen – Air Ground Integration Human Factors**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A12.c NextGen – Air Ground Integration Human Factors | $5,688,000 | $10,545,000 | +$4,857,000 |

For FY 2012, $10,545,000 is requested for NextGen – Air Ground Integration Human Factors. Major activities and accomplishments planned with the requested funding include:

Roles and Responsibilities

- Complete definition 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.
- Develop recommendations for function allocation strategies and policy between pilots(s), controller(s), Airline Operations Centers and automated systems to communicate, execute, monitor and resolve conflicts during delegated separation operations.

Human System Integration – Information Needs

- Determine which pilot flight procedures are associated with NextGen applications, using task and information needs analysis techniques, and develop guidelines for each type of procedure in NextGen.
- Define information needs for pilots to determine acceptability of suggested conflict avoidance maneuvers provided by automated systems or ATC.
- Complete initial guidance for the design of NextGen flight deck displays and alerts that are compatible with those in ATC, including those required for oceanic in trail procedures.
- Complete initial research to identify human factors issues associated with instrument procedure design and to develop human factors guidelines for instrument procedures.

Human System Integration – Human Capabilities and Limitations

- Complete development of a methodology to address the human capabilities and limitations of pilots (including single-pilot aircraft) to conduct a range of NextGen airspace procedures in normal and non-normal situations.
- Based on pilot performance capabilities and limitations, develop recommendations for system performance requirements and operating limitations that should be applied when using data communications with integrated and non-integrated flight management systems (FMS).

Human System Integration – System Integration

- Complete research to develop flight crew training recommendations for flight deck automation supporting NextGen operations for single pilot and two pilot crews.
- Conduct research to support guidance for data communications procedures, training, displays and alerts.

Risk and Error Management

- Develop guidance to support certification personnel in evaluating risks and mitigation of human error and potential unintended uses of new technology in NextGen systems and procedures.

- Initiate research to determine the expected nature, frequency and potential impact of pilot errors that may lead to exceeding Required Navigation Performance (RNP) containment criteria for trajectory operations.
- Assess human error impact and mitigation in Automatic Dependent Surveillance-Broadcast (ADS-B) applications including oceanic in-trail procedures, flight deck interval management, and closely spaced parallel operations.

The program will continue to assess human system integration issues in use of airborne NextGen concepts, capabilities, and procedures, and Air Traffic Management (ATM) leading to a full mission demonstration. Each of these research areas, although general in nature, will continue to be conducted in the context of specific near-to mid-term NextGen applications such as closely spaced parallel operations, oceanic in-trail procedures, etc.. Research will continue to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures and will also continue on human systems integration issues related to information needs, interface design and system integration required to support effective guidance for NextGen equipment design, procedure development and personnel training. Research will continue to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment. Research priorities address the implementation of RTCA NextGen Task Force recommendations as described in the NextGen Implementation Plan.

## 2. What Is This Program?

The NextGen - Air Ground Integration Human Factors Program addresses flight deck and 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 ATM 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.

By 2017, demonstrate that NextGen operations, procedures and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft across the full range of environmental conditions.

Integration of air and ground capabilities poses challenges for pilots and air traffic service providers. A core human factors issue is ensuring the right information is provided to the right human operators at the right time to make the right decisions. Transitions of increasingly sophisticated automation and procedures must be accompanied by supporting interoperability with baseline systems and refinement of procedures to ensure efficient operations and to mitigate potential automation surprises.

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.

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.

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 and Airspace Programs.
- Close collaboration with FAA organizations, notably Flight Standards and Aircraft Certification in the Aviation Safety (AVS) line of business.
- 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.

The NextGen - Air Ground Integration Human Factors Program collaborates with industry and other government programs through:

- Collaborative research with NASA on its safety, airspace and air portal projects including the identification of human factors research issues in the NextGen as technology brings changes to aircraft capabilities.
- Cooperative research agreements used with universities to address NextGen human factors issues.
- Coordination on research issues and plans with aircraft and avionics manufacturers and operators as well as international civil aeronautics authorities

In FY 2011, major activities and accomplishments planned with the requested funding include:

Roles and Responsibilities

- Define a taxonomy for describing the relationship between flight deck and ATC automated systems and human operators within NextGen applications.
- Assess human-automation coordination methods for performance costs and benefits in the context of near-term NextGen applications.

Human System Integration – Information Needs

- Determine which flight procedures and controller tasks are associated with NextGen applications, using task and information needs analysis techniques, and develop guidelines for each type of procedure in NextGen.
- Develop initial guidance for the design of NextGen flight deck displays and alerts that are compatible with those in ATC, including those required for oceanic in trail procedures.
- Continue research to identify human factors issues associated with instrument procedure design and to develop human factors guidelines for instrument procedures.

Human System Integration – Human Capabilities and Limitations

- Develop a methodology to address the human capabilities and limitations of pilots (including single-pilot aircraft) to conduct a range of NextGen airspace procedures in normal and non-normal situations.

Human System Integration – System Integration

- Complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.

- Conduct research to support guidance for data communications procedures, training, displays and alerts.

Risk and Error Management

- Assess human error impact and mitigation in ADS-B applications including oceanic in-trail procedures, flight deck interval management, and closely spaced parallel operations.
- 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.

Performance Linkages

The NextGen – Air-Ground Integration Human Factors Program supports the DOT strategic goal of Economic Competitiveness by leading U.S. transportation interests in targeted markets around the world through NextGen technologies.

Research will support development of policy, standards and guidance required to design, certify and operate NextGen equipment and procedures from the perspective of Air-Ground Integration. Additionally, this research will include integrated demonstrations of NextGen procedures and equipment in the context of ongoing Air-Ground Integration human factors research. The goals of the focused research endeavors are:

- By 2016 complete research to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures.
  - By 2013 complete initial research to evaluate and recommend pilot-ATC procedures for negotiations and shared decision making NextGen activities.
  - By 2015 complete research to identify and recommend mitigation strategies to address potential coordination issues between humans and automated systems.
  - By 2016 complete research to identify methods for effectively allocating functions between pilots/ATC and automated systems as well as mitigating any losses of skill associated with these new roles and responsibilities.
- By 2016 complete research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment.
  - By 2013 complete development of guidance to support certification and flight standards personnel in assessing suitability of design and training methods to support human error detection and correction.
  - By 2013 complete initial research investigating methods to mitigate mode errors and unintended uses of NextGen equipment.
  - By 2014 develop initial guidance on training methods to support detection and correction of human errors in near to mid-term NextGen procedures.
  - By 2016 complete research and modeling activities to identify, quantify and mitigate potential human errors in the use of NextGen equipment and procedures.
- By 2016 complete research on human systems integration issues related to information needs, human capabilities and limitations, interface design and system integration required to support effective guidance for NextGen equipment design, procedure development and personnel training.
  - By 2012 initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations.
  - By 2013 complete initial research to identify cognitive tasks, associated information needs and recommended display methods for tasks that require shared flight deck-ATC information.
  - By 2013 complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures.
  - By 2013 complete initial research to address human-automation integration issues regarding the certification of pilots, procedures, training and equipment necessary to achieve NextGen capabilities.
  - By 2014 complete initial research to provide recommendations for displays, alerts, procedures and training associated with data communications.

- By 2014 complete research to provide initial recommendations for equipment design, procedures and training to support use of 2 ½ to 4 D trajectories.
- By 2016 complete research to assess procedures, training, display and alerting requirements to support development and evaluation of planned and unplanned transitions between NextGen and legacy airspace procedures.

## 3. Why Is This Particular Program Necessary?

NextGen involves implementation of new complex systems and flight crew procedures. The NextGen Air Ground Integration Human Factors R&D program supports the FAA Aviation Safety Team's certification and operational approval processes and also provides tools to address flight crew procedures, maintenance procedures, training development, and continuous safety monitoring. Specific human factors research activities in this R&D program address advanced NextGen procedures such as trajectory operations, and the associated flight deck automation and air ground digital data communications technologies.

The NextGen mid-term sees a shift to the management of traffic by trajectories (Trajectory-Based Operations) throughout the operation, including initial flight planning, all phases of the flight, and post-flight analysis. Every Instrument Flight Rule (IFR) aircraft that is operating in and managed by the system is represented by a four dimensional trajectory (4DT) either provided by the user or derived from a flight plan by the ground system. The 4DT includes a series of points from departure to arrival representing the aircraft's path in four dimensions: latitude, longitude, altitude, and time. The 4DT gets refined over time as it is used for flight planning through separation management. To be effective, the trajectory must be maintained and exchanged with ground automation at sufficient intervals to reflect the latest detailed data, including intent information. Both controller and pilot must monitor aircraft conformance with the negotiated 4DT, supported by their respective ground and flight deck automated systems. Human factors efforts ensure conformance alerts and recommended recovery maneuvers are consistent and effective.

In the mid-term timeframe, a data communications capability between the air and the ground will permit the initial transition to air-to-ground data communications exchanges. Implementation of data communications reduces errors that can occur when flight crews transcribe and read back voice communications. Planned human factors R&D efforts are addressing flight deck displays, message content, and procedures for disseminating data communications to support transfer of routine ATC clearances, exchange of four dimensional flight plan trajectory information (to support trajectory operations), reroute requests, transfer of voice frequency channels, exchange of near term hazardous weather information, and allow flight crew reports for appropriately equipped aircraft. Current human factors research efforts are addressing data communication message set design factors to prevent recurrence of incidents involving human factors issues such as flight crew misunderstanding of clearances containing terms BY, AT, and EXPECT, and concatenated (compound) clearances with multiple elements.

The NextGen Air Ground Integration Human Factors R&D program includes critical work to ensure flight deck controls, displays, alerts, and procedures that are implemented to achieve the NextGen capabilities related to trajectory operations and associated flight deck automation and air ground digital data communications technologies are compatible with flight crew capabilities and limitations. Specific research plans are developed in coordination with FAA stakeholders including those in the Aviation Safety (AVS) line of business including Aircraft Certification Service and Flight Standards Service, and ATO program offices such as Data Communications, Surveillance and Broadcast Services, and other offices within the ATO NextGen and Operations Planning (AJP) organization. This research provides the foundation for guidelines, handbooks, advisory circulars, rules, and regulations that help ensure the safety and efficiency of NextGen aircraft operations.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best

allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

A reduction in funding to the NextGen - Air Ground Integration Human Factors program would defer until FY 2013 the planned FY 2012 completion of development of 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. This work provides human factors recommendations using scientific and technical information to assist Aircraft Certification Service personnel in their evaluation of new technology supporting NextGen applications. The result is a delay in research products by one year.

**Detailed Justification for**

# A12.d NextGen – Self-Separation Human Factors

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – NextGen – Self-Separation Human Factors**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A12.d NextGen – Self-Separation Human Factors | $8,247,000 | $9,934,000 | +$1,687,000 |

For FY 2012, $9,934,000 is requested for NextGen – Self-Separation Human Factors. Major activities and accomplishments planned with the requested funding include:

Surface/Runway Operations Awareness

- Conduct research to evaluate the effects of Enhanced Flight Visibility System (EFVS) Head-Up Display (HUD) clutter and masking on detection of potential ground conflicts during taxi operations across a range of visibility and lighting conditions and develop recommended mitigations.
- Initiate research to evaluate and recommend display methods to ensure pilot awareness of selected operating modes of Cockpit Display of Traffic Information (CDTI), including research to assess manual and automatic methods of transitioning between CDTI display of ground and air traffic for both takeoff and landing operations.
- Conduct research to provide and evaluate alternatives and recommend minimum acceptable cockpit display method(s), alerts, and operational procedures to mitigate the effects of position uncertainty when degraded positioning information or other system failures introduce position uncertainty in closely-coupled all-weather ground operations.

Reduced Separation

- Conduct initial research to evaluate the impact and potential risks associated with use of Traffic Alert and Collision Avoidance System (TCAS) in NextGen procedures.
- For near to mid-term NextGen reduced separation operations, initiate research to develop and evaluate recommendations for pilot/controller phraseology for clearances, instructions and effective communication of degraded systems and residual capabilities as well as transitions to and from NextGen unique airspace and procedures. For closely spaced parallel approach operations, this includes abandoning a closely-spaced parallel approach when a blunder or Mode C intruder is detected or in the event of abnormal situations (system malfunction, weather, etc.).

Delegated Separation

- Initiate research to evaluate Automatic Dependent Surveillance-Broadcast (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).
- Continue research to evaluate and recommend procedures, equipage and training to safely conduct oceanic and en route pair-wise delegated separation.

Cross-cutting

- For proposed delegated separation procedures and equipment, continue research to support development of training guidance for NextGen applications and technologies.
- Continue research to develop risk and error management strategies to identify and mitigate human-system errors.

- Initiate research to develop recommendations for location and grouping of NextGen related displays relative to the primary field of view.

The program will continue to assess human system integration issues in use of airborne NextGen concepts, capabilities, and procedures, and Air Traffic Management (ATM) leading to a full mission simulation in 2017. Research priorities address the implementation of RTCA NextGen Task Force recommendations as described in the NextGen Implementation Plan. Research will continue 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.

Research will continue to:

- Enable reduced and delegated separation in oceanic airspace and en route airspace.
- Support development of training guidance for NextGen applications and technologies.
- Develop risk and error management strategies to identify and mitigate human-system errors.
- Develop recommendations for location and grouping of NextGen related displays relative to the primary field of view.

## 2. What Is This Program?

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:

- Defining the potential impact and human factors issues of new technologies such as enhanced vision, synthetic vision, and electronic flight bags on separation activities.
- Defining human factors technical information needed to support the development of standards, procedures, and training by Flight Standards to implement NextGen applications.
- Developing procedures and training needed to implement new roles and responsibilities for pilots and controllers during trajectory operations.
- Defining human and system performance requirements for separation activities, e.g., spacing, merging, and passing.
- Developing and applying error management strategies, mitigating risk factors, and reducing automation-related errors associated with NextGen operations.
- Developing human factors criteria for the successful use of flight deck performance monitoring and decision support tools as they relate to NextGen operations.

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 and Airspace Programs.
- Close collaboration with FAA organizations, notably Flight Standards and Aircraft Certification in the Aviation Safety (AVS) line of business.
- 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.

The research program collaborates with industry and other government programs through:

- Collaborative research with NASA on its aviation safety and airspace projects including the identification of human factors research issues in the NextGen as technology brings changes to aircraft capabilities.
- Coordination on research issues and plans with aircraft and avionics manufacturers and operators.
- Coordination with appropriate RTCA Committees, e.g., Airborne Separation Assurance System.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Surface/Runway Operations Awareness

- Complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.
- Evaluate the effects of Enhanced Flight Visibility System (EFVS) Head-Up Display (HUD) clutter and masking on detection of potential ground conflicts during taxi operations across a range of visibility and lighting conditions.
- Conduct research on existing Synthetic Vision System (SVS) and EFVS to evaluate time required, accuracy, and pilot workload associated with recognizing and reacting to potential ground collisions or conflicts with other aircraft, vehicles and obstructions across a range of visibility and lighting conditions.

Reduced Separation

- For closely spaced parallel operations, continue research to determine CDTI requirements to support multiple simultaneous approaches, and evaluate workload and effects of blunder during the approach.

Delegated Separation

- Develop human performance models to predict errors and their impacts on performance for NextGen delegated separation operations.

Cross-cutting

- Continue development of a repository of NextGen human factors data, incorporating results of human factors research and human factors issues that surface during operational experience with systems and procedures relevant to near to mid-term NextGen applications.
- Evaluate the performance costs and benefits of various methods of decision support to include ability of human operators to understand automated system strengths and weaknesses.

<u>Performance Linkages</u>

The NextGen – Self Separation Human Factor Program supports the DOT Strategic Goal of Economic Competitiveness by leading U.S. transportation interests in targeted markets around the world through NextGen technologies.

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. The goals of the focused research endeavors are:

- By 2016, complete research to enable enhanced aircraft spacing for surface movements in low visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures.
    - By 2012 complete initial research to evaluate and recommend minimum display standards for use of enhanced and synthetic vision systems, as well as airport markings and signage, to conduct surface movements across a range of visibility conditions.

- By 2014 evaluate and recommend minimum display standards and operational procedures for use of CDTI to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff and departure phases of flight.

- By 2015, complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment.
  - 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, enable reduced and delegated separation in oceanic airspace and en route corridors.
  - By 2013 complete initial research to provide recommended guidance for design of cockpit displays and alerts to support delegated separation.
- 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 the future system adequately considers human systems integration issues.

## 3. Why Is This Particular Program Necessary?

NextGen involves implementation of new complex systems and flight crew procedures. FAA's Aviation Safety mission dictates that we ensure those systems are reliable and safe, even when they fail, and that we address the operational aspects of these systems. The NextGen Self Separation Human Factors R&D program supports the FAA Aviation Safety Team's certification and operational approval processes and also provides tools to address flight crew procedures, maintenance procedures, training development, and continuous safety monitoring. Specific human factors research activities in this R&D program address NextGen procedures such as area navigation (RNAV) and required navigation performance (RNP), and NextGen capabilities such as those derived from the use of Automatic Dependent Surveillance-Broadcast (ADS-B) as a surveillance source and to broadcast aeronautical information.

RNAV/RNP procedures provide new arrival and departure routes, and become more effective with performance-based Air Traffic Management capabilities such as time-based metering and the adoption of ATC digital communication that can dynamically define those procedures. With new ADS-B technologies, users will be provided cockpit-based surveillance and near real-time access to aeronautical flight information. In the near term, user situational awareness in both visual meteorological conditions and instrument meteorological conditions (IMC) will be enhanced. Flight crews on the airport surface and aloft will have the capability to detect conflicts or hazards created by aircraft, obstacles, weather areas, airspace restrictions, and airport surface vehicles. In the long-term end-state environment, select spacing, sequencing, and separation tasks may be performed by qualified and certified aircrews/aircraft within defined criteria and/or in designated situations or areas. An example of a key ADS-B initiative is the development of standards supporting Closely Spaced Parallel Operations (CSPO). The NextGen Self Separation Human Factors R&D program supports studies on simultaneous independent approaches to parallel runways to investigate potential reductions of runway separation standards. By completing the standards and obtaining agreement with the operators on a timeframe for their equipage, airports will likely be able to increase capacity and have greater design flexibility as they plan for new runways.

The NextGen Self Separation Human Factors R&D program includes critical work to ensure flight deck controls, displays, alerts, and procedures that are implemented to achieve the NextGen capabilities related to RNAV/RNP procedures and ADS-B technologies are compatible with flight crew capabilities and limitations. Specific research plans are developed in coordination with FAA stakeholders including those in the Aviation Safety (AVS) line of business (Aircraft Certification Service and Flight Standards Service), and ATO program offices such as Data Communications, Surveillance and Broadcast Services, and other offices within the ATO NextGen and Operations Planning (AJP) organization. This research provides the foundation for guidelines, handbooks, advisory circulars, rules, and regulations that help ensure the safety and efficiency of NextGen aircraft operations. Initiatives span assessments of new information requirements to allow pilots to safely maintain aircraft separation, especially during low visibility ground operations, and transition of integrated air and ground capabilities to ensure interoperability with

baseline systems and refinement of procedures to ensure efficient separation and mitigate potential automation surprises.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the REDAC reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R, E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

This work allows crews of ADS-B-In – equipped aircraft to efficiently use the ADS-B-In data in flight operations involving multiple applications and modes of CDTI. Reduction in funding would delay the capability for Aircraft Certification Service personnel to develop minimum requirements for new and modified flight deck designs to incorporate NextGen displays such as ADS-B/CDTI, Data Communications, and Synthetic and Enhanced Vision Systems' displays.

**Detailed Justification for**

## A12.e NextGen – Weather Technology in the Cockpit

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – NextGen - Weather Technology in the Cockpit**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A12.e NextGen - Weather Technology in the Cockpit | $9,570,000 | $9,186,000 | -$384,000 |

For FY 2012, $9,186,000 is requested for NextGen - Weather Technology in the Cockpit. Major activities and accomplishments planned with the requested funding include:

- Develop preliminary Weather Technology in the Cockpit (WTIC) functional and performance requirements from the adjudicated WTIC mid-term ConOps.
- Develop icing and turbulence products to disseminate signal latency, bandwidth, and quality of service requirements to the flight deck.
- Develop minimum requirements for the flight deck to support the management of meteorological (MET) information communications, storage and retrieval, and data latency.
- Identify the functional and performance requirements for a high-fidelity WTIC simulation, test and evaluation capability.
- Evaluate the usefulness of an in-flight display of uplinked satellite-based product that outlines the 30kft and 40kft convective cloud top heights in a two-hour look-ahead display focused on the aircraft position and flight direction for Pacific Ocean transoceanic flights between California and Australia.
- Demonstrate and evaluate the usefulness of the uplinking turbulence eddy dissipation rates (EDR) to flight deck for aircrew mitigation procedures.
- Equip aircraft to support aircrew evaluations of graphical icing and turbulence and cloud tops presentations.
- Implement Turbulence EDR algorithms including joint effort with aircraft manufacturers.

Research will include the expansion of the flight demonstration and evaluation to uplink in-flight display of 30kft and 40kft convective cloud top heights to include flights into the Gulf of Mexico, Caribbean, and South America regions and to Atlantic flights to Europe and Africa; support the development of Aeronautical Information Services/MET datalinks Minimum Operation Performance Standards and Minimum Aviation Safety Performance Standards with the commercial industry through RTCA Special Committees and EUROCAE 186/WG-51, 206/WG-76, 214/WG-78, 217/WG-44, 222, and 223; evaluation of the global communications demand, bandwidth, quality of service, security, latency, and coverage requirements to uplink, downlink, and crosslink MET information via broadcast and request and reply datalink services, and the research and development of a conceptual approach to sustain a common weather picture between the ground and onboard weather systems with human-in-the-loop evaluations.

Efforts will include the transitioning of the in-flight display demonstrations and evaluations of cloud tops, graphical turbulence and icing products, and EDR Turbulence to electronic flight bags (EFB) or Multifunctional Displays (MFD). The development of the minimum requirements for the flight deck to support the management of MET information communications, storage and retrieval, and data latency, the minimum requirements for human computer interface, MET information presentation, and intent of use for EFB/MFD, human factors interfaces and automated prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.); initiate a study to identify the requirements to develop a high-fidelity WTIC simulation, test and evaluation capability; and define a path for further development of airborne network-enabled use of radar-derived weather data capabilities that will advance cockpit systems to meet NextGen objectives (collaboration with NASA).

## 2. What Is This Program?

One of the weather-related goals of NextGen is to reduce weather delays, allowing more efficient and flexible ATM. The objective of the NextGen - Weather Technology in the Cockpit Program is to enable flight deck weather information and communications management minimum standards and human factors requirements 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 airborne sensor observations to nearby aircraft for weather avoidance decisions and ground-based processors for direct and forecast use in ATM decision-support processes.

The initial research will evaluate the overarching NextGen ConOps and requirements for NextGen weather support on the flight deck; identify the current capabilities to meet NextGen requirements, evaluate planned and funded development of new weather support capabilities; identify gaps between NextGen requirement and current developing weather support capabilities; allocate gaps to commercial sector, government, or both and NextGen Solution Sets to derive WTIC functional and performance requirements; and finally develop and execute the WTIC research program plan.

The WTIC program will also identify global datalink requirements and standards to transport meteorological (MET) information to and from the flight deck. The WTIC program requires datalinks to support uplink, downlink, and crosslink advisory and safety critical MET information to Parts 91, 121, and 135 NAS users in various coverage environments. Consequently, the WTIC program will define requirements and standards for bandwidth, security, quality of service, and reliability to the government and non-government operated datalinks to implement the MET datalink information.

In addition, the human factors (HF) research will enable the development of the human performance, technology design, and human-computer interaction requirements and standards to enable safe, efficient, and cost-effective operations and training, both on the flight deck and on the ground in hazardous weather. Although, technologically advanced graphical weather information products have entered the general aviation (GA) market in the recent decade, the percentage of accidents that has an attributed the cause to weather or weather-related pilot error has remained fairly stable (NTSB, 2006, 2008, 2009). The HF research will attempt to identify the shortcomings in current capabilities and to identify areas to focus weather technology advancements to optimize the safety and efficiency for Parts 91, 135, and 121 operators.

The information management and the HF research deliverables will enable the development of Air Circulars and Orders for NextGen training, symbology, and information standards; support of development aircraft certifications standards for Minimum Aviation Safety Performance Standards (MASPS), Minimum Operations Standards (MOPS), and Technical Standard Orders (TSO) to support development, operations, and procedures for weather technologies in the cockpit. In addition, the WTIC program research will support the development of the communications information management to include storage and retrieval requirements and standards to acquire MET information from commercial and government provided graphical and textual databases.

By 2015, demonstrate that technology and automation, combined with policy, procedures, and regulatory oversight, meets the Next Generation Air Transportation System (NextGen) goal to improve aviation safety in the presence of adverse weather not anticipated during preflight. Demonstrations will show the technology and automation used in the cockpit provides pilots and aircrews with 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 Concept of Operations (ConOps) are that it assists collaborative decision-making (pilot, controller, ATM, 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 far 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., analysis 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.

The NextGen - 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 Joint Planning and Development Office NextGen 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.), and 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.
- Various RTCA Special Committees, including SC-206, and SAE G-10 subcommittees.

The NextGen - 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 Memoranda of Agreement. Partnerships include:

- National Center for Atmospheric Research.
- National Aeronautics and Space Administration Langley and Glenn Research Centers.
- Public and private universities.
- Center for General Aviation Research.
- Initiatives with airlines, pilots, and manufacturers.

In FY 2011, major activities and accomplishments planned with the requested funding include:

- Develop mid-term ConOps and obtained partner, stakeholder, and user concurrence for weather technology in the cockpit based on foundational elements identified in the NextGen ConOps, including integration of weather-in-flight-deck decision-support tools, weather dissemination management, and GA operations.
- Validate Aerospace Recommended Practice 5740, Cockpit Display of Data Linked Weather Information.
- Determine the incremental weather information needed in cockpit operations for flight replanning and en route avoidance maneuvers, decision support, and situational awareness (for FAR Parts 121, 135, 91).
- Verify and validated NAS datalinks signal latency, bandwidth, and quality of service to disseminate icing and turbulence products to the flight deck within the NAS.
- Demonstrate the usefulness of an in-flight display of uplinked satellite-based product that outlined the 30kft and 40kft convective cloud top heights in a two-hour look-ahead display focused on the aircraft position and flight direction for Pacific Ocean transoceanic flights between California and Australia.
- Initiate the demonstration and evaluation of the usefulness of the uplinking turbulence eddy dissipation rates (EDR) to flight deck for aircrew mitigation procedures.
- Equip selected aircraft with certified EFBs to accomplish flight crew evaluations of convective oceanic cloud top flight, graphical turbulence and icing operational evaluation.
- Implement Turbulence EDR algorithms including joint effort with aircraft manufacturers.
- Investigate means for airborne network-enabled use of radar-derived weather data (collaboration with NASA).

<u>Performance Linkages</u>

The NextGen - Weather Technology in the Cockpit Program supports the DOT strategic goal of Economic Competitiveness by creating a competitive air transportation system which is responsive to customer needs through NAS on-time arrivals.

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 research goals are:

- By FY 2012, simulate and validate data-linked bandwidth, quality of service, security, and latency standards requirements for meteorological information to the cockpit.
- By FY 2012, develop MET Symbology use cases for human-in-the loop demonstrations.
- By FY 2012, demonstrate inflight cockpit display of data-linked hazardous weather for transoceanic aircraft.
- By FY 2013, develop human factors interfaces and automated prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).
- By FY 2014, simulate and validate cockpit use of data-linked weather decision support tools, including probabilistic forecasts.
- By FY 2014, high fidelity integrated weather technology in the cockpit simulation, test, and evaluation capability to facilitate new technologies assessments and human-in-the-loop evaluation of NextGen operational concepts.
- By FY 2014, evaluate concepts of use for weather information integrated in NextGen air and ground capabilities for airline operations centers and pilots.
- By FY 2014, develop guidance standards for airmen training and evaluation criteria for the use of probabilistic forecast products and pilot decision making support tools.
- By FY 2015, flight demonstration to evaluate the integration of four dimension flight path information including data-linked meteorological information into cockpit decision-making and shared situational awareness among pilots and dispatchers supported by NextGen air and ground capabilities.

## 3. Why Is This Particular Program Necessary?

Weather has been identified as a causal factor for 70 percent of delays and 20 percent of accidents as cited in "The Mission Need Statement for Aviation Weather (#339)". Between 1994 and 2003, there were 19,562 aircraft accidents involving 19,823 aircraft. Weather was a contributing or causal factor in 4,159 (21.3 percent) of these accidents. Of the 4,159 weather-related accidents, 4,167 aircraft were involved. From 1994 to 2003, the annual number of weather-related accidents has declined. However, the annual number of weather-related accidents has remained roughly constant as a percentage of total accidents. An example of the limits of pilots' ability to cope with severe weather is the crash of an Air France jet last year over the Atlantic Ocean, killing all 216 passengers and 12 crew members. Pilots currently have little information as they fly over remote stretches of the ocean, which is where some of the worst turbulence occurs. Providing pilots with at least an approximate picture of developing storms could help guide them safely around potentially severe weather.

Having access to more weather hazard information in the cockpit does not, however, necessarily translate into better pilot decision-making and performance. Although technologically advanced graphical weather information products have entered the GA market in the recent decade, the percentage of accidents that have an attributed cause due to weather or weather-related pilot error have remained fairly stable (NTSB, 2006, 2008, 2009). The intent of this program is to identify why the introduction of state-of-the-art weather information products have not dramatically improved the safety of GA operations concerning weather. This information will be leveraged for identifying shortcomings in current capability to support pilot weather decision making and identify areas to focus NextGen technology advancements to optimize the safety and efficiency of flight operations in hazardous weather for Parts 91, 135 & 121. The key is to provide high quality weather decision support tools to enable efficient flight replanning and enroute avoidance maneuvers in the presence of adverse weather not anticipated during preflight with a focus upon NextGen operations.

The WTIC Program research is to insure the adoption of cockpit, ground, and communication technologies, practices, and procedures that will provide pilots with shared and consistent weather information to enhance situational awareness, plus engage the aircrafts as a "network node" that autonomously exchanges weather information with surrounding aircraft and systems. The aircraft industry is moving toward Electronic Flight Bags (EFB) to enable secondary flight data information management and display. The shift in processing from the ground to the air requires significant increase in computing power which potentially can be supported with EFB technologies. The

WTIC Program research will address the technologies, standards, requirements, and procedural gaps to enable a WTIC capability to be implemented in NextGen.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want / Need To Fund The Program At The Requested Level?

A reduction in the WTIC FY 2012 total funding will impact the WTIC Airborne Sensor Technologies effort. A two percent reduction would have a minor impact to define a path for further development of airborne network-enabled utilization of radar-derived weather data capabilities. The impact will require NASA to adjust the FY 2012 planned deliverable schedule.

A further reduction will require NASA to rescope the total effort to develop a network-enabled utilization of airborne radar-derived weather data capabilities. This reduction will impact flight demonstration of the capabilities in the out years (FY 2014 and 2015); therefore, the program will not be able to test the fully network-enabled utilization of airborne radar-derived weather data capabilities.

**Detailed Justification for**
## A13.a Environment and Energy

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 –Environment and Energy**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A13.a Environment and Energy | $15,522,000 | $15,327,000 | -$195,000 |

For FY 2012, $15,327,000 is requested for Environment and Energy. Major activities and accomplishments planned with the requested funding include:

Noise and Emissions Analyses and Interrelationships

- Complete annual assessment of noise exposure and fuel burn.
- Develop integrated architecture for noise and emissions modules communications.
- Develop model for assessing global exposure to noise from transport aircraft.
- Validate methodologies used to assess aviation noise exposure and impacts as well as emissions and their impacts on air quality and climate change.
- Publish updates for airport air quality analysis handbook.
- Develop guidance document for estimating and reducing emissions from airport ground-support equipment.
- Continue integration and harmonization of databases and code management protocols.
- Continue upgrades to and assessment of Environmental Design Space Tool (EDS), and Aviation Portfolio Management Tool (APMT) models and use these models for integrated noise and emissions analyses, cost-benefit analyses and to support the CAEP work program.
- Develop and disseminate a preliminary planning version of Aviation Environmental Design Tool (AEDT) that will allow integrated assessment of noise and emissions inventories at the local, regional, and global levels.
- Develop methodology for use in AEDT to analyze open rotor aircraft noise and tradeoffs.

Aircraft Noise

- Continue to update and/or develop, as well as publish: procedures and technical guidance for noise certification of aircraft (transport category and subsonic jet airplanes that are both harmonized internationally and simplified.
- Assess land use practices and investigate mitigation strategies beyond 65 dB DNL.
- Continue investigation of feasibility of more stringent international noise certification standards for transport category and subsonic jet airplanes.
- Initiate studies to develop a new international noise standard for small prop engines and helicopters.
- Conduct pilot studies to develop relationships between noise exposure and health and welfare impacts.
- Advance methodologies to model noise propagation and structural response for current and potential future unconventional aircraft configurations.
- Investigate metrics for noise exposure from non-conventional open rotor and supersonic aircraft.
- Apply methodologies to incorporate potential health impacts of aircraft noise exposure within APMT.

- Assess potential global benefits of using newly developed noise-reduction technologies and identify technology goals for long-term reduction of aircraft noise.
- Update noise research roadmap.
- With the Aviation Emissions activity, conduct two COE-focused sessions at a national and an international conference.
- Publish COE PARTNER research findings.

Aviation Emissions

- Assess technological and scientific basis to support future ICAO engine emission standards.
- Advance science and develop metrics and reduce uncertainties in assessment of regional and global climate impacts of aviation.
- Advance and exercise multiscale air quality analysis models for impacts of airport and full flight aircraft emissions.
- Evaluate and publish sampling, measurement and analyses techniques and procedures for aircraft emissions testing and certification that are both harmonized and simplified.
- Develop measurement and sampling protocols and expand databases for aviation emissions of Hazardous Air Pollutants (HAPs) and PM.
- Validate modeling capability for dispersion of chemically reactive aircraft plume.
- Apply methodologies to incorporate air quality and health impacts of aircraft emissions within APMT.
- 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.
- With the Aircraft Noise activity, conduct two COE-focused sessions at a national and an international conference.
- Publish COE PARTNER research findings.

In FY 2012, the Energy and Environment Program will continue to focus on multiple fronts to support the Flight Plan goals of Greater Capacity and International Leadership. These include (1) development, harmonization of module and databases and integrated noise and emissions as well as cost-benefit analyses using aviation environmental suite of tools (AEDT, EDS and APMT); (2) advance science and develop metrics to characterize aviation noise and emissions at the source level, their dispersion as well as environmental, health and welfare impacts; and (3) update, simplify and harmonize procedures and technical guidance for aircraft noise and emissions certification of aircraft.

## 2. What Is This Program?

The program is developing and validating methodologies, models, metrics, and tools to assess and mitigate the effects 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 and characterization of the impacts of aircraft noise and aviation emissions.

The Environment and Energy (E&E) Program helps achieve FAA's environmental compatibility goal and supports the FAA Flight Plan. The program also provides fundamental knowledge and tools to support the Next Generation Air Transportation System (NextGen) research and development plan. The efforts complement activities in aircraft technology, alternative fuels, and efficient operations based mitigation solutions, environmental operational assessments, and environmental management systems development under NextGen investments.

The program specifically supports the following outcomes:

- The Flight Plan Noise Exposure Performance Target to reduce the number of people exposed to significant noise by four percent compounded annually through FY 2013 from the calendar year 2005.
- The Flight Plan Aviation Fuel Efficiency Performance Target to improve aviation fuel efficiency by one percent per year through FY 2013 to 11 percent, as measured by a 3-year moving average of the fuel

burned per revenue mile flown, from the 3-year average for calendar years 2000-2002. FY 2012 Target is 10 percent.

Specific activities include:

- Conducting 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.
- Leveraging a broad cross-section of stakeholders through the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence (COE) to foster breakthrough scientific, operations, policy, and work force advances to mitigate noise and emissions impacts.
- Minimizing the impact of aircraft noise – actions include: advancing the state of science/knowledge concerning effects of aircraft noise and emissions; and assessing the need to refine noise and emissions impact criteria and metrics; and improving operational procedures and technical guidance for aircraft noise and emissions certification standards.

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

- Working with the international aviation community to reduce aircraft noise and emissions.
- Improving aircraft noise and engine exhaust emissions certification standards and operational procedures.
- Promoting compatible land use.
- Characterizing the benefits of abatement measures to reduce population impacted by aircraft noise and analyzing 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 providing the foundation for the NextGen investments that help achieve and manage the NextGen goal to promote environmental stewardship by reducing significant community noise and air quality emissions impacts in absolute terms, limiting or reducing the impact of aviation greenhouse gas emissions on global climate, and balancing aviation's environmental impact with other societal objectives. Specific activities include:

- Developing fundamental knowledge to aid in better science-based understanding of impacts of aircraft noise and aviation emissions on air quality and climate change to enable the NextGen goal of sustained aviation growth by 2025, while reducing significant community noise and air quality emissions in absolute terms.
- Achieving carbon neutral growth by 2020 relative to aviation CO2 emissions in year 2005 as the base year.
- Developing tools to assess the ability of technologies for airframes, more efficient engines, advanced propulsion concepts, new fuels, new materials, market-based options, environmental standards and policies to reduce source noise and emissions.

FAA works closely with other federal agencies (including NextGen Joint Planning and Development Office Environmental Working Group or JPDO/EWG), industry, academia, and international governments and organizations (e.g. ICAO/CAEP, International Civil Aviation Organization/Committee on Aviation Environmental Protection) to design research and development (R&D) efforts that can mitigate the environmental impact of aviation. This unified regulatory approach to research identifies and influences technologies, models, regulations, certification criteria, and policies that can improve our present and future global environment.

The E&E program activities are closely coordinated with support from industry and federal agencies. FAA signed a series of Memoranda of Agreement (MOA) with NASA and DOD to understand and mitigate aviation noise and emissions. FAA is also pursuing collaborative agreements with the Department of Energy and EPA to leverage resources to address aviation's environmental impact. A number of E&E projects are executed by a consortium of PARTNER (Partnership for AiR Transportation Noise and Emissions Reduction — is a leading aviation cooperative research organization, and an FAA/NASA/Transport Canada-sponsored Center of Excellence) universities. The Volpe

National Transportation Systems Center continues to provide substantial technical assistance in the areas of aircraft noise and engine emissions measurement and assessment.

The E&E program supports the JPDO/EWG comprising FAA, NASA, EPA, DoD, DOC, Council on Environmental Quality, and OST, 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. FAA is working closely with FICAN (Federal Interagency Committee on Aviation Noise) to better understand, predict and control the effects of aviation noise.

FICAN also offers a forum for partnership, as it comprises all federal agencies concerned with aviation noise.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Noise and Emissions Analyses and Interrelationships

- Continued upgrades to AEDT, APMT and EDS including enhanced methodologies for noise, emissions and fuel burn calculations, harmonization of databases and modules for tools communication, integration and assessment as well as application of these aviation environmental tools for annual noise exposure and fuel burn assessments for Flight Plan and for cost-benefit and other analyses to support CAEP program.

Aircraft Noise

- Continued to update procedures and technical guidance for aircraft noise certification. Initiate feasibility studies for more stringent international aircraft noise certification standards. Work continued on many fronts including assessment of land-use practice and investigation of mitigation strategies beyond 65dB DNL; characterization of aircraft noise and its propagation; and improved understanding and representation of metrics for noise exposure and related health and welfare impacts.

Aviation Emissions

- Continued to develop and publish procedures and technical guidance materials for engine emissions testing and certification, improved characterization of aircraft emissions and modeling analysis capability for air quality and climate impacts; assessed related health and welfare impacts; and advanced best practices for aircraft emissions measurements.

Performance Linkages

The Environment and Energy Program supports the DOT strategic goal of Environmental Sustainability by reducing transportation related pollution and impact on eco systems through the mitigation of noise exposure.

The goals of the focused research endeavors are:

- By FY 2013, develop and field a fully validated Aviation Environmental Design Tool (AEDT).
- By FY 2013, advance further development of Aviation Portfolio Management Tool (APMT) and Environmental Design Space Tool (EDS) and employ them for cost-benefit analyses and aircraft technology evaluation, respectively.
- By FY 2013, use collected Hazardous Air Pollutants (HAPs) and PM emissions data, directly measured from aircraft engines to replace, to the extent possible, approximation methods and factors used in modeling tools.
- By FY 2014, initiate development of simulation-based environmental models.
- By FY 2015, advance capability for aviation noise; emissions; and fuel-burn-related, integrated-impact assessment.
- By FY 2015, initiate development of environmental models components to enable intermodal analyses.
- By FY 2015, demonstrate a first version of a simulation-based environmental model.
- By FY 2015, constrain uncertainties associated with aviation climate impacts, develop refined aviation climate impacts estimates and employ them for environmental cost-beneficial analyses.

- By FY2015, advance multiscale air quality modeling capability for aviation health impacts and employ for environmental cost-benefit analyses.
- By FY2015, advance characterization of aviation noise and related health and welfare impacts and employ for environmental cost-benefit analyses.
- By FY2016, Advance scientific approaches and methodologies for improved integrated analysis of noise and emissions inventories and impacts.

## 3. Why Is This Particular Program Necessary?

Despite the technological advancements achieved during the last forty years, aircraft noise still affects people living near airports, and aircraft emissions continue to be an issue, locally, regionally and globally. While energy efficiency and local environmental issues have traditionally been primary drivers of aeronautics innovation, the current and projected effects of aviation emissions on our global climate is a serious long-term environmental issue facing the aviation industry. Aside from their associated health and welfare impacts, aircraft noise and aviation emissions are a considerable challenge in terms of community acceptance of aviation activities and this challenge is anticipated to grow. Environmental impacts are often the number one cause of opposition to airport capacity expansion and airspace redesign. We must deal with these impacts to enable aviation to meet increased demand and operate with flexibility.

To deal with aviation climate impacts entails an understanding and quantifying the potential environmental impacts of aviation to help policymakers address environmental health and welfare impacts associated with aviation. This research will ensure identifying the right issues, measuring their impact, and designing appropriate measures to mitigate their effects. In the 1990s, this research effort was focused on noise regulatory issue, and later on emissions. However, these were treated as separate subjects. In trying to assess health and welfare impacts, optimize energy efficiency and develop environmental mitigation strategies, it has become evident there are important interrelationships and potential trade-offs. Taking an interdisciplinary approach to enhancing energy efficiency and minimizing aviation environmental impacts by developing data, analytical tools, and models that characterize and quantify the interdependencies between energy use, aircraft noise and various air pollutant emissions is a key element of the way forward for this research program. The goal is a more complete understanding of the complex interdependencies that exist among aircraft noise, fuel burn and emissions required for designing and regulating aircraft.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction in funding to the Environment and Energy program would delay release of model capable of computing greenhouse gas emissions at airport level from six months to 18 months. This model is needed to address new Council on Environmental Quality (CEQ) for environmental assessments; absent this capability, projects to enhance capacity would be delayed.

**Detailed Justification for**

# A13.b NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A13.b NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics | $26,509,000 | $20,523,000 | -$77,000 |

For FY 2012, $20,523,000 is requested for NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics. Major activities and accomplishments planned with the requested funding include:

Major activities and accomplishments planned with the requested funding include:

Technology Maturation

- Fabricate advanced aircraft component level flight test hardware.
- Integrate advanced low NOx combustor on engine demonstrator.
- Begin integration flight management system for flight demonstration.
- Conduct component level engine rig tests.
- Complete preliminary design review of advanced engine configuration for demonstration.
- Advance turbine blades and ceramic matrix composite turbine component for integration and testing.

Alternative Turbine Fuels

- Conduct demonstration testing for renewable alternative fuels.
- Conduct safety assessment for renewable alternative fuels.
- Conduct performance and environmental assessment of additional candidates for "drop-in" renewable alternative fuels.
- Assess production capacity and commercial fleet infusion of aviation alternative fuels.
- Initiate transition plans for alternative fuels.
- Identify additional candidates for "drop-in" aviation alternative fuels.

Metrics, Goals and Targets

- Evaluate noise and emissions impacts metrics for use in Next Generation Air Transportation System (NextGen) environmental analysis.
- Perform integrated NextGen noise and emissions impacts analysis.
- Initiate second phase of Aviation Climate Change Research Initiative (ACCRI) for assessment of aviation climate impacts.
- Refine and assess intermediate targets towards meeting NextGen environmental goals.

In FY 2012, the NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics Program will continue to advance system design, integration and testing of Continuous Lower Energy, Emissions and Noise (CLEEN) aircraft technologies for accelerated progress towards flight demonstration and system-wide assessments. For alternative

fuels, activities will focus on safety, performance and environmental assessments for qualification of renewable alternative fuels. Activities will also initiate to assess production capacity and fleet infusion as well as to develop transition plans for alternative fuels. On the Metrics, Targets and Goals front, activities will continue to refine and evaluate metrics for NextGen environmental impacts, advance capability for and assessment of environmental noise, air quality and climate impacts. This also includes improved climate impacts assessment under second phase of ACCRI activities. The work will also continue to refine estimates of environmental targets and assess gaps towards meeting NextGen environmental goals.

