Federal Aviation Administration

NARP

2012 National Aviation Research Plan

March 2012

2012 NARP
March 2012

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

Table Of Contents

Executive Summary

Aviation is a vital resource for the United States. It provides opportunities for business, job creation, 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 and 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 research and development (R&D) investments are well managed, deliver results, and sufficiently 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. The NARP uses R&D goals and performance targets to bridge the strategic visions laid out in the former *Flight Plan* and the new *Destination 2025*[1] to the 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 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 remain ambitious, and they challenge and encourage researchers to innovate, take risks, and seek non-traditional solutions.

This year, the NARP begins shifting the alignment of FAA R&D goals and corresponding performance targets from the former *Flight Plan,* to the strategic goals, outcomes, and performance metrics set forth in *Destination 2025.* Alignment of the FAA's R&D strategies to *Destination 2025* is expected to be completed next year in 2013.

In fiscal year (FY) 2013, the FAA plans to invest a total of $323,188,000 in R&D. The R&D investment spans multiple appropriations for the FAA, including $180,000,000 in Research, Engineering and Development (RE&D); $97,888,000 in Facilities and Equipment (F&E); $44,300,000 in the Airport Improvement Program (AIP); and $1,000,000 in Operations (Ops).

[1] Effective August 25, 2011, *Destination 2025* replaced the *Flight Plan* as the FAA's strategic plan.

Preface

Section 44501(c) of Title 49 of the United States Code (49 U.S.C. § 44501(c)) requires the Administrator of the FAA to submit the NARP to Congress annually with the President's Budget. The NARP includes both applied research and development as defined by the Office of Management and Budget (OMB) Circular A-11[2] and involves 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, to include aircraft safety, airports, commercial space transportation, environment and energy, and human factors. The NARP shows how these research elements work together and support the near-, mid-, and far-term research needs of the aviation community. The NARP defines ten R&D goals with performance targets and interim milestones, creating a multi-year plan that integrates program efforts and measures progress toward achieving these goals. In previous years, the NARP illustrated the alignment of 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*[3]. For 2012, the NARP will begin transitioning the alignment of the FAA's R&D portfolio goals from the *Flight Plan* to the new long-term vision recently set forth by the FAA Administrator in *Destination 2025*.

The 2012 NARP shows how the FAA R&D programs are achieving milestones that originally appeared in the 2006 NARP. Progress of research in 2011 is described and shows how the FAA R&D programs are progressing toward achieving 2016 R&D targets.

Chapter 1 provides an overview of the National Airspace System (NAS) mission, vision, and goals used to define the FAA's 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.

Chapter 2 maps the R&D programs planned for FY 2013 to the current FAA R&D goals. It provides a description of each R&D target, method of validation, and funding requirements for each R&D goal. Milestones for each program are identified and provide measures of interim progress toward achieving the R&D target. In addition, significant progress items achieved in 2011 are presented for each R&D goal.

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 research are a subset of the R&D portfolio and budget.

Chapter 4 provides a summary of each R&D program; 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 FY 2013.

Appendices are included in a separate volume from the main body of the 2012 NARP.

Appendix A provides a detailed description and justification for each R&D program, including the requested budget, planned activities and accomplishments, and criteria for success.

---

[2] OMB Circular A-11, *"Preparation, Submission and Execution of the Budget,"* August 18, 2011, section 84, pages 11-12 (www.whitehouse.gov/OMB/circulars).

[3] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 12, 2004 (www.jpdo.gov).

Appendix B provides detailed information on FAA partnerships with government, academic, and industry organizations. It lists information for FY 2011, 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, listed according to the reports produced by the committee in FY 2011. The FAA response to each recommendation is included. This appendix supports the evaluation section of Chapter 4.

Appendix D reports the status of all milestones in Chapter 2 of the 2012 NARP. To ensure complete transparency and to maintain continuity with previous editions of the NARP, this appendix notes any changes in the milestones aligned with the ten R&D goals.

Appendix E provides a list of acronyms and abbreviations used in the 2012 NARP appendices.

The *R&D Annual Review* is a NARP companion document which is also prepared by the FAA to submit to Congress with the President's Budget Request pursuant to 49 U.S.C. § 44501(c)(3). The *R&D