## 2. What Is This Program?

The program is protecting the environment by reducing significant aviation environmental impacts associated with noise, exhaust emissions, and increasing energy efficiency and availability to enable mobility and scalable capacity growth. Collaborating with industry, the program will advance and mature engine and airframe technologies to reduce aviation noise, air quality impacts, greenhouse gas emissions, and energy use. It will also provide data and methodologies to assess environmental sustainability including life-cycle environmental impact and support certification of alternative aviation fuels that could serve as drop-in replacements for today's petroleum-derived turbine engine fuels. This will lead to faster deployment of these fuels, and accompanying reductions in greenhouse gas and aviation emissions that impact air quality. Ultimately, the program will demonstrate advanced technologies and alternative fuels in integrated ground and flight demonstrations. The program is also helping to achieve NextGen goals by improving metrics to define and measure significant aviation environmental impacts. The program will improve the fundamental understanding of aviation environmental health and welfare and climate impacts, and translate impact into improved metrics that can be used to better assess and mitigate aviation's contribution. This program will identify the gaps in scientific knowledge to support NextGen; focus research in areas that will reduce key uncertainties to levels that allow action; and develop enhanced metrics to enable sound analyses. Ultimately, the program will enable the refinement of goals and targets to support the NextGen EMS to better manage and reduce aviation's environmental impacts to enable mobility and scalable capacity growth.

The NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics Program helps achieve NextGen goals to increase mobility by reducing environmental impacts of aviation in absolute terms, including significant community noise, air quality and global climate change. The program is focused on reducing current levels of aircraft noise, air quality and greenhouse gas emissions, and energy use and advancing sustainable alternative aviation jet fuels.

The Program specifically supports the following outcomes:

Demonstrate aircraft and engine technologies that reduce noise and air quality and greenhouse gas emission at the source level, to a developmental level that will allow quicker industry uptake of these new environmental friendly technologies to produce a fleet that will operate more efficiently with less energy usage and permit expansion of airports and airspace capacity in a scalable 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 percent compared to current technology, reducing energy consumption and greenhouse gas (CO2) emissions;
- Certifiable engine technology that reduces landing-and-takeoff-cycle nitrogen-oxide emissions by 60 percent, without increasing other gaseous or particle emissions, over the International Civil Aviation Organization (ICAO) standard adopted at the sixth meeting of the ICAO Committee on Aviation Environmental Protection;
- Certifiable aircraft technology that reduces noise levels by 32 decibels 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 the use of alternative fuels in aircraft systems, including favorable environmental qualification, successful demonstration and quantification of benefits and internationally agreed criteria to quantify relative carbon content; and
- Processing capability and technical data to support certification and assured safety of a drop-in replacement for petroleum-derived turbine engine fuels.

Determine the appropriate enhancements of goals and metrics to manage NextGen aviation environmental impacts that are needed to support Environmental Management Systems (EMSs) and achieve environmental protection that enables sustained aviation growth.

Specific activities include:

- Evaluate, establish, and implement advanced metrics to better assess and control noise, air quality impacts, and greenhouse gas emissions that may influence climate impacts from anticipated NextGen commercial aircraft operations.
- Evaluate and refine required technology and operational goals and targets to mitigate the environmental impact of NextGen and support NextGen EMS implementation.

FAA works closely with other federal agencies (including NextGen Joint Planning and Development Office Environmental Working Group or JPDO/EWG and U.S. Global Change Research Program), industry, academia, and international governments, organizations (e.g. ICAO/CAEP, International Civil Aviation Organization/Committee on Aviation Environmental Protection) and coalitions (e.g. CAAFI, Commercial Aviation Alternative Fuels Initiative) to design research and development (R&D) efforts that can mitigate the environmental impact of aviation and explore alternative gas turbine fuels.

As does the Environment and Energy Research Program and other NextGen activities, the NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics Program relies on a series of Memoranda of Agreement to work closely with NASA and DoD. FAA is also pursuing collaborative agreements with the Department of Energy, and EPA to leverage resources to address aviation's environmental impact.
Through the JPDO, the program supports the EWG comprising FAA, NASA, EPA, DoD, DOC, Council on Environmental Quality, and OST, 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.

In FY 2011, major activities and accomplishments planned with the requested funding include:

Noise, emissions, and fuel burn reduction technologies maturation

- Advanced CLEEN systems analyses for most promising technologies.
- Continued CLEEN component-level tests for most CLEEN promising technologies.
- Initiated Round 2 ground rig tests and continued design of CLEEN demonstration experiment.

Alternative turbine engine fuels

- Completed detailed feasibility study, including economic feasibility, environmental impacts, and assessment of potential for gas turbine renewable alternative fuels.
- Developed federally-agreed methodology to conduct environmental impact life cycle analyses for a range of renewable alternative turbine fuels.
- Initiated efforts to experimentally assess environmental impacts and benefits and costs of renewable alternative turbine engine fuels.

NextGen environmental metrics, goals, and targets

- Continued analysis of targets to achieve NextGen environmental goals.

- Continued efforts to determine how projected NextGen operations-generated emissions and noise impact human health and welfare and global climate and identify key uncertainties.
- Continued comprehensive, integrated assessment of NextGen air quality and noise impacts.

Performance Linkages

The NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics program supports DOT strategic goal of environmental sustainability by increasing the use of environmentally sustainability practices in the transportation sector. Those practices will improve capital projects that include environmental management systems, context sensitive solutions, or use a sustainable transportation project evaluation to manage the environmental impacts of construction and operations.

By FY 2016, complete design, fabrication and integration as well as system level analyses and testing of near-and mid-term CLEEN airframe and engine technologies to reduce noise, emissions, and fuel burn for civil subsonic jet aircraft; and develop plans for potential second phase of CLEEN program.

Airframe and engine technologies supporting milestones:

- By FY 2012, fabricate advanced aircraft component flight test hardware and complete flight tests.
- By FY 2012, integrate advanced low NOx combustor on engine demonstrator and conduct engine tests.
- BY FY 2012, Begin flight management system (FMS) demonstration.
- BY FY 2012, conduct preliminary design review for advanced engine configuration testing.
- By FY 2012, perform acoustic validation testing and analysis to verify noise reduction predictions.
- By FY 2012, characterize and test aircraft material properties for noise reduction.
- By FY 2013, perform detailed design review of advanced turbine blade cooling configuration and materials.
- By FY 2013, perform testing of exhaust system components.
- By FY 2013, perform detailed design review and component manufacture for advanced engine configuration testing.
- By FY 2013, perform acoustic validation testing and analysis to verify noise reduction predictions.
- By FY 2014, characterize and test aircraft material properties for noise reduction.
- BY FY 2014, perform ground test for advanced engine configurations.
- By FY 2014, complete testing of Flight Management System.
- By FY 2015, perform flight tests for advanced engine configurations.
- By FY 2015, develop plans for analyses and demonstration of evolving technologies in a potential second phase to CLEEN.
- By FY 2016, develop plans for analyses and demonstration of evolving technologies in a potential second phase to CLEEN.

By FY 2015, complete comprehensive assessment and research to support certification of drop-in and renewable alternative turbine engine fuels and develop implementation plan to foster implementation in the commercial fleet.

Alternative fuels supporting milestones:

- By FY 2012, conduct demonstration testing for renewable alternative fuels.
- BY FY 2012 conduct safety assessment for renewable alternative fuels.
- By FY 2012, conduct performance and environmental assessment of additional candidates for "drop-in" renewable alternative fuels.
- By FY 2012, assess production capacity and commercial fleet infusion of aviation alternative fuels.
- By FY 2012, initiate transition plans for alternative fuels.

- By FY 2012, identify additional candidates for "drop-in" aviation alternative fuels.
- By FY 2013, conduct safety assessment of renewable fuels.
- By FY 2013, conduct significant demonstration of additional drop-in alternative turbine engine fuels.
- By FY 2013, complete renewable alternative turbine engine fuels safety, environmental, and business case assessments.
- By FY 2014, complete transition plans for drop-in alternative fuels.
- By FY 2014, complete renewable fuels safety assessment.
- By FY 2015, complete transition plans for renewable alternative fuels.
- By FY 2016, identify and initiate assessment of non-drop-in fuels.
- By FY 2015, conduct initial feasibility study, including economic feasibility, environmental impacts, and assessment of potential for non-drop-in alternative aviation fuels.
- By FY 2016, conduct a demonstration of the performance characteristics of a non-drop-in alternative aviation fuel.

By FY 2016, investigate metrics, uncertainties on aviation emissions health and welfare and climate impact to facilitate NextGen EMS implementation.

Metrics supporting milestones:

- By FY 2012, initiate the second phase of Aviation Climate Change Research Initiative to reduce uncertainties in aviation climate impacts and refine associated magnitude.
- By FY2012, Evaluate noise and emissions impacts metrics and perform NextGen environmental analyses
- By FY 2013, continue refinements of aviation environmental impacts and metrics.
- By FY 2013, reduce key uncertainties of aviation impacts to levels that better inform appropriate action.
- By FY 2013, refine estimates of interim NextGen environmental targets and perform gap analyses.
- By FY 2014, refine metrics that more accurately capture aviation emissions health and welfare and climate impact and goals to facilitate EMS implementation.
- By FY 2014, refine estimates of interim NextGen environmental targets and perform gap analyses.
- By FY 2014, complete second phase of ACCRI program with improved estimates of aviation climate impacts.
- By FY 2015, continue refined assessment of aviation environmental, health, and climate impacts.
- By FY 2015, complete an updated assessment of aviation environmental, health, and climate impacts.
- By FY 2015, refine estimates of interim NextGen environmental targets and perform gap analyses.
- By FY 2016, advance capabilities for integrated analysis for aviation noise and emissions impacts.
- By FY 2016, develop improved estimates for targets and assess scenarios towards meeting the NextGen environmental goals.

## 3. Why Is This Particular Program Necessary?

Protecting the environment is at the heart of the NextGen plan. Ensuring energy availability and protecting the environment will be critical elements to enable the mobility (capacity and efficiency) our nation needs. The NextGen environmental strategy includes efforts to better understand the extent of the problem associated with aviation emissions and the development and fielding of new operational enhancements, aircraft and ATM technologies, alternative fuels, and policies to achieve near-term and long-term solutions. The NextGen Environment and Energy R&D program supports research to develop new aircraft technologies and sustainable fuels and to develop metrics to quantify NextGen's environmental impacts and inform performance targets.

The vast majority of improvements in environmental performance over the last three decades have come from enhancements in engine and airframe design. Although major contributors, improved technologies and air traffic

management will not be enough to reduce aviation's carbon dioxide ($CO_2$) footprint. Sustainable alternative fuels with lower overall carbon foot prints are critical to reducing aviation's climate impact in order to enable mobility. The main focus of this R&D effort is the CLEEN program. The CLEEN program is focused on reducing current levels of aircraft noise, emissions that degrade air quality, GHG emissions, and energy use, and it advances sustainable alternative fuels for aviation use.

Embedded in energy and environmental issues are several scientific uncertainties concerning aviation energy issues and aviation environmental impacts, particularly on climate. There are large uncertainties in our present understanding of the magnitude of climate impacts due to aviation non-CO2 emissions. Understanding the relative impacts of different emission (including altitude emissions impacts on air quality) is vital for informing NextGen EMSs implementation. The ACCRI is an element of the R&D program focused on addressing these uncertainties. In addition, noise is the most immediately objectionable impact of aviation, and the impact demanding the most Federal resources (i.e., minimum AIP grant set aside of $300M annually). Research is outdated that underpins determinations of aircraft noise impacts, land use compatibility guidelines, and federally funded noise mitigation. New noise metrics research effort is needed to reflect public sensitivity and current air traffic conditions, guide mitigation funding and local land use planning near airports, and assure the U.S. response to aircraft noise keeps pace with NextGen needs and international efforts.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

Any reduction in the requested budget will reduce and slow our ability to mature aircraft technologies for reduction in noise, emissions and fuel burn, qualification of alternative fuels for commercial aviation as well as limit our efforts for analysis of environmental impacts and metrics including ACCRI. Delay in advancing progress in these areas will severely limit our ability to meet NextGen environmental goals, prepare for international negotiations and efforts for sustainable and secure supply of alternative sources of jet fuels.

**Detailed Justification for**

# A14.a System Planning and Resource Management

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – System Planning and Resource Management**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A14.a System Planning and Resource Management | $1,766,000 | $1,718,000 | -$48,000 |

For FY 2012, $1,718,000 is requested for System Planning and Resource Management. Major activities and accomplishments planned with the requested funding include:

R,E&D Portfolio Development

- Prepare the FY 2014 R,E&D budget submission
- Manage FAA's R,E&D portfolio to meet efficiency goals
- Obtain Research Engineering, and Development Advisory Committee (REDAC) recommendations on planned R,E&D investments for FY 2014.
- Support the REDAC in its preparation of other reports, as requested by the Administrator.
- Deliver the 2012 National Aviation Research Plan (NARP) to the Congress with the President's FY 2013 Budget.

Research Partnerships

- Coordinate R&D activities with internal and external partners.
- Begin planning for the 2013 U.S.A./Europe Air Traffic Management R&D Seminar on NextGen and Single European Sky Air Traffic Management Research (SESAR).

Performance Measurement

- Measure quality, timeliness, and value of international research collaboration.

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 2014 program, review the proposed FY 2014 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 NARP and submit it to Congress concurrent with the FY 2013 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 program will manage the FAA R&D portfolio, identify high value products being produced by the R&D program, and promote the use of these products globally to benefit the international market. In FY 2012, this initiative will begin to measure quality, timeliness, and value of collaboration, expanding upon work done in FY 2011.

## 2. What Is This Program?

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.

In FY 2012, FAA will perform the following:

R,E&D Portfolio Development

- Publish the annual NARP.
- Manage the R,E&D portfolio development.
- Prepare the annual R,E&D budget submission.
- Host two REDAC meetings and multiple subcommittee meetings. The Committee provides advice on and reviews plans for the annual FAA R&D budget, and produces periodic and special reports providing advice and recommendations to FAA on its R&D portfolio.

Research Partnerships

- Establish and cultivate research partnerships both domestically and internationally to leverage programs, laboratories, and facilities to support the implementation of Next Generation Air Transportation System (NextGen) operational improvements.
- Manage the formulation and execution of interagency agreements and action plans with external research partners such as the National Aeronautics and Space Administration (NASA), Air Force Research Lab, the European Organization for the Safety of Air Navigation (EUROCONTROL), and Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking.
- Identify, validate, and catalog existing and needed research and technology activities internal and external to FAA to support the operational needs of the FAA's National Airspace System Enterprise Architecture.
- Jointly plan and conduct the USA/Europe Air Traffic Management R&D Seminar on NextGen and SESAR.

Performance Measurement

- Develop a strategic mapping for international collaboration.
- Identify a process to measure quality, timeliness, and value of collaboration.

The value of working with international partners to leverage research programs and studies to improve safety and promote seamless operations worldwide is an outcome for this program.

Ongoing activities will manage FAA's Research, Engineering and Development (R,E&D) portfolio, meet the President's criteria for R&D, increase program efficiency, and maintain management and operating costs.

The REDAC reviews FAA research commitments annually and provides guidance for future R,E&D investments. The members of this committee and its associated subcommittees are subject matter experts drawn from various associations, user groups, corporations, government agencies, universities, and research centers. Their combined presence in the REDAC fulfills a congressional requirement for FAA R&D to be mindful of aviation community and stakeholder input.

R&D partnerships include the Department of Transportation (DOT), the Joint Planning and Development Office (JPDO), NASA, other federal agencies, and EUROCONTROL.

In FY 2011, major activities and accomplishments planned with the requested funding include:

R,E&D Portfolio Development

- Prepare the FY 2013 R,E&D budget submission.
- Manage FAA's R,E&D portfolio to meet efficiency goals.
- Obtain REDAC recommendations on planned R,E&D investments for FY 2013.
- Support the REDAC in its preparation of other reports, as requested by the Administrator.
- Deliver the 2011 NARP to the Congress with the President's FY 2012 Budget.

- Develop a strategic mapping for international research collaboration.
- Identify a process to measure quality, timeliness, and value of international research collaboration.

Research Partnerships

- Coordinate R&D activities with internal and external partners.
- Conduct the 2011 U.S.A/Europe Air Traffic Management R&D Seminar on NextGen and SESAR.
- Update the Integrated Plan for Research Transition Teams with NASA.

Performance Measurement

- Develop strategic mapping for international research collaboration.
- Identify a process to measure quality, timeliness, and value of international research collaboration.

Performance Linkages

The System Planning and Resource Management Program supports the DOT strategic goal of Organizational Excellence in maintaining cost control and audit on R&D budget portfolio.

The goals of the focused research endeavors are:

- In FY 2012, FAA will maintain an R,E&D management workforce of no more than 10 percent of the total R,E&D workforce and will sustain the System Planning and Resource Management budget at 2 percent or less of the total R,E&D budget.
- In FY 2012, publish the NARP, which documents the annual R&D budget portfolio, describes activities of the REDAC, and contains the FY 2012-2016 R&D plans.
- By FY 2016, determine the value of international research collaborations.

## 3. Why Is This Particular Program Necessary?

This program provides the support for the FAA to formulate their annual R,E&D portfolio as well as to submit to Congress each year, the mandatory plan for the FAA research and development.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

Funding decreases would have negligible impacts on these efforts.

**Detailed Justification for**

# A14.b William J. Hughes Technical Center Laboratory Facility

## 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 – William J. Hughes Technical Center Laboratory Facility**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| A14.b William J. Hughes Technical Center Laboratory | $4,588,000 | $3,777,000 | -$811,000 |

For FY 2012, $3,777,000 is requested for the William J. Hughes Technical Center (WJHTC) Laboratory Facility. Major activities and accomplishments planned with the requested funding include:

Simulation Facilities

- The Simulation Team will achieve four fully functional cockpit simulators in the Cockpit Simulation Facility.
- The Simulation Team will fully integrate Target Generator Facility (TGF) into the Next Generation Air Transportation System (NextGen) Integration and Evaluation Capability (NIEC) simulation environment.
- The Simulation Team will support FAA involvement in the Research Park located near the William J. Hughes Technical Center.

Flight Program's Airborne Laboratories

- The Flight Program will be enhancing test aircraft(s) to allow participation in Weather in the Cockpit development and testing.
- The Flight Program anticipates the installation of an Enhanced Vision System into the Bombardier Global 5000 aircraft in support of the Airport Lighting Program.
- It is anticipated that the Flight Program will be support "Self Separation" procedure development and flight testing.

Concepts and Systems Integration

- Support 4DT profiles
- Integrate Traffic Flow Management Auxiliary Platform into the NIEC.
- Develop a robust capability to create multi-dimensional scenarios.

FAA sustains research facilities located at the William J. Hughes Technical Center (WJHTC) in support of its R&D program goals. These facilities consist of the Flight Program's Airborne Laboratories; Simulation Facilities, including the Target Generation Facility and the Cockpit Simulators; and the Concepts and Systems Integration Facilities, including the Human Factors Laboratory and the NIEC.

The FAA will continue to modify, configure, and sustain these research facilities located at the WJHTC to support its R&D program goals.

## 2. What Is This Program?

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 air traffic control (ATC) configurations, and changes in performance when new systems or procedures are introduced in order to evaluate human factors issues. These laboratories are comprised of integrated cockpit and ATC 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.

FAA sustains research facilities located at the WJHTC in support of its R&D program goals. These facilities consist of the Flight Program's Airborne Laboratories; Simulation Facilities, including the Target Generation Facility and the Cockpit Simulators; and the Concepts and Systems Integration Facilities, including the Human Factors Laboratory and the NIEC.

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; and environment and energy.
- Communications, Navigation, and Surveillance – The Flight Program Team supports on-site flight tests of the GPS Local Area Augmentation System in Newark to aid in the development of the precision landing system.
- NextGen – The WJHTC laboratories support concept validation and system integration.
- Automated Dependent Surveillance-Broadcast (ADS-B) – 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 Global Positioning System (GPS) Helicopter precision approaches to a heliport.
- Wide Area Augmentation System (WAAS) – 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.

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 the recreation of aircraft accidents for the purpose of collecting data in an attempt to determine the underlying cause.
- European Organization for the Safety of Air Navigation - 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, the Gulf of Mexico and Juneau 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.
- Industry - The Simulation team has partnered with UFA, Inc., to quantify voice recognition and response system performance in Technical Center Human in the Loop (HITL) simulations.

Facilities supporting R&D Goals at FAA's WJHTC: The following laboratory facilities provide the reliable test bed infrastructure to support these R&D customers, program goals, and outputs for FAA:

Simulation Facilities – TGF and Cockpit Simulators

- Approach Procedures
- NextGen
- Airspace Design
- Operational Evolution Plan Concept Validation

- Dynamic Vertical Reduced Separation Minima
- UAS
- ADS-B Concept Evaluation

Research & Development Flight Program – Airborne Laboratories

- Satellite Communications and Navigation Programs
- Separation Standards
- WAAS
- TERPS
- Safety
- Runway Incursion
- NextGen
- Local Area Augmentation System (LAAS)
- ADS-B
- Common Automated Radar Terminal System

Concepts and System Integration Facilities

- ATC Human Factors
- Airway Facilities Human Factors
- NextGen Concept Validation Studies
- Unmanned Aerial Systems
- ADS-B
- Data Communications (Data Comm)

In FY 2011, major activities and accomplishments planned with the requested funding include:

Simulation Facilities

- TGF fully realized its capability to support ATC tower visualization and surface movement studies. This capability supports research in the areas of runway incursions, and taxi clearances.
- The Cockpit Simulation Facility achieved a fully integrated simulation environment with its B-737-800/900, EMB-175, and A-320 simulators.

Flight Program's Airborne Laboratories

- The Flight Program worked to enhance the flying laboratories to meet the anticipated future needs of our flight test customers. These included the capability to capture all "Flight Data Recorder" information and make it available to project personnel in a variety of formats. The first aircraft to be equipped with this capability was the Global 5000.
- The Flight Program will be participating in Alternate Fuels testing, modifying test aircraft and performing various flight tests.

Concepts and Systems Integration

- The Human Factors team continued to merge results from three ongoing projects: Future En Route Workstation, FTWS and TODDS. Lessons learned will be applied to continued development work on the common automation platform to create one UI for all ATC environments.
- The NIEC team will continue to improve laboratory capabilities and integrate new tools and systems to support NextGen studies. Staffed NextGen Study Phase 2 will run early FY11.

Performance Linkages

The William J. Hughes Technical Center Laboratory Facility supports the Department of Transportation Strategic Goals of Safety, Economic Competitiveness, and Environmentally Sustainability. Safety is supported through integration of the Target Generator facility for runway incursion testing, which reduces transportation related injuries and fatalities; Economic Competitiveness by leading U.S. transportation interest in target markets around the world through full-mission demonstrations on NextGen technology integration; and Environmentally Sustainability through testing of transportation evaluation tools to manage the environmental impacts of construction and operations.

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.

## 3. Why Is This Particular Program Necessary?

This particular program sustains research facilities located at the William J. Hughes Technical Center (WJHTC) to support R&D program goals. These programs require specialized facilities to emulate and evaluate field conditions. The R&D programs require flexible, high-fidelity laboratories to perform full mission, ground-to-air, human-in-the-loop simulations. The R&D laboratories are comprised of a human factors laboratory, integrated cockpits and ATC workstation simulators, and flying laboratories consisting of aircraft specially instrumented and reconfigurable to support a variety of projects.

It is necessary to modify, upgrade, and sustain the R&D laboratory infrastructure and provide support services to support the R&D program goals.

## 4. How Do You Know The Program Works?

The Research, Engineering and Development Advisory Committee (REDAC) reviews and evaluates all programs in the FAA R&D program, including this line item, on an annual basis. Established by Congress in 1989, the Research Engineering, and Development Advisory Committee (REDAC) reports to the FAA Administrator on R,E&D issues and provides a link between FAA's program and similar efforts in industry, academia, and government. The REDAC specifically looks at the FAA research programs in terms of the relevance and appropriateness of the program to the National Airspace System and works to ensure FAA's program goals and priorities properly link to national needs. The committee also examines the quality and performance of the Research and Development program (through its subcommittee structure) and provides FAA with advice on how to best allocate funds to ensure a high quality R,E&D program. Representing corporations, universities, associations, consumers, and other agencies, REDAC members hold two-year terms.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

A reduction of funding to this program will reduce the number of fully functional cockpit simulators from four to three available in FY2012 to support complex human-in-the-loop, end-to-end airspace simulations for research, development, operational test and evaluation, and integration of NextGen into the NAS, including Trajectory Based Operations development support.

**Detailed Justification for**

# 1A01 Advanced Technology Development and Prototyping

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Advanced Technology Development and Prototyping**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| Advanced Technology Development and Prototyping | $28,100,000 | $19,000,000 | -$9,100,000 |

| R&D Activities | FY 2012 Estimated Cost |
|---|---|
| Runway Incursion Reduction Program | $5,000,000 |
| System Capacity, Planning and Improvements | 6,000,000 |
| Operations Concept Validation | 4,000,000 |
| NAS Weather Requirements | 1,000,000 |
| Airspace Management Program | 3,000,000 |
| Total | $19,000,000 |

## 2. What Is This Program?

### Runway Incursion Reduction Program

The Runway Incursion Reduction Program (RIRP) will continue research, development, and operational evaluation of technologies to increase runway safety. Consistent with standing National Transportation Safety Board recommendations and initiatives identified in the FAA Flight Plan, research emphasis will remain on technologies that provide for direct safety warnings to pilots and aircrews, as well as those that can be applied cost effectively at small to medium airports. The program will test alternative small airport surface detection technology and the application of these technologies for pilot, controller, and vehicle operator situational awareness tools. Current initiatives include Runway Status Lights technology enhancements such as Runway Intersection Lights logic, Light Emitting Diode (LED) technology, Low Cost Ground Surveillance (LCGS) Pilot, and Final Approach Runway Occupancy Signal for high density airports. When appropriate, investment analyses will be performed to support acquisition and implementation of selected solutions.

### System Capacity, Planning, and Improvements

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 and their environmental impacts. The tracking and monitoring capabilities of PDARS support studies and analysis of air traffic operations at the service delivery or national level. Also, the capacity and efficiency of the NAS is further expanded through capacity modeling which analyzes the impact of Next Generation air transportation system (NextGen) operational improvements. By recording the design

and performance of the legacy NAS PDARS establishes a de facto base case for before and after comparisons of NextGen accomplishments.

**Operations Concept Validation**

Developing operational concepts is an Office of Management and Budget (OMB) recommended first step in developing an Enterprise Architecture. This program develops and validates operational concepts that are key to the Air Traffic Organization's (ATO) modernization programs and the Next Generation Air Transportation System (NextGen). This work includes developing and maintaining detailed second level concepts that support validation and requirements development. Second level concepts identify the personnel and functional changes necessary for the ATO to provide customer service in ways that increase productivity and reduce net cost. Recent work includes developing second level concepts for En Route, Traffic Flow Management (TFM), NextGen Towers, and Integrated Arrival and Departure Operations. This information helps the aviation community anticipate what changes are needed in aircraft equipment in order to operate with the new technology being implemented in the NAS and develop new procedures.

The Operational Concept efforts look at the changing roles and responsibilities of the Air Traffic workforce and the design of Advanced Facilities to derive the associated functional requirements imposed on the NAS infrastructure. Concept development includes preparing system specifications, roles and responsibilities, procedures, training, and certification requirements. These development and validation activities support NAS modernization through: (1) concept / scenario development; (2) concept validation; (3) simulation and analysis; (4) system design; (5) metric development; and (6) modeling.

**National Airspace System Weather Requirements**

The National Airspace System (NAS) Weather Requirements program develops aviation weather mission analysis, users' needs analysis, and NAS and domain level functional/performance requirements; allocates requirements to the National Weather Service and FAA components; and harmonizes U.S. aviation weather requirements and standards globally.

This work is done to address the high cost of weather to today's NAS where weather is responsible for 70 percent of delays over 15 minutes and contributes to 24 percent of accidents and 34 percent of fatalities. Up to 2/3 of weather delays are avoidable, but despite a continuous flow of improvements available through aviation weather science and implementation solutions aimed at providing better weather information, the significant impact of weather on aviation remains.

The NAS Weather Requirements program supports the goals of:

- Safety, Reduced Congestion, and Global Connectivity in the Department of Transportation Strategic Plan,
- NAS Capacity, NAS Safety, and Global Harmonization goals of the FAA Flight Plan, and
- NAS and Domain Level Weather Requirements Data Base for NextGen under a Core Activity in the 2012 Business Plan entitled "12S.108C1 - Core Activity: National Airspace System Requirements Development."

The NAS Weather Requirements program is composed of five components:

1. Core weather requirements development and allocation,
2. Global standardization of NAS weather requirements,
3. Integration of weather information into capabilities needed by ATC Decision Support,
4. Fast track development of concept and requirements documentation for targeted NowGen operational needs, and
5. Core safety assessment capability under the Safety Management System (SMS) for required new weather capabilities.

1. The <u>core weather requirements development</u> component gathers and assesses users' needs for weather information by FAA ATC, pilots, Flight Operations Centers (FOCs), and airport operators and converts those users' needs into NAS and domain level functional and performance requirements for weather information. The program data bases the NAS weather requirements and allocates them to providers including the National Weather Service (NWS), elements of FAA, and/or commercial providers. Work includes completing requirements

allocation to map requirement to organizations and systems; performing a user need analysis for convective forecasting, turbulence, ceiling and visibility and in-flight icing; performing a gap analysis between current and NextGen timeframes; developing plans for how weather requirements will be validated; updating the Preliminary Portfolio Requirements document with NNEW and NWP requirements; and developing governance rules for the process to approve and allocate weather requirements.

2. The global standardization component arises out of FAA's official role as the U.S. Meteorological (MET) Authority to the International Civil Aviation Organization (ICAO). The role of the MET Authority to promote adoption of U.S. meteorological information requirements, standards and practices for global use through International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPS). This work is accomplished through about 12 ICAO planning, study, and operations groups. Work will consist of mitigating U.S. differences to ICAO Annex 3 Meteorological Service for International Air Navigation after Amendments are approved; developing US positions on issues arising from the ICAO Volcanic Ash Task Force; developing various working papers for the World Area Forecast Systems Operations Group; developing a user needs analysis and functional requirements for Space Weather; and work to amend ICAO Annex 3 to incorporate the NextGen concept of the 4-D Weather Data Cube.

3. The objective of the NAS Weather Requirements program is to effectively integrate weather information into capabilities needed by ATC Decision Support. The weather information requirements of operational decision support processes and tools (e.g. CATM) are assessed and incorporated into overall NAS Weather Requirements data base. This program is responsible for base-lining the integration requirements while NextGen funded programs will assess the NextGen requirements for integration.

4. The NAS Weather Requirements program funds deep-dive concept and requirements development and documentation of targeted NowGen operational needs. These are operational needs that can be addressed in the near term, prior to the NextGen solution, to meet urgent needs, and that can transitioned smoothly into NextGen solutions at a later time. Examples include (1) improved airborne observations of weather (icing, turbulence, winds, temperatures, and water vapor) for immediate use by controllers, FOC's, ATC, and pilots and (2) provision of near-real-time wind information needed to reduce the impact of adverse winds aloft (compression problem) on arrivals and departures at major hubs such as NYC. This program will fund the necessary ConUse and requirements development/allocation of weather information to support these NowGen needs.

5. The NAS Weather Requirements program is maintenance of a core safety assessment capability under the Safety Management System (SMS) for required new weather information products and capabilities. As changes are proposed as FAA updates weather systems and incorporates new weather product, safety risk assessments are conducted to ensure that the changes do not introduce unacceptable risk into the NAS.

**Airspace Management Program**

This Airspace Management Program (AMP) supports increased capacity by funding the physical changes in facilities necessary to accommodate airspace redesign. Redesign projects will take on increased emphasis at both the national and regional levels to ensure that FAA is able to effectively manage the projected growth in demand at FAA facilities and airports.

Implementation of airspace redesign efforts frequently results in changes in the number and shape of operational positions or sectors, including changes to sector, area or facility boundaries. Transition to a new configuration after airspace redesign is implemented requires changes in the supporting infrastructure. These infrastructure changes can include communications modifications such as changes in frequencies, connectivity of radio site to the control facility, controller-to-controller connectivity; surveillance infrastructure modifications to ensure proper radar coverage; automation modifications to the host data processing or flight data processing; interfacility transmission modifications; additional consoles and communications backup needs; and modifications to the facility power and cabling.

## 3. Why Is This Particular Program Necessary?

### a. Runway Incursion Reduction Program

Multiple RIRP initiatives are currently being formulated as a result of strong interest from Congress, industry and other oversight agencies. Prioritization of those initiatives is likely to evolve during the FY 2010 cycle as a result of "Call to Action" mandates and runway incursion incident trends. All five Low Cost Ground Surveillance prototype sites will be funded under RIRP, along with the documentation to prepare the program for JRC 2A.

### b. System Capacity, Planning, and Improvements

This program will facilitate the modeling and analysis of new runways, airfield improvements, air traffic procedures, and other technological implementations to improve airport capacity and system efficiency. Study Teams evaluate alternatives for increasing capacity at specific airports that are experiencing or are projected to experience significant flight delays. Capacity studies provide recommendations and solution sets for improving airspace and airport capacity.

### c. Operations Concept Validation

The FAA is proceeding with NAS modernization based on the NextGen Operational Concept for 2025. Concept development and validation is necessary to investigate specific concept elements, and to drive out operational and technical requirements and implications for human factors, training and procedures. 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.

### d. NAS Weather Requirements

This program is necessary because (1) the needs for weather information in the operation of the NAS are not being adequately met today, (2) those needs will grow exponentially with the growth in traffic planned for in NextGen, and (3) weather science itself is changing rapidly. These three factors point to the need to continually reassess NAS aviation weather requirements, and this program is the only capability in FAA that addresses weather requirements at the NAS and domain levels. These high level requirements are an essential foundation of system level requirements needed to guide NWS production, FAA weather systems development, and U.S. leadership in global harmonization of aviation weather requirements with ICAO.

### e. Airspace Management Program

Airspace Redesign is the FAA initiative to ensure that all airspace related capacity benefits facilitated by AMP, facility changes and automation improvements are achieved. AMP 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. Modernization of airspace through AMP is characterized by the migration from constrained ground based navigation to the freedom of a Required Navigation Performance (RNP) based system.

Airspace redesign efforts seek to optimize Terminal, En Route and Oceanic airspace by redesigning airspace in NY/NJ/PHL, CAP, Western Corridor, HAATS, and Las Vegas. F&E funding is planned for NY/NJ/PHL, CAP, Western Corridor, and national integration efforts of the program office. Airspace redesign efforts will modernize airspace in support the new flows associated with new runways in Chicago (ORD) and in Las Vegas.

## 4. How Do You Know The Program Works?

### a. Runway Incursion Reduction Program (RIRP)

The demonstration, evaluation and transition of mature runway safety technologies have proven to reduce the incidence of high-hazard (Category A/B) incursions and ultimately reduce the risk of a runway collision. Early development, testing and maturation of viable technologies result in reduced technical, cost and acquisition schedule risk, with early delivery of runway safety benefits.

### b. System Capacity, Planning, and Improvements

Capacity studies identify the operational benefits and delay-reduction cost savings of capacity enhancement alternatives. Program output includes: flight operational data for use in performance analysis; system safety, delay, flexibility, predictability, and user access performance measures on a daily basis; and travel times within geometric areas and for route segments (arrival fix to runway, runway to departure fix, etc.). Output also includes methodologies and prototypes for measuring the benefits of airport, airspace, and procedural enhancements. PDARS is the Air Traffic Control System Command Center's (ATCSCC) primary tool for accessing radar data and provides an objective tool for operational planning, assessment and support of flow management initiatives. Integration of PDARS with Airport Surface Detection Equipment (ASDE-X); Out, Off, On, and In time data; restrictions data; and playbook scenarios will help to reduce ground delays. These enhancements, which encompass the final phase of PDARS development and are an ATO community requirement, are critical for analyzing surface operations and baselining OEP performance. PDARS is a well-accepted and often used tool at all major ATC facilities. The impact will be realized on assessments of such issues as wake turbulence mitigation, New Large Aircraft (NLA), Very Light Jets (VLJs), reduced separation criteria, and alternative flow management methods.

### c. Operations Concept Validation

This program uses a variety of validation techniques to explore, develop, and mature NAS operational concepts. The program undertakes research, study, and analysis to explore new opportunities for service delivery, solve problems with current operations, and define high level operational and performance requirements. The Advanced Technology Development and Prototyping (ATD&P) Operational Concept Validation program is doing the early concept research for advanced operational concepts to ensure they are well understood and are based on valid assumptions. Concepts such as High Altitude Airspace and Integrated Arrival Departure Airspace were researched and validated under this Program prior to transition to NextGen Pre-Implementation Programs to ensure the operational impacts were well understood.

### d. NAS Weather Requirements

The principal users of NAS weather information are people and decision support systems in the various components of air traffic services, FOC's, pilots, and airport operators. Their needs for weather information are identified from analysis of (1) what decisions they make for which weather information is needed (users needs analysis) and (2) what and how good that 2B05 information must be (functional and performance requirements). Requirements are allocated to research in cases where the information is not available or directly to providers where capabilities are already developed. This program funds core capability for these allocation functions with substantial supplemental funding from NextGen programs for future capabilities.

We know that the program works to establish NAS weather requirements in the manner described above. We also know from extensive commercial and government system engineering history and practices that requirements set in this manner are essential to development of complete and efficient systems and procedures.

### e. Airspace Management Program

AMP has successfully managed airspace projects throughout the NAS. Without the coordination of AMP, multiple projects supporting the same airspace could arise. By having a central location all airspace changes and efforts are coordinated ensure project efficiency and success to the NAS.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

Funding of $19,000,000 is required to continue all activities within the ATD&P budget line item.

A reduction to ATD&P will have to be developed carefully so that significant damage is not done to important milestones on which considerable importance is attached. Any reduction could have the effect of slowing down the progress of precursor programs or the effort of studying technical outcomes in the various solution sets. We urge that any cuts necessary be provided in a general sense so that they can be managed so that the least impact would occur in the ATD&P program.

**Detailed Justification for**

## 1A08 Next Generation Transportation System (NextGen) – System Development

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Next Generation Transportation System (NextGen) – System Development**

| Activity/Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| Next Generation Transportation System (NextGen) – System Development | $66,100,000 | $109,000,000 | $42,900,000 |

| R&D Activities | FY 2012 Estimated Cost |
|---|---|
| NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | $10,000,000 |
| NextGen - New Air Traffic Management Requirements | 37,000,000 |
| NextGen - Operations Concept Validation – Validation Modeling | 10,000,000 |
| NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction | 15,000,000 |
| NextGen - Wake Turbulence – Re-categorization | 3,000,000 |
| NextGen - Operational Assessments | 10,000,000 |
| NextGen - System Safety Management Transformation | 18,000,000 |
| NextGen - Staffed NextGen Towers (SNT) | 6,000,000 |
| Total | $109,000,000 |

For FY 2012, $109,000,000 is requested for Next Generation Transportation System (NextGen) – System Development. Major activities and accomplishments planned with the requested funding include:

NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)

- Continue Human Factors program to support System Development and Enterprise Architecture during Service Analysis

NextGen - New Air Traffic Management Requirements

- Develop an integrated approach between separation assurance and collision avoidance, with special attention to the safety case
  - Develop and execute implementation plan for NextGen Traffic Alert and Collision Avoidance System (TCAS)
  - Develop standards and guidance for advanced safety assurance methods and simulation
- Common Trajectory Requirements and Implementation Strategy
  - Continue analysis to allocate functions to systems, ground and airborne
  - Lab demonstration and fast time modeling of common trajectory
  - Continue risk assessment
- RNAV/RNP via Data Communications
  - Delivery across data communications

    - On the fly development, evaluation and delivery
- New Radar Requirements (Surveillance and Weather)
    - Surveillance & Weather Radar Replacement (SWRR) - Analyze Phase 1 technology maturity and deliver recommendation
    - SWRR - Phase 2 concept demonstrator procurement preparation and contract award
    - SWRR - provide for best practices
    - Complete CRDR artifacts for wind-shear detection services work package 1 (NAS EA DP WxA)
- Development of industry standards/requirements and to evaluate the benefits associated with the current phase
- Availability of ADS-B data matching or exceeding coverage from the five current Long Range Radars along the proposed RNAV routes
- Development of ADS-B only RNAV routes along the East Coast and the Caribbean

NextGen - Operations Concept Validation – Validation Modeling

- Initial set of detailed operational scenarios for the far-term
- Concept Benefits Modeling (230% increase modeled by the end of 2013)
- Simulation and Analysis of Integrated Time Based Flow Management
- Initial version of NextGen end-to-end concept for the far-term (2025) for internal review

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction

- Implement enterprise level EMS framework
- Integrate environmental information into key decision processes
- Initiate targeted EMS Communications and outreach initiatives
- Conduct second phase of pilot studies based on outcomes from the first phase
- Initiate NextGen EMS implementation efforts at priority stakeholder organizations with significant near-term environmental issues
- Assess the impacts on NAS wide operations (including environmental performance) of aircraft standards for noise and emissions
- Significant exploration and demonstration of environmental control algorithms for surface and terminal operational procedures
- Analyze environmental impacts of CLEEN technologies on the NAS and assess approaches to optimize aircraft system environmental performance
- Analyze environmental impacts of alternative fuels on the NAS and assess approaches to optimize aircraft system environmental performance
- Investigate impact on NAS wide operations of market based options, including Cap and Trade and carbon charges, to limit aircraft greenhouse gas emissions
- Perform analysis for EMS Environmental Impacts and Metrics
- Finalize NextGen EMS implementation in initial FAA organizations
- Analyze NEPA compliance within the EMS framework
- Coordinate NextGen data management with NextGen planners and developers
- Significant exploration and demonstration of environmental control algorithms for en route operational procedures to reduce aircraft fuel burn, emissions and noise

- Investigate potential operational changes required to optimize aircraft operations for greenhouse gas reductions

NextGen - Wake Turbulence - Re-categorization

- Engineering and analysis necessary to determine system implementation feasibility of the Leader/Follower wake turbulence mitigation separation processes and procedures that being developed by the project
- Continued data collection of aircraft wake turbulence to achieve statistical confidence in the leader/follower separations being proposed
- Determine best methods for incorporating key weather and aircraft performance parameters into determination of safe and capacity efficient separation processes and procedures
- Develop framework structure for dynamic wake mitigation processes and procedures

NextGen - Operational Assessments

- Continue Aviation Environmental Design Tool (AEDT) and Aviation Portfolio Management Tool (APMT) enhancements for NextGen local to NAS-wide environmental analysis
- Refine analysis and assessment of NAS-wide NextGen environmental mitigation and cost-beneficial options for decision support
- Continue exploration of options to integrate environmental assessment capability with NextGen NAS models
- Enhance Operational Performance Model to support NextGen Operational Assessments
- Enhance Safety Model to support NextGen Operational Assessments
- Apply models to assess NAS wide impacts of Task Force recommendations
- Perform NAS-wide environmental assessment of the current aviation system

NextGen - System Safety Management Transformation

- Annual system-level safety assessment capability is productized, and validated
- Transition to steady state operations for analysis of known risks, safety enhancements, and benchmarks
- Continue to evolve ASIAS ability to automatically monitor for unknown risk based on complex text mining capabilities and seamless data sources
- The FAA-wide SMS capability is matured with ASIAS and SSA providing operational and data support for interoperability among SMS programs within the FAA, and with stakeholders

NextGen - Staffed NextGen Towers (SNT)

- Business Case Analysis Report
- Implementation Strategy and Planning
- Basis of Estimate
- Risk Metrics for final investment analysis
- Updated Enterprise Architecture products and amendments
- Completion of system safety documentation
- Maintain SNT equipment at Dallas/Ft. Worth (DFW) (field test site)

## 2. What Is This Program?

The Joint Planning and Development Office's (JPDO) 2004 Integrated Plan identified three key performance targets to achieve the desired capability by 2025. These are: (1) satisfy future growth in demand up to three times current levels; (2) reduce domestic curb-to-curb transit time by 30 percent; and (3) minimize the impact of weather and other disruptions to achieve 95 percent on time performance. Achievement of these targets by 2025 will be a

challenge. In addition, an increase in demand of three times the current levels could cause an equivalent increase in the number of accidents, aircraft noise and the volume of emissions, as well as the Air Traffic Control (ATC) workload. This line item provides the research and development required to resolve these potential problems:

**NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**

The significant features of this program are the development of a Human System Integration (HSI) Roadmap to complement the other roadmaps in the Enterprise Architecture, the development of a common air traffic workstation to accommodate the various NextGen technologies when providing services, and a series of integrated workstations that deliver the required services using the common workstation. The HSI Roadmap will explain the roles and responsibilities of the actors in the NAS (air traffic controllers, pilots, dispatchers, traffic managers, etc.), their interactions with NextGen technologies, linkage to required changes to staffing, personnel selection, training, and required research and development activities in the human factors area that are needed to realize the NextGen vision.

Research will examine the roles of ANSP and facilities maintenance personnel to ensure safe operations at increased capacity levels and the way the roles would be best supported by allocation of functions between humans and automation. The success of new NextGen technologies hinge upon the actions of air traffic service providers using new decision support tools or automation to achieve the operational improvement. The effectiveness of each of these solutions is contingent upon the proper human engineering of the new capability. This human engineering is not just the visible interface, but the characteristics of the tool and how the tool is used in the context of the work.

**NextGen - New Air Traffic Management Requirements**

The NextGen - New ATM Requirements 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." 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. For FY 2012, new ATM requirements will focus on four areas: TCAS, Airborne SWIM, Weather/surveillance radar, and Trajectory modeling.

TCAS had extraordinary success in reducing the risk of mid-air collisions. Now mandated on all large transport aircraft and installed on many smaller turbine powered aircraft, TCAS has been in operation for over a decade and has been credited with preventing several catastrophic accidents. TCAS is a critical decision-support system in the sense that it has been widely deployed (on more than 25,000 aircraft worldwide) and is continuously exposed to a high-tempo, complex air traffic system.

TCAS is the product of carefully balancing and integrating sensor characteristics, tracker and aircraft dynamics, maneuver coordination, operational constraints, and human factors in time-critical situations. Missed or late threat detections can lead to collisions, and false alarms may cause pilots to lose trust in the system and ignore alerts, underscoring the need for a robust system design. NextGen airspace will have increased capacity due to decreased aircraft separation made possible by new technologies and new procedures, such as the increased use of RNAV/RNP routes and Closely Space Parallel Runways operations. As aircraft separation is decreased, it is critical that TCAS be made even more accurate and dependable to ensure continued pilot trust in the system.

Airborne System-Wide Information Management (SWIM) - The current development of SWIM includes a gap in servicing airborne clients. European concepts of SWIM, built by SESAR, cover this. Thus there is a need for concepts that would harmonize the FAA and SESAR SWIM systems. There is a need to determine if airborne SWIM is a requirement or an optional feature. Airborne SWIM will identify performance and bandwidth requirements for airborne internet capability to support the exchange of ATM information such as weather, aeronautical information and flight information to support Traffic Flow Management. The program will develop standards and publish standards that will ensure harmonization with SESAR SWIM systems.

Trajectory-based operations require multi-domain interaction with aircraft trajectories in the far-term future. As a step towards that end, trajectory operations (TOps) have been defined to focus on the NextGen midterm. The TOps activity defined an initial cross-stakeholder, common view of the utilization of Communications, Navigation and Surveillance (CNS) components related to TOps in the midterm. The Trajectory modeling project will develop NAS-wide trajectory-related requirements for Mid-Term automation systems. System level requirements will then be developed and allocated across the automation systems. The project focuses on defining what trajectory information

and exchange methods are required, which trajectory prediction types are required and what is required to achieve trajectory interoperability across multiple domains.

The FAA plans to deploy Automated Dependent Surveillance-Broadcast (ADS-B) critical services (ATC separation services) in the New York terminal areas and on the surface at LaGuardia, Kennedy, and Newark airports in FY 2011. To support operational validation, this activity will support accelerating the equipage of New York-based JetBlue Airways to validate the Best Equipped/Best Served concept in the New York metro area and along the East Coast. JetBlue will equip aircraft with DO-260B-compliant ACSS ADS-B "In" & ADS-B "Out" avionics, certify the system, and demonstrate the operational benefits in revenue service.

**NextGen - Operations Concept Validation – Validation Modeling**

The NextGen - Operations Concept Validation – Validation Modeling Program addresses the development and validation of future end-to-end (flight planning through arrival) operational concepts with special emphasis on researching changes in roles and responsibilities between the FAA and airspace users (e.g., pilots and airlines), as well as the role of the human versus systems, that will increase capacity and improve efficiency and throughput. It will identify procedures that can decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS.

Furthermore, this program works toward developing operational methods that will meet the NextGen goal of expanding capacity by satisfying future growth in demand as well as reducing transit time (reduce gate-to-gate transit times by 30 percent and increasing on-time arrival rate to 95 percent). The research will provide an end-to-end NAS Operational Concept and a complete set of scenarios that describe operational changes for NextGen solution sets including: Trajectory Based Operations (TBO); High Density Arrivals/Departures and Airports; Flexible Terminal and Airports; Collaborative Air Traffic Management; and Networked Facilities. These products will be developed first for the Midterm (2018) and subsequently for the NAS in 2025.

**NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction**

Robust aviation growth could cause commensurate increases in aircraft noise, fuel burn, and emissions. Environmental impacts could restrict capacity growth and prevent full realization of NextGen. NextGen environmental goals are to reduce the system wide aviation environmental impacts in absolute terms notwithstanding the growth of aviation. The solution is to reduce the increased environmental impacts of aviation through new operational procedures, technologies, alternative fuels, policies, environmental standards and market based options to allow the desired increase in capacity. The environmental and energy development efforts under this program will lead to assessment of solutions to reduce emissions, fuel burn, and noise towards achieving NextGen environmental goals. The effort specifically focuses on explorations, simple demonstrations as well as methods to integrate these environmental impact mitigation and energy efficiency options with the NextGen infrastructure in a cost-beneficial and verifiable manner.

There are two environmental projects that support this program: Environmental Management System (EMS) and Environment and Energy.

The EMS will manage, mitigate and verify progress towards achieving the environmental goals in an iterative manner based on planning, implementing, measuring the effects of, and adjusting solutions that are based on well developed and demonstrated environmental impacts metrics. The EMS approach will allow optimization of advance options for noise, fuel burn, and emissions reduction to enable the air traffic system to handle growth in demand.

Environment and Energy - Advanced Noise and Emission Reductions: This program will employ proven capabilities as well as NAS-wide implementation of mitigation solutions through advanced aircraft (both engine and airframe) technologies, alternative aviation fuels and improved environmental and energy efficient operational procedures. These are the keys to reduce significant environmental impacts while improving the energy efficiency of the system.

**NextGen - Wake Turbulence – Re-categorization**

This program focuses on satisfying the capacity demands of future aviation growth. The last full review of wake separation standards used by air traffic control occurred nearly 20 years ago in the early 1990s. Since then, air carrier operations and fleet mix have changed dramatically, airport runway complexes have changed and new aircraft

designs (A-380, very light jets, unmanned aircraft systems) have been introduced into the NAS. The 20 year old wake separation standards still provide safe separation of aircraft from each other's wakes but it no longer provides the most capacity efficient spacing and sequencing of aircraft in approach and en-route operations. This loss of efficient spacing is adding to the gap between demand and the capacity the NAS can provide.

This program is part of a joint EUROCONTROL and FAA program that has reviewed the current required wake mitigation aircraft separations used in both the USA's and Europe's air traffic control processes and has determined the current standards can be safely modified to increase the operational capacity of airports and airspace that will have heavy operational demand in the NextGen era. Recently, work was done to accommodate the A380 class of aircraft and work continues to address introduction of other large aircraft into the NAS. This program builds on that joint work and is accomplishing a more general review to include regional jets, Unmanned Aerial Vehicles, micro jets, etc.

The next phase of the Wake Re-Categorization program is now underway. By 2014, this program will develop sets of tailored leader aircraft and follower aircraft wake separation standards whose application would depend on flight conditions and aircraft performance; resulting in being able to get more aircraft into and out of airports and in the same volume of airspace.

**NextGen - Operational Assessments**

The NextGen - Operational Assessment project focuses on three areas: Systems Analysis, Environmental Analysis, and Safety Assessments.

In the Systems Analysis area, an initial concept of use has been developed and the stakeholder RTCA Trajectory Operations sub-work group has been formed under the RTCA ATMAC (Air Traffic Management Advisory Committee) Requirement and Planning Work Group. This group is to deliver a Concept of Use for Trajectory-Based Operations by April 2010. This Concept of Use will form the starting point from which ATM requirements for trajectory modeling will be derived.

The Environmental Analysis program enables NextGen by providing comprehensive NextGen local to NAS-wide environmental assessment of the aviation system, analyzing the benefits of environmental impacts mitigation options and providing the guidance on environmentally effective and optimally cost-beneficial solutions to reduce the environmental constraints that might otherwise hinder capacity increases.

NextGen environmental analyses require that external forecasts of operations, such as the FAA Terminal Area Forecast (TAF), be combined with fleet technology assumptions to generate future year fleet and operations sequences. The plan is to develop a fleet and operations sequence module that is leveraged for U.S. NextGen analysis and compatible with Aviation Environmental Design Tool (AEDT) Regional and Aviation Portfolio Management Tool (APMT) Economics analysis requirements. This would include compatibility with the FAA TAF U.S. city-pair structure; and, once completed, would support the FAA Aviation Environmental Tools Suite and other aviation analysis tools.

This Safety Assessments project will continue to conduct system safety assessments, environmental-specific assessments, system performance evaluations, and risk management activities. This research will include initial NAS-wide assessment of methods to mitigate NextGen environmental impact and developing cost-beneficial options to support decision making. This research will also continue to explore integration of advanced performance assessment capability with NAS models for other NextGen programs.

**NextGen - System Safety Management Transformation**

This program provides research leading to a comprehensive and proactive approach to aviation safety in conjunction with implementation of NextGen capacity and efficiency capabilities. The implementation of these capabilities will require changes in the process of safety management, the definition and implementation of risk management systems, and management of the overall transformation process to ensure that safety is not only maintained but improved. A core foundation of the system safety transformation is the introduction of system-wide access and sharing of aviation safety data and analysis tools within the aviation community, providing safety resources that are integrated with operations of aviation industry stakeholders.

Capabilities to merge and analyze diverse sets of aviation information will be provided to expose and track precursors to incidents/accidents, allowing safety analysts within the FAA and aviation industry to understand emerging risks before they become potential safety issues. This research also enables safety assessments of proposed NextGen concepts, algorithms, and technologies and provides system knowledge to understand economic (including implementation) and operational and performance impacts (with respect to safety) of NextGen system alternatives. A demonstration will be conducted at a National Level. System Safety Assessment working prototype that will proactively identify emerging risks as NextGen capabilities are defined and implemented.

**NextGen - Staffed NextGen Towers (SNT)**

With demand in air transportation expected to grow significantly in the NextGen timeframe from today's traffic levels, there is a need for new, innovative ways to provide tower services. In response to this challenge, the Joint Planning and Development Office (JPDO) outlined a future air traffic system in which tower services are provided from remote locations without requiring the air traffic provider to have direct visual observation of the airport environment. This concept is referred to as a NextGen - Staffed NextGen Tower (SNT). SNT plans to address airport capacity problems by increasing the capacity of high-density hub airports in low visibility and night conditions and by improving services at the satellite airports. Through a companion vision for Automated NextGen Towers (ANT), it also plans to increase the capacity of the presently non-towered airports.

SNT is planned for medium and high density airports as these airports are likely to have most aircraft equipped with avionics that will support SNT operations. ANT is planned for non-towered and low density airports. The development of both the SNT and ANT automated tower capability are planned as part of this project. The SNT and ANT concepts will require substantial concept engineering funding as advanced decision support tools will be needed for such events as conformance monitoring using aircraft movement tracking; advanced Data Communications to ensure safe operations at non-towered airports; and use of aircraft derived data (ADD) for identification of off-nominal events.

This project is in the concept engineering phases providing the necessary requirements, specifications and supporting documentation leading to an investment decision on an FAA system that should increase throughput and safety; provide for cost-effective expansion of services to a larger number of airports; and reduce tower construction costs. Requirements, operational procedures, and cost benefit information will be generated and documentation refined in preparation for the initial investment decision.

## 3. Why Is This Particular Program Necessary?

The solution involves four areas of research and development – safety, capacity, human factors, and environment. The safety research includes expanding information sharing and data analysis to identify and mitigate risks before they lead to accidents. The capacity research develops new air traffic management systems to support NextGen measures and NextGen concepts to determine if they can achieve the targets for 2025; and develops flexible airspace categories to increase throughput. The human factors research provides higher efficiency levels in air traffic control and identifies the new role for controllers as more responsibility shifts to the flight crew. The environmental research explores new procedures, and adapts new technologies and fuels into the National Airspace System (NAS) to reduce emissions, fuel burn, and noise; and includes demonstrations, methods to adapt the current infrastructure, and estimates of costs and benefits.

## 4. How Do You Know The Program Works?

Projects in the NextGen - Systems Development solution set encompass the entirety of the airspace and airports within the NAS. Since its beginning, NextGen - Systems Development has made great progress expediting the integration of new technologies within these domains. Below are examples of such successes and planned activities that have and will continue to improve the overall operations within the NAS.

NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)

- Developed Human Error Database Structure and Results of Preliminary Human Hazard Analysis
- Integrated NextGen Workstation – Initial midterm NextGen En route, TRACON and Tower Workstation Requirements

NextGen - New Air Traffic Management Requirements

- Define Baseline Requirements for Future TCAS Systems
- Define required level of TCAS Independence for Future Systems
- Develop Final Airborne SWIM Concept of Use
- Initial trajectory information and exchange requirements

NextGen - Operations Concept Validation – Validation Modeling

- Refined NextGen Midterm Concept of Operations for the NAS to provide the overall midterm operational framework for NextGen

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction

- Assess the NAS-wide benefits of CLEEN aircraft technologies and alternative fuels
- Identify opportunities for environmental gains for Taxi/Ramp, Terminal and En route area operations
- Demonstration of environmental control algorithms used in Taxi/Ramp, Terminal, and En route procedures

NextGen - Wake Turbulence - Re-categorization

- Provide recommendation package to International Civil Aviation Organization (ICAO) on new wake separation standards (Phase 1)

NextGen - Operational Assessments

- Systems Analysis - Deliver NextGen Performance Assessment Annual Report
- Develop a framework and models to support environmental assessment of the NAS-wide system
- Develop a framework and models to support economic assessment of the NAS-wide system

NextGen - System Safety Management Transformation

- Expand ASIAS to achieve statistically significant coverage of NAS operations

NextGen - Staffed NextGen Towers (SNT)

- Complete standards and alternatives development in support of an initial investment decision and OMB Exhibit 300 preparation
- Maintain SNT equipment at DFW (field test site)

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

$109,000,000 is required to allow for continued execution of work within the NextGen - System Development solution set. The FY 2012 work will satisfy future growth in demand up to three times current levels, reduce domestic curb-to-curb transit time by 30 percent and minimize the impact of weather and other disruptions to achieve 95 percent on time performance. NextGen - System Development provides the research and development required to resolve these potential problems. In addition, an increase in demand of three times the current levels could cause an equivalent increase in the number of accidents, aircraft noise and the volume of emissions, as well as the ATC workload. With a reduction in funding, achievement of these targets and solving these issues by 2025 will not occur.

With reduction in the NextGen - System Development budget the NextGen - Staffed NextGen Towers program will not be funded. As a result the key benefits contained in this program will be affected. These benefits include the following:

- Increased capacity at airports in low visibility and night conditions
- Reduced risk of runway incursions
- Enhanced safety of the FAA's air traffic systems

The reduction of facility operational and construction costs will not be realized, as well as the ability to provide air traffic services to additional airports with low incremental costs.

A further reduction in the NextGen - System Development program both NextGen - Staffed NextGen Towers and Operations Concept Validation, Validation Modeling will not be fully funded. As a result key benefits contained in these programs will be affected. Along with the benefits lost from NextGen - Staffed NextGen Tower mentioned above, loss of the NextGen - Operations Concept Validation -NextGen – Validation Modeling program will result in the failure to measure the proposed NextGen system alternatives to determine whether or not the system meets the capacity targets of NextGen. The development of methods, metrics, and models to measure capacity improvements will not be completed.

A reduction to NextGen will have to be developed carefully so that significant damage is not done to important milestones on which considerable importance is attached. Any reduction could have the effect of slowing down the progress of precursor programs or the effort of studying technical outcomes in the various solution sets.

**Detailed Justification for**

# 4A09A Center for Advanced Aviation Systems Development

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 – Center for Advanced Aviation Systems Development**

| Program Activity | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| **Center for Advanced Aviation Systems Development** | $24,124,000 | $22,785,000 | -$1,366,000 |

For FY 2012, $8,157,000 is requested for the research and development portion of the Center for Advanced Aviation Systems Development (CAASD) Program. The research and development portion of the CAASD program is approximately 28.3% of the entire program. The Federally Funded Research and Development Center (FFRDC) Executive Board has approved the sixth edition of the FAA CAASD Long Range Plan (FYs 2011 – 2015).

## What Is This Program?

CAASD is a FFRDC, operating under a Sponsoring Agreement with The MITRE Corporation. CAASD has unique knowledge, skills, and capabilities in aviation research, systems engineering, and analysis. CAASD also conducts a continuing program of research, development, system architecture, and high-level system engineering to meet FAA's long-term NAS requirements. MITRE has developed a broad and deep understanding of the entire installed NAS, including NAS systems and their interdependencies. MITRE's unique experience and expertise has been indispensable to the FAA in helping define and validate key concepts and evolutionary paths to achieve NextGen. Its contributions will continue to be critical to FAA in transforming the nation's air transportation system in an effective and timely manner. A Product Based Work Plan (PBWP) is developed within the context of the FAA Flight Plan and the NextGen Implementation Plan, National Airspace System (NAS) Enterprise Architecture, National Aviation Research Plan (NARP), other agency long-range plans, and the FAA CAASD Long Range Plan (FY 2011- 2015). The CAASD PBWP and Long Range Plan, both approved by the FAA's FFRDC Executive Board, define an outcome-based program of technically complex research, development, and system engineering assignments designed to support the goals and requirements of the NAS and the NextGen. CAASD activities include:

NAS and NextGen Systems Integration and Evolution - Improve understanding of the future environment, including anticipated demand at airports and for airspace; anticipate the impact of planned improvements on future capacity; develop and integrate the NextGen enterprise architecture, operational concepts, capability action plans, and roadmaps to achieve an integrated evolution and align agencies' enterprise architectures; analyze NAS-wide strategic issues and ensure their alignment with the evolving NextGen architecture.

Communications Modernization - Conduct engineering analysis, communications network definition, and transition strategy studies for the FAA's Voice Communications and System-Wide Information Management programs; conduct spectrum analysis focusing on strategic issues related to the availability of adequate spectrum resources to support aeronautical communications for NextGen operational concepts.

Performance Based NAS - Conduct technical analyses to identify airports and runways that will benefit from Required Navigation Performance and Area Navigation procedures allowing for increases in capacity and efficiency of traffic flows; develop algorithms and prototype performance case analyses to validate Flight Standards procedure development tools; analyze and model aspects of navigation assets, including Wide Area Augmentation System, Local Area Augmentation System, divestiture of navigation aids, modernization of Global Positioning System, and interoperability with other Global Navigation Satellite Systems.

En Route Evolution - Perform system engineering analyses for new technologies, capabilities and procedures for the en route system architecture and operational applications that enables NextGen technologies to increase capacity and improve operational safety; conduct analyses to identify and mitigate key technical and operational risks for specific NextGen mid-term capabilities; validate the operational feasibility and expected efficiency and productivity gains for

the set of NextGen mid-term capabilities; conduct benefit and cost analyses of key NextGen mid-term capabilities, and assess the prioritization of these capabilities.

Terminal Operations and Evolution - Provide technical and operational insight into terminal systems and operations that can be used to safely permit reduced separation standards and/or significantly increase overall system capacity and productivity; provide technical and operational expertise to enhance the quality and efficiency of Terminal Radar Approach Control (TRACON) controller training, to allow for reduced training time and cost, improve trainee success rates, and improved workforce capabilities (e.g., reduced operational errors, improved productivity).

Airspace Design and Analysis - Structure and execute technical analyses that will inform FAA and Industry decisions on airspace design and management; investigate, innovate, and develop modeling, simulation, and analysis capabilities facilitating airspace design; explore issues that influence strategic airspace management and design policy, such as sectorization concepts. Integrate technical analyses and design management efforts to provide a national, system-wide optimization of airspace.

NAS System Operations - Assess system performance; develop improved analytic techniques and capabilities for system operations analysis; develop improved measurement techniques for assessing operations; develop and evaluate new metrics to measure overall NAS operational performance; improve the FAA's responsiveness to customer issues and improve traffic management strategies; design, model, and assess new system operations procedures for new capabilities and airspace changes that will be implemented in the near future.

Traffic Flow Management (TFM) Operational Evolution - Provide assessment of concept maturity, operational feasibility and implementation risks, including identification of cross-domain dependencies; collaborate with NAS users, other TFM researchers, and FAA contractors to create consensus on new capabilities, procedures, and priorities for improving TFM safety, efficiency, predictability, and productivity; translate concepts into requirements and assess the impact of enhancement capabilities on the TFM modernization system.

Aviation Safety - Perform technical analyses of NAS-wide accident and runway incursion risk to identify airports or specific types of operations with the highest risk, and prioritize implementation of appropriate operational and technological mitigations, leading to a reduction in accidents and runway incursions; develop metrics and processes that allow FAA to proactively identify potential safety issues.

Mission Oriented Investigation and Experimentation (MOIE) - Develop tools and techniques for studying system capacity, throughput, performance, system dynamics and adaptation to technology and policy driven change; strengthen the systems engineering skills and tools of the FFRDC.

NAS-Wide Information System Security - Develop technical guidance to engineer security capabilities into the NAS; provide guidance on security threats, technology, standards, and practices to evolve Information System Security to adapt to changing threats and technology advances; create an IT infrastructure that will be resilient, flexible, and adaptable, and provide a defense-in-depth strategy.

Broadcast and Surveillance Services – Conduct research for Automatic Dependent Surveillance-Broadcast (ADS-B) ground and cockpit-based solutions; prototype basic and advanced ADS-B applications that will result in improved efficiency and capacity in the NAS and improve airspace access and national security; assess the impact of ADS-B on safety, capacity, and efficiency benefits; develop domestic and international requirements and engineering standards for future ADS-B applications.

Special Studies, Laboratory and Data Enhancements - Provide an integrated research environment that ensures individual research activities, prototypes, and capabilities can be brought together with the appropriate mixture of fidelity and flexibility to facilitate integrated investigations, compressed spiraling of operational concepts and procedure development.

## Why Is This Particular Program Necessary?

The FAA, along with its aviation partners, faces a broad range of technically complex challenges to achieve the NextGen. Although FAA employees are highly knowledgeable about those technologies, it would be impossible to employ all of the research, science and engineering expertise needed to develop and improve them. The FAA requires highly specialized simulation and computer modeling capabilities that it does not have in-house and are only available through an FFRDC that has unique knowledge, skills, and capabilities in aviation research, systems

engineering and analysis. In addition, CAASD's charter permits access to sensitive and confidential agency information and data that is not normally available to support contractors. CAASD's expertise is critical to FAA in transforming the nation's air transportation system in an effective and timely manner.

## How Do You Know The Program Works?

While the relationship between the FAA and CAASD can be described as a well-functioning partnership, the FFRDC entity must be managed and focused to perform the most important work of the agency, while conserving scarce resources. Periodic program assessments are employed and a structured management framework is in place to ensure that completed work yields effective and efficient results. A major review is conducted every five years to validate and justify the continued need for the FFRDC as well as to assess its efficiency and effectiveness. Two key components of the FAA's ongoing CAASD management program are the FAA's FFRDC Executive Board (FEB) and the Outcome Management Team (OMT). The FEB meets semi-annually to approve Outcomes, formulate and review goals and objectives of CAASD programs, and determine broad policy matters. The OMT, chaired by the Director, Systems Engineering and Safety, is comprised of senior managers responsible for ensuring the optimal allocation of resources, maximizing benefits from CAASD products and services, and ensuring that work performed by CAASD is consistent with the mission and criteria approved for the FFRDC. This senior management involvement illustrates the importance the FAA places on CAASD. The CAASD PBWP, the traditional foundation for CAASD planning, defines the research, systems engineering, analysis activities, and products targeted to achieve defined Outcomes. The FAA CAASD Long Range Plan maps out projected requirements for five years. CAASD is evaluated periodically using several structured mechanisms to ensure FFRDC efficiency and effectiveness.

## Why Do We Want/Need To Fund The Program At The Requested Level?

CAASD support over the past decade has proven to be an invaluable strategic asset to the Department of Transportation, the FAA, and the U.S. Government as a whole. Establishing a stable source of funding, along with a long-term contractual relationship, is in the best interest of the public and the FAA because it permits economies that can only be supported with an established work force and provides continuity of services for an efficient and effective use of an experienced professional staff. High quality research, systems engineering, and analytical capabilities help FAA meet the technically complex challenges in the NAS. CAASD efforts support all Flight Plan goals across the board and the FFRDC continues to play a key role in defining NextGen. Its expertise is critical to FAA's efforts to transform the nation's air transportation system in an effective and timely manner.

**Detailed Justification for**

## Airport Cooperative Research Program

### 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 Airport Cooperative Research Program**

| Program/Component | FY 2010 Actual | FY 2012 Request | Change FY 2010 – FY 2012 |
|---|---|---|---|
| Airport Cooperative Research Program | $15,000,000 | $15,000,000 | $0 |

| R&D Activities | FY 2012 Estimated Cost |
|---|---|
| Airport Cooperative Research - Capacity | $5,000,000 |
| Airport Cooperative Research - Environment | 5,000,000 |
| Airport Cooperative Research - Safety | 5,000,000 |
| Total | $15,000,000 |

For FY 2012, FAA requests $15 million, 2 positions and 1.5 full-time equivalents (FTE) which is 0.5 FTE over the FY 2010 enacted level. Position increases and inflationary costs will be absorbed within the requested level.

Funding in FY 2012 will support the following key outputs and outcomes:

- Environmental research is conducted with an objective to reduce community exposure to noise, reduce aviation emissions, and address water quality; and
- ACRP will select approximately 30 research topics to fund in FY 2012. Research reports will be for research studies that develop handbooks and best practices and other research that will provide information for airport owners, operators, and consultants in the areas of airport safety, airport management and financing, airport environmental and sustainability, airport planning.

### 2. What Is The Program?

This program supports DOT's Safety goal (*Reduction in transportation-related injuries and fatalities)*, Economic Competitiveness goal (*Maximum economic returns on transportation policies and investments*), and Environmental Sustainability goal (*Reduced transportation related pollution and impact on ecosystems*).

ACRP was authorized by section 712 of Vision 100 – Century of Aviation Reauthorization Act. The Secretary of Transportation signed a Memorandum of Agreement among DOT, FAA, and National Academy of Sciences to implement the ACRP. The Secretary also appointed the 13 members of the board of governors of the ACRP. The Transportation Research Board (TRB) of the National Academy is administering the program. The ACRP board of governors has met every six months to review progress and select additional topics to fund. Over 100 submitted topics will be reviewed at the July 2010 meeting and the most promising topics selected for subsequent contract award. The Board of Governors selects the highest rated topics, subject to the funds available, to proceed to contract solicitation and award. The TRB appoints expert technical panels for each selected project. The technical panels convert the topics into requests for proposals to select contractors to perform the research. The panels also monitor each project to ensure it stays on track and meets project deliverables.

ACRP conducts research studies that provide information to airports in the form of handbooks and best practices among other research on issues of interest to airports in the areas of safety, airport management, airport financing, airport sustainability, and airport planning. Recent ACRP reports published included such studies as:

- Innovative Approaches to Addressing Aviation Capacity in Coastal Mega-Regions;
- Enhancing Land Use Compatibility; and
- Airport Sustainability.

Anticipated FY 2012 accomplishments include:

- ACRP awards contracts that are selected for funding;
- ACRP Board of Governors will meet to select projects to fund; and
- TRB appoint project technical panels to monitor previous research projects awarded.

### 3. Why Is This Particular Program Necessary?

The Airport Cooperative Research Program was established by Congress to conduct research on issues common to airports but that is not being done under other federal research programs and is not capable of being done by individual airports. The research is selected from topics submitted by airports and the aviation community. The Board of Governors consists of airport executives, airport associations, and federal agencies that ensure the projects selected will benefit airports and will not duplicate ongoing federal research.

### 4. How Do You Know The Program Works?

We know the program works by the interest of the airport community that submits over 100 topics for research each year. We also track the ACRP performance by the number of research studies underway and the number of reports published. We have also initiated a dissemination project to improve the methods used to make the published reports available to airports and consultants using electronic methods and web based availability, and to develop statistics on the number of requests for ACRP reports.

### 5. Why Do We Want/Need To Fund The Program At The Requested Level?

The airport community and the airport associations have been strong supporters of ACRP. Congress approved increasing ACRP in FY 2009 by $5 million to a total of $15 million with the additional money being focused on airport environmental research. A reduction would mean that the program would fund one to three fewer research studies being funding in FY 2012.

**Detailed Justification for**

# Airport Technology Research Program

## 1. What Is The Request And What Will We Get For The Funds?

**FY 2012 Airport Technology Research Program**

| Program/Component | FY 2010 Actual | FY 2012 Request | Change FY 2010 – FY 2012 |
|---|---|---|---|
| Airport Technology Research | $22,472,000 | $29,250,000 | $6,778,000 |

| R&D Activities | FY 2012 Estimated Cost |
|---|---|
| Airport Technology Research - Capacity | $12,025,000 |
| Airport Technology Research - Environment | 1,500,000 |
| Airport Technology Research - Safety | 15,725,000 |
| Total | $29,250,000 |

For FY 2012, the Associate Administrator for Airports requests $29.25 million, 25 positions and 24 FTE to fund the Airport Technology Research program. This is an increase of $6.8 million (30 percent) over the FY 2010 enacted level. The request will fund research in the areas of airport pavement, airport marking and lighting, airport rescue and firefighting, airport planning and design, wildlife hazard mitigation, runway surface technology, and visual guidance. The results of this research are used in updating Advisory Circulars, manuals, and technical specifications that airports rely on when expending Airport Improvement Program (AIP) grant funds. We will also initiate a program to conduct noise measurements across airport communities and concurrent public surveys and sleep disturbance studies to collect data that will be used to guide national aviation noise policy, determinations of community impacts from aircraft noise, federal land use compatibility guidelines around airports, and noise mitigation funding.

The table below summarizes the research activities funded by this request.

**FY 2012 Airport Technology Research (ATR) Projects ($000)**

| Research Project | FY 2010 Actual | FY 2012 Request | Increase/ Decrease |
|---|---|---|---|
| Advanced Airport Pavement Design | 468 | 300 | -168 |
| Pavement Design & Evaluation Methodology | 936 | 1,000 | 64 |
| National Airport Dynamic Tests | 2,850 | 3,000 | 150 |
| Heavy vehicle simulator | 0 | 500 | 500 |
| Field Instrumentation & Testing | 750 | 750 | 0 |
| Improved Paving Materials and Lab | 1,550 | 2,000 | 450 |
| Non-Destructive Pavement Testing | 1,537 | 1,500 | -37 |
| Center of Excellence | 312 | 250 | -62 |
| Airport Planning | 364 | 500 | 136 |
| Airport Design | 728 | 700 | -28 |
| Operation of New Large Aircraft (NLA) | 800 | 700 | -100 |
| Composite Materials Firefighting | 453 | 500 | 47 |
| Airport Wildlife Hazards Abatement | 2,500 | 2,550 | 50 |
| Airport visual guidance/runway incursions reduction | 1,200 | 3,900 | 2700 |
| Airport Visual Guidance test bed | 2,000 | 1,100 | -900 |
| Aircraft Braking friction | 1,607 | 3,250 | 1643 |
| Aircraft Noise Annoyance Data and Sleep Disturbance Around Airports | 0 | 1,500 | 1500 |
| Surface Operations | 312 | 300 | -12 |
| Rescue and Fire Fighting | 624 | 700 | 76 |
| **Subtotal—Contracts** | **18,991** | **25,000** | **6,009** |
| In-House (FTEs, ) | 3,481 | 4,250 | 769 |
| **TOTAL** | **22,472** | **29,250** | **6,778** |

A new initiative on the Aircraft Braking and Friction performance was started in FY 2010 under the general heading of Surface Operations. This area covers runway surface maintenance during summer and winter months, improvements in the very successful arresting systems research and development (R&D), and investigating the braking performance of aircraft on contaminated runways. In FY 2012 we are requesting $3.25 million in the area of Aircraft Braking and Friction performance. This is a collaborative effort with the U. S. Air Force and several private engineering firms to evaluate the performance of current generation Auto Brake Systems with Antiskid (ASBS) in decelerating large commercial airplanes on contaminated runways. The product of the evaluation will be a Math Simulation Model capable of predicting landing distances for decelerating and stopping large commercial airplanes on contaminated runways.

This R&D effort was necessitated by the National Transportation Safety Board (NTSB) safety recommendations, dated October 16, 2007, in response to a commercial airplane accident which occurred at Chicago Midway International Airport (MDW) on December 8, 2005. The accident involved a Southwest Airlines (SWA) Boeing 737-7H4 airplane that ran off the runway during landing. The actual landing distance of the airplane significantly exceeded the estimated landing distances calculated by the SWA On-Board Performance Computer. This accident illustrates the current lack of accurate data for predicting landing performance of large airplanes with ASBS on runways covered with water, ice, or snow.

The research effort will be conducted to develop a Math Modeling Simulation which accurately predicts the performance of current generation ASBS in decelerating large commercial airplanes on contaminated runways. Data and performance characteristics extracted from Dynamometer Testing and Simulator Testing and Evaluation will be used in the validation of the Math Modeling Simulation. The Math Modeling Simulation will identify performance parameters required to predict airplane landing distances.

The objective of this initiative is to identify measurable airplane performance parameters which can be utilized to accurately predict airplane landing distances on contaminated runways. It is anticipated that these parameters would be measurable using existing airplane instrumentation or recorded by the Flight Data Recorder, and communicated through data transmission systems. These parameters could be translated into estimated landing distances and conveyed to pilots approaching the particular runway.

An increase of $1.5 million is requested for a new initiative to investigate the effects of aircraft noise near representative U.S. airports. Community annoyance, impacts on schools and other noise sensitive institutions, and land uses due to aircraft noise have historically driven public opposition to airport development and changes in flight procedures near airports. Measuring subjective reactions through social surveys is accepted as the most direct method for determining how people in a community respond to noise. The seminal work by Schultz published in 1978 developed a correlation (exposure-response relationship) between transportation noise exposure levels in terms of the day-night average noise level DNL and the percent of the population highly annoyed by that transportation noise from social surveys. Schultz' work was re-affirmed by the federal Interagency Commission on Noise (FICON) in 1992. Currently available data shows that people react more adversely to aircraft noise than to noise from other transportation modes (e.g., highway, rail). Research that is specific to the aircraft noise dose-response relationship has largely been done in European and Asian countries[1]. The most recent U.S. data have been acquired in conjunction with lawsuits against airports, which may not be reflective of normal situations. It is, therefore, unlikely that an aircraft noise exposure-response relationship based on current available data is sufficiently representative of current U.S. conditions. In summary, the U.S. is depending upon increasingly outdated research as the basis of federal determinations of aircraft noise impacts on residential communities and noise sensitive institutions, federal land use compatibility guidelines, and federally-funded noise mitigation.

Another prominent public concern has been sleep disturbance from nocturnal aircraft noise. Developing a relationship between the degree of sleep disturbance and the level of nocturnal noise exposure is a prerequisite for identifying and protecting communities from adverse noise effects. There is currently no widely accepted exposure-response relationship for sleep disturbance.

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[1] *"An Updated Catalog of 628 Social Surveys of Residents' Reaction to Environmental Noise (1943-2008)", http://www.faa.gov/about/office_org/headquarters_offices/aep/research/science_integrated_modeling/*

Establishing up-to-date exposure-response relationships for community annoyance and sleep disturbance in the U.S. requires an extensive data acquisition campaign covering a wide variety of airport types and geographic locations. The results of this work will be used to guide national aviation noise policy, determinations of community noise impacts, land use guidelines around airports, and mitigation funding.

This new program is a follow on effort to related research conducted under the Airport Cooperative Research Program. Specifically, the new effort will conduct social surveys to measure subjective reactions to aircraft noise, collect sleep disturbance data, and characterize community noise exposure across a broad spectrum of airports having different service missions, and at locations covering a broad range of aircraft noise exposure and responses.

This request includes $5 million in the area of visual guidance/visual guidance test bed work to investigate new lighting technologies on our visual guidance test bed. This multiyear initiative is to develop a state of the art visual guidance technology test bed that would enable visual guidance engineers an opportunity to design, install, test, monitor, and report on what it will take to create a visual guidance infrastructure that will take full advantage of state of the art technologies in Signs, Lighting and Markings to provide a more efficient infrastructure and the best visual cues to the airport user.

The research conducted utilizing this test bed will provide FAA and our nation's airports a better understanding of what is needed to properly design and operate various airport lighting systems that use new state of the art lighting devices. The results will be published and may also be adopted into an FAA AC. Conducted properly, this effort will bring FAA to the forefront of airport visual guidance technology and better align our airports so that they can support demands expected with the NextGen of aviation.

The trend in aircraft industry is to produce aircraft with extended range capability, which results in high gross weight and tire pressures. The effects of high tire pressure are localized and concentrated in the surface layers (like HMA). This makes it imperative to study the effects of high tire pressures on the HMA surface and also develop HMA mix design procedures to produce mixes that can withstand these anticipated high tire pressures.

The Heavy Vehicle Simulator (HVS) will be used to perform the testing. It will be easier and economical to insulate and heat the test pavement under the HVS. Also, heating is applied from the top which is more representative of an in situ pavement. For testing pavement rehabilitation techniques, the structurally failed pavement under NAPTF test vehicle during a construction cycle can be rehabilitated with different techniques (reflective cracking resistant HMA mixes, concrete overlays, etc.) and then tested with HVS. This request includes $500,000 to continue such testing.

Funding in FY 2012 will support the following key outputs and outcomes:

- Evaluate the performance of current generation Auto Brake Systems with Antiskid (ASBS) in decelerating large commercial airplanes on contaminated runways. The product of the evaluation will be a Math Simulation Model capable of predicting landing distances for decelerating and stopping large commercial airplanes on contaminated runways;
- Initiate a new initiative to investigate the effects of aircraft noise near representative U.S. airports. Community annoyance, impacts on schools and other noise sensitive institutions, and land uses due to aircraft noise have historically driven public opposition to airport development and changes in flight procedures near airports;
- Conduct research to study the effects of high tire pressures on the pavement surface and also develop pavement mix design procedures to produce mixes that can withstand these anticipated high tire pressures;
- New technology and techniques that can improve airport lighting and marking to help reduce surface accidents and runway incursions while improving capacity;
- Improved 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.

## 2. What Is The Program?

Research will be conducted in the areas of airport pavement, airport marking and lighting, airport rescue and firefighting, airport planning and design, wildlife hazard mitigation, runway surface technology, and visual guidance. The results of this research are used to update ACs, manuals, and technical specifications that airports rely on when expending AIP funds.

The Airport Technology Research Program supports DOT's Safety goal (*Reduction in transportation related injuries and fatalities*), State of Good Repair (*Increased proportion of transportation infrastructure assets in good condition*) and Environmental Sustainability (*Reduced transportation related pollution and impact on ecosystems*).

Safety
The safety research conducted to improve airport safety and marking, airport lighting, aircraft rescue and firefighting, and wildlife hazard mitigation, leads to updates in ACs and airport equipment specifications that directly improve airport design, procedures and emergency response equipment.

Wildlife habitat management research results are published in a widely distributed manual. The FAA's wildlife strike database and website provides information about wildlife habitat management and hazardous species control and serves as a repository of incidents and accidents involving wildlife strikes around the nation. The FAA continues to evaluate emerging and adapted technologies, to detect and deter birds and provide timely alerts to airport personnel regarding hazardous bird activity. Research will continue to develop improved FOD detection and management techniques. Ongoing research is also conducted in aircraft rescue and firefighting technology leading to more efficient fire fighting techniques for post crash fire protection of both the conventional aluminum constructed aircraft as well as newer advanced composite material construction.

Past research also led to the development of EMAS that have been installed at more than 40 airports and have safely stopped overrunning aircraft in at least five separate instances.

State of Good Repair
The pavement research leads to updates in pavement design and constructions standards and improvements in pavement maintenance techniques that keep airport runways and taxiways in good or better condition.

The research conducted is producing significant benefits in increased safety and potential cost savings. In support of capacity, the research results from the National Airport Pavement Test Facility (NAPTF) are providing technical data needed to validate new design standards and to assure compatibility between aircraft and airport runways worldwide. The cooperative research and development agreement and collaboration with international research organizations has led to the creation of many innovative, FAA-developed software programs that have changed the way airport pavements are designed and evaluated. Some examples include:

- **FAARFIELD**, or FAA Rigid and Flexible Iterative Elastic Layer Design, provides a simpler way for airport designers to determine the needed thickness of airport pavements. It also helps meet the standards for different airplanes, and models the thicknesses needed to handle the mix of aircraft traffic. It has the potential to save FAA and airport authorities tens of millions of dollars in airport pavement redesign efforts;
- **ProFAA**, a runway profile data analysis software program, is an innovative method that allows users to calculate roughness and simulate aircraft response to obtain a better understanding of overall pavement life and aircraft fatigue;
- **COMFAA** computes Aircraft Classification Numbers following the internationally mandated ICAO standard. A library of common aircraft types is provided and the user can also define arbitrary gear configurations. The program is valuable for computing the Pavement Classification Number for any mix of aircraft traffic, which an airport may currently or in the future experience; and
- **BAKFAA** is a program designed to be used with falling-weight deflectometer (FWD) equipment as part of a pavement evaluation program. BAKFAA reads the data from a variety of FWD devices and returns back calculated layer properties. The computational engine in BAKFAA is LEAF (Layered Elastic Analysis – FAA). LEAF is built into FAARFIELD, but can also be downloaded and run separately under BAKFAA. The FAA has made the Visual Basic™ source code for BAKFAA and LEAF available for programmers to run LEAF from their own applications.

Environmental Sustainability
As stated above, an increase of $1.5 million is for a new initiative to investigate the effects of aircraft noise near representative U.S. airports. The results of this work will be used to guide national aviation noise policy, determinations of community noise impacts, land use guidelines around airports, and mitigation funding.

**Anticipated 2012 accomplishments include:**

- Complete evaluation to characterize FOD found on airports;

- Initiate collection of taxiway deviation data at a design group I airport;
- Initiate research program on cargo aircraft interior fire suppression to include full-scale live fire testing;
- Complete Advanced Composite Material Cutting study;
- Conduct evaluation of proposed new lighting infrastructure utilizing Visual Guidance test bed;
- Conduct demonstration of baseline Low Cost Surface Surveillance Framework project;
- Continue analyzing full-scale data from the NAPTF;
- Continue improvements upon and update the pavement design procedures (FAARFIELD) based on full scale data from NAPTF and airport instrumentation sites;
- Continue conducting technical workshops of all FAA analysis tools (PROFAA, FAARFIELD, BAKFAA, LEDFAA and FAA PAVEAIR);
- Continue development of increasing pavement design life from 20 to 40 years for large hub airports;
- 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;
- Complete development of a web-based application for FAA APVEAIR as a suite of FAA analysis tools (PROFAA, FAARFIELD, BAKFAA, LEDFAA);
- Analyze data collected from pavement instrumentation at assorted Airports throughout the Unites States; and
- Start full scale testing of “green” paving materials with Accelerated Pavement Test machine.

## 3. Why Is This Particular Program Necessary?

The Airport Technology Research Program is essential as it leads to improvements in airport safety and marking, airport design, airport lighting, aircraft rescue and firefighting, mitigation of wildlife hazards and improvements in pavement design and construction. The new technology developed from the research such as the EMAS and the penetrating firefighting nozzles have been implemented and are improving airport safety. EMAS technology alone has safely arrested 6 overrunning aircraft with no fatalities or injuries.

## 4. How Do You Know The Program Works?

The Airport Technology Research Program is reviewed every six months by FAA’s Research, Engineering and Development Committee’s (REDAC) Subcommittee on Airports. The Subcommittee has members from airports, aircraft manufacturers, Airline Pilots Association (ALPA) and airport associations. The Subcommittee is briefed on both ongoing research and planned research and offers recommendations to ensure the research program is responsive to the needs of FAA and the airport community.

Each research project is sponsored by a Headquarters engineer that prepares the research requirements, reviews the research plan, and approves the completed deliverables. The success of the research is reflected in our ability to issue updated and new program guidance. For example, the results of the research into the capability of Foreign Object Debris (FOD) radar resulted in publication of a FOD radar specification that airports can use to competitively procure FOD radars with AIP grant funds.

## 5. Why Do We Want/Need To Fund The Program At The Requested Level?

The funds are requested to continue the ongoing research and the new research activities programmed for FY 2012. A reduction in funding would mean decreased contract support and would defer some project activities.

**Detailed Justification for**

## Commercial Space Transportation Safety

### 1. What Is The Request and What Will We Get For The Funds?

**FY 2012 Commercial Space Transportation Safety**

| Program / Component | FY 2010 Enacted | FY 2012 Request | Change FY 2010-FY 2012 |
|---|---|---|---|
| Commercial Space Transportation Safety | $145,000 | $1,000,000 | +$855,000 |

In FY 2012, the FAA AST R&D program plans to be executing approximately 25-35 individual R&D tasks based on actual numbers of research tasks of past years.

Of that number, approximately 15-20 will be executed under the auspices of the FAA AST Center of Excellence for Commercial Space Transportation (COE CST). The rest will be performed though other contracts or grants conducted by AST.

No new major R&D initiatives are anticipated to be started in FY 2012.

**FY 2012 Key Outputs and Outcomes**

- Execute research and development projects awarded to the Center of Excellence for Commercial Space Transportation, with additional small research tasks through other entities.

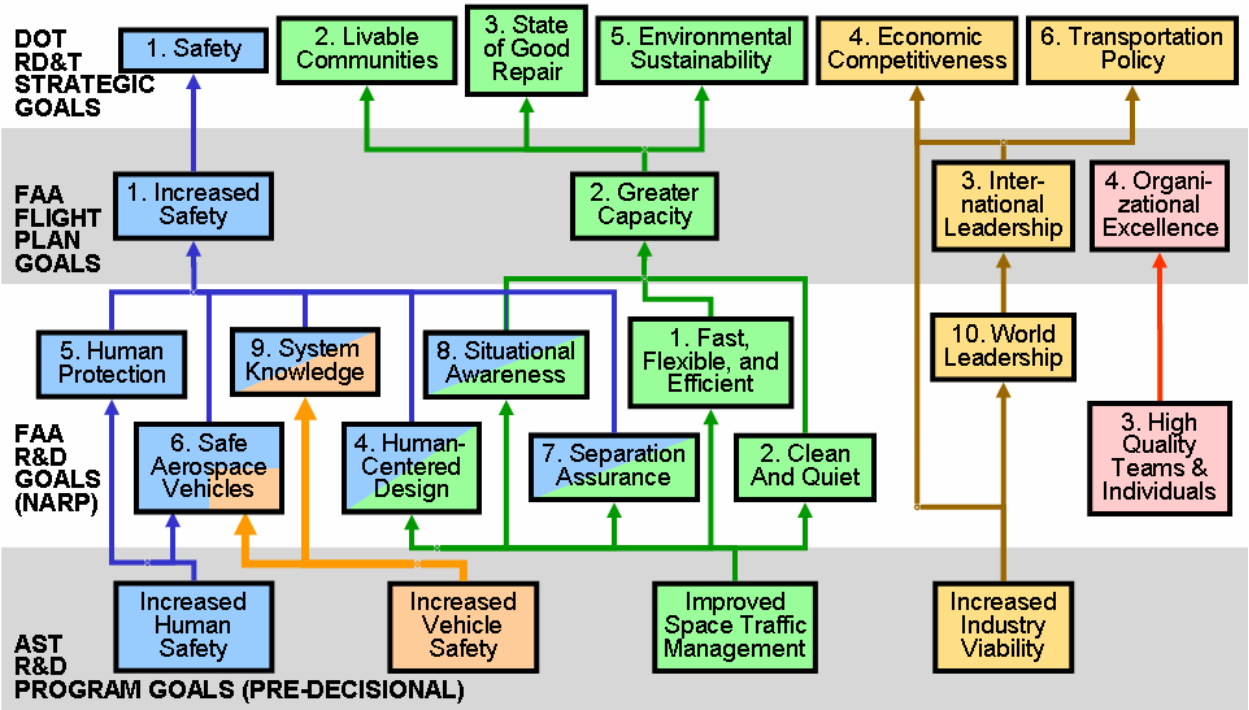
### 2. What Is The Program?

The FAA AST R&D program includes multiple tasks in each of the four major Commercial Space Transportation R&D areas, including (1) Space Traffic Management and Launch Operations, (2) Launch Vehicles, Operations, Technologies & Payloads, (3) Human Spaceflight, and (4) Space Transportation Industry Viability. These tasks are conducted through contract work or the newly established Center of Excellence for Commercial Space Transportation (COE CST).

Currently, there are nine COE CST member universities, including (in alphabetical order): Florida Institute of Technology (FIT or Florida Tech), Florida State University (FSU), New Mexico Institute of Mining and Technology, (NMT or New Mexico Tech), New Mexico State University (NMSU), Stanford University (SU), University of Central Florida (UCF), University of Colorado at Boulder (CU), University of Florida (UF), and University of Texas Medical Branch at Galveston (UTMB).

The major accomplishments of FY 2011 include (1) completion of R&D research project milestones, and (2) publication and presentation of FY 2010 R&D research project results at technical conferences.

The DOT RD&T Strategic Goals, FAA Flight Plan Goals, and FAA R&D strategic goals are all supported by the AST R&D program are shown in the graphic below:




## 3. Why Is This Particular Program Necessary?

The beneficiaries, public, and customers of the AST R&D program are primary comprised of the U.S. public and members (i.e., economic entities deriving direct and indirect benefits) of the U.S. commercial space transportation industry.

The intended benefits of the AST R&D program to its beneficiaries, public, and customers are (1) better understanding of the physiological and other effects on the human spaceflight participants (including crew) as a result of activities associated with commercial space flight, (2) increased understanding and application of the analytical, technological and operational methods and tools to increase the safety of commercial space vehicles, (3) improvements in safety, efficiency and environmental impact of space traffic management operations and integration with air traffic systems, including those aspects as applied to launch and reentry sites, and (4) better awareness and understanding of the impact of commercial, policy, international, legal, and regulatory factors on the viability of the commercial space transportation industry.

There are no viable alternatives to the AST R&D activities that exist within the sectors of government, industry, or academia. Independent civil and military government R&D interests that intersect with the commercial space transportation industry are sharply focused on achieving their agency-specific mission goals. In-house R&D activities of the established aerospace industry is strongly focused on technologies needed by their government customers, and the combined R&D of the emerging commercial space industry is not sufficiently comprehensive to be considered a viable alternative to the AST R&D program.

## 4. How Do You Know The Program Works?

All AST R&D funded activities undergo multiple review processes within the Office by Technical Monitors and finally members of the Senior Staff. Annual funding reviews have been implemented to ensure sufficient efficiency, effectiveness and progress on all research tasks performed.

The Research, Engineering and Development Advisory Committee (REDAC) has no evaluative role for AST R&D activities. Instead, the Commercial Space Transportation Advisory Committee (COMSTAC) evaluates the AST R&D portfolio on an annual basis.

For the portion of AST R&D activities that are performed within the Center of Excellence for Commercial Space Transportation (COE CST), internal review processes of research task proposals are conducted by their Principal Investigator Advisory Council with input from their Industry Advisory Board. These additional layers of academic and industry review help ensure high quality and relevant research that aligns closely with industry needs.

## 5. Why Do We Need To Fund The Program At The Requested Level?

Because of the long-term commitment made by the FAA to the COE CST, any reductions in funding will limit the amount of R&D that can be performed by AST outside the COE CST program.

The requested funds are required to continue ongoing research projects in FY 2012:

- Magneto-Elastic Sensing for Structural Health Monitoring
- Autonomous Rendezvous and Docking for Space Debris Mitigation
- Establish a Framework to Capture a Body of Knowledge for Commercial Spaceport Practices through 2012
- High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles
- Definition and Design of a Medical and Physiological Database System for Commercial Spaceflight
- Application of Johnson Space Center's Human System Risk Management Approach to Commercial Suborbital and Short Duration Orbital Flights
- Flight Crew Medical Standards and Passenger Acceptance Criteria
- Wearable Biomedical Monitoring Equipment for Passengers on Suborbital and Orbital Spaceflights
- Testing and Training of Personnel and Hardware in High-G Profiles Using the NASTAR Center Centrifuge

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# Appendix B: Partnership Activities

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## Introduction

The FAA enhances and expands its R&D capabilities through partnerships 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 and expand the U.S. technology base. The Agency uses a variety of partnership mechanisms to achieve its goals, as described in the following sections, working with government, industry, and academic organizations.

## 1. Working with Government

Researchers at the FAA collaborate with their colleagues in government, both foreign and domestic, through Memoranda of Understanding (MOU), Memoranda of Agreement (MOA), Interagency Agreements (IAs), and International Agreements.

Both MOUs and MOAs support joint research activities between departments or agencies. 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 under a broader MOU. An MOA may include IAs, written agreements between FAA and other agencies, in which FAA agrees to receive from, or exchange supplies or services with, the other agency. International Agreements establish an R&D relationship between FAA and foreign governments or quasi-governmental entities.

### 1.1 Memoranda of Understanding

An MOU is a written document that establishes policies or procedures of mutual concern. An MOU does not require either party to obligate funds and does not create a legally binding commitment. Title 49 U.S. Code 106 (f) (2) (A) and 106(l) and (m) authorizes FAA to establish MOUs. 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 an MOU. The FAA also works closely with the Department of Defense (DOD) and the Department of Agriculture (USDA), especially in the environmental area. Table B.1 provides details of the MOUs currently in place.

**Table B.1 - Active MOUs in FY 2010**

| Active MOUs in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Type and Title | Partner | Objective |
| 9/30/10 | Environment and Energy (Lourdes Maurice) | MOU (58-0202-0-173N)<br>Develop the Feedstock Readiness Tool | USDA | This MOU sets a framework of cooperation with the Department of Agriculture, facilitating research to assess the dependability of feedstock supplies for the production of advanced biofuels for jet aircraft. |
| 6/9/08 | Joint Planning and Development Office | MOU<br>Next Generation Air Transportation System Joint Planning and Development Office | DOD<br>DOC<br>DHS<br>NASA | This MOU constitutes a formal agreement to implement the congressionally mandated Next Generation Air Transportation System (NextGen) joint planning and development pursuant to the Vision 100 – Century of Aviation Reauthorization Act (Pub. L. 108-176) |
| 5/15/06 | Research & Technology Development (Richard May) | MOU (FNA/11)<br>A Partnership to Achieve Goals in Aviation and Space Transportation | NASA | This MOU seeks partnering in the pursuit of complementary goals in aviation and space transportation, including safety, airspace system efficiency, environmental compatibility, international leadership, and others. |

## 1.2 Memoranda of Agreement

An MOA is a written document that creates a legally binding commitment and may require the obligation of funds. Title 49 U.S. Code 106 (f) (2) (A) and 106(l) and (m) authorizes FAA to establish MOAs. NASA and DoD are the FAA's closest R&D partners. Table B.2 provides details of the MOAs currently in place.

**Table B.2 - Active MOAs in FY 2010**

| Active MOAs in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Type and Title | Partner | Objective |
| 10/13/10 | Environment and Energy (Lourdes Maurice) | MOA<br>Research on the Potential Effects of Aircraft Noise and Emission on Public Health and Welfare | DHHS/ CDC | The MOA establishes a working relationship to facilitate collaborative research on the potential effects of aircraft noise and emissions on public health and welfare, leading to potential program recommendations to reduce adverse impacts. |

| Active MOAs in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Type and Title | Partner | Objective |
| 12/18/08 | Traffic Management Advisor (TMA) (Bill Boyer) | MOA (SAA2-402282) Interconnecting Information Systems to the FAA Traffic Management Advisor (TMA) WJHTC Test Subsystem Under MOU (FNA/11) | NASA | This MOA provides NASA access to certain National Airspace System (NAS) data from the FAA's TMA WJHTC Test Subsystem to facilitate the development of air traffic management decision support tools. It prescribes the security policies and procedures for interconnecting NASA information systems to the FAA's TMA WJHTC Test Subsystem. |
| 6/23/05 | Environment and Energy (Lourdes Maurice) | MOA Impact of Aviation Air Emissions on Climate and Global Atmospheric Composition Under MOU (FNA/11) | NASA | This MOA establishes programs and plans to determine aviation emissions that have the potential to impact global atmospheric composition, stratospheric ozone and climate. |
| 4/25/05 | Environment and Energy (Lourdes Maurice) | MOA Collaboration on Research and Development to Measure and Mitigate the Environmental Impacts of Aircraft Noise and Aviation Air Emissions | DoD | This MOA supports 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. |
| 6/15/99 | Flight Safety (John Frye) | MOA (FNA/08-99-01) Aviation Safety Reporting System (ASRS) Under MOU (FNA/11) | NASA | This MOA describes the basic relationship between the FAA's Aviation Safety Reporting Program and the NASA ASRS, and outlining the roles and responsibilities of each agency. |

## 1.3 Interagency Agreements

An IA is a written agreement between the FAA and another Federal agency, as defined in Section 551(a) of Title 5 of the United States Code, where one agency agrees to receive from, or exchange supplies or services with, the other agency, and the agreement includes an obligation of funds. The Federal Aviation Act of 1958, Title 49 U.S. Code 106(1) and 106(m), and Title 31 U.S. Code 1535 authorize FAA to establish IAs. Title 49 U.S. Code 40121(c) 2 further authorizes FAA to establish joint activity with DoD. Table B.3 provides details of the active interagency agreements in FY 2010.

## Table B.3 - Active Interagency Agreements in FY 2010

| Active Interagency Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Number and Title | Partner | Objective |
| 1/27/10 | Human Factors Research & Engineering (Tom McCloy) | IA DTFAWA-10-X-80005 NextGen Human Factors Air Traffic Control Research Under MOU (FNA/11) | NASA | This IA establishes roles and responsibilities for the FAA and NASA to collaborative develop NextGen. The FAA and NASA will research, study, analyze, model, test and implement the advanced services and capabilities that will be required for NextGen |
| 9/22/09 | Flight Safety (John Frye) | IA DTFAWA-09-X-80016 Aviation Safety Reporting System (ASRS) Under MOU (FNA/11) | NASA | The ASRS is designed to provide information to the FAA and the aviation community to identify and eliminate unsafe conditions to prevent accidents. NASA receives, processes, and analyzes the raw information ensuring confidentiality of the reporter |
| 8/19/09 | Human Factors Research and Engineering (Paul Krois) | IA DTFAWA-09-X-80020 NextGen Human Factors Air Traffic Control Research Under MOU (FNA/11) | NASA | The IA establishes a partnership between FAA and NASA to research, study, analyze, model, test and implement the advanced services and capabilities required for NextGen to be successful |
| 6/12/09 | Human Factors (William Johnson) | IA DTFAWA-09-A-80018 Enhancement of Aeronautical Research and Technology Development Under MOU (FNA/11) | NASA | This IA provides a framework under which NASA and the FAA can collaborate in aeronautics research and technology |
| 9/24/08 | ATS Concept Development and Validation (Michele Merkle) | IA DTFAWA-08-X-80031 Research and Technology Development Under MOU (FNA/11) | NASA | This IA 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) |
| 9/5/08 | Human Factors Research and Engineering (Tom McCloy) | IA DTFAWA-08-X-80023 Human Factors Research Under MOU (FNA/11) | NASA | This IA fosters collaboration between FAA HFRE and NASA Ames on human factors research that support the FAA's goals of greater capacity and increased safety |
| 8/12/08 | Unmanned Aircraft Systems (Xiaogong Lee) | IA DTFACT-08-X-00005 P-STAR Radar Systems Under MOU (FNA/11) | NASA | This IA establishes 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 |

| Active Interagency Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Number and Title | Partner | Objective |
| 7/9/08 | Atmospheric Hazards (James T. Riley) | IA DTFACT-08-X-00007 Characterization of High Ice-Water Content Environments Under MOU (FNA/11) | NASA | This IA fosters 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 |
| 7/7/08 | Airworthiness Assurance (Felix Abali) | IA DTFACT-08-X-00004 Software Enhancement, Standardization and Material Database Generation for Damage Tolerance Analysis Under MOU (FNA/11) | NASA | This IA establishes a cooperative procedure to enhance the NASA Crack Growth Program software and generate material database for damage tolerance analysis |
| 6/25/08 | Data Communication (Rafael Apaza) | IA DTFAWA-08-X-80021 Research for Aviation Communications/ Navigation/Surveillance/ Information Systems Under MOU (FNA/11) | NASA | This IA fosters 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 |
| 6/2/08 | Airworthiness Assurance (Traci Stadtmueller) | IA DTFACT-08-X-00002 Support substantiation of FAA Advisory Circular AC 29-2C Section MG-15 Airworthiness Approval of HUMS | DoD | This IA obtains technical information related to HUMS AC compliance and validation – flight testing, operational HUMS development, and commercial HUMS validation |
| 9/21/07 | Wake Turbulence (Jeff Tittsworth) | IA DTFAWA-07-X-80026 Wake Turbulence and Associated Reduced Separation Research. Under MOU (FNA/11) | NASA | This IA builds upon and expands 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 |
| 8/13/07 | PDARS (Rich Nehl) | IA DTFAWA-07-X-00033 Performance Data Analysis and Reporting System (PDARS) Under MOU (FNA/11) | NASA | This IA enables continued collaboration in research and development efforts by NASA and the FAA on the utilization and enhancement of PDARS |
| 6/14/07 | Continued Airworthiness (Traci Stadtmueller) | IA DTFACT-07-X-00008 Rotorcraft Health Usage Monitoring System (HUMS) | DoD | This IA supports FAA research efforts in HUMS operational development, commercial HUMS validation, and HUMS Advisory Circular compliance validation and demonstration |

| Active Interagency Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Number and Title | Partner | Objective |
| 4/24/07 | Continued Airworthiness (David Galella) | IA DTFACT-07-X-00005 Continued Airworthiness Assurance – Flight Safety | DoD | This IA provides 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 |
| 1/10/07 | Atmospheric Hazards (James T. Riley) | IA DTFACT-07-X-00002 Ground Deicing/Anti-icing Program | NSF | This IA fosters technical participation with and financial support for National Center for Atmospheric Research (NCAR) on ground icing research |
| 8/03/06 | Continued Airworthiness (Xiaogong Lee) | IA DTFACT-06-X-00008 Rotorcraft Health Usage Monitoring System (HUMS) | DoD | This IA provides engineering support for the FAA rotorcraft structural integrity research program |
| 4/13/06 | Aircraft Catastrophic Failure Prevention Program (Donald Altobelli) | IA DTFACT-06-X-00005 Aircraft Catastrophic Failure Prevention – Flight Safety | DoD | This IA provide technical support in these areas: 1) Uncontained Engine Failure Research; 2) Dry Bay Fire Protection; 3) Fuel System Explosion – Protection; 4) Engine Malfunction plus Inappropriate Crew Response; and 5) Engine and Other Aircraft System Impending Failure Diagnostics Research |
| 10/6/05 | Continued Airworthiness (Xiaogong Lee) | IA DTFACT-06-X-00001 Damage Tolerance Methodologies in Rotorcraft Structures and Dynamic Components | DoD | This IA enhances collaboration between FAA and U.S. Army Research, Development, and Engineering Command to support FAA rulemaking and the implementation of damage tolerance methodology in the design and certification of rotorcraft and dynamic components |
| 6/27/05 | Human Factors (Charles C. Johnson) | IA DTFACT-05-X-00011 Flight Deck Illumination by Unauthorized Lasers | DoD | This IA evaluates laser eye protection during human-in-the-loop simulation studies; develops database models to enhances airmen training; and develops and evaluate procedures for flight crew awareness and recovery action |

## 1.4 Interagency Committees

The FAA creates partnerships 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.

## 1.5 International Agreements

The FAA uses International Agreements with foreign governments or quasi-governmental entities to establish a technical assistance or R&D relationship between the FAA and the foreign entity. Title 49 U.S. Code 40113(e) authorizes FAA to establish International Agreements. Table B.4 presents the active international agreements in FY 2010.

**Table B.4 - Active International Agreements in FY 2010**

| Active International Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Title and Type | Partner | Objective |
| 12/09 | Aircraft Icing Program (Jame T. Riley) | Aircraft and Propulsion System Icing Research Annex 1 to MOC NAT-I-8417 | National Resources Council of Canada | This agreement forms cooperative research on simulation of ice crystal environments for the investigation of effects of such environments on engines. |
| 09/15/09 | System Safety Management (John Lapointe) | Aviation System Safety MOC AIA/CA-52 | Civil Aviation Authority – The Netherlands | This agreement establishes a method of cooperation in R&D programs in the area of aviation system safety including the risks to the public connected with civil aviation activities and operations in the vicinity of airports. |
| 9/24/04 | Wake Vortex Research (Paul Fontaine) | Air Traffic Management Research MOC NAT-I-3454-1 | EURO CONTROL | This agreement is to collaborate and share experiences on various ATM research topics that are of interest to both the United States and Europe. |
| 9/24/04 | Environmental Modeling for ATM and Safety Management Techniques (Lourdes Maurice) | Harmonizing Safety and Environmental Factors Annex to MOC NAT-I-3454-5 | EURO CONTROL | This agreement is to collaborate and share on methods for evaluating safety management, ATM security and ATM environmental factors. |
| 4/02/04 | Fire Safety (Gus Sarkos) | Aircraft Cabin and Fire Safety Appendix 7 to Annex III of MOC AIA/CA-41 | Civil Aviation Authority – United Kingdom | This agreement establishes a method of cooperation in performing research to improve passenger survivability during aircraft emergencies or accidents involving fire. |

| Active International Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Effective Date | FAA R&D Program (POC) | Agreement Title and Type | Partner | Objective |
| 6/18/70 | Aircraft Icing (Warren Underwood) | Deicing and Anti-Icing Research Memorandum of Cooperation (MOC) NAT-I-0831 (PA-17) | Transport Canada | The investigation of aerodynamic flow-off characteristics of anti-icing fluids contaminated with different types of frozen precipitation; the investigation of the effectiveness of proposed laboratory test procedures in evaluating aircraft anti-icing fluids' failure modes in mixed icing conditions; and the investigation into other associated aircraft deicing problems and issues. |

## 2. Working with Industry

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 U.S. technology base and leverage federal R&D investments.

### 2.1 Cooperative Research and Development Agreements

Cooperative Research and Development Agreements (CRDAs) allow the FAA and its partners to share facilities, equipment, services, intellectual property, and personnel resources with industry, academia, and state and local governments in collaborative R&D activities. CRDAs are a highly effective way to meet congressionally mandated technology transfer requirements. In FY 2010, the FAA issued amendments to nine existing CRDAs and established two new ones, bringing the total of active agreements to twenty-two. Table B.5 provides details on the active CRDAs in FY 2010.

**Table B.5 - Active Cooperative Research and Development Agreements in FY 2010**

| Active Cooperative Research and Development Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | CRDA Number | Industry Partner | Subject |
| 08/10/10 | Airport and Aircraft Safety (Nelson Miller) | 2010-A-0269 | RFID TagSource LLC Camden, NJ | Radio frequency identification technologies |
| 05/13/10 | Unmanned Aircraft Systems Research (Xiaogong Lee) | 2010-A-0266 | Insitu, Inc. | Unmanned Aircraft Systems Safety Research, Modeling, and Simulation |
| 07/15/09 | Unmanned Aircraft Systems Research (Kerin Olson) | 2009-A-0258 | General Atomics Aeronautical Systems, Inc. San Diego, CA | Modeling and simulation to assess the impact of Unmanned Aircraft Systems |
| 06/26/09 | Unmanned Aircraft Systems Research (Kerin Olson) | 2009-A-0259 | AAI Corporation, Hunt Valley, MD | Modeling and simulation to assess the impact of Unmanned Aircraft Systems |

| Active Cooperative Research and Development Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | CRDA Number | Industry Partner | Subject |
| 06/19/09 | Unmanned Aircraft Systems Research (Kerin Olson) | 2009-A-0260 | GE Aviation Systems LLC, Grand Rapids, MI | Modeling and simulation to assess the impact of Unmanned Aircraft Systems |
| 01/27/09 | Laboratory Future Development (Joseph DiLuzio) | 2009-A-0257 | Diakon Solutions, LLC Cape May Court House, NJ | Aircraft Geometric Height Measurement Element |
| 01/6/09 | Human Factors (Ben Willems) | 2008-A-0252 | The Richard Stockton College of New Jersey, Pomona, NJ | Index of cognitive activity and characteristics of the air traffic control task |
| 12/10/08 | Laboratory Future Development (Joseph DiLuzio) | 2008-A-0251 | Diakon Solutions LLC, Cape May Court House, NJ | For the advancement and commercialization of Sun Keyboard System Translator |
| 10/23/08 | Weather (Thomas Ryan) | 2008-A-0255 | Center for Network Centric Product Support Research LLC, East Hartford, CT | Network centric airborne microserver |
| 08/5/08 | Technical Strategies and Integration (John Wiley) | 2008-A-0249 | HiTec Systems Inc., Egg Harbor Township, NJ | Aviation-related research in support of DoD rapid response-third generation activities |
| 02/19/08 | Unmanned Aircraft Systems Research (James Sizemore) | 2008-A-0245 | New Mexico State University, Las Cruces, NM | Unmanned aircraft system research |
| 10/30/07 | Continued Airworthiness (John Bakuckas) | 2007-A-0236 | The Boeing Company, Huntington Beach, CA | Composite repair of aircraft structures |
| 09/21/07 | SERC/NextGen (Trung Nguyen) | 2007-A-0235 | Network Centric Operations Industry Consortium Inc., Newport Beach, CA | Provide guidance for NetCentric standards and protocols that may be incorporated by the NextGen Program. |
| 07/18/07 | Surveillance (Michael McNeil) | 2007-A-0233 | CNS Aviation, Vienna, VA | Flight testing for ADS-B separation standards |
| 02/20/07 | Human Factors & Aviation Medicine (Ben Willems) | 2006-A-0219 | Drexel University, Philadelphia, PA | Air Traffic Controller Cognitive Modeling |
| 12/13/06 | Surface Surveillance (Jeffery Livings) | 2006-A-0223 | RVision LLC, San Diego, CA | Airport Surface Surveillance |
| 07/25/06 | Air Traffic Models and Evaluation Tools (Mike Paglione) | 2006-A-0216 | Rowan University, Glassboro, NJ | Development and improvement of a graphical user interface for the display of recorded air traffic data |
| 01/17/06 | Air Traffic Models and Evaluation Tools (Graham Elliott) | 2005-A-0213 | Ordinate Corporation, Menlo Park, CA | Machine-graded aviation English test for pilots for measuring levels of English language proficiency |
| 07/17/02 | Capacity and Air Traffic Management Technology (Albert Rehmann) | 2002-A-0171 | The Boeing Company, McLean, VA | Develop modeling and simulation tools to assist in tech implementation of capacity enhancing capabilities for the National Airspace System |

| Active Cooperative Research and Development Agreements in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | CRDA Number | Industry Partner | Subject |
| 04/05/02 | Airport Technology Research – Safety (Jim Patterson) | 2001-A-0164 | The Boeing Company, Seattle, WA | Utilization of statistical analysis for determining airplane contact risks of varying-span airplanes on taxiways of varying separation |
| 07/29/96 | Airport Technology Research – Capacity (Satish Agrawal) | 1996-A-0097 | The Boeing Company, Seattle, WA | Development of the National Airport Pavement Test Machine |
| 09/07/94 | Airport Technology Research – Safety (Ryan King) | 1994-A-0065 | Engineered Arresting Systems Corp., Logan Township, NJ | Testing of a soft ground arresting system developed to safely stop aircraft that overrun the available length of runway |

## 2.2 Patents Issued Through the U.S. Patent and Trademark Office

The FAA encourages its inventors to patent new technologies through the U.S. Patent and Trademark Office. A patent is a grant of a property right and gives the owner the right to exclude anyone else from making, using, or selling the invention. Inventions patented by FAA inventors are available for commercial licensing with royalty payments shared with the inventor and the agency. Legislation allows inventors to receive up to $150,000 a year over their salary from royalty payments. The agency's Technology Transfer Program Office promotes the agency's patents for commercialization. Table B.6 lists the current U.S. patents issued to the U.S. DOT, FAA.

Two licensing agreements are in effect for Patent No. 5,981,290 "Microscale Combustion Calorimeter" and Patent No. 6,464,391 "Heat Release Rate Calorimeter for Milligram Samples."

Under the patent provisions of government funding agreements, recipients must disclose each subject invention that they make to the federal agency and may elect to retain title to any patentable subject matter. If the recipient retains title, the government receives a broad license to use the invention for government purposes throughout the world.

The FAA has identified approximately 60 active patents resulting from FAA funded agreements. These patented technologies are available for use by the government, and its contractors, on a cost-free basis when used for government purposes. For more information, see http://www.tc.faa.gov/technologytransfer/ttpatentsthru_grant.html.

**Table B.6 - Patents Issued for DOT/FAA**

| Patents Issued for DOT/FAA | | | |
|---|---|---|---|
| Date of Patent | Patent No. | Title | Description |
| 09/22/09 | 7,592,816 | Localizer cable fault analyzer | An analyzer that memorizes which antenna in a Localizer antenna array caused a fault |
| 11/02/04 | 6,812,834 | Reference sample for generating smoky atmosphere | A reference sample for testing fire detectors and a method for testing using the reference samples |
| 10/29/02 | 6,470,730 | 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 |
| 10/22/02 | 6,467,950 | 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 |
| 10/15/02 | 6,464,391 | 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 |
| 09/12/00 | 6,116,049 | 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 |
| 11/09/99 | 5,981,290 | Microscale Combustion Calorimeter | A calorimeter for measuring flammability parameters of materials using only milligram sample quantities |

### 2.3 Small Business Innovation Research

These 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. The government awards a Phase II contract based on the results of Phase I, which is the actual research phase. The government encourages contractors to pursue other funding sources for Phase III and to attract venture capitalists to commercialize the innovation.

## 3. Working with Academia

The FAA works with academia in three ways, focusing on building a cadre of engineers and scientists who will form the next generation of aeronautical experts throughout our nation in industry, academia, and government. The Joint University Program (JUP) is a partnership between FAA and three universities to develop a safer and more efficient air transportation system. The aviation research grants program is open to the nation's colleges, universities, and other non-profit research institutions. In the Air Transportation Centers of Excellence (COEs) national universities compete to participate in a 10-year program to conduct research and develop aviation technologies in a specific area. Within that period of time, the center becomes a self-sufficient national aviation resource.

## 3.1 Joint University Program for Air Transportation Research

The JUP is a research partnership between the FAA and three universities (Ohio University, Massachusetts Institute of Technology, and Princeton University). The program aids in the development of a safer and more efficient air transportation systems by identifying promising targets for development, conducting long-term research, and educating technological leaders. The FAA and NASA benefit directly from the results of the research and, less formally, from valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical expertise in industry, academia, and government. For more information, see http://u2.princeton.edu/~jup/.

## 3.2 Aviation Grants

Public Law 101-508 authorized the FAA to establish research grant programs that encompass a broad spectrum of aviation research activities. These programs encourage and support innovative and advanced research with potential benefit to the FAA mission. All colleges, universities and other non-profit research institutions qualify for research grants. This FAA program supports the long-term growth of the aviation industry by encouraging academic institutions to establish and nurture aviation research programs that increase the aviation talent base. Table B.7 lists the FAA research grants started in FY 2010. The FAA awarded $5,840,482 in new research grants in FY 2010, and an additional $16,395,404 to grants started in prior fiscal years for a total of $22,235,886 in grant awards in FY 2010.

**Table B.7 - FAA Research Grants Started in FY 2010**

| FAA Research Grants Started in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 09/01/10 | Airport Technology Research – Capacity (David Brill) | 2010-G-012 Evaluate the Impact of Concrete Material Properties, Joint Type, and Support Condition on Airport Pavement Design | Rowan University | $76,983 |
| 09/01/10 | NextGen - Air Ground Integration Human Factors (Dan Herschler) | 2010-G-021 Synthetic Speech and Visual data Communication for Flight Deck Use | Embry-Riddle Aeronautical University | $96,497 |
| 09/01/10 | NextGen - Self-Separation Human Factors (Dan Herschler) | 2010-G-022 Guidance for the Location and Grouping of NextGen Displays on Future Flight Decks | Regents of the University of Michigan | $414,214 |
| 08/23/10 | WAAS Program (Wade Terrell) | 2010-G-023 Process to Identify Candidate Instrument Approaches for Cancellation | Flight Safety Foundation | $50,000 |

| FAA Research Grants Started in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 08/16/10 | Unmanned Aircraft Systems (UAS) (Traci Stadtmueller) | 2010-G-019 Development of Probability Models for UAS Performance | Auburn University | $300,000 |
| 08/16/10 | Continued Airworthiness (Traci Stadtmueller) | 2010-G-020 Validation of FAA AC-29-2C for Usage Credits | Helicopter Association International | $487,684 |
| 08/09/10 | Airport Technology Research - Safety (Donald Gallagher) | 2010-G-013 Lighting and Visual Guidance Research for Airport Applications | Rensselaer Polytechnic Institute | $488,836 |
| 08/09/10 | Continued Airworthiness (Dr. Felix Abali) | 2010-G- 014 Data and Methodologies for Structural Life Evaluation of Small Airplanes | Wichita State University | $340,948 |
| 08/09/10 | Joint University Program (JUP) (Paul Tan) | 2010-G-015 FAA Joint University Program for Air Transportation: Proposal for Activities for Princeton University | The Trustees of Princeton University | $150,000 |
| 08/09/10 | Continued Airworthiness (John Bakuckas) | 2010-G-016 Analytical and Experimental Studies on Airworthiness and Sustainment of Aircraft Structures | Drexel University | $501,433 |
| 08/09/10 | GPS Civil Requirements (Thomas Nagle) | 2010-G-017 Civil Monitoring of GNSS Performance | The University of Texas at Austin | $382,004 |
| 08/09/10 | Joint University Program (Paul Tan) | 2010-G-018 Integrated Avionics Technology Development | Ohio University | $150,000 |
| 07/27/10 | Airport Technology Research – Safety (Ryan King) | 2010-G-009 Radiant heat (Geothermal) prototype for Airfield Pavements | Southern Tier Economic Partnership, Inc. | $374,000 |
| 07/20/10 | Unmanned Aircraft Systems (UAS) (Tong Vu) | 2010-G-010 Architecture for Cognitive Radio Operations in US | The Regents of the University of Colorado | $386,294 |
| 07/20/10 | Airport Technology Research - Safety (Ryan King) | 2010-G-011 Implementing Conductive Concrete with Renewable Energy to Develop Anti-icing Airfield Runways | University of Arkansas Board of Trustees | $155,341 |
| 07/09/10 | Air Traffic Control/Technical Operations Human Factors (Carol Manning) | 2010-G-008 Neuroimaging Study of Mental Fatigue | The Board of Regents of the University of Oklahoma | $429,506 |
| 06/01/10 | Technical Operations Navigational Services (Jason Burns) | 2010-G-006 Risk Analyses to Enhance GBAS Performance for NextGen Applications | Tufts University | $99,949 |

| FAA Research Grants Started in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 05/26/10 | Satellite-based Navigation (John Warburton) | 2010-G-007 Wideband Satellite Anomaly Research | Ohio University | $75,000 |
| 05/04/10 | Atmospheric Hazards/Aircraft Icing (James T. Riley) | 2010-G-004 Effect of Ice Accretion on Full-scale, Swept-wing Aerodynamic Performance and Control Effects | Board of Trustees of University of Illinois | $154,687 |
| 05/01/10 | Fire Research and Safety (Robert Ochs) | 2010-G-003 Development of Next Generation Burner Operation Settings for Fire Testing of Powerplant Components | University of Cincinnati | $199,999 |
| 04/29/10 | NextGen - Air Ground Integration Human Factors NextGen - Self Separation Human Factors (Dan Herschler) | 2010-G-005 Research Plan to Evaluate Single-pilot Synthetic and Enhanced Vision Systems Operations | Board of Regents, University of Nevada at Reno | $48,771 |
| 03/25/10 | Continued Airworthiness (David Galella) | 2010-G-002 Fundamental Engineering Studies of Magnetic Particle Inspection and Impact on Standards and Industrial Practice | Iowa State University | $218,336 |
| 02/04/10 | Advanced Qualification Program (Elena S. Edens) | 2010-G-001 Broadening the Scope of AQP Through Training Evaluation and Development | University of Central Florida | $260,000 |
| Total of awards originating in FY 2010: | | | | $5,840,482 |

## 3.3 Air Transportation Centers of Excellence

The FAA recognizes the need to develop the nation's technology base and support the nation's next generation of engineers and scientists. To accomplish this, the FAA establishes Centers of Excellence (COEs) through long-term cooperative agreements with the nation's universities to conduct research and develop expertise in specific aviation-related technologies. The agreements encourage collaboration between government, academia, and industry to advance aviation technologies, and they require the universities to match FAA grants dollar for dollar through partnerships with industry affiliates and state and local governments. Centers may also receive funds through cost-share contracts. The cooperative agreement allows funding for the center over a period of 10 years after which the FAA intends for each partnership to meet COE requirements by becoming a self-sufficient national aviation resource. By being self-sufficient, the COE university members may continue to be utilized by the FAA but the agency will no longer commit to annual base funding. Because of its developed expertise, COE members will generate support from others and be able to compete for and conduct research activities for industry and other government entities.

Since the inception of the COE program, the FAA has competitively established nine COEs. Three of the centers, including Computational Modeling of Aircraft Structures, Aviation Operational Research (NEXTOR), and Airworthiness Assurance, satisfied the 10-year requirements. Currently, the FAA sponsors six active centers with academic institutions throughout the United States. These include:

- COE for Commercial Space Transportation
- COE for Research in the Intermodal Transport Environment
- Joint COE for Advanced Materials
- COE Partnership for AiR Transportation Noise and Emission Reduction
- COE for General Aviation Research
- COE for Airport Technology

### 3.3.1 COE for Commercial Space Transportation

On August 18, 2010, U.S. Secretary of Transportation Ray LaHood announced the selection of the new COE for Commercial Space Transportation. The R&D efforts of the COE will address four major areas: space launch traffic management and launch operations; launch vehicles, operations, technologies and payloads; human spaceflight; and industry viability, including commercial, policy, international, legal, and regulatory viability. New Mexico State University will serve as the administrative lead with eight university members, including Stanford University, the University of Florida, the Florida Institute of Technology, the New Mexico Institute of Mining and Technology, Florida State University, the University of Central Florida, University of Colorado, and the University of Texas: Medical Branch. The FAA entered into nine cooperative agreements with member universities to establish the COE for an initial period that will extend through 2015. The cooperative agreements that initiated the center in FY 2010 included the awards listed in Table B.8.

**Table B.8 - Grants Awarded in FY 2010 to the COE for Commercial Space Transportation**

| COE for Commercial Space Transportation Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 9/20/10 | Commercial Space Transportation Safety (Ken Davidian) | 10-C-CST-NMT: FAA Air Transportation Center of Excellence for Commercial Space Transportation | New Mexico Institute of Mining and Technology | $150,000 |
| 9/20/10 | Commercial Space Transportation Safety (Nick Demidovich) | 10-C-CST-UCF: FAA Air Transportation Center of Excellence for Commercial Space Transportation | University of Central Florida | $100,000 |
| 9/15/10 | Commercial Space Transportation Safety (Kelvin Coleman) | 10-C-CST-UC: FAA Air Transportation Center of Excellence for Commercial Space Transportation | Colorado University, Boulder | $300,000 |

| COE for Commercial Space Transportation Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 9/15/10 | Commercial Space Transportation Safety (Kelvin Coleman) | 10-C-CST-FIT: FAA Air Transportation Center of Excellence for Commercial Space Transportation | Florida Institute of Technology | $150,000 |
| 9/15/10 | Commercial Space Transportation Safety (Nick Demidovich) | 10-C-CST-FSU: FAA Air Transportation Center of Excellence for Commercial Space Transportation | Florida State University | $100,000 |
| 9/15/10 | Commercial Space Transportation Safety (René Rey) | 10-C-CST-NMSU: FAA Air Transportation Center of Excellence for Commercial Space Transportation | New Mexico State University | $400,000 |
| 9/15/10 | Commercial Space Transportation Safety (Dan Murray) | 10-C-CST-SU: FAA Air Transportation Center of Excellence for Commercial Space Transportation | Stanford University | $400,000 |
| 9/15/10 | Commercial Space Transportation Safety (Nick Demidovich) | 10-C-CST-UFL: FAA Air Transportation Center of Excellence for Commercial Space Transportation | University of Florida | $100,000 |
| 9/15/10 | Commercial Space Transportation Safety (Doug Graham) | 10-C-CST-UTMB: FAA Air Transportation Center of Excellence for Commercial Space Transportation | University of Texas Medical Branch, Galveston | $300,000 |
| Total awarded in FY 2010: | | | | $2,000,000 |

### 3.3.2 COE for Research in the Intermodal Transport Environment

In 2004, the Administrator selected the COE for Airliner Cabin Environment (ACER) with Harvard University and Purdue University as the technical leads and Auburn University as the administrative lead. Following the Phase I evaluation, the COE expanded scope from airliner-cabin research activities to include the intermodal transport environment. In 2008, it was renamed the COE for Research in the Intermodal Transport Environment (RITE). This COE conducts R&D on cabin air quality, chemical and biological threats, and related topics. The FAA expects this COE to become self-sufficient by 2014. In FY 2010, in addition to the grant awards provided in Table B.9, the FAA entered into seven final cooperative agreements with each of the COE leads and members in preparation for the COE becoming self-sufficient by 2014. Member universities include Boise State University, Kansas State University, University of California at Berkeley, and the University of Medicine and Dentistry of New Jersey. This center generated $2.8M in matching contributions in FY 2010. For additional information see: http://www.acer-coe.org/.

**Table B.9 - Grants Awarded in FY 2010 to the COE for Research in the Intermodal Transport Environment**

| COE for Research in the Intermodal Transport Environment Awards in FY 2010 |
|---|

| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
|---|---|---|---|---|
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-UMDNJ-008: Exposure to Flame Retardants in Commercial Aircraft | University of Medicine and Dentistry of New Jersey | $81,067 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-PU-006: Further Studies of Infectious Disease Transmission in Airliner Cabins | Purdue University | $180,856 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-HU-005: Exposure to Flame Retardants in Commercial Aircraft | Harvard University | $231,584 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-HU-006: Studies of Infectious Disease Transmission in Airliner Cabins | Harvard University | $193,271 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-KSU-010: Further Studies of Infectious Disease Transmission in Airliner Cabins | Kansas State University | $106,806 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-KSU-011: Application of Hazard Analysis & Critical Control Points (HACCP) Methods to Disease Transmission on Fomites in Aircraft | Kansas State University | $110,440 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-KSU-012: Sensors and Prognostics to Mitigate Bleed Air Contamination Events | Kansas State University | $192,220 |
| 3/15/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-KSU-013: Exposure to Flame Retardants in Commercial Aircraft | Kansas State University | $27,957 |
| 1/25/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-UMDNJ-007: Development of Risk Paradigm for Pesticides and Ozone/Ozone By-Products | University of Medicine and Dentistry of New Jersey | $469,828 |
| 1/25/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-AU-002: Hazard Analysis and Critical Control Point Methodology Applied to Disease Transmission | Auburn University | $294,665 |
| 1/25/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-AU-003: Sensors and Prognostics to Mitigate Bleed Air Contamination Events | Auburn University | $351,240 |
| 1/21/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-PU-005: Developing a Risk Paradigm for Pesticides and VOC's from Ozone Reactions in Aircrafts | Purdue University | $173,534 |
| 1/21/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-BSU-002: Sensors and Prognostics to Mitigate Bleed Air Contamination Events | Boise State University | $153,367 |

| COE for Research in the Intermodal Transport Environment Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 1/21/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-BSU-003: In-Flight Sensor System and Database Deployment | Boise State University | $70,327 |
| 1/21/10 | Aeromedical Research (Jean Watson) | 07-C-RITE-KSU-009: In-Flight Sensor System and Database Deployment | Kansas State University | $29,999 |
| 11/30/09 | Aeromedical Research (Jean Watson) | 07-C-RITE-UMDNJ-006: Ozone and its Volatile Reaction Byproducts and Domestic and International Flights | University of Medicine and Dentistry of New Jersey | $150,000 |
| Total awarded in FY 2010: | | | | $2,817,161 |

### 3.3.3 Joint COE for Advanced Materials

In 2003, the Administrator selected the Joint COE for Advanced Materials (JAMS) with the University of Washington and Wichita State University as the lead members. This COE 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. The FAA expects this COE to become self-sufficient by FY 2013. In FY 2010, in addition to the grant awards provided in Table B.10, the FAA entered into twelve final cooperative agreements, including each of the COE leads and members, in preparation for the COE to become self-sufficient by 2013, which is 10 years after its formation. Member universities include: Edmonds Community College, Northwestern University, Oregon State University, Purdue University, University of California at Los Angeles, University of Delaware, Florida International University, University of Utah, Tuskegee University, and Washington State University. This center generated matching contributions in excess of $2.7M in FY 2010. For additional information, see http://www.jams-coe.org/.

**Table B.10 - Grants Awarded in FY 2010 to the Joint COE in Advanced Materials**

| Joint COE in Advanced Materials Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 8/13/10 | Advanced Materials/Structural Safety (Allan Abramowitz) | 08-C-AM-UU-004: Durability of Adhesively Bonded Joints for Aircraft Structures | University of Utah | $110,401 |
| 8/13/10 | Advanced Materials/Structural Safety (Allan Abramowitz) | 08-C-AM-WISU-017: Certification by Analysis | Wichita State University | $185,000 |
| 8/12/10 | Advanced Materials/Structural Safety (Lynn Pham) | 08-C-AM-UW-013: Integrated Aeroservoelastic Uncertainty/Damage Tolerance/Reliability of Composite Aircraft | University of Washington | $60,000 |

| Joint COE in Advanced Materials Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 8/12/10 | Advanced Materials/Structural Safety (Lynn Pham) | 08-C-AM-UW-014: Reliability Based Damage Tolerant Structural Design Methodology | University of Washington | $60,000 |
| 8/12/10 | Advanced Materials/Structural Safety (David Westlund) | 08-C-AM-UW-015: Improving Adhesive Bonding of Composite through Surface Characterization | University of Washington | $85,000 |
| 8/6/10 | Advanced Materials/Structural Safety (David Westlund) | 08-C-AM-FIU-001: Effect of Surface Contamination on Composite Bond Integrity and Durability | Florida International University | $85,000 |
| 8/6/10 | Advanced Materials/Structural Safety (David Westlund) | 07-C-AM-FIU-004: Effect of Surface Contamination on Composite Bond Integrity and Durability | Florida International University | $85,000 |
| 8/6/10 | Advanced Materials/Structural Safety (David Westlund) | 08-C-AM-WISU-016: Liquid Resin Molded Materials Guidelines and Recommendations: Update | Wichita State University | $150,000 |
| 8/4/10 | Advanced Materials/Structural Safety (Lynn Pham) | 08-C-AM-UCLA-001: Impact Damage Formation on Composite Aircraft Structures | University of California at Los Angeles | $344,500 |
| 8/2/10 | Advanced Materials/Structural Safety (Allan Abramowitz) | 08-C-AM-UW-012: Compliance Methodology with FAA Requirements for Crashworthiness of Composite-Intensive Structures | University of Washington | $100,082 |
| 8/2/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-015: Development and Safety Management of Composite Certification Guidance | Wichita State University | $100,000 |
| 7/21/10 | Advanced Materials/Structural Safety (Lynn Pham) | 08-C-AM-WISU-014: Effect of CACRC Depot Repairs on Composite Airframe Structures | Wichita State University | $180,000 |
| 7/21/10 | Advanced Materials/Structural Safety (Lynn Pham) | 08-C-AM-OSU-002: Failure of Notched Laminates Under Out-of-plane Bending | Oregon State University | $77,666 |
| 7/12/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-UW-011: Administration of the FAA Center on Advanced Materials in Transport Aircraft Structures | University of Washington | $75,532 |
| 7/12/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-011: Development and Safety Management of Composite Certification Guidance | Wichita State University | $200,000 |
| 7/12/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-012: Administration of the Center of Excellence for Composites and Advanced Materials at Wichita State | Wichita State University | $75,000 |

| Joint COE in Advanced Materials Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 7/12/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-013: Damage Tolerance Testing and Analysis Protocols for Full-Scale Composite Airframe Structures under Repeated Loading | Wichita State University | $260,000 |
| 6/23/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-UW-010: Certification of Discontinuous Composite Material Forms for Aircraft Structures | University of Washington | $135,133 |
| 6/23/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-UU-003: Development and Evaluation of Fracture Mechanics Test Methods for Sandwich Composites | University of Utah | $61,381 |
| 6/21/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-010: Development and Safety Management of Composite Certification Guidance | Wichita State University | $42,000 |
| 6/21/10 | Advanced Materials/Structural Safety (David Westlund) | 08-C-AM-UW-009: Inverse/Optimal Thermal Repair of Composites | University of Washington | $34,220 |
| 1/13/10 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-WISU-009: Production Control Effect on Composite Material Quality and Stability | Wichita State University | $125,000 |
| 10/20/09 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-UW-007: Improving Adhesive Bonding of Composites Through Surface Characterization | University of Washington | $34,000 |
| 10/20/09 | Advanced Materials/Structural Safety (Curt Davies) | 08-C-AM-UW-008: Certification of Discontinuous Composite Material Forms for Aircraft Structures | University of Washington | $65,000 |
| Total awarded in FY 2010: | | | | $2,729,915 |

### 3.3.4 COE Partnership for AiR Transportation Noise and Emissions Reduction

In 2003, the Administrator selected the COE Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) with Massachusetts Institute of Technology as the lead member. This COE is co-sponsored by NASA and Transport Canada and 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. The FAA expects this COE to become self-sufficient by FY 2013. In FY 2010, in addition to the grant awards provided in Table B.11, the FAA entered into eight final cooperative agreements with the COE lead and each member in preparation for the COE to become self-sufficient by 2013, which is 10 years after its formation. Member universities include: Harvard University, Pennsylvania State University, Purdue University, Stanford University, Missouri University of Science and Technology (formerly University of Missouri - Rolla), University of North Carolina - Chapel Hill, and Georgia Institute

of Technology. Membership expanded this year to include Boston University, University of Illinois at Urbana-Champaign, and the University of Pennsylvania. This center generated matching contributions in excess of $7.2M in FY 2010. For additional information, see http://www.partner.aero/.

**Table B.11 - Grants Awarded in FY 2010 to the COE Partnership for AiR Transportation Noise and Emissions Reduction**

| COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 9/22/10 | Environmental Protection Agency (Laszlo Windoffer) | 09-C-NE-GIT-008: Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring from a NAS Perspective | Georgia Institute of Technology | $200,000 |
| 9/22/10 | NextGen -– Environment and Energy -– Environmental Management System and Advanced Noise and Emissions Reduction (Laszlo Windoffer) | 09-C-NE-GIT-009: NextGen En Route Traffic Optimization to Reduce Fuel Burn and Emissions Part 2 | Georgia Institute of Technology | $35,217 |
| 9/22/10 | U. S. Air Force (Warren Gillette) | 09-C-NE-MIT-004: Alternative Jet Fuels Air Mobility Command Study | Massachusetts Institute of Technology | $300,000 |
| 8/4/10 | Environment and Energy (Christopher Sequeira) | 09-C-NE-HU-002: Evaluation of Particulate Matter Differential Toxicity | Harvard University | $54,794 |
| 8/2/10 | Environment and Energy (Daniel Jacob) | 09-C-NE-MIT-003: Environmental Cost-Benefit Analysis of Ultra Low Sulfur Jet Fuels | Massachusetts Institute of Technology | $169,070 |
| 6/21/10 | Air Traffic Organization (Joseph Post) | 09-C-NE-PU-004: Studies of Continuous Descent Arrival | Purdue University | $67,707 |
| 6/4/10 | NextGen -– Environment and Energy -– Environmental Management System and Advanced Noise and Emissions Reduction (Warren Gillette) | 09-C-NE-MIT-002: Environmental Cost-Benefit Analysis of Alternative Jet Fuels | Massachusetts Institute of Technology | $650,000 |
| 6/2/10 | NextGen -– Environment and Energy -– Environmental Management System and Advanced Noise and Emissions Reduction (Pat Moran) | 09-C-NE-GIT-007: Evaluation of MFAST for TARGETS | Georgia Institute of Technology | $50,000 |

| COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 5/24/10 | NextGen -– Environment and Energy -– Environmental Management System and Advanced Noise and Emissions Reduction (Laszlo Windoffer) | 09-C-NE-GIT-006: NextGen En Route Traffic Optimization to Reduce Fuel Burn and Emissions Part 2 | Georgia Institute of Technology | $726,234 |
| 5/21/10 | NextGen Environmental Research -– Aircraft Technologies, Fuels, and Metrics (Carl Ma) | 09-C-NE-MST-003: SAE Non-Volatile PM Methodology Component Demonstration During the Alternate Aviation Fuels Emissions Experiment (AAFEX) II-Biofuels | Missouri University of Science and Technology | $650,000 |
| 5/21/10 | Environment and Energy (Hua He) | 09-C-NE-PSU-003: Evaluation of the Impact of Whole-House Construction on Aircraft Noise Perception | Pennsylvania State University | $15,000 |
| 5/21/10 | Environment and Energy (Hua He) | 09-C-NE-GIT-005: Sound Transmission Indoors Study of Whole Houses | Georgia Institute of Technology | $50,000 |
| 5/17/10 | Environment and Energy (Lourdes Maurice) | 09-C-NE-MIT-001: Program Management for Aircraft Noise and Aviation Emissions Mitigation Center of Excellence | Massachusetts Institute of Technology | $425,000 |
| 5/14/10 | Environment and Energy and NextGen Environmental Research -– Aircraft Technologies, Fuels, and Metrics (Christopher Sequeira) | 09-C-NE-UNC-001: An Enhanced Characterization of Aviation Emissions Impacts on Air Quality at Subgrid Scales | University of North Carolina – Chapel Hill | $225,000 |
| 5/14/10 | Environment and Energy (Hua He) | 09-C-NE-GIT-004: Open Rotor Noise Impact to Airport Communities | Georgia Institute of Technology | $99,999 |
| 5/5/10 | Environment and Energy (Laurette Fisher) | 09-C-NE-PSU-002: Noise Quest | Pennsylvania State University | $50,000 |
| 5/5/10 | Environment and Energy (Hua He) | 09-C-NE-PU-003: Sound Structural Transmission Soundproofing Residential Buildings in Noise Impacted Areas Near Airports with Ventilated Windows | Purdue University | $85,000 |
| 4/26/10 | Environment and Energy (Carl Ma) | 09-C-NE-MST-002: Technical Issue Resolution of a SAE Aerospace Recommended Practice for Aircraft Non-Volatile PM by December 2011 | Missouri University of Science and Technology | $520,000 |
| 4/26/10 | Environment and Energy (Laurette Fisher) | 09-C-NE-PU-002: Noise Exposure Response -– Sleep Disturbance | Purdue University | $160,000 |

| COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 4/26/10 | NextGen -– Environment and Energy -– Environmental Management System and Advanced Noise and Emissions Reduction (Laszio Windhoffer) | 09-C-NE-GIT-003: Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring from a NAS Perspective | Georgia Institute of Technology | $175,000 |
| 4/26/10 | Environment and Energy (Laurette Fisher) | 09-C-NE-PSU-001: Sonic Boom Mitigation | Pennsylvania State University | $85,000 |
| 4/14/10 | Environment and Energy (Mehmet Marsan) | 09-C-NE-PU-001: Human Response – Annoyance | Purdue University | $145,000 |
| 4/14/10 | Environment and Energy (Christopher Sequeira) | 09-C-NE-HU-001: Health Impacts of Aviation-Related Air Pollutants | Harvard University | $115,000 |
| 4/14/10 | Environment and Energy (Rangsayi Halthore) | 09-C-NE-SU-001: Studying the Effects of Aircraft Exhaust on Global and Regional Climate | Stanford University | $250,000 |
| 4/2/10 | NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction (Rhett Jefferies) | 09-C-NE-GIT-002: EDS Assessment of CLEEN Technology | Georgia Institute of Technology | $450,000 |
| 3/15/10 | Environment and Energy and NextGen Environmental Research -– Aircraft Technologies, Fuels, and Metrics (Rangsayi Halthore) | 10-C-NE-UI-001: Development and Evaluation of Climate Metrics for Aviation Based on Climate-Chemistry Modeling Analyses | University of Illinois at Urbana - Champaign | $224,834 |
| 3/15/10 | Environment and Energy (Joseph DiPardo) | 09-C-NE-GIT-001: EDS Development and Application | Georgia Institute of Technology | $1,000,000 |
| 12/20/09 | Environment and Energy (Carl Ma) | 09-C-NE-MST-001: NIST Traceable PM Calibration Source for Aircraft | Missouri University of Science and Technology | $150,000 |
| 12/20/09 | Environment and Energy (Carl Ma) | 07-C-NE-UMR-011: SAE E31 Methodology Development and Associated PM and HAP Emissions Characteristics for a High-Bypass Turbofan Engine | Missouri University of Science and Technology | $150,000 |
| Total awarded in FY 2010: | | | | $7,277,855 |

### 3.3.5 COE for General Aviation Research

Established in 2001, Embry-Riddle Aeronautical University serves as the lead member for the COE for General Aviation Research (CGAR). This COE conducts safety-related R&D with application to non-commercial aviation in the following areas: NextGen ADS-B, weather in the cockpit, safety management systems, remote airport lighting systems, training standards, and

unmanned aircraft systems. The FAA expects the COE to become self-sufficient by 2011, which is 10 years after its formation. In FY 2010, the FAA issued a two-year extension to each of the four cooperative agreements with the COE lead and members to allow adequate transition time for orderly phase down and to enable the COE to become self-sufficient by 2013. Core university members include Wichita State University, University of North Dakota, and the University of Alaska - Fairbanks and Anchorage. Table B.12 provides the grants awarded to the COE in FY 2010. This center generated matching contributions in excess of $1M in FY 2010. For additional information, see http://www.cgar.org/.

**Table B.12 - Grants Awarded in FY 2010 to the COE for General Aviation Research**

| COE for General Aviation Research Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 8/18/10 | NextGen- Weather Technology in the Cockpit (Ian Johnson) | 07-C-GA-ERAU-029: Weather Technology in the Cockpit – Pilot Training Requirements | Embry Riddle Aeronautical University | $33,152 |
| 7/28/10 | Unmanned Aircraft Systems (John Zvanya) | 07-C-GA-UAF-005: Development of a 3-Dimensional Radar Based Airspace Monitoring and Surveillance Instrument | University of Alaska – Fairbanks and Anchorage | $226,204 |
| 7/16/10 | System Safety Management (Huasheng Li) | 07-C-GA-ERAU-028: A Database Management System for General Aviation Safety | Embry Riddle Aeronautical University | $91,407 |
| 7/12/10 | Airport Technology Research – Safety (Donald Gallagher) | 07-C-GA-ERAU-027: Pilot Awareness of Current and LED Elevated Runway Guard Lighting | Embry Riddle Aeronautical University | $16,445 |
| 7/7/10 | COE Management (Peter Sparacino) | 01-C-ERAU-1O: Year Ten, Management & Administrative Support – General Aviation Center of Excellence | Embry Riddle Aeronautical University | $186,419 |
| 6/23/10 | System Safety Management (Michael Vu) | 07-C-GA-UND-013: Flight Data Monitoring – General Aviation Safety Information Analysis and Sharing Phase II | University of North Dakota | $245,077 |
| 6/23/10 | System Safety Management (Michael Vu) | 07-C-GA-ERAU-025: Flight Data Monitoring: General Aviation Safety Information Analysis & Sharing | Embry Riddle Aeronautical University | $99,341 |
| 3/1/10 | System Safety Management (Michael Vu) | 07-C-GA-ERAU-021: General Aviation System Safety Management Research | Embry Riddle Aeronautical University | $12,957 |
| 12/16/09 | Flightdeck/Maintenance/ System Integration Human Factors (Dan Hersheler) | 07-C-GA-ERAU-019: Synthetic Speech and Visual Data Communications for Flight Deck Use | Embry Riddle Aeronautical University | $80,805 |

| COE for General Aviation Research Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| Total awarded in FY 2010: | | | | $991,807 |

### 3.3.6 COE for Airport Technology

In 1995, the Administrator selected the COE for Airport Pavement Research with the University of Illinois at Urbana-Champaign as the lead member and North Carolina A&T University as a participating member. This COE initially focused on pavement issues. In 2005, Rensselaer Polytechnic Institute joined the COE and the FAA expanded the scope to include R&D on wildlife hazard mitigation, lighting, and other airport safety topics, and changed its name to the Center of Excellence for Airport Technology (CEAT). In FY 2010, in addition to grant awards provided in Table B.13, the FAA issued an extension to the final cooperative agreements in preparation for the COE becoming self-sufficient by 2012. This center has generated matching contributions in excess of $1M during FY 2010. For further information, see http://www.ceat.uiuc.edu/.

**Table B.13 - Grants Awarded in FY 2010 to the COE for Airport Technology**

| COE for Airport Technology Awards in FY 2010 | | | | |
|---|---|---|---|---|
| Award Date | FAA R&D Program (FAA POC) | Grant Number and Title | Recipient Institution | Award Amount |
| 7/20/10 | Airport Technology Research – Safety (Ryan King) | 05-C-AT-UIUC-028: Deployment and Assessment of Avian Radar Systems at JFK, ORD, NASWI, and SEA | University of Illinois at Urbana-Champaign | $841,671 |
| 4/16/10 | Airport Technology Research – Capacity (David Brill) | Graduate Student Support FY 2010 | University of Illinois at Urbana-Champaign | $254,800 |
| Total awarded in FY 2010: | | | | $1,096,471 |

# Appendix C: Research, Engineering and Development Advisory Committee

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## Introduction

The FAA values the ongoing involvement of the Research, Engineering and Development Advisory Committee (REDAC) in reviewing its current and planned R&D programs and has established a formal process for the agency to reply to Committee recommendations.

The REDAC meets twice a year, in the fall and in the spring to review and provide advice on the R&D portfolio. In the fall of 2009, the committee provided guidance for planning the fiscal year (FY) 2012 R&D portfolio. During the spring of 2010, the committee reviewed and provided recommendations on the proposed FY 2012 R&D portfolio investments.

There are five standing subcommittees that support the REDAC by conducting detailed program reviews in the summer and winter for the following research areas: Aircraft Safety; NAS Operations; Environment and Energy; Airports; and Human Factors. The REDAC reviews the reports from these subcommittees and approves their detailed guidance and recommendations for inclusion in the REDAC reports to the Administrator.

This appendix summarizes the REDAC recommendations made during FY 2010, including FAA responses to the following reports:

1. *REDAC Guidance for the FY 2012 R&D Portfolio*, October 19, 2009
   [Note that this report includes a status update on the *Report of the Separation Standards Working Group* dated September 20, 2006, a report from an ad hoc subcommittee of the REDAC that FAA responded to on May 14, 2007, originally appearing in the *2008 NARP*.]

2. *REDAC Recommendations on the FY 2012 R&D Portfolio*, May 10, 2010

In FY 2011, FAA expects to receive the Committee's recommendations on FAA's planned research and development investments for FY 2013, including detailed recommendations from the standing subcommittees.

## 1. *REDAC Guidance for the FY 2012 R&D Portfolio*, October, 19, 2009

The Committee Chairman Dr. John Hansman submitted the REDAC's guidance for planning the FY 2012 R&D portfolio to the Administrator on October 19, 2009. The FAA provided responses to the recommendations on January 29, 2010.

### General Observations

**Excessive Safety Standards for New Systems** - The safety standards and target levels of safety being applied to new systems, technologies, or demonstrations appear to be overly conservative. While it is important to maintain and improve the high level of safety in the system, excessive safety requirements put NextGen at risk and can actually degrade safety through increased complexity, cost, delay, and uncertainty in gaining operational approval. The responsibility for safety assessment is distributed throughout the agency and there does not appear to be a clear system level process for managing risk and arbitrating safety requirements for new systems or new procedures such as reduced separation standards. The REDAC recommends an independent review of the safety standards and processes being applied to new systems and recommendations for a balanced approach to safety.

**FAA Response**: The Federal Aviation Administration appreciates the concerns the Committee expressed and agrees with the need for the effective management of safety processes. The FAA operates under a Safety Management System (SMS) that requires an assessment of all changes before they become operational. The Associate Administrator for Aviation Safety, Peggy Gilligan, and Chief Operating Officer, Hank Krakowski, chair an SMS implementation Steering Committee, which oversees the SMS process and its proper application. Recognizing the importance of safety assessments for implementation of NextGen, the FAA has also established a cross-agency team, lead by an Aviation Safety (AVS) representative detailed to the Next Generation Air Transportation System (NextGen) Integration and Implementation (I&I) office. The cross-agency team is responsible for coordinating across all lines of business and performing organizations to ensure consistency in approach and the timely integration and execution of safety assessments. In addition, the FAA has initiated an internal review to apply lean processes to the development, implementation, and use of new instrument flight procedures, associated aircraft equipment, and operational approvals. This review will include the safety management aspects of this specific implementation. Thus, the FAA does not believe an independent review of safety standards and processes is necessary at this time.

**Growing Importance of Environmental Issues** - Environmental issues, particularly those relating to greenhouse gas emissions, are emerging as key constraints on the air transportation system. The REDAC urges that environmental issues be given the same consideration as capacity issues in research and strategic planning as they are just as significant a risk to the future viability of the air transportation system.

**FAA Response**: We agree with this recommendation that environmental issues be given high level attention. Environmental considerations are becoming integral to the FAA's aviation capacity growth strategy. We have in fact adopted an FAA-wide Environmental Management System (EMS) approach to effectively manage aviation environmental goals. We are working

aggressively and implementing key activities (such as developing advanced aircraft technologies and fuels, advancing efficient operations, developing new modeling capabilities, etc.) that will help to inform, develop, and implement effective environmental impacts mitigation strategies and ensure the future viability of our air transportation system.

**NextGen Research Requirements** - The REDAC was encouraged to see the beginning of a well defined process for generating NextGen research requirements from the Enterprise Architecture. The REDAC is concerned that the architecture may be more complex than necessary and cautions that the process could become unwieldy or intractable if not carefully managed.

**FAA Response**: Thank you for the recognition of the work the FAA has done to define the process for generating NextGen research requirements. The FAA believes the Enterprise Architecture (EA) is a critical component in the process of generating NextGen research requirements, and we are pleased REDAC recognizes the positive steps made in linking the two. In generating research requirements, keep in mind that NextGen is an incredibly complex endeavor. For the integration, planning, and execution of NextGen, all interfaces must be identified and managed and, therefore, the EA must contain the appropriate level of detail to identify these linkages. While a significant level of detail and complexity exists, the FAA uses the level of detail warranted in order to define research requirements and manage NextGen implementation.

**Software and Digital Systems** - The FAA has a unique need for expertise on critical software and digital systems both for its certification and acquisition responsibilities. The REDAC reiterates its concern that there has been inadequate progress in developing the core competency and technical workforce in this area. The REDAC recommends that this be given urgent priority.

**FAA Response**: The FAA agrees that software and digital systems is a critical area of expertise, and the FAA continues to make hiring an urgent priority in this area. To date, the Aircraft Certification Service Headquarters has hired three software and digital systems engineering specialists in the last two years. The AVS organization continues to actively search to fill the Chief Scientific and Technical Advisory positions for both Aircraft Computer Software and Advanced Avionics.

Within the NextGen and Operations Planning Service Unit (ATO-P), Office of Airport and Aircraft Safety (AJP-63) plans to hire additional staff in this area within the next year. We are seeking individuals who have knowledge of integrated and complex aircraft digital systems and have conducted safety assessments of civil airborne systems and equipment.

**Unmanned Air Systems** - There continues to be pressure to develop a long term Con-Ops for UAS operations in the NAS for DOD and civil users. The current Certificate of Authorization processes are short term solutions and are unable to keep pace with the demand. While there has been some progress, the REDAC considers the current approach inadequate to meet the needs of government and industry.

**FAA Response**: A joint FAA, Department of Defense (DoD), National Aeronautics and Space Administration (NASA), and Department of Homeland Security (DHS) Senior Executive Committee has been established to develop an overall strategy for Unmanned Aerial System (UAS) integration into the National Airspace System (NAS) in the NextGen environment. The Committee will develop an integrated plan for interagency UAS research and development initiatives that will support development of UAS technical standards and corresponding regulatory policy and guidance for UAS-NAS integration.

As part of the NextGen research portfolio, the FAA is working with industry, academia, and government agencies to identify and validate required capabilities and performance levels for the safe integration of UAS into the NAS. Specifically, through the use of modeling, human-in-the-loop simulations, demonstrations, and flight testing, the FAA is supporting near-term tactical and strategic initiatives. Related supporting activities include operational assessments of site specific, proposed ground based and airborne based sense and avoid solutions, operational procedures validation, and evaluations of NextGen enabling technologies and concepts such as 4-dimensional trajectory based operations and ADS-B.

Near-term needs of the UAS community are being addressed by the FAA through the Certificate of Authorization (COA) process which enables NAS access for public UAS based on a comprehensive safety assessment of proposed operations. The COA submittals have steadily increased and the FAA is developing process improvements to address the increase in demand. For civil access, the FAA has addressed NAS access needs through the review and update of the Experimental Certificate process.

**Weather in the Cockpit Research Program** - The recently formed Weather in the Cockpit research program was found by several REDAC subcommittees to lack a clear mission, goals or connection to NextGen requirements. The program should be focused or terminated.

**FAA Response:** FAA concurs with the recommendation to better focus the program. The Weather-in-the-Cockpit program was a new start in Fiscal Year (FY) 2009 and did not receive funding or have adequate staff until late in the fiscal year. FAA will continue to work to clarify the goals and objectives of this program.

## Subcommittee on Human Factors

**Finding (1):** In the previous cycle, the REDAC Human Factors Subcommittee had expressed some concern regarding the extent to which human factors was "being adequately addressed in NextGen programs beyond the efforts of AJP 61". On the basis of the Administrator's response to those concerns, released on 9/22, we were quite gratified with the extent to which attention is given to these issues. We also feel confident that this attention will be enduring as NextGen progresses, given the criticality of avoiding major human factors bottlenecks that have caused substantial setbacks in some previous FAA developmental efforts (e.g., the STARS system and the AAAS system in the 1990s). The briefing given by Kathy Abbott, CSTA for flight deck Human Factors, which the subcommittee received in our September meeting provided compelling evidence for the high priority offered to human factors in some units outside of

AJP61. Furthermore, we are quite gratified with the appointment of the Chief Systems Engineer for Human Factors within the NextGen I&I program, which we assume will be a permanent position with the authority to properly influence NextGen decisions as required. In order to facilitate this influence, we would also hope that this would grow into a full-time position.

**Recommendation (1a)**: Continue to place strong emphasis on human factors issues, as reflected in the Human System Integration Roadmap.

**FAA Response (1a)**: We agree that the Human System Integration (HSI) Roadmap is pivotal to addressing human factors issues for NextGen. ATO-P Office of Human Factors Research and Engineering (AJP-61) is identifying and tracking areas for improvement in the next annual update to start in the second quarter of FY 2010, and will continue to keep the Human Factors Subcommittee abreast of these activities.

**Recommendation (1b)**: Assure in particular that human factors issues related to levels of automation in decision aiding, such as out-of-the-loop performance degradation, and human operator response to unexpected off-nominal events (e.g., automation failures) receive utmost priority and sustained funding, for both flight deck and air traffic research.

**FAA Response (1b)**: As briefed to the Human Factors Subcommittee as part of the NextGen presentation on budget line Self Separation and Air Ground Integration, research on human factors issues in flight deck automation and decision aiding includes pilot and air crew response to out-of-the-loop performance degradation and response to off-nominal events. Additionally, the NextGen Air Traffic Management (ATM) Human Factors Controller Efficiency program has initiated a Human Factors Safety project with a dedicated effort to address human error and human performance issues. The context of the human factors safety analysis is the total job of the controller including off-nominal events and automation failures. Performance and skill degradation as a result of reliance on automation is a specific area of attention in the Strategic Training Needs Analysis of this program to determine the recurring training needs for skill maintenance.

**Recommendation (1c)**: Following the excellent briefing from Flight Deck Certification, the subcommittee wishes to continue to receive briefings from other program elements within the FAA, which have direct human factors components, or involve human-in-the-loop simulation. These include, in particular, planned and completed simulations of concepts of operation within AJP66, and on all research on weather displays, and weather-related decision aids.

**FAA Response (1c)**: AJP-61 recognizes the importance of ensuring the Human Factors Subcommittee has all necessary information from other program elements within the FAA addressing NextGen research and development. We will coordinate relevant presentations for future meetings including human-in-the-loop simulations conducted by AJP-66 on NextGen concepts of operations, and research by ATO-P Office of Aviation Weather (AJP-68) on weather displays and decision aids.

**Finding (2):** The subcommittee was very impressed with the proactive efforts made by AJP61 to understand and collaborate with NASA human factors programs and harness NASA research

expertise. We understand that the memorandum of agreement is about to be finalized and that efforts are already underway within the NASA Aviation Safety Program to develop research products of use for the FAA NextGen program. We observed that both flight deck and air traffic (within the FAA) have harnessed research within NASA's Aviation Safety Program (specifically the Integrated Intelligent Flight Deck project, regarding which we were well briefed). We were however less certain of the degree of collaborative involvement of NASA's airspace program in the FAA work.

**Recommendation (2a)**: Continue the excellent progress of collaboration with NASA's Integrated Intelligent Flight Deck project, within the Aviation Safety Program.

**FAA Response (2a)**: We agree and AJP-61 will continue collaboration to ensure involvement with the NASA Aviation Safety Program's Integrated Intelligent Flight Deck Project with particular emphasis on applications such as merging and spacing and closely spaced parallel operations. We will also emphasize transitioning NASA research products to FAA for integration as part of our NextGen Air Ground Integration research efforts.

**Recommendation (2b)**: Try to further engage human factors research within NASA's Airspace Systems program in collaboration, particularly with regard to the work carried on by this group, in air-ground integration and collaborative decision making.

**FAA Response (2b)**: The NextGen Air Ground Integration Human Factors research program does collaborate with NASA's Airspace Systems program in addressing applications such as merging and spacing, closely spaced parallel operations, and collaborative decision making. Additionally, the NextGen ATM Human Factors Controller Efficiency program has initiated an effort to review the NASA Research Announcements (NRA) in the Air Traffic Management domain including collaborative decision making. The NRAs and in-house NASA research efforts will be reviewed for mid-term NextGen application by the NASA Human System Integration Division as part of their collaborative effort with the FAA. The area of collaborative decision making is currently being addressed in the FAA program.

## Subcommittee on Airports

**Finding (1):** The subcommittee is pleased with the progress shown by FAA on the projects that are currently underway. The Subcommittee is likewise pleased to see that the Airport Cooperative Research Program (ACRP) program is well established, fully funded, and is achieving the goals that were hoped for when it was initiated. We see no redundancies between the two programs as they are proving to be complimentary to one another.

**Recommendation**: The subcommittee recommends that FAA reach out to other Lines of Business for consideration of the inclusion of other lines of business (such as ATO) on appropriate ACRP project technical panels.

**FAA Response**: The FAA agrees with this recommendation. We will work with the other Lines of Business to invite them to provide technical experts on appropriate ACRP technical panels.

**Finding (2):** The Technical Center's research into bird radar systems, as part of the Wildlife Hazard and Mitigation research area, is progressing steadily.

**Recommendation**: As other detection sensors and technologies are being explored (such as: laser; optical; thermal imaging; and sound, etc.), the subcommittee recommended that coordination be pursued with MIT Lincoln Lab on radar research and development, and also that the research team initiate coordination with ATO researchers to explore the integration of avian radar research with terminal surveillance activities into a concept of operations to communicate bird hazards identified by avian radar.

**FAA Response**: The FAA agrees with this recommendation. We will initiate research to explore the feasibility of integrating avian radar into the tower and making the bird hazard data available to controllers and pilots.

**Finding (3):** The subcommittee is pleased to see the continuing R&D activities on Aircraft Rescue and Fire Fighting (ARFF), especially the efforts on composite material fire fighting, improved RFF equipment and agents, and work regarding the operation of new large aircraft.

**Recommendation**: Continue this research with a high priority.

**FAA Response**: The FAA agrees with this recommendation and will continue this research with a high priority.

**Finding (4):** The Subcommittee continues to have keen interest in the progress of research in the NextGen area.

**Recommendation**: Keep the Subcommittee informed of NextGen tasks, especially as they relate to airports and airport issues.

**FAA Response**: The FAA concurs. We will provide appropriate NextGen airport related briefings at the next subcommittee meeting in March 2010.

## Subcommittee on Environment and Energy

**Finding (1)**: The issue of global climate change is becoming a major driver of environmental policy. In spite of its importance, there is a lack of understanding of aviation's impact on climate change, especially in the area of non-$CO_2$ pollutants. A more robust research effort with respect to climate change is necessary to develop reasoned policy on this subject.

**Recommendation**: Current Aviation Climate Change Research Initiative (ACCRI) funding appears to be inadequate to fully study the non-$CO_2$ impacts of aviation. The Agency should therefore ensure that future funding requests contain the resources necessary for emerging global climate change research.

**FAA Response**: Climate concerns are indeed among the most pressing issues the aviation industry is facing today. Given tradeoffs among emissions and their climate impacts, solutions for mitigation of aviation climate impacts require improved scientific understanding of impacts, particularly for non-$CO_2$, within the well defined uncertainty bounds. We have implemented the next phase of the Aviation Climate Change Research Initiative (ACCRI) program with support from other federal agencies. Progress made and lessons learned during this 3-year targeted program will provide direction for future work. We should look at these results first to determine future funding needs. We will continue to monitor progress, quality, and usefulness of ACCRI outcomes and evaluate funding requirements for ACCRI program against other environment and energy research priorities.

**Finding (2):** Alternative aviation fuels are probably the most promising near-term tools for managing aviation's impact on the environment. The CAAFI project to develop and certify such fuels represents a significant research effort and reflects the necessary industry/government and intra-government cooperation necessary to address this issue.

**Recommendation**: Continued funding and support for the CAAFI initiative is absolutely necessary, as is the continuing partnership between industry and government and between the FAA and partner government agencies. To the extent possible, the FAA should ensure that efforts by other public entities (such as the military) are included in research efforts to avoid an unnecessary duplication of effort.

**FAA Response**: We agree with this recommendation and believe that deployment of alternative commercial aviation fuels offers one of the most promising solutions to achieve NextGen environmental goals for reduction of greenhouse gas emissions. The role of alternative fuels is becoming more critical, not only given the increasing demand to address and mitigate climate change, but also for energy security. We are very aggressively pursuing the path for securing ASTM approval, environmental acceptability, and quick infusion of alternative fuels into the civil fleet. We are working very closely with Department of Energy and other Federal agencies such as NASA and DOD so that we all mutually benefit from the concerted efforts while following the guidelines prescribed by the Environmental Protection Agency for sustainability.

**Finding (3):** On the local level, the issue of aircraft noise remains a major priority for many citizens. In addition, the nature of noise-related complaints has somewhat shifted its focus to areas well beyond traditional areas of substantial impact.

**Recommendation**: The Office of Environment and Energy has embarked on a major new research effort to define the current noise landscape and to develop the actions needed to address any identified concerns. The Agency should endorse and encourage this effort by requesting adequate funding to continue this project.

**FAA Response**: The FAA agrees with this recommendation. We fully support this major research effort on aircraft noise, impacts, and metrics. We are developing a roadmap for aircraft noise research based on the recommendations of experts from the international community. We have initiated implementation of key activities which have potential for high return and contributions to aviation's noise mitigation efforts. We will continue to weigh allocation of

resources for this effort against other environment and energy research priorities. We are pleased that the FY 2010 budget appropriation includes funding for operational aspects that will complement and support this research.

**Finding (4):** The PARTNER Center of Excellence continues to occupy a central role in environmental research activities**.**

**Recommendation**: The FAA should continue to request the funding necessary to support PARTNER activities. (Note: There was some concern expressed by Subcommittee members over the fact that current versions of the pending FAA Reauthorization bill include the formation of a new Center of Excellence for Alternative Aviation Fuel, when research in this area can be accomplished through PARTNER).

**FAA Response**: The FAA continues to fund Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) at an appropriate level to maximize benefits from its world-class expertise and contributions. FAA support to PARTNER in year 2009 increased by 25 percent relative to year 2008 support level. We agree and advocate that the PARTNER Center of Excellence is fully capable to take on challenges and additional responsibilities for Alternative Fuels Research. We will continue to provide this information to Congress in the reauthorization process.

## Subcommittee on Aircraft Safety

**Finding (1):** The Aircraft Safety Subcommittee noted that AVS FY 2012 Strategic Guidance requires that each Research Requirement describe the expected outcome desired by the sponsor and include an implementation plan describing how the outputs of the research will be used and implemented by the sponsoring organization in support of the desired outcome. The subcommittee noted that posing the research question is a best practice and an essential starting point for all projects.

**Recommendation**: The Subcommittee recommends that the AVS FY 2012 strategic guidance referenced in the above finding be retroactively applied across the entire AVS Research Portfolio. Adoption of this recommendation will ensure that research projects start with a desired end state in mind. The Subcommittee recommends that the research question for each project be carefully posed by the researcher in close coordination with the sponsor.

**FAA Response**: The FAA agrees with the Subcommittee recommendation to retroactively apply the specification of the expected outcome and an implementation plan describing how the outputs of each research project will be used by the sponsor. We are working with the research sponsors and performers to implement this process improvement including its retroactive application.

**Finding (2):** The Aircraft Safety Subcommittee found the Fire Research and Safety Program to be relevant, well managed and directly responsive to aircraft safety requirements.

**Recommendation**: The Subcommittee recommends that FAA ensure the Fire Research and Safety Program continue to be adequately staffed and funded.

**FAA Response**: We agree with the Subcommittee's finding that the Fire Research and Safety Program is relevant, well managed, and responsive to sponsor aircraft safety requirements. We also concur with the recommendation that the Fire Research and Safety Program continue to be adequately staffed and funded in accordance with FAA requirements and available resources.

**Finding (3):** The Aircraft Safety Subcommittee again noted the lack of a comprehensive and integrated Software and Digital Systems Project Plan and noted little progress in acquiring the specialized expertise required to support this critical research program.

**Recommendation**: The Subcommittee again recommends that a comprehensive and integrated program be developed and appropriate specialized expertise be acquired to spring board the FAA to a leading position in complex software and digital system safety. Inability to attract specialized talent should no longer be an acceptable excuse for lack of progress in establishing a core capability.

**FAA Response**: The FAA will provide the Aircraft Safety Subcommittee with a deep dive briefing on its Aircraft Certification Software and Digital Systems (SDS) Research Plan at the March 2010 subcommittee meeting. The briefing will also include an overview of the Aircraft Certification Software and Electronic Hardware Program Management Plan, which guides the FAA's regulatory policy activities in the area of software and digital systems. Both of these plans have been in existence for over a decade. Recently, the SDS Technical Community Representative Group drafted a comprehensive R&D Plan that identifies requirements specific to NextGen. This plan is currently under management review and will complement the existing Aircraft Certification Software and Electronic Hardware Program Management Plan.

The FAA agrees that software and digital systems is a critical area of expertise, and the FAA continues to make hiring an urgent priority in this area. To date, the Aircraft Certification Service Headquarters has hired three software and digital systems engineering specialists in the last two years. AVS continues to actively search to fill the Chief Scientific and Technical Advisory positions for both Aircraft Computer Software and Advanced Avionics. Within ATO-P, AJP-63 plans to hire additional staff in this area within the next year. We are seeking individuals who have knowledge of integrated and complex aircraft digital systems and have conducted safety assessments of civil airborne systems and equipment.

**Finding (4):** The Aircraft Safety Subcommittee found the Aviation Safety Information Analysis Sharing (ASIAS) project is directly responsive to the need of safety analysts within the FAA and aviation industry to understand emerging risks before they become potential safety issues and applauds the progress made in increasing the number of airline ASIAS participants. The Subcommittee notes that the ASIAS program does not address general aviation at the present time.

**Recommendation**: The Subcommittee recognizes that the attempt to automatically monitor for unknown risk based on complex data mining capabilities and seamless data sources is in fact the

most difficult challenge in ASIAS and recommends that parameters be developed to indicate when the quest to accomplish this objective should be re-examined.

**FAA Response**: ASIAS is implementing data and text mining algorithms to automatically categorize text reports by topic and identify novel and emerging topics; identify anomalous flights and groups of anomalous flights; correlate anomalies with known safety risks and contributing factors; and trigger additional action or analysis when anomalies indicate a new issue or significant change in a known risk. Developing and implementing data mining algorithms is an iterative, multi-step process. Performance parameters are being developed to determine when the objectives of the vulnerability discovery activity are met in the modeling, evaluation, and deployment phases of data mining. When these performance objectives are met, the focus will shift from development of data mining models to routine monitoring using these models. Strategies will be developed to trigger re-evaluation of the performance of the models during the monitoring phase since it is possible that changes in operations or governance will degrade the performance of the vulnerability discovery modeling.

**Finding (5):** The Aircraft Safety Subcommittee expressed concern about the realism of wake vortex and wind shear characteristics being used for research in advanced maneuver capable flight simulators.

**Recommendation**: The Subcommittee recommends that FAA take particular care in validating wake vortex and wind shear models with real world aircraft response data.

**FAA Response**: The FAA will collaborate with aircraft Original Equipment Manufacturer (OEM) to collect the requisite aircraft response data; however, this is a long-term effort. In the interim, we will continue to use published wake science results to further validate flight simulator wake and wind shear models. These models will be continually enhanced as actual OEM aircraft response data becomes available and wake science continues to mature.

**Finding (6):** The Aircraft Safety Subcommittee noted and applauds the progress made in achieving a limited amount of F&E funding in support of the Aerospace Medical Research Program.

**Recommendation**: The subcommittee encourages the other research laboratories to pursue similar funding options applying the aeromedical approach.

**FAA Response**: We concur with the recommendation. We will look in more detail at the approach used successfully by the Civil Aerospace Medical Institute and apply it, as appropriate, to the other safety laboratories in the Airport and Aircraft Safety Group.

**Finding (7):** The Aircraft Safety Subcommittee noted that the Volcanic Ash Project under the Aviation Weather Research Program is not consistent with previous SAS recommendations.

**Recommendation**: The Subcommittee again recommends that research be limited to a very focused approach on how to detect and avoid a volcanic ash encounter. The Subcommittee does not believe the research related to the development of onboard technologies to detect or harden

an aircraft against volcanic ash is warranted. The Subcommittee recommends that the research be limited to the development of procedures for getting tactical information to flight crews so they can effectively avoid the hazardous areas. Finally the Subcommittee believes that even this limited scope for research is relatively low priority in the broad research portfolio.

**FAA Response:** As reported in the Administrator's letter to Dr. Hansman on September 22, 2009, the FAA agrees that research on onboard technologies to detect or harden an aircraft against volcanic ash is not needed. Indeed, research on such on-board capabilities has not been part of our research program in the past nor is it now. With respect to ash plume detection and reporting to flight planners and flight crews for hazard avoidance, FAA has suspended research into those and other aspects of volcanic ash hazards pending a full review of the need for further research.

**Finding (8):** The Aircraft Safety Subcommittee expressed concern about the apparent lack of a comprehensive and integrated program plan for the NextGen Weather Technology in the Cockpit Program.

**Recommendation:** The Subcommittee recommends that the REDAC NAS Operations Subcommittee do a "deep dive" review of the Weather in the Cockpit Program at their next review meeting.

**FAA Response:** FAA concurs with the recommendation and we will provide a detailed briefing to the NAS Operations Subcommittee at their spring meeting.

**Finding (9):** The NextGen Self Separation and Air Ground Integration Human Factors Program was briefed at a macro level. As a result the Subcommittee was unable to determine whether the program was focused on very specific and real research requirements.

**Recommendation:** The Subcommittee recommends that the REDAC Subcommittee on Human Factors do a "deep dive" review of the NextGen Self Separation and Air Ground Human Factors Program at their next review meeting.

**FAA Response**: The REDAC Human Factors Subcommittee has received detailed presentations at the past two meetings on NextGen. These presentations were on budget line items called NextGen Self-Separation and NextGen Air Ground Integration, and addressed the 11 program areas comprising these research investments. In Dr. R. John Hansman's letter to the FAA Administrator dated May 18, 2009, the REDAC Human Factors Subcommittee found "the NextGen research work plans proposed by both Air Traffic Control and Technical Operations (NextGen Controller Efficiency) and Flight Deck (NextGen Self Separation and NextGen Air Ground Integration) domains were well crafted and reflect a good allocation of budget. The Subcommittee was pleased to see the efforts within NextGen Self-Separation and NextGen Air Ground Integration focused on flight deck automation and human-automation function allocations." We will continue to ensure the Human Factors Subcommittee receives thorough briefings on these two NextGen flight deck research budget line items.

**Finding (10):** The Aircraft Safety Subcommittee noted the positive progress made in the Unmanned Aircraft System (UAS) Research Program related to UAS regulations and standards.

**Finding (11):** The Aircraft Safety Subcommittee noted good progress by the System Safety Management Team in the development of prognostic safety assessment models intended to predict the safety impact of proposed improvements to the NAS. When completed and validated, it is essential that FAA use the tools to guide NextGen implementation.

**Finding (12):** Under the Flight Deck/Aviation Maintenance/System Integration Human Factors Program, the SAS found the 30 plus projects to be responsive to the research questions posed by the sponsor, but did not find a documented basis for the research questions. The Subcommittee also noted the lack of a priority process related to current projects in the program.

**Recommendation**: The Subcommittee recommends that FAA perform a gap analysis of the current projects against data driven requirements for increased safety.

**FAA Response**: Research requirements for AVS for flight deck human factors are organized using a Web site for the associated Technical Community Requirements (sic) Group (TCRG). This site identifies the sponsors, the requirements they have submitted, and the priorities assigned to the requirements by the TCRG. The sponsor requirements provide the rationale for the research questions. The site also provides information on the prioritization process that considers safety data, certification issues, and internal/external forces as factors influencing the prioritization of individual requirements. The process links research expenditures to these prioritized requirements to ensure that the most important requirements are funded first. The FAA believes that no additional gap analysis is needed.

In FY 2008 and FY 2009, the AVS TCRG approved approximately 19 human factors (HF) requirements for funding. The number of projects approved aligned with AVS R&D strategic guidance which emphasized the HF research area since HF had been identified as a common contributor to aviation safety incidents and accidents. In FY 2010, the TCRG approved nine human factors requirements and in FY 2011, the TCRG prioritized six human factors requirements. We believe that this sharper focus on a narrower set of the highest priority HF research requirements at least partially addresses the finding. This reduction in the number of research requirements corresponds to an appropriate use of resources on the research topics that offer the greatest potential for improving safety.

**Finding (13):** The Aircraft Safety Subcommittee noted the good work being performed under the Maintenance and Inspection (M&I) Program and looks forward to the results being transmitted into practice.

**Finding (14):** The Aircraft Safety Subcommittee found the research conducted by FAA in cooperation with industry, under the Transport Structural Integrity Metallic R&D Program, to be relevant and a good example of self funding through industry cost sharing and engineering support complemented by the benefits from commercialization.

**Finding (15):** The Aircraft Safety Subcommittee found the Electrical Systems Program to be a practical approach to advance the knowledge of FAA in anticipation of the introduction of new technology. The Subcommittee looks forward to seeing this knowledge translated into regulatory guidance.

**Finding (16):** The Aircraft Safety Subcommittee fully supports the FAA taking advantage of the Rotorcraft research work being done by the Department of Defense related to Health Usage Monitoring System.

**Recommendation**: The Subcommittee recommends that FAA stay in lock step with the outputs of the U.S. Army rotorcraft R&D program. It is essential that FAA not fall behind.

**FAA Response**: The FAA agrees with REDAC Finding 16 and will continue work to partner with the DoD on joint rotorcraft research related to Health Usage Monitoring System. The FAA will maintain close coordination of its rotorcraft research activities with the U.S. Army rotorcraft research and development program and take full advantage of the Army research outputs.

**Finding (17):** The Aircraft Safety Subcommittee appreciated the Propulsion Research Program review, particularly the field event history that provided the motivation for the research portfolio. The data presented shows a significant reduction in the number of aircraft threatening non-contained rotor fracture events over time. It is evident that the FAA team has formed a strong partnership with industry to develop and enact effective improvements in the design, manufacture and inspection methods for engine rotors.

**Finding (18):** The Flight Controls and Mechanical Systems (FC&MS) activities presented had a clear focus with relevant objectives. Specific findings were as follows:

The Aircraft Safety Subcommittee did not review the results of the FAA Rudder Study. However, it was presented as a FY09 accomplishment with the final report due in FY09. The Subcommittee is anxious to receive copies of the final report when available and believes it will provide useful training guidance to the transport pilot community.

The General Aviation Basic Envelope Protection effort was reported as completing phase 1. The concept has the potential of protecting against GA loss of control in flight. However, the Subcommittee believes there are significant human factors issues that must be initially considered before designing a GA envelope protection system. For example, how does the system account for pilot in the loop control inputs when an automatic control device is also attempting to recover the aircraft from an upset? Under what circumstances should control be taken from the pilot? Should the automatic recovery system provide guidance cues to the pilot who then implements the recovery maneuver?

The Fly-by-Wire Research is long past due given that fly-by-wire aircraft have been certified and in operation for several years. The focus of this activity is documenting what has already been done, rather than new research. The output from this activity will enable future designs to not require certification under special conditions.

**Recommendation**: The General Aviation Envelope Protection activity must include human factor/performance issues, in particular pilot in the loop scenarios, when developing design and performance requirements for a GA Basic Envelope Protection Concept.

**FAA Response**: The FAA agrees with the recommendation. From the conceptual stages of this research effort, the FAA recognized human factors and human performance as critical aspects to developing design requirements and implementation strategies for any general aviation envelope protection system. This project will specifically consider and evaluate the pilot/machine interface for any proposed system during each phase of development. FAA human factors specialists and flight test pilots from the Small Airplane Directorate are currently reviewing the conceptual work done in Phase I and will participate in simulation and flight test studies of any proposed implementation strategy in future phases of the project. These evaluations will address system-pilot compatibility, engagement limits, control authority, and other design aspects related to human performance.

**Finding (19):** The Aircraft Safety Subcommittee was impressed with the research activities underway at the Centers of Excellence for: Airliner Cabin Environment; Advanced Materials and; General Aviation Research. The subcommittee believes that when complemented with FAA management competence and leadership, these cost sharing arrangements represent cost effective ways to conduct relevant research and advance the knowledge of FAA. The subcommittee found that to be the case in the programs reviewed.

**Finding (20):** The Aircraft Safety Subcommittee noted the good work being performed under the Aircraft Icing Program and looks forward to the research results being translated into regulatory guidance. The subcommittee does however question the operational benefit related to 3D icing studies.

**Recommendation:** The subcommittee recommends that FAA review the requirement to generate 3D ice shapes.

**FAA Response**: The operational benefit for 3D ice accretion and aerodynamic effects studies is directly related to current and upcoming certification guidance material needed by the FAA to support aircraft icing certification.

Computational fluid dynamics (CFD) analysis methods are powerful tools among a suite of icing engineering tools used by aircraft design and manufacturing companies. Virtually all of the medium and large airplane manufacturers already use 3D ice accretion codes as part of their certification methodology. Guidance material for the use of 2D codes is well documented with substantial verification and validation data. This is not the case, however, for 3D ice accretion codes needed for analysis of modern airfoil designs with swept wings and other 3D, compound-geometry surfaces.

The FAA is often challenged to determine how well the tools operate, what historically acceptable benchmark database they can be compared to, and how to assign a confidence level to the resulting analysis. There is very little public experimental data for both verification and validation of 3D icing codes. The swept wing experimental studies being done in this project are

required to improve knowledge of iced aerodynamic phenomena and to build a database that can support validation of 3D ice accretion prediction codes and aerodynamic effects. This research is of significant importance for the next generation of aircraft design and in preparation for determining how to address the application of increasingly complex icing CFD tools that the FAA is beginning to see in its certification activities.

## NAS Operations Subcommittee

**Finding (1):** (Modeling and Simulation) The NextGen design still (see last year's findings) appears to be based largely on intuition and consensus, rather than modeling, analysis, simulation, and demonstration or testing. The FAA needs both a facile high level analysis tool (such as NASPAC and its derivatives) and a detailed modeling and simulation capability to support detailed system design trade studies to inform the NextGen design, both mid-term and far-term.

**Recommendation (1a)**: Utilize the capabilities of NASA, JPDO and other government or private partners to achieve the modeling and simulation capability needed to support detailed system design studies for all phases of NextGen.

**FAA Response (1a)**: We concur with the need for a broad approach to meeting modeling and simulation needs. The FAA and its industry partners rely on a suite of modeling and simulation tools to research, develop, test, and evaluate air traffic management technologies and procedures. FAA's fast-time models range from very high-level policy-oriented models (e.g., the NAS Strategy Simulator), to system-wide models (National Airspace System Performance Analysis Capability (NASPAC), Airspace Concept Evaluation System (ACES), LMInet) through regional airspace models (e.g., Airport and Airspace Delay Simulation Model (SIMMOD) and Reorganized Air Traffic Control Mathematical Simulator (RAMS), to detailed airport models (e.g., ADSIM, runwaySimulator). The FAA is currently undertaking a modernization of its primary airport capacity model, ADSIM, and its primary system-wide model, NASPAC. MITRE/CAASD continues to develop System-Wide Modeler, a state-of-the-art NAS-wide model used to support various FAA studies. The FAA works actively with the ATM modeling community, both domestically and internationally, and continuously evaluates new models. For example, as part of its global technical outreach efforts, the FAA's William J. Hughes Technical Center is working with the Agent Technology Center at Czech Technical University, using their AGENTFLY model. The FAA Office of Systems Analysis, in collaboration with George Mason University (GMU) and the National Center of Excellence for Aviation Operations Research (Nextor), sponsors an annual system-wide modeling workshop on the GMU campus, which is attended by modeling researchers from throughout the community. In the environmental arena the FAA has invested considerable funds developing the Aviation Environmental Design Tool (AEDT), which, when completed, will be used to assess the environmental impacts of ATM operations. In addition to fast-time modeling tools, the FAA uses several Human-In-The-Loop (HITL) simulation laboratories to help develop ATM concepts. These laboratories include those at the William J. Hughes Technical Center and MITRE/CAASD. The FAA is currently expanding these laboratories to accommodate NextGen research and development requirements.

**Recommendation (1b)**: The FAA should brief the plan to achieve the needed modeling and simulation capabilities to the REDAC NAS Operations Subcommittee.

**FAA Response (1b)**: The Office of Systems Analysis (AJP-D) will brief the REDAC NAS Operations Subcommittee on FAA's existing and planned modeling and simulation capabilities at the next possible opportunity.

**Finding (2):** (Weather Program) The subcommittee was pleased with the first version of the ATM-Weather Integration Plan. Integration is now happening, with a good example being an Integrated Departure Reroute Planning (IDRP) by CAASD/MIT LL, but it is still a significant challenge.

**Recommendation:** The FAA Plan should become an ATM-Weather Integration research and development Program with ATO, CAASD, and FAA ATM research components, and the use of modeling and simulation to understand the benefits. The subcommittee encourages the FAA to be expeditious in this development.

**FAA Response**: The FAA concurs with the recommendation. Implementation of the ATM-Weather Integration Plan will include exploratory research and development program tasks, including modeling, simulation, prototyping and end user operational evaluations to assess potential benefits and operational suitability of selected weather-informed ATM decision support tools. The added research and development focus will be reflected in updates to the plan.

**Finding (3):** The Weather-in-the-Cockpit program was recently formed as RED program in ATO. Subcommittee found that it lacks a clear mission, goals, or a connection to NextGen requirements. In addition, weather information is already reaching many GA cockpits, and the connectivity to existing technology was not clear.

**Recommendation**: The FAA should review this program with lead weather researchers to establish clear objectives consistent with other activities, the FAA mission, and Next Gen objectives. An example goal might be to consider an aircraft role as airborne weather sensing node feeding NNEW.

**FAA Response:** FAA concurs with the recommendation to better focus the program. The Weather-in-the-Cockpit program was a new start in FY 2009 and did not receive funding or have adequate staff until late in the fiscal year. FAA will continue to work to clarify the goals and objectives of this program.

**Finding (4):** (Concept Development ) While the subcommittee was pleased with the substance and format of the Concept Development briefing, there is still a need to better understand the overall context of the research needs and fit of the work being done into a plan for NextGen development.

**Recommendation (4a):** Provide the subcommittee future briefings on context and fit between the concept development and exploration research and the NextGen plans and Enterprise

Architecture. Specific focus on the open and yet unanswered research questions in the context of connecting the research to the solution sets and OI's is needed.

**FAA Response (4a)**: ATO-P Office of Concept Development and Validation (AJP-66) will provide the subcommittee future briefings on the relationship between the concept development and exploration research and the NextGen plans and Enterprise Architecture. AJP-66 is currently conducting concept integration analysis to link NextGen concepts to specific operational improvements and ongoing research. The analysis will identify mid-term and far-term operational improvements that do not have any research and development associated with them. The analysis will also identify additional research questions associated with the operational concepts that are not supported by an ongoing research activity (i.e., identify the gaps in concept level research). While this analysis will not be completed in time for the next NAS Ops Subcommittee meeting in March, the results of this analysis could be briefed to the NAS Ops Subcommittee in August 2010.

**Recommendation (4b)**: As was recommended by the NAS Operations Subcommittee previously, more resources should be devoted to this activity in order to understand other NextGen drivers (e.g. UAS, see below).

**FAA Response (4b)**: Funding for the NextGen-Operational Concept Validation-Validation Modeling budget line has increased from $4 million in FY 2008 and FY 2009 to $10 million in FY 2010. In addition, the Advanced Technology Development and Prototyping Operational Concept Budget Line adds another $8 million for concept level research. Lastly, AJP-66 does work with other programs and organizations that have funding for research and demonstrations, such as the UAS program, to develop operational concepts as a critical element of their research/demonstration program. This outreach has been successful for development of a Surface Trajectory Based Operation Operational Concept and an Integrated Arrival, Departure and Surface Operational Concept.

**Finding (5):** (Staffed NextGen Tower) The subcommittee recognizes the need for a Staffed NextGen Tower capability to improve safety in an affordable way and was pleased to learn of the FAA's plans. The operational concept and demonstration plan could benefit from further development of details. For example, it appears that undue emphasis may be placed on using only certified ASDE-X data for the surveillance source when other options (e.g., non-certified ASDE-X, ADS-B, MLAT, radar) may be better suited for particular applications.

**Recommendation**: The subcommittee recommends that the business case for SNT be strengthened with the value of additional operational efficiency and safety improvements. The subcommittee recommends that the use of other forms of surveillance should be explored (e.g., non-certified ASDE-X, ADS-B, MLAT, radar). These alternatives need to be considered in the context of how SNT might roll-out into the NAS (e.g., whether starting at smaller airports or larger airports first or timing relative to aircraft equipage).

**FAA Response**: The Staffed NextGen Tower (SNT) program office appreciates the REDAC NAS Operations Subcommittee's insights and agrees with the recommendation for moving the SNT program forward. We are actively working on integrating the recommendations expressed

by the REDAC as we plan and execute program activities. One area that we are investigating is how to move SNT forward without formal certification of ASDE-X. We are also actively investigating alternative surveillance forms to be used for SNT that may be demonstrated at the SNT field site. These include cameras and intelligent video processing; radio frequency identification applications; and loop sensor technology. In addition, we will conduct a study examining surveillance sources and their feasibility for use at small and medium airports and the supporting infrastructure at these airports. Based on the information obtained from the above activities, we will identify the most appropriate roll-out strategy for SNT. In addition, we are working to identify the best strategy for taking SNT through investment analysis. Current discussions have focused on integrating SNT with the Tower Flight Data Manager investment activities.

**Finding (6):** (Environment) It was excellent for the subcommittee to be brought up to speed on the environmental tool AEDT. FAA is to be commended for developing this tool, and particularly for assisting in its use in the NASA NRA examining the impact of new vehicles in the NAS—this is a model of how the use of such tools can be accelerated and improved to provide one input into decision making and system design. Without significant changes to NASPAC, however, AEDT and NASPAC are inconsistent tools, which may hinder their use together.

**Recommendation**: The AEDT tool could be used in an iterative fashion in the FAA design and decision-making process to ensure that environmental issues are assessed early, rather than in an "ex post facto" fashion to assess the impact of previously developed routes, procedures, etc.

**FAA Response**: We agree with this recommendation. We are very diligently working on advancing the NAS-wide environmental assessment capability of the Aviation Environmental Design Tool (AEDT) tool. We are also working on interfacing and integrating AEDT with other aviation tools so that environmental and energy benefits can be quantified to inform and evaluate decision-making. We will continue to expand AEDT capabilities for smooth flow of data from NASPAC and other simulation tools.

**Finding (7):** (UAS Integration in the NAS) A number of projects and demonstrations with various elements of DOD were presented. These evaluations and demonstrations did not appear to flow from any top-down research and development plan for UAS integration. While encouraged that the FAA is beginning to address UAS integration in the NAS, the subcommittee considers the current approach inadequate to meet the outcomes needed and timing requirements of both government and industry.

**Recommendation (7a)**: Establish, in partnership with DHS and DOD, a Government internal civil-military concept of operations for UAS, as a prelude to developing public-private partnering relationship strategies for incremental implementation.

**Recommendation (7b)**: Establish a partnership design process, with industry and the appropriate FAA, DOD, and DHS organizations to produce a relationship strategy. Focus the initial stages of the design process on (1) reaching a shared view of demand, and (2) establish a

shared concept of operations, and (3) decide on best approaches to the partnership design, implementation, and operation.

**FAA Response (7a) and (7b)**: The FAA is working jointly with other government agencies, specifically DOD, NASA, and DHS, to establish a UAS Executive Committee (EXCOM). The UAS EXCOM structure and process will facilitate interagency collaboration of research and development activities to integrate public use UAS in the NAS. The FAA will continue efforts to partner with industry stakeholders using Collaborative Research and Development Agreements and Other Transaction Authorities to conduct research to support UAS integration in the NAS. In addition, we work with RTCA committees and working groups to develop civil aviation standards for UAS.

**Finding (8):** (Demonstrations) The FAA presentation on Govt-Industry partnerships for demonstrations highlights the FAA's early efforts to increase the level of accountability and management across activities that involve the more highly visible collaborative projects. This is a very positive step towards improved management of the FAA's research portfolio. The subcommittee looks forward to receiving updates in this area.

**Recommendation:** The FAA should document and publish the specific research objectives associated with each demonstration and report regularly to the subcommittee the performance of the demonstrations against the previously-defined objectives, including measures of positive outcomes as well as shortfalls in meeting those objectives.

**FAA Response**: FAA demonstration activities are meant to be short-term projects designed to support specific decision points in the NAS enterprise architecture. The NextGen Integration and Implementation Office (AJP-A) in coordination with the Service Units has the responsibility for prioritizing and approving demonstration activities. Each NextGen funded demonstration has its objectives, activities, and high level schedule identified in a Project Level Agreement (PLA) between the executing office and the NextGen I&I Office. The NextGen I&I Office continue to implement processes that support consistent status reporting and feedback of demonstration activities. These processes should be able to provide information on the performance and demonstration outcomes. We will be able to brief the Subcommittee on the status of these processes at a future meeting.

**Finding (9):** It is a clear intention of the FAA to invest in laboratory infrastructure that can be used for future collaborative efforts in a broad set of NextGen areas. Subcommittee has some concerns, however, on whether this additional infrastructure is a cost-effective use of government resources.

**Recommendation**: FAA should examine the proposed new laboratory capabilities against other capabilities to which the Agency has access, and should identify the anticipated utilization of this new investment as well as the level of sustained use of present capabilities.

**FAA Response:** The FAA recognizes that an assessment of its laboratory capabilities against other capabilities to which the Agency has access should be done and we have done preliminary work in this area. In 2008 the FAA conducted an assessment of FAA-owned air traffic

management laboratories against the potential laboratory needs for NextGen. This assessment included the FAA's Federal Laboratory (FAA William J. Hughes Technical Center) and the Civil Aerospace Medical Institute.

Collaboration among technologies and facilities is already in practice within the FAA. For instance, the test bed at the FAA Technical Center known as the NextGen Integration and Evaluation Capability (NIEC) is not a new laboratory but rather is an integration of existing capabilities into a single location. The NIEC is a real-time, flexible, object-oriented, rapid prototyping and simulation environment that simulates the enterprise architecture infrastructure and supports low to medium fidelity simulations. There are two other FAA test beds in Texas and Florida; however, they are used for specific demonstrations and testing based on their capabilities. The key difference between NIEC and the other FAA test beds is the interconnectivity to existing NAS systems that exist in their entirety only at the FAA Technical Center. The test bed in Texas is used primarily for ATC ground-based live testing and the Florida test bed is used to demonstrate live flight-testing. Each FAA test bed has unique and distinctive characteristics that lend themselves to specific demonstrations and testing capabilities; however, the FAA will take the existing capabilities into consideration as the FAA invests in future laboratory infrastructure for NextGen areas.

The FAA is taking a leadership role in identifying and examining current and prospective NextGen funded laboratory and demonstration facility capabilities; preparing a gap analysis; and developing a plan to leverage resources.

The FAA also expects to identify and examine other federal laboratories for possible collaboration such as NASA Ames Research Center, Department of Energy's Sandia National Lab, and the Department of Defense's Test Resource Management Center. Since the FAA is currently the co-chair of the Infrastructure Working Group (co-led by DOD, NASA, and FAA) in support of the National Plan for Aeronautics Research and Development and Related Infrastructure, they are already positioned for further collaboration.

## FAA Updated Response to the Separation Standards Working Group Report

[Note that the following is a status update on the *Report of the Separation Standards Working Group* dated September 20, 2006, a report from an ad hoc subcommittee of the REDAC that FAA responded to on May 14, 2007, originally appearing in the *2008 NARP*.]

**Finding (10):** It was reported that the target level of safety has been increased to 10-E9. This level does not appear to be statistically achievable to the NAS Operations Subcommittee.

**Recommendation**: The target level of safety needs to be reassessed for its reasonableness and applicability. Safety levels of new systems should be compared against a baseline which is defensible based on current operations and statistical analyses.

**FAA Response:** The FAA SMS requires that we demonstrate an acceptable risk level for a catastrophic event. For an absolute safety case, that level is 10-E9 per hour of operation;

however, that level would not be required for a comparative safety case that uses an acceptable baseline. Also, please see the FAA response to the REDAC General Observation – *Excessive Safety Standards for New Systems*.

**Finding (11):** The NAS Operations Subcommittee ascertained that the responsibility for separation standards in the FAA was not clearly defined. While ATO apparently has the ultimate responsibility, coordination with AVS was unclear.

**Recommendation**: Given possibly different operating paradigms in NextGen, the FAA should have clear points of responsibility for the development and implementation of separation standards.

**FAA Response:** The FAA operates under a SMS that requires the assessment of all changes in the NAS before they become operational. This includes the implementation of separation standards. This is clearly a defined process. Please see the FAA response to the REDAC General Observation - *Excessive Safety Standards for New Systems*.

## 2. *REDAC Recommendations on the FY 2012 R&D Portfolio*, May, 10, 2010

The Committee Chairman Dr. John Hansman submitted REDAC's recommendations on the FY 2012 R&D portfolio to the Administrator on May, 10, 2010. The agency provided the following response to the recommendations on September, 16, 2010.

### General Observations

**Recommendation:** Concern on Level of Technical Expertise in Key Areas - The FAA has a unique need for expertise in key areas such as critical software and digital systems and human factors both for certification and acquisition. The REDAC reiterates its concern that there has been inadequate progress in developing the core competency and technical workforce in this and other key areas. The problem is recognized by the agency but progress has been limited due to the inability of the FAA to compete on the market for highly desirable talent. The REDAC recommends maintaining the priority in this area and investigating internal approaches for workforce development in key areas including hiring high potential junior staff with "fast track" training and responsibility paths.

**FAA Response:** The FAA agrees that we do have a unique need for expertise in key areas such as critical software and digital systems, and human factors both for certification and acquisition.

To address your concern related to developing the core competency and technical workforce in this and other key areas, we will be focusing our attention on using several existing mechanisms that provide some guidance for near- and mid-term planning. These include the FAA Flight Plan, the National Aviation Research Plan (NARP), and the AVS annual research and development (R&D) strategic guidance (SG). The AVS R&D SG is typically released 28 months in advance of the year of execution and describes the primary areas of AVS R&D interest. Furthermore, Aviation Safety R&D requirements are finalized at least 18 months in advance of project start dates. These provide data to define needed core capabilities.

As briefed to the Subcommittee on Aircraft Safety, AVS is taking steps to implement a life-cycle planning system for R&D. In its fully implemented state, requirements will be described through all phases of the program life-cycle: problem definition, research stages, implementation of the solution, and post implementation evaluation. In this system, research requirements will be programmed for all research phases and provide an even longer view for planning purposes.

Lastly, AVS Chief Scientists and Technical Advisors will begin developing annual reports that provide a long-view assessment of aviation safety and technology areas for which R&D support may be required. First reports are expected in January 2011.

In addition to activities described above, there are additional data sources available for guidance. For a long-term view, examples include the National Plan for Aeronautics Research and Infrastructure, and the National Academies-National Research Council Decadal Survey of Civil Aeronautics. For a more current view, there are several sources of excellent information from groups such as the Commercial Airplane Safety Team and the International Helicopter Safety Team.

The majority of these ongoing activities address the aviation research demand areas that will be needed by the FAA. To ensure that the FAA is capable of responding in those demand areas, the Research and Technology Development Office (AJP-6) will be assessing the data from these ongoing efforts to translate that information into what core research capabilities and facilities are needed to support current and projected research needs, along with developing a plan for securing the appropriate resources. AJP-6 will also begin investigating internal approaches for workforce development in key areas including hiring high potential junior staff with "fast track" training and responsibility paths.

The FAA will review the status of these efforts with the Committee at the next meeting.

**Recommendation:** NextGen Technical and Program Risk Management - The REDAC observes that much of the NextGen planning has been success based and it is unclear if technical and program risks have been fully identified. The REDAC recommends that the FAA should review NextGen plans to identify assumptions which establish technical and program risk in key areas such as human factors and software certification. These risks should be mitigated by risk management strategies which validate or dispute assumptions through early research and identify mitigations to the most likely and significant risks. In addition, there should be consideration given to how the NextGen plans would adapt to unfavorable research and development test results.

**FAA Response:** The FAA appreciates the REDAC's observation regarding technical and programmatic risk and recognizes that, given the scope of the Committee, the FAA has not briefed the REDAC on our detailed plans for managing NextGen implementation. However, all of the REDAC recommendations are active elements of the existing NextGen planning and execution processes. The FAA has established a risk based management framework for NextGen that explores the full range of options rather than pursuing a single implementation path. That includes identifying technical and program risks and the related risk management strategies. For additional information regarding the FAA's management approach, please refer to the 2010 NextGen Implementation Plan, which includes a chapter that lays out our approach.

**Recommendation:** Need for a Comprehensive View of FAA Research and Development Portfolio - The REDAC has had difficulty meeting its responsibility to evaluate the FAA R&D portfolio due to the complexity of how research and development are funded and managed within the agency for historical and operational reasons. It would be useful to the REDAC and the Agency to have a comprehensive mapping of all research and development related activity.

**FAA Response:** Research and technology development efforts being conducted with the FAA and by external partners such as the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), Massachusetts Institute of Technology Lincoln Lab (MITLL), MITRE Corporation (CAASD), universities, Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking, etc., are continuously being cataloged and evaluated for inclusion on the NAS Enterprise Architecture Infrastructure Roadmaps. Evaluation of this research involves extensive coordination with FAA research and program managers, infrastructure roadmap leads, the Chief National Airspace System (NAS) Enterprise Architect, as

well as NextGen solution set managers, to determine whether the maturity level, timeframe, and application of the expected research outcomes have potential for influencing one or more decision points defined to achieve the FAA's mid-term NextGen Operational Improvement (OI) targets. Through this process the FAA will also be able to identify gaps in the research required to support the NextGen OIs.

All other research activity determined to be outside the scope of the NAS Enterprise Architecture is captured in the annual National Aviation Research Plan which is congressionally mandated and published every year.

**Recommendation:** Nav Lean - The REDAC was encouraged by the plan to investigate Lean processes for certification, safety and operational approval motivated, in part, by prior REDAC concerns regarding excessive safety standards for new systems. The REDAC looks forward to the results of this study and would like to support this effort.

**FAA Response:** In response to recommendations from the RTCA Task Force on NextGen Mid-Term Implementation, the FAA has initiated the Navigation (NAV) Procedures project. Using "Lean Processes," the project will review and make recommendations to improve and streamline all processes used to request, prioritize, process, improve, and implement performance-based conventional instrument flight procedures (IFP). The focus of the improvements will be to create safe, repeatable, beneficial, and efficient processes that comply with applicable regulations. By September 30, 2010, a report will be provided to AVS and ATO leadership with recommendations for improving and streamlining development and delivery of all IFPs in the NAS. AVS and ATO leadership, in coordination with the Office of Airports (ARP) and Office of Policy, Planning and Environment (AEP) [The Office for Policy, International Affairs, and Environment (APL)], will assess and approve these recommendations for implementation.

The NAV Lean Team is composed of six Working Groups (WG) with leads representing ATO and AVS. Each WG will review and make recommendations to improve and streamline their respective processes. Relative to the REDAC's reference to safety and operational approval, one of the six WGs is the Safety Management System (SMS) and Operational Approval Working Group. This WG will (1) examine the current requirement to use the SMS method to assess potential changes in risk associated with the introduction of a new or revised IFP into regional airspace, (2) examine the special authorization process, which specifies aircraft, equipment, and pilot requirements for approving procedures such as Category II/III Instrument Landing System (ILS) or Required Navigation Performance (RNP) Special Aircraft and Aircrew Authorization Required (SAAAR), and (3) review and recommend changes to the appropriate safety targets.

Upon project completion, the FAA would be happy to brief the REDAC on NAV Lean as desired by the REDAC or any of the subcommittees.

## FAA Response to REDAC Recommendations on the FY 2012 R&D Portfolio

### Subcommittee on Airports

The Subcommittee was pleased to learn that the funding for the Airport Technology Branch was $22.47M in the Omnibus Appropriation, that staff at the Tech Center are creating 10-year research plans for both the Safety and Pavements area, and that the many projects underway are being handled responsibly and with obvious expertise.

**Finding (1):** In the ARFF area, the subcommittee expressed significant interest in the research to develop standards for determining the amount of agent needed on New Large Aircraft (NLA). The subcommittee appreciated the point that new technologies may offset the need for new agent types, quantities, or delivery systems, but the highest priority remains to complete the research that will establish if FAA needs to change its requirements for the amount of firefighting agent needed for U.S. airports receiving NLA service.

**Recommendation:** The FAA should continue the high priority ARFF research to answer the question on the amount of firefighting agent require for airports receiving NLA service.

**FAA Response:** We concur. The Airport R&D Branch at the FAA William J. Hughes Technical Center has been directed to make completion of this portion of the Aircraft Rescue Fire Fighting (ARFF) research a priority.

**Finding (2):** The Subcommittee was pleased with the advances made on Foreign Object Damage (FOD) detection equipment, and is pleased that the research is focusing on performance standards rather than individual product acceptance. Likewise, in the area of wildlife detection equipment, the research is aiming at criteria that will provide alerts to tower personnel as opposed to demanding full time attention to what amounts to yet another monitoring device.

**Recommendation:** The subcommittee recommends that in the case of both FOD detection and the Wildlife detection radars the FAA provide guidance on best management practices in implementing and operating the systems along with the system performance specifications.

**FAA Response:** We concur. The FAA is developing guidance for implementing FOD detection systems to go along with the previously published performance specification. The bird radar performance specification is under development and we will issue implementation guidance for bird radars along with the issuance of the bird radar performance specification.

**Finding (3):** The subcommittee also found that FAA's friction research is coalescing with the Takeoff and Landing Performance Advisory Committee. Research is close to concluding a single runway friction assessment tool that will resolve pilot inputs, airport operations inputs and even friction measuring devices into a single classification to assess and declare the condition of a runway.

**Recommendation:** FAA should support the implementation of the Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) method and should promote its use worldwide.

**FAA Response:** We concur. We intend to continue to support the ongoing TALPA work both within the FAA and at International Civil Aviation Organization (ICAO).

**Finding (4):** The subcommittee was pleased with the presentation from the FAA's National Planning and Programming Office (APP) on the progress of the NextGen program and the impact on airports. The Subcommittee believes this is a very important area, and the brief demonstrated that FAA has considered the recommendations stated in previous REDAC reports.

**Recommendation:** The FAA should continue to provide updates at future subcommittee meetings on NextGen and its impact on airports.

**FAA Response:** We concur. The FAA invited the Office of Airport Planning and Programming to provide an update on NextGen impacts on airports at the Subcommittee meeting August 25-26, 2010.

**Finding (5):** The Subcommittee was pleased with the research in the area of alternative paint/marking materials.

**Recommendation:** The subcommittee recommends that future guidance should contain information on how to apply the materials. Also, the subcommittee recommends that guidance on the use of Type I / III glass beads in airport paints should clearly state which type would be more appropriate for airport use. There is currently a disparity in the existing guidance and recent research results, and airports would benefit by having the latest, up-to-date information on this topic.

**FAA Response:** The FAA will add clarifying information when the Advisory Circular is updated.

**Finding (6):** The subcommittee also found that the research on developing a low cost ground surveillance (LCGS) system for airports is very promising. The purpose of the research is to review and evaluate LCGS systems, with a focus on how they can be used by airports to improve airport surveillance. The subcommittee commented that the proposed Airports solution appears to be much more robust than that being investigated in Air Traffic Organization's LCGS program.

**Recommendation:** The subcommittee recommended that whatever solution is found for the LCGS program needs to have ATO involvement, since both systems may be used by either airport operations or ATC. The subcommittee felt that it is critical that LCGS be focused on the airport operator.

**FAA Response:** We concur. The Airport R&D Branch will continue to coordinate with ATO on the ongoing evaluation of LCGS. Updates will be provided at the next Subcommittee meeting.

**Finding (7):** In the GPS ground-vehicle navigation project, a project has been initiated to evaluate current technologies, provide a list of implementation and operational recommendations, and to provide cost estimates for equipment procurement. The subcommittee found that the research currently underway is well executed.

**Recommendation:** The Subcommittee recommends that the research team work with the Airport GIS program to develop future technology / system requirements (e.g. maps in vehicle display). The GPS ground vehicle research team is also investigating the challenge of how the equipment might provide zone/proximity alerts to the driver of a vehicle operating on an airport with a complex geometry. The subcommittee recommends that human factors issues should be considered when determining how often a driver is alerted. A system that provides constant alerts may give drivers a false sense of security and cause them to not be as vigilant as they otherwise would be when traversing an airport.

**FAA Response:** We concur. The Airport R&D Branch provided a briefing on this issue at the Subcommittee meeting August 25-26, 2010.

**Finding (8):** The subcommittee is pleased that the research aimed at developing an airport and airspace simulation model is being coordinated with the Airports GIS program staff. The main elements of this project are to: build the airport database; improve the digitization of airports; develop a process to use PDARS data; and build airport latitude and longitude data in a way that is consistent with the directives of FAA Advisory Circular 150/5300-18B (Airport Data – Geographic Information System Standards).

**Recommendation:** The Subcommittee recommends that the FAA follow-up with a vendor who may have already been able to incorporate ASDE-X and PDARS data into typical simulation software.

**FAA Response:** We concur. The Airport R&D Branch provided an update on this issue at the subcommittee meeting August 25-26, 2010.

**Finding (9):** Pavement research continues to provide benefits to the airport industry.

**Recommendation (a):** In the area of Alkali-Silica Reactivity (ASR) testing, the subcommittee recommends that the existing research projects construct additional slabs of known non-reactive aggregates that have been appropriately screened with the proper ASTM testing protocols as a control group. This approach would provide data to indicate if the anti-icing agents are causing a deleterious reaction or exacerbating the deleterious reaction of inferior materials. Preliminary research through the IPRF indicates that improper screening of aggregates may in fact pose a greater threat to deleterious reactions in concrete than the anti-icing agent itself.

**FAA Response:** We concur. The Airport R&D Branch will construct new non-ASR susceptible slabs for testing as space becomes available.

**Recommendation (b):** Additionally, the subcommittee recommends that the Technical Center consider research into the load-transfer effectiveness of dowelled and un-dowelled pavements. It is recommended the FAA consider constructing "dummy" contraction joints following the specifications listed in FAA Advisory Circular 150/5320-6E, and measure the load transfer across these joints. This data would also provide engineers valuable information when designing and specifying joint types for airfield pavements. The national costs for using steel dowels in pavement construction are rising, and research into this subject may help airport operators reduce future construction costs by eliminating unnecessary design features.

**FAA Response:** We concur. The Airport R&D Branch will first review data from previous slabs: CC1 with dummy joints and then compare results with the data collected during CC2 and CC4 as well as new data from CC6 which have doweled joints. Data collected at Denver International Airport instrumented slab will also be reviewed and analyzed. If inconclusive the Airport R&D Branch will build a new section in which different joint types; dummy, doweled, tied and possibly new designs, can be compared.

## Subcommittee on Aircraft Safety

The Subcommittee on Aircraft Safety (SAS) of the FAA Research, Engineering and Development Committee (REDAC) met at MITRE's Center for Advanced Aviation Systems Development on March 9-11, 2010. The meeting included tours of the CAASD Integrated ATM Lab with demonstrations of CDTI/ADS-B Applications and Runway Incursion-Flight Deck-based Direct Warning. The primary purpose of the meeting was to review FY12 Research Requirements and included detailed reviews, "Deep Dives" into several research programs.

### General Observations

- The SAS again found the presentations given by FAA managers and researchers to be of uniformly high quality.
- The method of summarization and content presentation of the many complex topics continues to improve and were readily comprehensible at a management level.
- The prioritization process of research proposals appears to be effective.
- The SAS believes that the portfolio content is substantially correct, but is concerned that several research programs lack a sufficient level of technical expertise to assure success.
- The SAS found no programs that should be eliminated.
- The extent to which FAA leverages the work and expertise of other government agencies, industry and academia continues to be an effective way to conduct relevant research.

- The SAS finds FAA to be extremely responsive in responding to subcommittee comments and recommendations.

- Specific Findings and Recommendations on individual areas of research reviewed and discussed by the subcommittee follow.

**Finding (1):** (Icing Program) The Aircraft Icing program is well defined and poised to deliver high value. The icing program has built important collaborative research relationships with other FAA programs, NASA, Canadian research organizations, European research organizations and the aerospace industry. This is to be commended as it will enable the FAA to expand its icing research portfolio and increase their impact by conducting collaborative research programs on high priority programs of mutual interest. The high ice-water content, engine icing program is such a high priority program and leverages many of these relationships. This program addresses the engine malfunctions due to ice crystals that have occurred on many commercial flights in convective weather primarily in the tropics. The Appendix C research including the work on 3D ice accretion and icing aerodynamics certification methods is well conceived and is important to the FAA mission of flight safety. This program is currently building an international coalition and research plan and this should be encouraged. Finally, aircraft icing is an important safety area where the FAA has significant interests and responsibility. The icing program has several high priority programs and very limited in-house expertise. They rely heavily on partners and grantee/contractors to manage their programs. Concern exists within the Subcommittee regarding the lack of FAA "bench strength" in this important area.

**Recommendation:** The FAA needs to continue to support the high priority high ice-water content, engine icing research program and support the Appendix C research on 3D ice accretion. The Subcommittee recommends that FAA review the current "bench strength" and take appropriate hiring action to assure continuity in technical strength well into the future in the aircraft icing research area.

**FAA Response:** The FAA recognizes the limitations on in-house expertise in atmospheric and aerodynamic science and engineering and have addressed these in the short term by developing research partnerships with NASA, the U.S. National Center for Atmospheric Research, National Research Council Canada, Environment Canada, other national research organizations and academic institutions that carry expertise in the areas of interest we are pursuing. For the longer term, the FAA William J. Hughes Technical Center is currently advertising a position for a research meteorologist and there may be an opportunity to add an aerodynamicist to the research team. The Aircraft Icing Chief Scientist and Technical Advisor (CSTA) will continue to work with FAA research program managers to support increases to internal expertise needed to meet a bench strength capability within the FAA that assures continuity in technical strength in the aircraft icing research area.

**Finding (2):** (Weather in The Cockpit) The Weather in the Cockpit program appears to be on the right track using a gap analysis to help define the needed research requirements. A concern remains regarding the planned timing of research completion in 2015 intended to support the mid term NextGen implementation of 2018.

**Recommendation:** Assure the research deliverables are progressively released to enable industry to respond to them in formulating solutions to the Weather in the Cockpit imperative.

**FAA Response:** FAA concurs with the recommendation to progressively release Weather Technology in the Cockpit (WTIC) program deliverables to enable timely industry response. The WTIC program schedule will be updated to reflect those releases.

**Finding (3):** (Propulsion Malfunction Research) The Subcommittee found the planned Propulsion Malfunction research plan would benefit from deep engagement with engine and airframe manufacturers contributing their knowledge & expertise in this area.

**Recommendation:** The FAA should develop an industry partnership approach to assist & accelerate the Propulsion Malfunction research activity.

**FAA Response:** The Propulsion Malfunction research plan involves significant partnering with airframe, engine, and sensor manufacturers and health monitoring experts, such as Boeing, General Electric, Pratt Whitney, and Meggitt. Past collaborative research (in this area) is described in the following reports:

- "Indications of Propulsion System Malfunctions" report number DOT/FAA/AR-03/72
- "Indications of Propulsion System Malfunctions – Sustained Thrust Anomaly Study" report number DOT/FAA/AR-06/15
- "Engine Damage – Related Propulsion System Malfunctions" report number DOT/FAA/AR-08/24

Additionally, FAA researchers are an integral part of the Aerospace Industries Association Propulsion Indications Task Team (PITT) that is working to develop recommendations for future changes 14 CFR 25.1305 (Power Plant Instruments). FAA researchers also provide inputs for the propulsion section of the recently published AC 25-11A Electronic Flight Deck Displays. The PITT committee has members from all the major airframe and engine manufacturers.

Future research in propulsion malfunction will continue these partnership activities.

**Finding (4):** (Unmanned Aircraft System) The ongoing Unmanned Aircraft System research is urgently needed to define a path to permit safe operation of UAS vehicles in the NAS. Although this broad and difficult area has been hampered by several leadership and organizational changes in the past few years, the SAS has noted good traction in the recent past.

**Recommendation:** The Subcommittee recommends that the research sponsoring office & the research performing technical community continue to jointly refine the development of the research requirements and firmly establish the optimum path to achieve the important goal of enabling UAS operation in the NAS.

**FAA Response:** The FAA concurs with the Subcommittee recommendation to continue ongoing efforts to refine research requirements for UAS research. The FAA is already engaged

in efforts to establish the optimum path to enable UAS operations in the NAS. Chief among these is the UAS Executive Committee (UAS ExCom).

The UAS ExCom was established under direction from Congress in Section 935 of the National Defense Authorization Act of 2010. The UAS ExCom Senior Steering Group (SSG) has established the NAS Access Working Group to develop a plan to address UAS NAS access barriers and provides a path to expanded access for federal and public use UAS NAS access in the near- (< 5 years), mid- (5-10 years), and long- (>10 years) terms.

The NAS access plan will identify activities, milestones, and resources required to determine best approaches for meeting the needs and priorities of the UAS ExCom agencies within the identified timeframes.

FAA research activities associated with each NAS access barrier will be jointly developed and refined by the FAA sponsoring and performing organizations and coordinated with the other UAS ExCom organizations.

The FAA will provide regular updates on the progress of UAS research planning at future Subcommittee meetings.

**Finding (5):** (ASIAS) The SAS found that the ASIAS research project has made significant progress and continues to be directly responsive to the need of safety analysts within the FAA and aviation industry. The subcommittee commends the work being done by MITRE CAASD and notes the increased degree of trust that has developed from ASIAS industry participants. ASIAS is clearly an integral component of a Safety Management System designed to bring today's safe aviation system to even higher levels of safety.

**Recommendation:** The SAS recommends that the FAA continue efforts to increase the number of airline participants and ensure that the ASIAS program continues to be a safety tool that is increasingly used to identify emerging risks before they become potential safety issues.

**FAA Response:** The FAA concurs with the recommendation and is continuing efforts to increase the number of airlines actively participating in Aviation Safety Information Analysis and Sharing (ASIAS) and now has 30 airlines sharing de-identified data from Flight Operational Quality Assurances programs and/or Aviation Safety Action Programs. The FAA continues to target additional airlines to obtain statistically significant numbers in terms of geographic locations, aircraft types, airline operations (regional versus large carrier), etc. While continuing to conduct directed studies and track metrics of known safety issues, ASIAS is increasing efforts in the development and implementation of analytical methods to detect potential safety risks to the NAS and forward these issues to appropriate safety teams for mitigation.

**Finding (6):** (Conduct of Research and Development) The SAS commends FAA for the advancing the development of a monthly reporting template to monitor progress in achieving measurable milestones and deliverables of all research activities in the Aviation Safety R&D portfolio.

**Recommendation:** The SAS recommends that FAA adopt a monthly reporting template and move quickly to implement it across the entire Aircraft Safety R&D portfolio.

**FAA Response**: The FAA thanks the Subcommittee for adopting the FAA response to SAS Recommendation 2009-3-3 which was presented to the Subcommittee at the March 11, 2010 meeting as follows, "Recommend SAS support for the AVS template for monthly reporting." The FAA concurs with the follow-on recommendation and agrees that a consistent performance reporting system is needed to effectively manage the Aviation Safety R&D Program and monitor progress in achieving milestones and deliverables as well as tracking eventual implementation of the results.

In further support of this objective, several actions are underway. AJP-6, the performing organization, has conducted a pilot status reporting process and will continue to evaluate the effectiveness of this format for content and frequency. AVS, the sponsoring organization, led by the Office of Accident Investigation and Prevention, has established an RE&D Performance Reporting Working Group. This working group, whose members represent the Office of Accident Investigation and Prevention, the Aircraft Certification Service, the Flight Standards Service, the Office of Air Traffic Oversight, and the Office of Research and Technology Development, will consider best practices for research and development reporting in private industry, Government, and academia. The goal is to provide common and consistent information to all stakeholders. The FAA will review these efforts with the Subcommittee at the September 2010 meeting.

**Finding (7):** The SAS continues to believe that successful conduct of research and development demands a series of sponsor-performer arrangements and conditions, all of them often urged on FAA by various groups.

1. Although a partnership in the execution of the research including shaping the approving methods and products expected is required, it is essential that the responsible sponsor organization have a strong voice not only in the setting of requirements – but also the funding authority.

2. The responsible sponsor organization must have a strong voice in the design and performance of the work, and must clearly monitor and have oversight of the work so that meaningful results can emerge.

3. The responsible sponsor organization must itself have the technical and management skills to fully understand and monitor the work of the performing organization – whether it is within or outside the FAA. While this cadre of expertise may need to be small, it must be able to understand and guide the work. Experience in R, E&D has shown that in the absence of such skills in FAA, the results are almost always poor.

**Recommendation:** The subcommittee recommends that FAA review the structure of the Aircraft Safety Research Program to ensure that the current roles of the sponsor and performing organizations are best suited for successful conduct of safety research. This review should include roles related to authority over and management of research funds.

**FAA Response:** The FAA agrees with the subcommittee recommendation to review the structure of the Aviation Safety Research Program and the respective roles of the sponsor, performer, budget, and financial management organizations. The Aviation Safety Research Program is perhaps the most complex research program within the FAA both in terms of size and breadth. There are multiple organizations involved and collaboration between all of them is essential to capitalize on the strengths and resources of each.

Although the R&D Portfolio Development Process Guidance Reference Document describes the current roles of sponsor and performer organizations, it does so at a high level applicable to the entire FAA. To address this recommendation specifically for the Aviation Safety Research Program will require the FAA to more fully explore and assess the roles and responsibilities of the organizations involved with the aircraft safety R&D portfolio. This will be a complex undertaking that will take time to complete. The FAA will develop a plan for completing such an assessment for review by the Subcommittee at a future date.

**Finding (8):** (The Proper Role of TCAS) TCAS was intended to be an independent safety net in the ATC system. It was recognized from the beginning that the independence would not be total, since TCAS depends on the Mode S data link and the barometric altimeter. However, every attempt was made to provide as much real separation and independence from the ATC system tools as possible.

**Recommendation:** The SAS believes that, as the community explores the closer integration of TCAS with other systems such as ADS-B and aircraft autopilot systems, the potential safety risks associated with the reduction of independence need to be carefully considered. The SAS requests further detail from the FAA on this issue and how these potential safety risks are assessed.

**FAA Response:** The FAA agrees with the basic concern, that collision avoidance cannot become completely dependent on Automatic Dependent Surveillance-Broadcast (ADS-B). The FAA requested RTCA to expand the scope of the Traffic Alert and Collision Avoidance System (TCAS) committee to address this issue as part of a broader TCAS review. The RTCA Special Committee (SC) 147 is developing recommendations on how to make TCAS II more compatible with the NAS, including how to potentially integrate ADS-B data into a next-Collision Avoidance System (CAS). SC-147 is tasked with development of recommendations that would: 1) make collision avoidance more compatible with routine operations in congested airspace, including busy terminal areas in the NAS, now and through 2025; 2) make appropriate use of ADS-B information in a future collision avoidance system; and 3) reduce the radio frequency congestion at 1090 megahertz. The report from SC-147 is due September 2011 and will contain a road map of major changes and associated schedules.

In support of the committee, the FAA TCAS Program Office is conducting research to support developing a metric to assess independence of future collision avoidance systems with regard to air traffic (AT) control surveillance (i.e., AT separation service or separation assurance). The analysis was initiated based on the NAS planned deployment of ADS-B and backup systems. Nevertheless, the conclusions on independence are intended to have broad applicability for worldwide use. In addition to the completion of the independence work, the program office has

tasked team members with evaluating the required availability and integrity of CAS as well. The FAA sees this information as necessary for the evaluation and certification of future CAS. This work will help assess issues associated with protection from corruption and ability to revert to an independent collision avoidance capability, recognizing that some level of dependency may be acceptable. This information is seen as necessary for the evaluation and certification of future CAS and will be made available to the RTCA committee.

**Finding (9):** (Structural Integrity/Composites) The Subcommittee on Aircraft Safety considers the research effort on Structural Integrity/Composites to be a model program. With a very small but clearly expert internal FAA management resource, this effort leverages the work and expertise of other government agencies and the industry on a critical safety matter. The focus on developing standards and guidance based on theory and practical experience, and the emphasis on providing usable guidance to FAA people, and many others, makes this a valuable example of how to do things right. The Subcommittee endorses the proactive approach to composite structure maintenance and inspection being executed. Staying ahead of the composite aircraft fleet is very important to assure future continued operational safety.

**Finding (10):** (FAA Facilities and Laboratories) The Aircraft Safety Subcommittee wishes to reemphasize an earlier recommendation on FAA funding and support for facilities and efforts which serve not only FAA but are also resources for the world. These facilities and efforts – such as much of the work of the Civil Aeromedical Institute and the William J. Hughes Technical Center – have a world-wide impact and contribute in important ways to the eminence and high reputation of FAA. Support of these efforts and increasing public knowledge and understanding of these activities is critical to the success of research activities in support of NextGen, self-separation, human factors, reduction of spacing between parallel runways, RNP, etc. Even in difficult budget periods, adequate funding must be provided not only for the modernization, care and feeding and operation of existing facilities but funding must also be provided to ensure that laboratories with required capabilities to support future research are available when needed. Precedence for the use of F&E funding for the procurement, upgrade, repair or operation of facilities and equipment at the Tech Center and CAMI has been established. The procurement of equipment for CAMI, the support of the Pavement Test Facility and repair of R&D facilities at the Tech Center are examples recently cited by Tech Center Counsel.

**Recommendation:** The subcommittee recommends that FAA seriously explore creative ways outside of the RE&D budget to support the modernization and operation of existing laboratories and the establishment of laboratory capabilities to support future research requirements.

**FAA Response**: The FAA is statutorily bound to use appropriated funds in accordance with public law. FAA Order 2500.8B, Funding Criteria for Operations, Facilities and Equipment, Research, Engineering and Development, and Grants-In-Aid for Airports Accounts, provides guidance on the use of these funds. Each year during the preparation of the R&D portfolio, the FAA identifies gaps between existing laboratory capabilities and future needs based on identified research requirements. The FAA uses an established budget formulation processes to prioritize a list of new and existing programs and resource allocations, including those for laboratories. As

one would expect, these resource allocations rely quite heavily on compelling long-term research requirements.

Recently, the FAA has expanded the use of Cooperative Research Development Agreements (CRDAs) and Other Transaction Authority (OTAs) to facilitate industry collaboration in the development and upgrading of our research laboratories. The recently opened NextGen Integration and Evaluation Capability (NIEC) facility is the FAA's research platform to explore, integrate, and evaluate NextGen concepts through simulation activities resulting in concept maturation and requirements definition. Three CRDAs were used to add UAS simulators and flight test vehicles to its suite of capabilities.

The Florida Test Bed located in Daytona Beach is managed by the FAA, supported by Embry-Riddle Aeronautical University through an OTA, and provides access to industry consortium partners. This site will provide an environment that allows open access for industry users and vendors such that new capabilities can be more rapidly harnessed and partnerships can be fostered with industry and academia.

**Finding (11):** (Software and Digital Systems) The Software and Digital Systems Program appears to be moving in the right direction to meet the near-term and mid-term needs of the NextGen program. A notable accomplishment in FY 10 was the development and submission of a SDS comprehensive research plan which is intended to consolidate the SDS research planning that has taken place and show how FAA objectives are being met. The baseline regulatory support programs in addition to the FY12 research requirements provide a solid context within which to assess the research initiatives. It was also noted that the research currently planned will not meet the anticipated far-term needs of the NextGen.

**Recommendation:** The FAA needs to continue to support the SDS program and ensure the staffing and resources needs are adequate to meet the research needs. In order to address NextGen far-term requirements the SDS program should develop a joint research plan with NASA to ensure the far-term research being done by NASA will transition to the FAA and address the complex system integration expectations of the NextGen by 2025.

**FAA Response:** The FAA agrees with the SAS recommendation. The FAA will continue its support of the Software and Digital System research program and has taken actions to secure its in-house expertise and ensure required resources to provide research results. The NextGen long-term requirements for SDS will be driven by the NextGen capability implementation schedule and associated aircraft equipage requirements, which will be based on the outcome of the NextGen Avionics Roadmap being developed by the Joint Planning and Development Office (JPDO) Aircraft Working Group. The FAA will continue its long tradition of working with NASA on joint aeronautics and aviation safety research initiatives to ensure proper technology transition from development to implementation. The FAA will work with NASA in identifying technical challenges of NextGen long-term SDS issues and developing joint technology transition/implementation strategies.

**Finding (12):** The SAS remains concerned about whether FAA's internal core capability can successfully carry out the Software and Digital Systems research plan. It was noted that the

Chief Scientific and Technical Advisory positions for Aircraft Computer Software and Advanced Avionics remain vacant. It was also noted that one hire was made at the Tech Center in FY 2010 which puts the staff even with the FY09 with 1 additional hire planned for FY11. The SAS strongly asserts that the absence of a critical mass of talent in this program will lead to unsatisfactory research results.

**Recommendation:** The SAS again recommends that FAA aggressively take action to acquire the specialized expertise to support this critical program.

**FAA Response:** We agree that the FAA needs specialized expertise to support Software and Digital Systems (SDS) research and policy, and we continue to create and fill staff-level positions for software, systems, and avionics specialists in our aircraft certification headquarters organization and the Research and Technology Development Office (R&TD). However, we believe the Agency must be selective when filling CSTA positions. A CSTA must have the exceptional technical expertise and communication skills necessary to be a true leader in the aviation community. In May, the FAA hired a new CSTA for Advanced Avionics. We are currently scheduling interviews with two new candidates to fill the vacant CSTA position for Aircraft Computer Software. We have interviewed 22 candidates since the position became vacant.

The R&TD Office recognizes the technical challenges of SDS research requirements and the need to acquire special expertise. In FY 2010, the Airport and Aircraft Safety Group (AJP-63) hired a highly qualified individual into the SDS research program and plans to add another position in FY 2011.

**Finding (13):** (FAA Core Research Capability) The SAS is concerned that several research programs lack a sufficient level of technical expertise to ensure success. The Icing Program and the Software and Digital Systems Program are obvious examples.

**Recommendation:** The SAS recommends that the FAA Sponsor Organization and Performing Organization jointly undertake a study to quantify the core capability required for both organizations to support all critical research programs and take steps to obtain FAA support to acquire the needed core capability.

**FAA Response**: The FAA thanks the subcommittee for its recommendation. Although we agree with the finding, the FAA believes that there are already several means in place to address what core research capabilities are needed and we do not support undertaking the recommended study.

The FAA already has several mechanisms which provide a level of guidance for near- and mid-term planning. These include the FAA Flight Plan, the National Aviation Research Plan, and the AVS annual R&D SG. The AVS R&D SG is typically released 28 months in advance of the year of execution and describes the primary areas of AVS R&D interest. Furthermore, Aviation Safety R&D requirements are finalized at least 18 months in advance of project start dates. These provide data to define needed core capabilities.

As briefed to the SAS, AVS is taking steps to implement a life-cycle planning system for R&D. In its fully implemented state, requirements will be described through all phases of the program life-cycle: problem definition, research stages, implementation of the solution, and post implementation evaluation. In this system, research requirements will be programmed for all research phases and provide an even longer view for planning purposes.

Lastly, AVS Chief Scientists and Technical Advisors will begin developing annual reports that provide a long-view assessment of aviation safety and technology areas for which R&D support may be required. First reports are expected in January 2011.

In addition to activities described above, there are additional data sources available for guidance. For a long-term view, examples include the National Plan for Aeronautics Research and Infrastructure, and the National Academies-National Research Council Decadal Survey of Civil Aeronautics. For a more current view, there are several sources of excellent information from groups such as the Commercial Airplane Safety Team and the International Helicopter Safety Team.

The majority of these ongoing activities address the aviation research demand areas that will be needed by the FAA. To ensure that the FAA is capable of responding in those demand areas, AJP-6 will be assessing the data from these ongoing efforts to translate that information into what core research capabilities and facilities are needed to support current and projected research needs, along with developing a plan for securing the appropriate resources. In summary, the FAA believes it is already responding to the Subcommittee recommendation.

**Finding (14):** (The Impact of Computers/Automation on Aircraft Safety) The SAS noted the challenges related to obtaining the optimum balance between the role and power of the pilot and of the automation systems on the aircraft along with the optimal method of information display to the pilot. The challenges increase as computers and Automation Systems become more powerful. These same challenges and issues apply to the increasing levels of automation being introduced into the Air Traffic Management Systems on the ground.

**Recommendation (a):** The SAS recommends that FAA consider the need for additional research to ensure that the optimum balance between the power of the pilot and of the automation systems.

**FAA Response:** The FAA agrees that human-automation interaction is a key challenge for aviation safety. The FAA led a coordinated industry study of aircraft accidents, incidents and normal operations associated with flight path management, including flight deck automation. This effort was jointly sponsored by the Performance-based Operations Aviation Rulemaking Committee (PARC) and by the Commercial Aviation Safety Team (CAST). This study has provided insights into the nature of current human-automation interaction break-downs, and serves as a foundation for further FAA research, policy, and guidance. We propose to provide the REDAC SAS with a briefing on this PARC/CAST Flight Deck Automation Working Group effort at the next meeting.

**Recommendation (b):** The SAS recommends that FAA consider the need for additional research to devise better, more fool-proof methods of testing automation systems for fault detection as well as for single and multiple fault survivability.

**FAA Response:** The FAA agrees that safety assurance for complex automation is a challenge for aviation as well as other safety-critical domains outside of aviation. Key issues include verification and validation of requirements for complex information processing systems, safe integration of components developed by separate organizations (including off-the-shelf components), and life-cycle management (e.g., configuration control with multiple minor software upgrades). The FAA and industry (e.g., SAE S-18 committee) have been developing criteria to evaluate systems and will continue to update system design and test criteria with the best practices available. The software and digital systems research program is also pursuing multiple research topics that support the development and implementation of industry best practices that address these issues. We will continue to provide the REDAC SAS with updates on these research efforts.

**Finding (15):** (Rotorcraft Research) The Subcommittee is pleased to see the rotorcraft research work being conducted in a coordinated effort with the Army as was recommended. The research supporting addressing tiltrotor safety assurance approach is very much needed.

**Recommendation:** The Fly-by-Wire Research work being done in support of the certification approach for the advanced tiltrotor Bell 609 aircraft should be accelerated to assure it is rapidly transitioned to guidance and regulatory material.

**FAA Response:** The FAA agrees with the finding and recommendation of the Subcommittee. The FAA researchers will work with the FAA Rotorcraft Directorate to review the fly-by-wire requirements and establish collaborative efforts with applicable research activities of fixed-wing fly-by-wire research initiatives that should accelerate the research.

**Finding (16):** (FAA Center of Excellence for General Aviation Research: CGAR) The SAS continues to be impressed with the research activities at the COE for GA Research. The CGAR is another example of how cost sharing arrangements, complemented by FAA management competence and leadership, can be an effective way to conduct relevant research and advance the knowledge of FAA staff.

**Recommendation:** The FAA needs to continue to support relevant research activities at CGAR.

**FAA Response**: The FAA thanks the committee for the positive assessment of CGAR and their valuable contributions to improvements in aircraft safety. The FAA will continue to use the appropriate research expertise at CGAR for aviation safety research in such areas as WTIC, SMS, and UAS.

**Finding (17):** The UAS/Conventional Aircraft certification requirements matrix developed at a COE appeared to be of value to the UAS community. It was not clear as to why the matrix is not yet publicly available.

**Recommendation:** The subcommittee requests further details on the public availability and intended use of the UAS matrix.

**FAA Response:** The initial findings of a regulatory study were published by the FAA in the report DOT/FAA/AR-09/7, titled: Unmanned Aircraft System Regulatory Review. A list of regulatory sections rated with its applicability to UAS was organized into a UAS matrix. This study included a top-level review on the applicability of Title 14 Code of Federal Regulation (CFR) to UAS operating in the NAS. The goal of this review was to systematically examine the relevant federal regulations, statutes, orders, and policies and identify the known issues resulting from the rapid growth of UAS technology.

Subsequent analyses of 14 Code of Federal Regulations (14 CFR) Part 43, 61, and 91 led to the further development of the UAS matrix. That additional work is documented in two draft reports that are under FAA review. The FAA will make a concerted effort to expedite their publication. The matrix can be used as a reference to study regulatory compliance issues of UAS operating in the NAS.

## Subcommittee on Environment and Energy

**Finding (1):** In reviewing future year budget estimates for environmental research, the subcommittee noted that the proposed funding levels are essentially flat for the years 2013 and beyond. Since, as a practical matter, the costs of doing business in these years will increase, this "flat-lining" leads to an effective reduction in research funds available while the research needs and complexities are increasing.

**Recommendation:** While the subcommittee understands the problems in projecting out-year funding levels, we recommend that out-year budgets at least provide a factor for inflation in order not to project a practical decrease in funding levels. In addition, the Agency should attempt to communicate to the subcommittee its actual needs in future years so effective advice can be given.

**FAA Response:** The FAA is directed by Office of Management and Budget (OMB) to base its future budget estimates on OMB outyear projections. OMB bases it projections on policy decisions and it may keep an appropriation on a straight line with no increase for inflation. It is true that this flat-lining leads to a reduction in contract funds, not only because of inflation, but also because the R,E&D appropriation contains in-house funds. Since there always has been an increase in the in-house cost each year, the amount for contract allocation is reduced by the increase on in-house costs. Fortunately, it is also true that in the past several years the actual funding levels that OMB has allocated to the R,E&D appropriation has exceeded their initial estimate due to the growth in the NextGen program, however, this is not something that we can continue to anticipate.

The Environment & Energy program is built to meet the target allocation based on the OMB estimate. This is something the FAA cannot change. If the subcommittee feels that the funding

profile does not adequately fund all the requirements, then the committee may recommend an increase in funding and/or recommend a change in the requirements.

**Finding (2):** The subcommittee noted the progress being made in the development of a new noise roadmap. At the same time, it appears that there is a funding shortfall that has the potential of slowing progress in this area. Specifically, there does not appear to be funding to conduct required community surveys.

**Recommendation:** The Office of Environment and Energy should work with the Office of Airports to determine whether funding in the airports research program to fund the $1.5 million necessary to conduct community noise surveys is available.

**FAA Response:** We agree that implementing the new noise research roadmap is important. The Office of Environment and Energy and the Office of Airports are working closely together to explore multiple options to fund the most critical, within the context of multiple priorities and budget limitations. We can brief the subcommittee on the status of their efforts at the next meeting in September, 2010.

**Finding (3):** The subcommittee notes, and is encouraged by, the continuing cooperation with NASA in a variety of environmental research areas.

**Recommendation:** The subcommittee recommends that the growing cooperation between the FAA and NASA in the area of environmental research must continue and expand. This expansion is especially important in the Agency's relationship with NASA's Airspace Systems and Fundamental Aero programs.

**FAA Response:** We are pleased that the subcommittee noted our progress in this area. FAA-NASA cooperation is essential for greening aviation. We are working very closely with NASA and other federal agencies through the Aeronautics Science and Technology Subcommittee (ASTS) of the National Science and Technology Council (NSTC) to define national R&D goals and set priorities. The FAA and NASA are working very closely and coordinating aircraft technology development programs to achieve our national goals and support the NextGen environmental objectives. In addition, both FAA and NASA are working closely on airspace programs and have formed joint Research Transition Teams (RTTs) to focus on technology transition. Environmental concerns are a key consideration of the joint RTT effort.

**Finding (4):** The subcommittee notes that the FAA and the EPA appear to be better engaged in addressing aviation environmental issues.

**Recommendation:** The subcommittee recommends that cooperation between the FAA and the EPA should expand. Specifically, the FAA should request that the EPA actively participate in the REDAC Environmental Subcommittee.

**FAA Response:** We are pleased with our growing collaboration with the Environmental Protection Agency (EPA). Our agencies are working closely together in various forms,

including the International Civil Aviation Organization, the ASTS of the NSTC, the Airports Cooperative Research Program (ACRP) and the Environmental Working Group of the JPDO. We are also in the process of appointing Christopher Grundler, the Deputy Director of EPA's Office of Transportation and Air Quality and the Chief Executive of the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan, to serve on the REDAC Environment and Energy Subcommittee.

**Finding (5):** The subcommittee finds that the cooperation between the Office of Environment and Energy and ATO is an excellent example of breaking down barriers between Agency organizations. One specific area of cooperation that merits mention is the requirement for NEPA compliance in the modernization effort. The subcommittee appreciates these continuing efforts to integrate environmental considerations into operational decisions.

**Recommendation:** Building on the growing relationship between the operational and environmental components of NextGen will be crucial as the Agency moves forward with its modernization efforts. This intra-agency cooperation should therefore continue and expand. In order to facilitate the subcommittee's assessment of ongoing environmental research needs, we recommend and request that ATO provide a briefing to the subcommittee on exactly how environmental considerations are being integrated into the NextGen models.

**FAA Response:** We fully agree that close collaboration between the ATO and the Office of Environment and Energy (AEE) is essential to the success of NextGen. We have asked the AEE staff to ensure that the Environment and Energy Subcommittee is briefed on collaborative activities between both organizations, as they relate to our R&D program, at the upcoming September 2010 meeting.

**Finding (6):** AEE's research efforts to support the ICAO/CAEP process continue to be a priority. The issues being considered in the ICAO process are increasingly complex and need to be informed by good science. Communication of these efforts to the stakeholder community is essential, especially the explanations of how the research underpinnings are integrated into the formation of the U.S. policy.

**Recommendation:** The FAA needs to continue communicating strategic planning and the status of research efforts that inform environmental policy decisions. Specifically, it is recommended that the FAA should conduct a workshop for stakeholders, including the international community, to communicate the status and underlying assumptions of the use of the Agency's Aviation Environmental Portfolio Management Tool (APMT).

**FAA Response:** We are committed to ensuring our policy decisions are data driven and informed by the latest science. The use of the Aviation Environmental Portfolio Management Tool (APMT) is a key component of our strategy. The FAA has continually briefed stakeholders on the status and underlying assumptions of APMT via different venues including the frequent meetings of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence and national and international conferences and workshops. We have also provided status updates and detailed information to all participants in the International Civil Aviation Committee on Aviation Environmental Protection (ICAO/CAEP) process. However,

we can always do more. In response to this recommendation we have asked my staff to convene a workshop and provide detailed briefings on APMT to all our stakeholders.

**Finding (7):** The PARTNER Center of Excellence appears to be maturing and making excellent contributions to the environmental research effort. We continue to remain concerned about proposed Congressional language in the FAA Reauthorization bill that calls for the establishment of a new Center of Excellence on alternative fuels. The existing PARTNER structure already has the capacity to conduct this research.

**Recommendation:** If an additional Center of Excellence is established, existing COEs should be encouraged to compete for selection and the Agency should consider the additional costs associated with administering a new COE when conducting its source selection.

**FAA Response:** We are very pleased with the progress and excellent technical reputation of the PARTNER Center of Excellence. We will ensure that any new Center of Excellence on Alternative Fuels is established through a full and open competition. PARTNER Universities can compete as a team or individual. Our primary selection criteria will be technical excellence, but costs will also be carefully considered.

## Subcommittee on Human Factors

**Background:** Previous recommendation and FAA response letter dated January 29, 2010. Recommendation: Continue to place strong emphasis on human factors issues, as reflected in the Human System Integration Roadmap.

**FAA Response:** We agree that the Human System Integration (HSI) Roadmap is pivotal to addressing human factors issues for NextGen. ATO-P Office of Human Factors Research and Engineering (AJP-61) is identifying and tracking areas for improvement in the next annual update to start in the second quarter of FY 2010, and will continue to keep the Human Factors Subcommittee abreast of these activities.

**Finding (1):** As noted above in the FAA's response to this recommendation, human factors is receiving gradually increasing emphasis as the FAA moves forward with NextGen. In particular, this evidence was provided by:

- A sustained high budgeting level in critical human factors research areas, both within Flight Deck and Air Traffic , particularly with regard to self separation including the various options for delegating responsibilities to the flight crew, and air-ground integration (and their implications for human-automation interaction), as well as the F&E budgeting for the controller workforce.
- The January meeting, held with Steve Bradford, that initiated discussions into key needs for R,E & D in NextGen to address human factors issues within.
- The human factors portfolio about which we were briefed provides a very suitable vehicle for integrating and disseminating HF research to the wider NextGen design community.

- The emphasis in the FAA's response on understanding pilot and controller response to off-nominal events.

**Recommendation (a):** Continue the progress toward deeper involvement of human factors in NextGen planning and research. We believe that continued development of the HSI roadmap is a major vehicle for making this happen. However, this planning effort must also extend beyond the research planning focus of AJP-61 to an extensive review of NextGen plans for the need to address human factors issues. This review should consider where assumptions about human performance in future NextGen operations establish technical and programmatic risks that need to be mitigated by a risk management strategy that preemptively identifies and seeks mitigations to the most likely and significant risks. Likewise, this planning effort must plan for the key decision points and critical path items contingent upon addressing human factors in NextGen development.

**FAA Response (a):** The human element is a critical factor in successfully implementing NextGen and the FAA agrees that we must continue our emphasis on human factors. Considerable effort was expended to develop the Human System Integration (HSI) Roadmap and the FAA continues to expand those efforts. Extensive engagement is occurring across the solutions sets to address NextGen human performance and human system integration issues, solutions, risks, and mitigations. As is well documented in the NextGen Implementation Plan, the human element is embedded throughout all NextGen activities. Those elements are performed at many levels of maturity and by many different organizations. The need to continue to emphasize greater coordination and integration of human factors in NextGen is being addressed by various initiatives related to HSI governance, analysis, and documentation. These endeavors include those initiated or supported by the AJP Chief Scientist for Architecture and NextGen Development in concert with the Human Factors Research and Engineering Group (AJP-61) related to the assessment of HSI roles and responsibilities, documentation, and review of human factors portfolios, planning, and coordination exchanges for technical human factors risks and revision of concept of use and HSI processes.

As an additional consideration, to assist with human element issues related to Air Traffic Controllers and to promote further collaboration, a National Air Traffic Controllers Association (NATCA) representative has been assigned to the NextGen I&I Office to provide operational expertise in the full cycle of development of NextGen from concepts through implementation and to provide guidance regarding optimal NATCA participation in NextGen initiatives.

**Recommendation (b):** We recommend that the NextGen I&I office (AJP-A) vigorously pursue the appointment of a full time position for Chief Systems Engineer for-Human Factors. This position must be given the responsibility and authority to examine NextGen plans for situations where human factors considerations must be addressed, both to meet the NextGen plans as articulated, and to mitigate technical and program risks established by assumptions about human performance. In addition, this position should serve to foster the appropriate application of human factors knowledge throughout NextGen developments, as well as identifying areas needing research. Thus, this position will additionally serve as a vital link between the research focus of AJP-61 and development and engineering aspects of NextGen developments applying

human factors. We recommend that AJP-61 personnel have input in assessing the qualifications of potential hires for this position.

**FAA Response (b):** The Chief Systems Engineer (CSE) for Human Factors, who was in the NextGen Integration and Implementation (I&I) Office, recently retired. The FAA agrees with the importance the REDAC has placed on the position, as well as the requirements for the position, and will be aggressively pursuing replacing this expertise during our upcoming hiring as a human factors integration lead in a new office within System Engineering and Safety (AJP-1).

**Recommendation (c):** As we have in the past, we recommend that every effort be made to select a permanent replacement for the head of AJP-61, following the departure of Karlin Toner.

**FAA Response (c)**: The FAA is pleased to announce that Dr. Paul Krois has been selected to be permanent head of the AJP-61 Human Factors Research and Development Group. Dr. Krois has been acting in that capacity during Dr. Karlin Toner's detail to the Department of Transportation. He brings a wealth of experience to the position and is responsible for ensuring that human factors receives increased emphasis as the FAA moves forward with NextGen.

**Recommendation (d):** As we have in the past (September Rec 1c), we recommend that the subcommittee be briefed on two critical areas with HF components (but outside the funding lines of AJP-61): (1) Human factors aspects of the weather program by AJP-68 and (2) concepts of operations and research by AJP-66. We recognize that such briefings could not be scheduled for the recent March meeting because of time constraints.

**FAA Response (d)**: The FAA agrees and gave briefings to the REDAC at the August 2010 meeting on human factors aspects of the 1) NextGen Weather Technology in the Cockpit RE&D program and 2) NextGen concept validation. The weather information products developed by meteorology laboratories are subjected to operational suitability evaluations designed and carried out by the Aviation Weather Group (AJP-68) human factors experts at the William J. Hughes Technical Center prior to their entry into operations. In addition, the WTIC program staff includes an Engineering Psychologist to oversee the significant proportion of the WTIC program devoted to human factors work.

**Recommendation (e):** Assure that the new human factors research portfolio makes contact with (articulates in general form) all of those HF efforts within the FAA that lie outside of the direct funding line of AJP-61.

**FAA Response (e):** We agree with the recommendation. One of the benefits of the development of the NextGen Human Factors Portfolio is the availability of a comprehensive set of plans and ongoing NextGen human factors activities to the entire NextGen community. The Human Factors Portfolio currently contains over 100 entries of projects that are being sponsored by various elements of the FAA. As other research activities are identified through external and internal coordination as well as through the conduct of Human Factors Reviews (which in the future will be aligned under the auspices of technical interchange meetings of the Human Factors Coordinating Committee), the portfolio contents and value will continue to be enhanced.

**Recommendation (f):** We recommend that the current FAA research program continue to follow the guidance of the Administrator's response, and insure that human in the loop simulations include off-nominal events, and focus on evaluating pilot and controller responses to those events.

**FAA Response (f)**: The FAA concurs. Off-nominal events have been included in many FAA controller-in-the-loop simulations such as involving the Tower Information Display System and the Staffed NextGen Tower concept conducted at the William J. Hughes Technical Center and are also addressed as part of the NextGen Controller Efficiency human factors program as part of studies on human error and safety. Off-nominal events are included in all NextGen flight deck human factors assessments of applications and from an integrated air-ground perspective. The FAA is building the set of intended off-nominal scenarios to complement currently available scenarios in NAS Enterprise Architecture (EA) Operational Views. These scenarios when added to the EA will assist in directing human factors research toward human-automation risk mitigation.

**Background:** Previous recommendation and FAA response letter dated January 29, 2010. Recommendation: Continue the excellent progress of collaboration with NASA's Integrated Intelligent Flight Deck project, within the Aviation Safety Program.

**FAA Response**: The FAA concurs and AJP-61 will continue collaboration to ensure involvement with the NASA Aviation Safety Program's Integrated Intelligent Flight Deck Project with particular emphasis on applications such as merging and spacing and closely spaced parallel operations. We will also emphasize transitioning NASA research products to FAA for integration as part of our NextGen Air Ground Integration research efforts.

**Finding (2):** We were fully satisfied with the FAA's response that such collaboration remains in force and is expanding. In particular the research portfolio of Flight Deck NextGen projects reflects a very high level of coordination with and FAA funding of research performed by NASA that leverages their expertise and resources.

**Recommendation:** Continue on-going collaboration in the areas of Air Traffic and Airspace Systems. Of note out of FAA-funded reimbursable tasks to be completed by NASA, we hope that the FAA will soon exploit the results of the task generating recommendations regarding ATC priority research issues for NextGen.

**FAA Response**: The FAA intends to continue and strengthen the collaboration with the NASA Ames Human System Integration Division and the Airspace Systems program. This collaboration is recognized as mutually beneficial and has helped to enhance the capabilities of the FAA human factors research program. We are using NASA's recommendations to help craft and prioritize the future tasks that will support the integration of NextGen Operational Improvements. We consider NASA a full member of our NextGen human factors team.

**Finding (3):** The subcommittee received a series of excellent briefings from human factors researchers at MITRE, regarding HITL simulations of various concepts that will appear in

NextGen. From this briefing it appeared that the FAA, through AJP-61 has taken a good step forward for keeping closely in touch with the conduct and products of this high quality and NextGen-relevant human factors-related research. This briefing also provided an opportunity for AJP-61 staff to learn about MITRE CAASD research in related areas, and establish direct contacts.

**Recommendation:** The FAA (via AJP-61) should continue the coordination and look for opportunities to progress the coordination with MITRE, as much of it appears to fit directly into issues within the HSI roadmap, and has profound implications for future concepts (e.g., potential increase in controller workload, resulting from the more rapid updates associated with ADS-B driven displays.)

**FAA Response:** The FAA concurs. Following the recent human factors exchange between AJP-61 and MITRE, it was mutually agreed that another exchange within approximately six months would be conducted. Several follow-up actions were also identified to facilitate sharing of reports and other information. The proven value of this meeting approach supports the continuation and institutionalization of such exchanges.

## NAS Operations Subcommittee

**Observation:** The subcommittee held its meeting at the MIT Lincoln Laboratory, and heard briefings on MIT/LL's surveillance research, weather forecasting research, weather-ATM integration research, and air traffic control tower research. Additionally, briefings were given on the FAA's PARTNER program, the FAA's RED budget, and the FAA's NAS Operations PPT research. The MIT/LL briefings were at an excellent level of technical depth, and gave the subcommittee members unusually clear insight into the way some of this work for the FAA is being conducted.

**Finding (1):** The committee was briefed on two programs which will require new approaches to evaluating safety: Unmanned Aircraft Systems (UAS) Airspace Access, and Staffed NextGen Tower (SNT). Both introduce new operating paradigms, with new and significantly different human roles and responsibilities. Overly conservative requirements, with insufficient analysis, will inhibit the addition of new capabilities. The subcommittee reaffirmed the statement in the October 19, 2009 REDAC letter to the Administrator that "there does not appear to be a clear system-level process for managing risk and arbitrating safety requirements for new systems or procedures." At the REDAC meeting in April, the Chair learned with pleasure of the "lean" process instituted by AVS and ATO as an excellent first step to have such a process.

**Recommendation:** The NASOPS subcommittee requests a briefing to the full subcommittee on the new processes for assessing safety levels developed by AVS and ATO.

**FAA Response:** In response to recommendations from the RTCA Task Force on NextGen Mid-Term Implementation, the FAA has initiated the NAV Procedures project. Using "Lean Processes," the project will review and make recommendations to improve and streamline all processes used to request, prioritize, process, improve, and implement performance-based,

conventional IFP. The focus of the improvements will be to create safe, repeatable, beneficial, and efficient processes that comply with applicable regulations. By September 30, 2010, a report will be provided AVS and the ATO leadership with recommendations for improving and streamlining development and delivery of all IFPs in the NAS. AVS and ATO leadership, in coordination with ARP and AEP [APL], will assess and approve these recommendations for implementation.

The NAV Lean Team is composed of six WGs with leads representing ATO and AVS. Each WG will review and make recommendations to improve and streamline their respective processes. Relative to the REDAC's reference to safety and operational approval, one of the six WGs is the SMS and Operational Approval Working Group. This WG will (1) examine the current requirement to use the SMS method to assess potential changes in risk associated with the introduction of a new or revised IFP into regional airspace, (2) examine the special authorization process, which specifies aircraft, equipment, and pilot requirements for approving procedures such as Category II/III ILS or RNP SAAAR, and (3) review and recommend changes to the appropriate safety targets.

Upon project completion, the FAA would be happy to brief the REDAC on NAV Lean as desired by the REDAC or any of the subcommittees.

**Finding (2):** The budget briefing contained the RED budget request for FY11 and one line (BLI 1A08) from the F&E budget devoted to NextGen, but information from other CIP BLIs, such as those for the NextGen Solution Sets, was not forthcoming. Clearly, R&D (as defined by OMB) for NextGen is being performed in these other lines (e.g. RWI). Without complete budgetary and programmatic context of the FAA's R&D program, NASOPS is unable to give balanced advice on the overall allocation of R&D efforts and whether the most important work is being undertaken. NASOPS has raised this issue before.

**Recommendation:** All Research and Development for NextGen should be presented to NASOPS, which would include that performed in funding under Solution Sets, Transformational Programs, and/or cross-cutting R&D.

**FAA Response:** The FAA recognizes the need to set the appropriate context for REDAC briefings in support of the REDAC's review of the FAA's research program. We will continue to strive to improve the context for NextGen-related research contained in the NARP. However, a detailed NASOPS review of all NextGen Solution Set content is neither feasible nor appropriate due to the broad scope and implementation focus of the vast majority of that work. Recognizing the need for improving and clarifying our engagement with the aviation community through the multiple timeframes associated with NextGen, in May the FAA released an overview of our renewed engagement strategy. The strategy reiterates the need for REDAC to continue to provide advice on the FAA's R&D as captured in the NARP. Also, the FAA is forming a new executive-level advisory group to replace the Air Traffic Management Advisory Committee to reflect the broader views and engagement necessary for near and mid-term NextGen implementation. The new advisory group will have a broader aviation community membership to include industry participants who speak for the interests of safety, airport, environment, and global harmonization, as well as air traffic.

**Findings (3):** The majority of NextGen R&D presented emphasizes Part 121 NextGen implementation, with little attention focused on on-demand commercial air carriers, air taxis, charter, business, corporate, private, and other GA operators. Without addressing the unique aspects of these operators, NextGen implementation may be delayed and opportunities for innovation will be missed.

**Recommendation:** Develop an overall R&D strategy, identifying top research issues and key decisions the research will drive, for all classes of aviation, and recommend the overall strategy for fostering and maturing research and development for both mid-term and long-term time periods. The strategy should include R&D focused on activities in Parts 135 and 91, as well as UAS and rotorcraft operations.

**FAA Response:** The FAA's NextGen plans encompass the needs of all user communities. To capture stakeholder interests, the FAA firmly believes a collaborative environment between the FAA and the aviation community is essential throughout the implementation of NextGen. We recognize substantial benefit will be achieved through our continued engagement.

FAA's collaboration across the aviation community has already produced meaningful results as illustrated by the RTCA Task Force recommendations. The recommendations included input from across the aviation community to include commercial airlines, general aviation, manufacturers, airports, and the military. The Task Force made a significant effort to develop a comprehensive list of recommendations for NextGen implementation that the FAA has fully embraced. We have fully integrated our response to those recommendations into our NextGen implementation plans and actions. Meanwhile, the FAA will seek to obtain go-forward input from all aviation communities across the broad NextGen applications. For example, the FAA recently completed CRDA with three unmanned aircraft manufacturers to facilitate meaningful R&D efforts to enable the transition of UASs into the NAS and meet a wide variety of stakeholders needs.

**Finding (4):** The FAA's R&D investments are weighted to enable the mid-term implementation of NextGen capabilities. The lead for longer term NextGen outcomes require sustained investment beginning now to ensure timely implementation. The subcommittee is concerned that these areas are inadequately funded, and that the FAA is not planning to leverage innovation in the private sector (e.g., using incentives such as the "X prize", public-private collaborations, or the establishment of notional performance requirements) for these long-term objectives.

**Recommendation:** This R&D should capitalize on innovation from the private sector, partly by including consideration of how to incentivize users to equip (e.g. "first adopters").

**FAA Response:** While the Committee is correct in its observation, the FAA's primary research focus as an implementing agency is on mid-term capabilities while keeping an active view on longer term capabilities. The FAA, through the RTT, remains engaged with NASA and JPDO on long-term research needs for NextGen. In addition, the FAA continues to pursue new cooperative agreements with industry and academia to further NextGen advancement. The FAA believes its funding level is adequate to accomplish both the mid-term and long-term needs.

In addition, the FAA appreciates the REDAC's concerns regarding incentivizing users to equip. The FAA remains engaged with industry following the receipt of RTCA Task Force recommendations in this area and we continue to explore associated policy issues with the Administration. We continue to work closely with industry to develop a business case for the requisite investment in NextGen technologies.

**Finding (5):** There remains a need to better understand the overall context of the research needs and fit of the Concept Development work being done relative to NextGen development. Additionally, this area has been cut in funding, contrary to previous recommendations.

**Recommendations (a):** Provide the subcommittee future briefings on context and fit between the concept development and exploration research and the NextGen plans and Enterprise Architecture. Specific focus on connecting the research to the solution sets, infrastructure roadmaps (e.g. automation and human factors), and OIs is needed.

**FAA Response (a):** A two-day NextGen Operational Concept Review was held in June 2010 to 1) achieve greater alignment across all ATO concepts to avoid duplication and identify gaps, 2) share key highlights of concepts, 3) discuss value derived from concepts, and 4) understand the processes by which concepts are developed, vetted, and approved. The findings will be used to support a Concept Integration Analysis being conducted by the Air Traffic Services Concept and Validation Development office (AJP-66). A summary briefing of the findings can be presented at the next NAS OPS subcommittee meeting.

Research and technology development efforts being conducted within the FAA and by external partners such as NASA, DOD, MITLL, MITRE CAASD, universities, SESAR Joint Undertaking, etc. are continuously being cataloged and evaluated for inclusion on the NAS Enterprise Architecture Infrastructure Roadmaps. Evaluation of this research involves extensive coordination with FAA research and program managers, infrastructure roadmap leads, the Chief NAS Enterprise Architect as well as NextGen solution set managers to determine whether the maturity level, timeframe, and application of the expected research outcomes have potential for influencing one or more decision points defined to achieve the FAA's mid-term NextGen OI targets. Through this process the FAA will also be able to identify gaps in the research required to support the NextGen OIs.

**Recommendations (b):** As was recommended by NASOPS previously, more resources should be devoted to this activity. Current funding does not permit far term concept development (e.g. > 2018), or research on concepts not currently in the portfolio (e.g. dynamic airspace resectorization, TFM evolution ConOps, 4-D trajectory management).

**FAA Response (b):** The FAA continues to rely on and will benefit from far-term concept development and research being conducted by external partners such as NASA, DOD, MITLL, Mitre CAASD, universities, SESAR Joint Undertaking, etc. AJP is also cataloging this far-term research for future evaluation relative to inclusion on the NAS Enterprise Architecture Infrastructure Roadmaps.

**Finding (6):** The MIT/LL briefings were a "deep dive" into weather forecast technology and the interaction with TFMM mechanisms. The committee was very pleased with the quality of the work. The evolution of weather research at MIT/LL, NOAA, ESRL, and NCAR into development of useful products now including CoSPA is a testimonial to the value of this research, and MIT/LL staff did an excellent job noting the inclusivity of efforts among these labs.

These briefings showed progress in addressing some of the recommendations of the WAIWG by the work at MIT/LL, but the remainder of the weather-ATM integration R&D being accomplished elsewhere needs to be addressed in this regard. For example, the committee was told that the FY10 funding for the RWI and NNEW areas has been delayed due to internal FAA processes.

**Recommendation:** NASOPS will request a complete FAA weather R&D briefing, with a strategy for addressing the WAIWG recommendations and equivalent levels of detail for work being funded elsewhere, at an upcoming meeting.

**FAA Response:** AJP-68 will be pleased to brief the NASOPS, upon request, on the FAA strategy for addressing the WAIWG recommendations. The brief will cover the weather integration work funded by FAA and NASA and performed by an array of government and contract programs.

**Finding (7):** Traffic managers are concerned with managing the scarce NAS resources to best meet the needs of NAS users. They have become specialized in their roles as managers of the NAS assets and flows. This is a very different job from that performed by controllers, but traffic managers are nonetheless selected from the ranks of the Air Traffic Controllers and were originally selected with the controller skill set in mind. We were encouraged to hear that the FAA human factors research is exploring (mid-term) NextGen controller selection criteria and training, but, there is currently little or no human factors focus on the unique and growing role of Air Traffic Managers.

**Recommendations (a):** Initiate a human factors research program to identify the specific skill set required for Air Traffic Managers in the present and 2018 NextGen systems. This research should culminate in selection and training standards for Air Traffic Managers.

**FAA Response (a):** Realignment of Air Traffic Managers located in en route and terminal field facilities from ATO-System Operations to the en route and terminal service units poses that their work is more closely coupled to field operations in contrast to the more strategic operations at the Air Traffic Control System Command Center. Research into the skill set required for Air Traffic Managers is projected to become part of the NextGen Controller Efficiency human factors program starting in FY 2013. The effort will involve a strategic job analysis to determine how the job of the traffic flow manager will change in the NextGen era and result in selection and training requirements. AJP-61 will engage ATO-System Operations to best ensure that human factors research supports their approach to workforce planning including selection and training.

**Recommendations (b):** Initiate a research effort to identify the skill sets required for Air Traffic Controllers and Airspace Managers for 2025 and beyond, since the people who will be hired in the next 5-10 years will still be in these jobs in that time frame, but the role of controllers airspace managers will undergo significant changes in that timeframe.

**FAA Response (b):** The long-term research needs identified by the REDAC are important and can be further considered after the selection criteria for NextGen in the mid term are defined and validated. At this time, the FAA Enterprise Architecture provides insufficient information regarding long-term operational improvements and potential changes to facilities and other aspects of the work environment. Our intent is to refresh the strategic job analysis for controllers and air traffic managers in 2015 to provide an understanding of the requirements for these positions in 2025.

**Finding (8):** NASOPS was impressed with the breadth of projects in the FAA's COE E&E program PARTNER. Overall funding has increased to $8M for the current FY, and the funding appears to be stable. A strong cadre of partner universities participates in PARTNER with good support from industry in the projects. NASOPS did not, however, receive sufficient insight into the overall program to judge quality and portfolio adequacy.

**Recommendation:** NASOPS requests "deep dive" briefings on PARTNER to (a) understand how it fits into the overall E&E program, (b) assess ATM-related projects being conducted, and (c) understand PARTNER processes for technology transfer.

**FAA Response**: We appreciate your interest in PARTNER. However, detailed review of PARTNER's effort is the responsibility of the Environment and Energy Subcommittee. Focusing solely on PARTNER's efforts would not provide an adequate view of our Environment and Energy research efforts. We encourage members of the NASOPS Subcommittee to attend the Environment and Energy REDAC Subcommittee meetings to better understand our efforts. PARTNER also convenes semiannual meetings to brief PARTNER Advisory Board on its extensive research portfolio. A request will be made to the PARTNER Director to extend an invitation to NASOPS REDAC Subcommittee members to attend PARTNER Advisory Board meetings. This is the most effective approach to address the NASOPS recommendation.

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# Appendix D: NARP Chapter 2 Milestone Status

The 2011 NARP presents an established research plan that describes how the FAA R&D programs are progressing toward achieving the R&D targets through 2016. The plan maintains continuity with the previous R&D goals and the milestones supporting those goals. "Appendix D - 2011 Chapter 2 Milestone Status" enhances the visibility of this continuity.

Appendix D summarizes the status of the milestones in Chapter 2 (as compared with the Chapter 2 milestones from the 2010 NARP) and provides an explanation for any changes. The tables below list the programs under each R&D Goal in alphabetical order by program name.

Appendix D is intended to help the reader see how the program milestones change from year to year and to understand the rationale for all changes. We expect occasional changes, given the nature of research and the reality of government budget processes.

| R&D Goal 1 – Fast, Flexible, and Efficient | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| AIP | Airport Cooperative Research - Capacity | 2008 | Increase airport capacity | Completed |
| | | 2011 | Develop guidebook to assist airport planners with airfield and airspace capacity evaluation | On schedule |
| | Airport Technology Research - Capacity | 2012 | Develop new standards and guidelines for runway pavement design | On schedule |
| A12.b | NextGen - Wake Turbulence | 2008 | Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions | Completed |
| | | 2010 | CLARIFIED<br>Determine air navigation service provider (ANSP) (and pilot as needed) situational aircraft separation display concepts required for implementation of the NextGen Trajectory-Based Operation (TBO) and High Density concepts | Completed<br><br>CLARIFIED<br>The change deletes "pilot and" which was after "Determine" and adds the parenthetical clause "(and pilot as needed)." |
| | | 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 | On schedule |
| | | 2013 | CLARIFIED<br>Modify procedures as requested to allow use of closely spaced parallel runways for arrival operations during non-visual conditions (2 to 3 airports per year per TF5 recommendations and for requests from airports) | On schedule<br><br>CLARIFIED<br>The change adds parentheses at the end of the milestone to clarify the deliverable. |

| R&D Goal 1 – Fast, Flexible, and Efficient | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A08E | NextGen - Wake Turbulence - Re-categorization | 2011 | CLARIFIED<br>Determine initial set of optimal aircraft flight characteristics and weather parameters for use in setting wake separation minimums | On schedule<br><br>CLARIFIED<br>The change is from "Determine set of optimal" to "Determine initial set of optimal". |
| | | | 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 | On schedule<br><br>In April 2010, ICAO and FAA harmonized the weight category boundary between Heavy and Large aircraft. Joint AA/EUROCONTROL RECAT proposal for 6 new categories briefed to ICAO and will be formally submitted in early FY 2011. |
| | | 2013 | Determine how best to incorporate the leader/follower based wake separation standards into the en-route and terminal automation platforms | On schedule |
| | | 2016 | CLARIFIED<br>Develop the algorithms that will be used in the ANSP (and flight deck as needed) automation systems for setting dynamic wake separation minimum for each pair of aircraft | On schedule<br><br>CLARIFIED<br>The change is from "ANSP and flight deck" to "ANSP (and flight deck as needed)". |
| -- | NextGen Demonstrations and Infrastructure Development | 2008 | Demonstrate improved trajectory-based operations in mixed-equipage, oceanic airspace with actual aircraft and procedures | Completed |
| | | 2009 | Develop and simulate separation procedures that vary according to aircraft capability and pilot training | Completed |
| | | | Demonstrate the addition of convective weather (current and forecast) into Traffic Management Advisor (TMA) routing to increase throughput and efficiency for large, super density airports | Completed |
| | | | Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication | Completed |

| R&D Goal 1 – Fast, Flexible, and Efficient | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.k | Weather Program | 2010 | REVISED<br>Develop 0-8 hour advanced storm prediction algorithm | Completed<br><br>REVISED<br>Changed from “0-6 hour” to “0-8 hour” due to research results exceeding original expectations |
| | | | Transition Rapid Refresh Weather Forecast Model for implementation at National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction | Completed |
| | | 2011 | REVISED<br>Demonstrate 0-8 hour advanced storm prediction algorithm | On schedule<br><br>REVISED<br>Changed from “0-6 hour” to “0-8 hour” due to research results exceeding original expectations |
| | | 2013 | REVISED<br>Transition 0-8 hour advanced storm prediction algorithm for implementation | On schedule<br><br>REVISED<br>Changed from “0-6 hour” to “0-8 hour” due to research results exceeding original expectations |
| | | 2014 | DELAYED<br>Transition in-flight icing Alaska forecast and analysis capability for implementation | DELAYED<br>The milestone is delayed from 2013 to 2014 due to changing Weather Program Planning Team priorities. |

| R&D Goal 2 – Clean and Quiet | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A13.a | Environment and Energy | 2008 | Develop and distribute the first generation of integrated noise and emission prediction and modeling tools, including an environmental cost module | Completed |
| | | | 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 | Completed |

| R&D Goal 2 – Clean and Quiet | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A13.a | 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 | Completed |
| | | | Develop a preliminary planning version of an Aviation Environmental Design Tool (AEDT) that will allow integrated assessment of noise and emissions impact at the local and global levels | Completed |
| | | 2011 | Develop a new metric to quantify the environmental impacts of new aircraft types | On schedule |
| | | | Investigate feasibility of new standards for aircraft noise and emissions certification | On schedule |
| | | | Assess the level of certainty of aviation's impact on climate change, with special emphasis on the effects of contrails | On schedule |
| | | | Complete development of first-generation ground plume model for aircraft engine exhaust | On schedule<br><br>The estimated completion date is the Summer of 2011, but completion depends on specific airport operations and weather conditions for collecting data comparable to prior data collection campaigns. |
| | | 2012 | Expand noise data collection to very light jets and supersonic aircraft | On schedule |
| | | 2013 | Obtain direct measurements of hazardous air pollutants and particulate matter data to update modeling tools | On schedule |
| | | | Update environmental assessment models to incorporate new noise metrics | On schedule |
| AIP | Airport Technology Research – Environment | 2012 | NEW<br>Initiate a project to study aircraft noise annoyance data and sleep disturbance around airports | NEW<br>Program initiation is contingent upon Congressional approval of FY 2012 budget. |

| R&D Goal 2 – Clean and Quiet | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A13.a<br><br>AIP | Environment and Energy<br><br>Airport Cooperative Research – Environment | 2009 | Develop methodologies to quantify and assess the impact of Particulate Matter and Hazardous Air Pollutants | Completed |
| | | 2010 | Develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions | Completed |
| | | 2014 | Complete development and field a fully validated suite of tools, including the AEDT and the Aviation Environmental Portfolio Management Tool (APMT) | On schedule |
| A13.a<br><br>A13.b<br><br>AIP | Environment and Energy<br><br>NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics<br><br>Airport Cooperative Research – Environment | 2011 | Determine how aviation-generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate | On schedule |
| 1A08D<br><br>AIP | NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction<br><br>Airport Cooperative Research – Environment | 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 | On schedule |
| 1A08D | NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction | 2013 | Evaluate, refine, and apply Environmental Management System (EMS) decision support tools to the aviation system | On schedule |

| R&D Goal 2 – Clean and Quiet | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A08D | NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction | 2013 | REVISED<br>Identify and pursue the development of flight management system and other system technologies that will be the most effective at producing environmental benefits | On schedule<br><br>REVISED<br>Replaced "engine and airframe" with "flight management system and other system technologies" |
| | | 2014 | Assess NAS-wide benefits of environmental mitigation solutions comprised of new technologies, alternative fuels, advanced operational procedures, market measures, and options for policy and noise/emissions standards | On schedule |
| | | | Demonstrate optimized en route operations that enhance fuel efficiency and reduce emissions | On schedule |
| | | 2015 | Refine and update approaches for EMS performance tracking | On schedule |
| 1A08F | NextGen - Operational Assessments | 2011 | Enhance regional analysis capability in aviation environmental analysis tools | On schedule |
| A13.b | NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics | 2010 | Complete detailed feasibility study, including economic feasibility, measure environmental impacts, and demonstrate drop-in potential for alternative fuels | Completed |
| | | | 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 | Completed |
| | | 2011 | Complete tests and data collection to determine if the right metrics are being used to assess the impact of aircraft noise | On schedule |
| | | | Establish the relationship between aviation engine exhaust and the gases and particulate matter that are deposited in the atmosphere | On schedule |
| | | | Complete detailed feasibility study, including economic and environmental impacts and an assessment of potential of renewable alternative fuels for gas turbine engines | On schedule |

| R&D Goal 2 – Clean and Quiet | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A13.b | NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics | 2013 | Complete significant demonstration of "drop-in" alternative turbine engine fuels | On schedule |
| | | | Demonstrate airframe and engine technologies to reduce noise and emissions | On schedule |
| | | | NEW<br>Identify and pursue the development of engine and airframe technologies that will be the most effective at producing environmental benefits | On schedule<br><br>NEW<br>Milestone added because it is a part of CLEEN. |
| | | | DELETED<br>Establish engine design sensitivities by measuring particles emitted from combustor engine systems | DELETED<br>Editorial error corrected. This is not one of the program's milestones. |
| | | 2014 | Complete assessment of renewable alternative turbine engine fuels | On schedule |
| | | 2015 | Assess environmental benefits of first round of Continuous Lower Energy, Emissions and Noise (CLEEN) airframe and engine technologies through integrated flight demonstration | On schedule |
| | | | Complete transition plans for renewable alternative fuels | On schedule |

| R&D Goal 3 – High Quality Teams and Individuals | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.i | 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 |
| | | | Identify the performance limitations of the controller in the terminal and tower environments | Completed |
| | | 2008 | Conduct initial simulation to determine what weather information is required by en route and tower controllers to improve efficiency | Completed |
| | | | Demonstrate efficiency improvements when controllers receive information on aircraft equipage, performance capabilities, and applicable procedures in a mixed equipage environment | Completed |

| R&D Goal 3 – High Quality Teams and Individuals | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.i | Air Traffic Control/Technical Operations Human Factors | 2012 | NEW<br>Improve computer-human interface design to reduce information overload and resulting errors | NEW<br>New start program contingent upon approval of FY 2012 budget |
| | | 2013 | NEW<br>Assess the Front Line Manager Quick Reference Guide for effectiveness in aiding ATC safety | NEW<br>New start program contingent upon approval of FY 2012 budget |
| | | 2014 | NEW<br>Provide a draft of a revised Human Factors Design Standard for human factors application to ATC system acquisition | NEW<br>New start program contingent upon approval of FY 2012 budget |
| 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | 2010 | Define anticipated controller workload reductions due to implementation of data communications | Completed |
| | | | Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area | Completed |
| | | 2012 | MOVED<br>Apply program-generated human factors knowledge to improve aviation system personnel selection and training | On schedule<br><br>MOVED<br>Milestone moved from A11.i Air Traffic Control/Technical Operations Human Factors to better align the program objectives with NextGen initiatives |
| | | 2013 | CLARIFIED<br>Analyze controller roles in a strategic air traffic environment for the impact on personnel selection and training | On schedule<br><br>CLARIFIED<br>AJN requested removal of the description “for en route and terminal domains” after the word “environment” to reflect the movement away from domains toward phases of flight. |
| | | | Demonstrate collaborative air traffic management efficiencies enabled by common situation awareness between flight operators and ANSP | On schedule |

| R&D Goal 3 – High Quality Teams and Individuals | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A08A | NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) | 2013 | Demonstrate increased ANSP efficiencies through new procedures that allow ANSP personnel to manage and introduce routing, airspace, and equipage mix changes in the dynamic air traffic environment | On schedule |
| | | 2015 | MOVED<br>Develop selection procedures to transform the workforce into a new generation of service providers that can manage traffic flows in a highly automated system | On schedule<br><br>MOVED<br>Milestone moved from A11.i Air Traffic Control/Technical Operations Human Factors to better align the program objectives with NextGen initiatives |
| | | 2016 | Perform an analysis of controller roles in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur | On schedule |

| R&D Goal 4 – Human-Centered Design | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| AIP | Airport Cooperative Research - Capacity | 2011 | Document ramp operational and safety techniques and how airport operators implement pavement maintenance programs | On schedule |
| A11.g | Flightdeck/ Maintenance/System Integration Human Factors | 2012 | Develop human factors guidance for Automatic Dependent Surveillance – Broadcast (ADS-B) enabled Cockpit Display of Traffic Information (CDTI) certification and operational approval | On schedule |
| | | | Provide human factors guidance for the design of instrument procedures | On schedule |
| A12.c | NextGen - Air Ground Integration Human Factors | 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 | Completed |
| | | 2011 | Develop initial mid-term analysis describing the relationship between human pilots and controllers with associated automated systems | On schedule |

| R&D Goal 4 – Human-Centered Design | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A12.c | NextGen - Air Ground Integration Human Factors | 2012 | Complete initial research to evaluate and recommend procedures for negotiations and shared decision-making between pilots and controllers | On schedule |
| | | | Complete research to develop methods to mitigate mode errors in use of NextGen equipment | On schedule |
| | | | Initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations | On schedule |
| | | 2013 | Complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures | On schedule |
| | | 2014 | Develop initial guidance on training methods to support detection and correction of human errors in near- to mid-term NextGen procedures | On schedule |
| | | 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 | On schedule |
| | | | Complete initial research to enable safe and effective changes to controller roles and responsibilities for NextGen procedures | On schedule |
| | | | Complete research to identify and manage the risks posed by new and altered human error modes in the use of NextGen procedures and equipment | On schedule |
| A12.c<br><br>A14.b | NextGen - Air Ground Integration Human Factors<br><br>William J. Hughes Technical Center Laboratory Facility | 2017 | Functional demonstration – demonstrate integrated pilot and controller functional capabilities | On schedule |

| R&D Goal 5 – Human Protection | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.j | Aeromedical Research | 2010 | Validate computational models of chemical air contaminants, such as volatile organic compounds (VOCs), to evaluate health and safety impacts on passengers and crew | Completed |
| | | 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 | On schedule |
| | | | Develop and validate chemical kinetic models for bleed air systems for health and safety effects on passengers and crew | On schedule |
| | | 2014 | DELAYED<br>Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants | DELAYED<br>The completion date is delayed from 2010 to 2014 due to changing sponsor priorities. |
| | | | DELAYED<br>Apply and validate advanced air sensing technology for VOCs in the aircraft cabin environment | DELAYED<br>The completion date is delayed from 2011 to 2014 due to changing sponsor priorities. |
| | | | DELAYED<br>Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain | DELAYED<br>The completion date is delayed from 2012 to 2014 due to changing sponsor priorities. |
| | | 2015 | DELAYED<br>Develop bleed air contamination models of engine compressors and high temperature air system for effects on the health and safety of passengers and crew | DELAYED<br>The completion date is delayed from 2011 to 2015 due to changing sponsor priorities. |

| R&D Goal 5 – Human Protection | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| | Aeromedical Research | 2015 | CLARIFIED and DELAYED<br>Establish validation parameters for mathematical models that can evaluate whether aircraft type designs meet requirements for evacuation and emergency response capability, in lieu of actual tests | CLARIFIED<br>Original wording: Validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability<br><br>DELAYED<br>The completion date is delayed from 2012 to 2015 due to changing sponsor priorities. |
| | | | Develop a methodology to compile, classify, and assess aviation-related | On schedule |
| | | | | On schedule |
| | | | Incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control | On schedule |
| | | 2016 | REVISED<br>Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors | REVISED TO ORIGINAL<br>The completion date is reverted to 2016, the originally submitted date. |

| R&D Goal 5 – Human Protection | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | 2014 | REVISED<br>Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content (HIWC) environments | On schedule<br><br>REVISED<br>New wording reflects combination with other research goals under a single 2014 milestone.<br><br>Old Wording: Develop data and methods supporting the evaluation of aircraft engines for operation in high ice water content environments |
| AIP | Airport Cooperative Research - Safety | 2012 | DELAYED<br>Assess role of airports and airlines in the spread of vector-borne diseases | DELAYED<br>The completion date is delayed from 2011 to 2012 due to the ACRP Oversight Committee's expansion of the scope of the project to provide guidance to airports and airlines. |
| | Airport Technology Research - Safety | 2011 | Complete evaluation of new airport runway pavement groove shape to reduce risk of overrun due to hydroplaning | On schedule |
| | | 2012 | Develop aircraft rescue and fire-fighting procedures and equipment standards to address double-decked large aircraft | On schedule |
| Ops | Commercial Space Transportation Safety | 2008 | Conduct a study to provide a basic understanding of what is necessary in an Informed Consent form for commercial space flight participants | Completed |
| A11.a | Fire Research and Safety | 2012 | Define composite fuselage fire safety design criteria | On schedule |
| A11.k | Weather Program | 2012 | Transition mountain-wave turbulence forecast capability for implementation | On schedule |
| | | 2015 | DELAYED<br>Transition turbulence forecast capability for all flight levels for implementation | DELAYED<br>The completion date is delayed from 2012 to 2015. Reprioritizations based on NextGen requirements have moved this milestone to FY 2015. |

| R&D Goal 5 – Human Protection | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.k | Weather Program | 2016 | Transition global turbulence forecast capability for implementation | On schedule |
| | | 2017 | DELAYED<br>Transition convectively-induced turbulence forecast capability for implementation | DELAYED<br>The completion date is delayed from 2013 to 2017. Reprioritizations based on NextGen requirements have moved this milestone to FY 2017. |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.c | Advanced Materials/Structural Safety | 2010 | Develop certification methods for damage tolerance and fatigue of composite airframes | Completed |
| | | 2012 | DELETED<br>Define criteria for use of embedded sensors in fault-tolerant structures | DELETED<br>The FAA sponsor in Aviation Safety (AVS) removed this milestone, as it is no longer an imminent certification concern. |
| | | 2013 | NEW<br>Establish required skills and develop training materials for all second level composite structures knowledge areas (maintenance inspection, structural engineering, and manufacturing) for operational safety | NEW<br>This milestone was added to directly support the FAA sponsor's (AVS) business plan items for composite structures. |
| A11.f | Aircraft Catastrophic Failure Prevention Research | 2013 | Develop and verify a generalized damage and failure model with regularization for aluminum and titanium materials impacted during engine failure events | On schedule |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.d | Aircraft Icing - Atmospheric Hazards/Digital System Safety | 2013 | REVISED<br>Identify safety issues and propose mitigation approaches when software development techniques and tools are used in airborne systems | On schedule<br><br>REVISED<br>Wording revised to comply with sponsor request.<br><br>Old Wording: Evaluate development and integration techniques that will produce software for complex highly integrated systems that must comply with airworthiness requirements. |
| | | 2014 | REVISED<br>Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content (HIWC) environments | REVISED and DELAYED<br>Delayed from 2013 to 2014 due to technical challenges and scheduling of open circuit wind tunnel during winter months. New wording reflects combination with other research goals under a single 2014 milestone.<br><br>Old Wording: Develop methods for the airworthiness testing of engines in simulated high ice water content environments |
| Ops | Commercial Space Transportation Safety | 2010 | Conduct a study to examine the operational environment, determine the number of sensors needed, define the data recovery process, and provide black box survivability criteria for use in developing requirements for a black box system to be used in commercial space transportation systems (expendable launch vehicles and reusable launch vehicles (RLV)) | Completed |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| Ops | Commercial Space Transportation Safety | 2010 | DELETED<br>Conduct an assessment on the outputs from two specialized, independent system safety analyses conducted by separate parties to determine the optimal system safety method. The assessment will include the strengths and weaknesses, the hazard analysis depth, the hazard identification thoroughness, and the projected resource utilization | DELETED<br>Deletion is due to contractual transitions and new-starts. Additionally, reorganization and restructuring of the Commercial Space R&D activities resulted in a reprioritization of this milestone below current activity thresholds. |
| | | 2011 | DELAYED<br>Conduct a study to identify means of preventing hazards (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically hydrogen peroxide, $H_2O_2$, and nitrous oxide, $N_2O$) used in propulsion systems in commercial space applications | DELAYED<br>The completion date is delayed from 2010 to 2011. Evolving research requirements and administrative barriers delayed the transfer of funding between agencies and delayed the start of this task. The new completion date is February 2011. |
| | | | CLARIFIED and DELAYED<br>Conduct a study to provide guidance to the FAA and industry on the use of operational limitations and inspection requirements for suborbital reusable launch vehicles (RLV) comprised of composite materials. The results of this study will help to develop effective rules for operations and maintenance for use of composite materials, as they apply to commercial space transportation | CLARIFIED<br>Old Wording: Replaced “AST” with “the FAA”.<br><br>DELAYED<br>The completion date is delayed from 2010 to 2011. Evolving research requirements and administrative barriers delayed the transfer of funding between agencies and delayed the start of this task. Work is in progress and the expected completion date is April 2011. |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| Ops | Commercial Space Transportation Safety | 2011 | DELAYED<br>Conduct a study to provide information on the capability, limitations, and considerations for GPS implementation in space launch and reentry environments, such as Space and Air Traffic Control, which will be used to help determine requirements for GPS usage and future technologies | DELAYED<br>The completion date is delayed from 2010 to 2011. Evolving research requirements and administrative barriers delayed the transfer of funding between agencies and delayed the start of this task. Work is progressing. APL received funding and the expected completion date is April 2011. |
| A11.e | Continued Airworthiness | 2010 | DELETED<br>Complete development of damage-tolerant design methods as the basis for propeller structural design and assess impacts on propeller weight | DELETED<br>The FAA sponsor (AVS) deleted the requirement in FY 2009 and did not provide funding to complete the task. The research up to that point was insufficient to complete the requirement. The program produced a report on design method and on propeller weight, but in no case was the work completed. |
| | | 2011 | Apply damage-detection technologies for inspecting remote and inaccessible areas of in-service aircraft with metal structures | On schedule |
| | | | Complete the study in usage, design, and training issues for rudder control systems in transport aircraft | On schedule |
| | | 2012 | DELETED<br>Complete development of methods and data for damage tolerance analysis of rotorcraft structure | DELETED<br>The FAA sponsor (AVS) deleted the requirement in FY 2009. Prior to milestone deletion, the program developed fatigue-crack-growth databases for use in damage-tolerant assessments of rotorcraft components. The material databases will be transferred to rotorcraft companies and the developers of component life-prediction codes. |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.e | Continued Airworthiness | 2013 | Develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems (HUMS) for usage credits | On schedule |
| A11.a | Fire Research and Safety | 2011 | Provide comprehensive guidance on lithium battery fire safety | On schedule |
| A11.m | NextGen – Alternative Fuels for General Aviation | 2016 | REVISED and DELAYED<br>Develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded avgas | REVISED and DELAYED The milestone is revised and completion date is delayed from 2015 to 2016 due to new information in the following study: NextGen Alternative Fuels for General Aviation - FY 2011-2015 FAA Aviation Fuel and Engine Test Facility.<br><br>Old Wording: Evaluate and characterize all candidate replacement formulations for 100LL |
| A11.b | Propulsion and Fuel Systems | 2014 | CLARIFIED and DELAYED<br>Complete a certification tool that will predict the risk of failure of turbine engine rotor disks that may contain undetected material and manufacturing anomalies | CLARIFIED and DELAYED<br>The milestone is delayed from 2012 to 2014. The FAA sponsor (ANE) has requested additional enhancements to the DARWIN™ code that will extend the project to FY 2014 with a total additional funding requirement of $2.4M for FY 2013 and FY 2014.<br><br>Old Wording: Complete a certification tool (DARWIN™) that will predict the risk of failure of rotor disks containing material and manufacturing anomalies. |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.l | Unmanned Aircraft Systems Research | 2012 | CLARIFIED<br>Determine a set of performance characteristics and operational requirements for sense and avoid (SAA) technologies | On schedule<br><br>CLARIFIED<br>Wording change reflects revised sponsor requirements.<br><br>Old Wording: Determine performance characteristics and operational requirements for UAS detect, sense, and avoid technologies (DSA) |
| | | 2013 | REVISED and DELAYED<br>Analyze data and identify potential safety implications of system performance impediments of communications latency | REVISED and DELAYED<br>The completion date is delayed from 2012 to 2013 due to revised sponsor requirements.<br><br>Old Wording: Analyze data on the safety implications of system performance impediments to UAS command, control, and communication (C3) in different classes of airspace and operational environments |
| | | 2014 | DELETED<br>Develop risk management concepts, models, and tools for UAS | DELETED<br>Milestone deleted due to change in sponsor (AVS) priority. |

| R&D Goal 6 – Safe Aerospace Vehicles | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.l | Unmanned Aircraft Systems Research | 2016 | REVISED and DELAYED<br>Conduct field evaluations of UAS technologies in an operational environment, including SAA, C2, and contingency management technologies. The documented results will be used to develop certification and airworthiness standards | REVISED and DELAYED<br>Wording change reflects revised sponsor requirements. The completion date is delayed from 2015 to 2016 due to decreased funding levels.<br><br>Old Wording: Conduct field evaluation of DSA technology, C3 technologies, and flight termination procedures |

| R&D Goal 7 – Separation Assurance | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A12.d | NextGen - Self-Separation Human Factors | 2011 | Complete initial research to evaluate and recommend procedures, equipage, and training to safely conduct oceanic and en route pair-wise delegated separation | On schedule |
| | | | 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 | On schedule |
| | | 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 | On schedule |
| | | 2014 | Complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings | On schedule |
| | | | 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 | On schedule |

| R&D Goal 7 – Separation Assurance | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A12.d | NextGen - Self-Separation Human Factors | 2015 | Complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment | On schedule |
| | | | CLARIFIED<br>Enable reduced and delegated separation in oceanic airspace and en route corridors | On schedule<br><br>CLARIFIED<br>Clarification of milestone wording deletes “high-density”. |
| | | 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 | On schedule |

| R&D Goal 8 – Situational Awareness | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| AIP | Airport Technology Research - Safety | 2010 | Develop advisory material to install new visual guidance systems | Completed |
| | | 2011 | Develop performance standards for avian radar use on airports | On schedule |
| | | 2012 | Develop guidance material for airport planning to ensure consistency from the operator’s perspective from airport to airport | On schedule |
| Ops | Commercial Space Transportation Safety | 2009 | Conduct a study to determine the need to develop a temporal wind database to support the launch of wind-weighted, unguided, suborbital rockets launched from nonfederal launch sites | Completed |
| | | | Conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of radar wind profiler to obtain winds to greater altitudes than currently available | Completed |

| R&D Goal 8 – Situational Awareness | | | | |
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| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| Ops | Commercial Space Transportation Safety | 2009 | Review integrated operations of reusable launch vehicles (RLV) from spaceports, joint use airport and spaceports, as well as the airspace surrounding those facilities and provide recommendations on how to safely integrate and conduct routine RLV operations | Completed |
| A12.e | NextGen - Weather Technology in the Cockpit | 2010 | Assess bandwidth demand of graphical icing products (Current Icing Product and Forecast Icing Product) and graphical turbulence products (Graphical Turbulence Guidance) for potential delivery via existing and planned FAA data link services | Completed |
| | | 2011 | DELAYED<br>Develop NextGen mid-term concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit | DELAYED<br>The completion date is delayed from 2010 to 2011 so that the Weather Technology in the Cockpit Capabilities Report can be completed and a formal NextGen Concepts is released. The delay will enable a more comprehensive and realistic Mid-term Concept of Operations. |
| | | | Identify, validate, and document datalink system attributes that may affect use of weather in the cockpit | On schedule |
| | | 2012 | Simulate and evaluate available cockpit weather technologies | On schedule |
| | | 2013 | Develop prototype weather modules for flight deck | On schedule |
| | | 2014 | Simulate, test, and evaluate cockpit use of weather decision support tools, including probabilistic forecasts | On schedule |
| | | | Simulate, test, and evaluate fully-integrated cockpit use of NextGen operational concepts, including WTIC | On schedule |
| | | 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 | On schedule |

| R&D Goal 8 – Situational Awareness | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A01A | Runway Incursion Reduction | 2010 | Develop system enhancements for runway status lights | Completed |
| A11.k | Weather Program | 2010 | Develop CONUS ceiling, visibility, and flight category forecast capability | Completed |
| | | 2012 | Demonstrate 1-3 hour CONUS ceiling, visibility, and flight category forecast capability | On schedule |
| | | 2014 | DELAYED<br>Transition in-flight icing Alaska forecast for implementation | DELAYED<br>The milestone is delayed from 2013 to 2014 due to changing Weather Program Planning Team priorities. |
| | | 2014 | Demonstrate 1-12 hour CONUS ceiling, visibility, and flight category forecast capability | On schedule |
| | | 2016 | Transition 1-12 hour CONUS ceiling, visibility, and flight category forecast capability for implementation | On schedule |

| R&D Goal 9 – System Knowledge | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| AIP | Airport Cooperative Research - Capacity | 2011 | Develop a guidebook for airport operators and air cargo industry stakeholders that provides tools and techniques for measuring economic impacts of air cargo activities at the national, regional, and local level | On schedule |
| | Airport Cooperative Research - Safety | | Develop and validate a software tool to quantify risk and support engineering decision-making related to runway safety area requirements | On schedule |
| Ops | Commercial Space Transportation Safety | 2010 | Conduct a study with current information related to the state of the commercial suborbital transportation industry with a focus on market demand, safety, operability, and international coordination | Completed |

| R&D Goal 9 – System Knowledge | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| Ops | Commercial Space Transportation Safety | 2011 | DELAYED<br>Conduct a study to evaluate the adequacy of current rules and polices related to commercial space transportation, implement new rules, policy, and advisory materials, and identify barriers to industry caused by unnecessary or conflicting regulations | DELAYED<br>The completion date is delayed from 2010 to 2011. This task is awaiting available resources and award of a pending Commercial Space Industry Viability Research contract. A protracted contract transition that resulted in a protest by the incumbent delayed funding to this project. |
| | | | NEW<br>Release Commercial Space Transportation Research Road Map document, v1.0 | NEW<br>On schedule |
| A11.e | Continued Airworthiness | 2011 | Complete study of risk-based fleet management for small-airplane continued operational safety | On schedule |
| 1A08F | NextGen - Operational Assessments | 2009 | Develop and implement NAS-wide regional environmental analysis capability within AEDT | Completed |
| | | 2010 | Implement weather effects in AEDT environmental analyses | Completed |
| | | 2012 | Develop and implement NAS-wide cost-benefit environmental analysis capability with APMT | On schedule |
| | | 2013 | Explore options to integrate environmental assessment capability with NextGen NAS models | On schedule |
| | | 2016 | Employ AEDT and APMT for NAS-wide environmental analyses | On schedule |
| 1A08G | NextGen - System Safety Management Transformation | 2009 | Evaluate current information protection and assurance models and evaluate potential conflicts with privacy and consumer advocacy groups | Completed |
| | | 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 | On schedule |
| | | 2012 | Validate the Net Enabled Operations Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders | On schedule |

| R&D Goal 9 – System Knowledge | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A08G | NextGen - System Safety Management Transformation | 2013 | Complete the Aviation Safety Information Analysis and Sharing (ASIAS) pre-implementation activities, including concept definition, with other JPDO member agencies, participants, and stakeholders | On schedule |
| | | 2014 | Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across NextGen | On schedule |
| 1A01C<br><br>1A01B | Operations Concept Validation<br><br>System Capacity, Planning and Improvement | 2008 | Demonstrate capacity increase to 130% of baseline levels | Completed |
| 1A01C<br><br>1A08C<br><br>1A01B | Operations Concept Validation<br><br>NextGen - Operations Concept Validation - Validation Modeling<br><br>System Capacity, Planning and Improvement | 2011 | CLARIFIED<br>Demonstrate an increase in capacity and efficiency at 2018 forecasted traffic levels | CLARIFIED<br>Researchers will perform fast-time simulation to assess the potential benefits of NextGen Operational Improvements, using standard air traffic forecasts designed to represent realistic traffic demand for each year from the present until 2025. The previous wording of the milestones did not accurately reflect the research methods nor did it provide a target that reflects changing air traffic conditions.<br><br>Old Wording:<br>Demonstrate capacity and efficiency increase up to 166% of baseline levels |

| R&D Goal 9 – System Knowledge | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| 1A01C<br><br>1A08C<br><br>1A01B | Operations Concept Validation<br><br>NextGen - Operations Concept Validation - Validation Modeling<br><br>System Capacity, Planning and Improvement | 2013 | CLARIFIED<br>Demonstrate an increase in capacity and efficiency at 2021 forecasted traffic levels | CLARIFIED<br>Researchers will perform fast-time simulation to assess the potential benefits of NextGen Operational Improvements, using standard air traffic forecasts designed to represent realistic traffic demand for each year from the present until 2025. The previous wording of the milestones did not accurately reflect the research methods nor did it provide a target that reflects changing air traffic conditions.<br><br>Old Wording:<br>Demonstrate capacity and efficiency increase up to 230% of baseline levels |
| | | 2016 | CLARIFIED<br>Demonstrate an increase in capacity and efficiency at 2025 forecasted traffic levels | CLARIFIED<br>Researchers will perform fast-time simulation to assess the potential benefits of NextGen Operational Improvements, using standard air traffic forecasts designed to represent realistic traffic demand for each year from the present until 2025. The previous wording of the milestones did not accurately reflect the research methods nor did it provide a target that reflects changing air traffic conditions.<br><br>Old Wording:<br>Demonstrate capacity and efficiency increase up to 300% of baseline levels |
| A11.h | System Safety Management | 2010 | Demonstrate a one-third reduction in the rate of fatalities and injuries | Completed |

| R&D Goal 9 – System Knowledge | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A11.h | System Safety Management | 2011 | Develop automated tools to monitor databases for potential safety issues | On schedule |
| | | 2012 | Demonstrate a working prototype of network-based integration of information extracted from diverse, distributed sources | On schedule |
| | | | Demonstrate a one-half reduction in the rate of fatalities and injuries | On schedule |
| | | | Develop risk management concepts, models, and tools for transport category airplanes | On schedule |
| | | 2016 | DELAYED<br>Demonstrate a two-thirds reduction in the rate of fatalities and injuries | DELAYED<br>Chapter 2, R&D Goal 5, R&D Target date has changed from 2015 to 2016; this milestone evaluates the target for R&D Goal 5, so for consistency with the other R&D Targets, the milestone date has been updated from 2015 to 2016. |
| A11.l | Unmanned Aircraft Systems Research | 2012 | DELETED<br>Develop risk management concepts, models, and tools for unmanned aircraft systems | DELETED<br>Milestone deleted due to change in sponsor (AVS) priority. |

| R&D Goal 10 – World Leadership | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A14.a | System Planning and Resource Management | 2008 | Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2008-2013 FAA R&D plan | Completed |
| | | 2009 | Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2009-2014 FAA R&D plan | Completed |
| | | 2010 | Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2010-2015 FAA R&D plan | Completed |

| R&D Goal 10 – World Leadership | | | | |
|---|---|---|---|---|
| **BLI** | **Program Name** | **Year** | **Milestone** | **Status** |
| A14.a | System Planning and Resource Management | 2010 | Determine criteria for assessing the benefits of the international research collaboration | Completed |
| | | 2011 | Develop a strategic mapping for international research collaboration | On schedule |
| | | | Identify a process to measure quality, timeliness, and value of international research collaboration | On schedule |
| | | | NEW<br>Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2011-2016 FAA R&D plan | NEW<br>Milestone added for continued measurement of progress in this program.<br><br>On schedule |
| | | 2016 | Determine final value of international research collaboration | On schedule |

# Appendix E – Acronyms and Abbreviations

| Acronym | Definition |
|---|---|
| **0-9** | |
| 100LL | 100 Low Lead |
| 4DT | Four-Dimensional Trajectory |
| **A** | |
| AAIADS | Aerospace Accident Injury and Autopsy Data System |
| AC | Advisory Circular |
| ACCRI | Aviation Climate Change Research Initiative |
| ACER | Airliner Cabin Environment Research |
| ACES | Airspace Conflict Evaluation System |
| ACRP | Airport Cooperative Research Program |
| ADS-B | Automatic Dependent Surveillance-Broadcast |
| ADSIM | Airport Runway Simulator |
| AEDT | Aviation Environmental Design Tool |
| AEE | FAA Office of Environment and Energy |
| AEH | Airborne Electronic Hardware |
| AIA | Aerospace Industries Association |
| AIP | Airport Improvement Program Appropriation |
| AIR | Aircraft Certification Service |
| AJP-6 | FAA Research and Technology Development Directorate |
| AJP-61 | FAA Human Factors Research and Engineering Group |
| AJP-63 | FAA Airport and Aircraft Safety Group |
| AJP-66 | FAA Concept Development and Validation Group |
| AJP-68 | FAA Aviation Weather Group |
| AJP-A | FAA NextGen Integration and Implementation Directorate |
| AMP | Airspace Management Program |
| ANE | New England Region - Aircraft Certification Service Engine and Propeller Directorate |
| ANSP | Air Navigation Service Provider |
| AOC | Airline/Aviation/Aircraft Operations Center |
| APL | FAA Office of Policy, International Affairs, and Environment |
| APMT | Aviation Environmental Portfolio Management Tool |
| APP | FAA Airport Planning and Programming Office |
| AQP | Advanced Qualification Program |
| ARAC | Aviation Rulemaking Advisory Committee |
| ARFF | Aircraft Rescue Fire Fighting |
| ARP | FAA Office of Airports |
| ASBS | Auto Brake Systems with Antiskid |
| ASDE-X | Airport Surface Detection Equipment |
| ASIAS | Aviation Safety Information Analysis and Sharing |
| ASR | Alkali-Silica Reactive |
| ASRS | Aviation Safety Reporting System |

| Acronym | Definition |
|---|---|
| ASTM | ASTM International (formerly the American Society for Testing and Materials) |
| ASTS | Aeronautics Science and Technology Subcommittee |
| AT | Air Traffic |
| ATC | Air Traffic Control |
| ATCSCC | Air Traffic Control Systems Command Center |
| ATC/TO | Air Traffic Control/Technical Operations |
| ATD&P | Advanced Technology Development and Prototyping |
| ATM | Air Traffic Management |
| ATO | FAA Air Traffic Organization |
| ATO-P | FAA NextGen and Operations Planning Service Unit |
| Avgas | Aviation Gasoline |
| AVS | FAA Office of Aviation Safety |
| **B** | |
| BLI | Budget Line Item |
| **C** | |
| C2 | Control and Communications |
| C3 | Command, Control, and Communication |
| CAAFI | Commercial Aviation Alternative Fuel Initiative |
| CAASD | Center for Advanced Aviation System Development |
| CACRC | Commercial Aircraft Composite Repair Committee |
| CAEP | Committee on Aviation Environmental Protection |
| CAMI | Civil Aerospace Medical Institute |
| CAS | Collision Avoidance System |
| CAST | Commercial Aircraft Safety Team |
| CATS | Causal-Model for Air Transport System |
| CDTI | Cockpit Display of Traffic Information |
| CEAT | COE for Airport Technology |
| CFD | Computational Fluid Dynamics |
| CFR | Code of Federal Regulations |
| CGAR | COE for General Aviation Research |
| CIP | Current Icing Product |
| CLEEN | Continuous Lower Energy, Emissions, and Noise |
| CNS | Communications, Navigation and Surveilance |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| COA | Certificate of Authorization |
| COE | Center of Excellence |
| ConOps | Concept of Operations |
| CONUS | Continental United States |
| COTS | Commercial-Off-The-Shelf |
| CRC | Coordinating Research Council |
| CRDA | Cooperative Research and Development Agreement |
| CSF | Cockpit Simulation Facility |

| Acronym | Definition |
|---|---|
| CSPO | Closely Spaced Parallel Operations |
| CSPR | Closely Spaced Parallel Runways |
| CSTA | Chief Scientific and Technical Advisor |
| **D** | |
| DARWIN™ | Design Assessment of Reliability With INspection |
| DFW | Dallas-Fort Worth International Airport |
| DHS | U.S. Department of Homeland Security |
| DNL | Day Night Level |
| DoD | U.S. Department of Defense |
| DOT | U.S. Department of Transportation |
| DSA | Detect, Sense, and Avoid |
| **E** | |
| E&E | Environment and Energy |
| EA | Enterprise Architecture |
| EDR | Eddy Dissipation Rates |
| EDS | Environmental Design Space |
| EFB | Electronic Flight Bag |
| EFVS | Enhanced Flight Vision Systems |
| EMS | Environmental Management System |
| EPA | U.S. Environmental Protection Agency |
| EUROCONTROL | European Organization for the Safety of Air Navigation |
| EVS | Enhanced Vision System |
| EWG | Environmental Working Group (formerly the Environmental Integrated Product Team, or E-IPT) |
| EWIS | Electrical Wiring Interconnect Systems |
| EXCOM | Executive Committee |
| **F** | |
| F&E | Facilities and Equipment Appropriation |
| FAA | Federal Aviation Administration |
| FAR | Federal Aviation Regulation |
| FC&MS | Flight Controls and Mechanical Systems |
| FEB | FFRDC Executive Board |
| FFRDC | Federally Funded Research and Development Center |
| FICAN | Federal Interagency Committee on Aviation Noise |
| FMS | Flight Management System |
| FOC | Flight Operations Center |
| FOD | Foreign Object Debris |
| FTE | Full-Time Equivalent |
| FWD | Falling Weight Deflectometer |
| FY | Fiscal Year |
| **G** | |
| GA | General Aviation |
| GAMA | General Aviation Manufacturers Association |
| GHG | Greenhouse Gas |

| Acronym | Definition |
|---|---|
| GMU | George Mason University |
| GPS | Global Positioning Satellites/System |
| **H** | |
| HAP | Hazardous Air Pollutant |
| HEMS | Helicopter Emergency Medical Services |
| HF | Human Factors |
| HITL | Human-In-The-Loop |
| HIWC | High Ice-Water Content |
| HMA | Hot-Mix Asphalt |
| HSI | Human System Integration |
| HUD | Head-Up Display |
| HUMS | Health and Usage Monitoring System |
| **I** | |
| I&I | Integration and Implementation |
| IA | Interagency Agreement |
| ICAO | International Civil Aviation Organization |
| IFP | Instrument Flight Procedures |
| IFR | Instrument Flight Rule |
| ILS | Instrument Landing System |
| IM | Interval Management |
| IMC | Instrument Meteorological Conditions |
| IWP | Integrated Work Plan |
| **J** | |
| JAMS | Joint Center of Excellence for Advanced Materials |
| JPDO | Joint Planning and Development Office |
| JUP | Joint University Program |
| **L** | |
| LAAS | Local Area Augmentation System |
| LCGS | Low Cost Ground Surveillance System |
| LEAF | Layered Elastic Analysis - FAA |
| LED | Light Emitting Diode |
| LS-DYNA | Finite Element Code |
| **M** | |
| MASPS | Minimum Aviation System Performance Standards |
| MET | Meteorological |
| MFD | Multifunction Display |
| MITLL | Massachusetts Institute of Technology Lincoln Laboratory |
| MMPDS | Metallic Materials Properties Development and Standardization |
| MOA | Memorandum of Agreement |
| MOC | Memorandum of Cooperation |
| MOPS | Minimum Operational Performance Standards |
| MOU | Memorandum of Understanding |
| **N** | |
| NAPTF | National Airport Pavement Test Facility |

| Acronym | Definition |
|---|---|
| NARP | National Aviation Research Plan |
| NAS | National Airspace System |
| NASA | National Aeronautics and Space Administration |
| NASEA | National Airspace System Enterprise Architecture |
| NASPAC | NAS Performance Analysis Capability |
| NATCA | National Air Traffic Controllers Association |
| NAV | Navigation |
| NAWC | Naval Air Warfare Center |
| NCAR | National Center for Atmospheric Research |
| NCEP | National Centers for Environmental Prediction |
| NDI | Nondestructive Inspection |
| NEPA | National Environmental Policy Act |
| NextGen | Next Generation Air Transportation System |
| NEXTOR | National Center of Excellence for Aviation Operations Research |
| NGIP | NextGen Implementation Plan |
| NIEC | NextGen Integration & Evaluation Capability |
| NLA | New Large Aircraft |
| NMSU | New Mexico State University |
| NNEW | NextGen Network Enabled Weather |
| NOAA | U.S. National Oceanic and Atmospheric Administration |
| NOx | Nitrogen Oxide |
| NRA | NASA Research Announcement |
| NSTC | National Science and Technology Council |
| NTSB | National Transportation Safety Board |
| NWS | National Weather Service |
| **O** | |
| OEM | Original Equipment Manufacturer |
| OI | Operational Improvement |
| OMB | Office of Management and Budget |
| OMT | Outcome Management Team |
| Ops | Operations Appropriation |
| OST | Office of the Secretary of Transportation |
| OTA | Other Transaction Authority |
| OTP | Oceanic in-Trail Procedures |
| **P** | |
| PARC | Performance Based Operations Aviation Rule-Making Committee |
| PARTNER | Partnership for Air Transportation Noise and Emissions Reduction |
| PBN | Performance Based Navigation |
| PBWP | Product Based Work Plan |
| PDARS | Performance Data Analysis and Reporting System |
| PDRI | Probabilistic Design for Rotor Integrity |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| PITT | Propulsion Indications Task Team |
| PM | Particulate Matter |

| Acronym | Definition |
|---|---|
| **R** | |
| R&D | Research and Development |
| R&TD | Research and Technology Development Office |
| R,E&D | Research, Engineering and Development Appropriation |
| REDAC | Research, Engineering, and Development Advisory Committee |
| RIRP | Runway Incursion Reduction Program |
| RITE | FAA National Air Transportation COE for Research in the Intermodal Transportation Environment |
| RLV | Reusable Launch Vehicle |
| RNAV | Area Navigation |
| RNP | Required Navigation Performance |
| ROGIDS | Remote Onboard Ground Ice Detection System |
| RR | Rapid Refresh |
| RTCA | Radio Technical Commission for Aeronautics |
| RTT | Research Transition Team |
| RWI | Reduce Weather Impact |
| RWSL | Runway Status Light |
| **S** | |
| SAA | See and Avoid |
| SAAAR | Special Aircraft and Air Crew Authorization Required |
| SAE | Society of Automotive Engineers |
| SAS | Subcommittee on Aircraft Safety |
| SATCOM | Satellite Communications |
| SC | Special Committee |
| SCPI | System Capacity, Planning and Improvement |
| SDS | Software and Digital Systems |
| SESAR | Single European Sky Air Traffic Management Research |
| SG | Strategic Guidance |
| SIMMOD | FAA's Airspace and Airport Simulation Model |
| SLD | Supercooled Large Droplet |
| SMS | Safety Management System |
| SNT | Staffed NextGen Towers |
| SVS | Synthetic Vision System |
| SWA | Southwest Airlines |
| SWIM | System Wide-Information Management |
| **T** | |
| TAF | Terminal Area Forecast |
| TALPA | Takeoff and Landing Performance Assessment |
| TAS | Terminal Area Safety |
| TBO | Trajectory-Based Operation |
| TCAS | Traffic Alert and Collision Avoidance System |
| TCRG | Technical Community Representative Group |
| TERPS | Terminal Instrumentation Procedures |
| TF | Task Force |

| Acronym | Definition |
|---|---|
| TFM | Traffic Flow Management |
| TGF | Target Generator Facility |
| THERMAKIN | FAA Thermal-Kinetic Burning Model |
| TMA | Traffic Management Advisor |
| TO | Technical Operations |
| TOps | Trajectory Operations |
| TRACON | Terminal Radar Approach Control |
| TSO | Technical Standard Order |
| **U** | |
| UAS | Unmanned Aerial Systems |
| UAS | Unmanned Aircraft System |
| UEDDAM | Uncontained Engine Debris Damage Assessment Model |
| UI | User Interface |
| U.S. | United States |
| USAF | U.S. Air Force |
| **V** | |
| VFR | Visual Flight Rules |
| Vision 100 | Vision 100–Century of Aviation Reauthorization Act of 2003 |
| VLJ | Very Light Jet |
| VOC | Volatile Organic Compound |
| **W** | |
| WAAS | Wide Area Augmentation System |
| WG | Working Group |
| WJHTC | William J. Hughes Technical Center |
| WRF | Weather Research and Forecast |
| S&WRR | Surveillance and Weather Radar Replacement |
| WTIC | Weather Technology in the Cockpit |
| WTMSR | Wake Turbulence Mitigation for Single Runway |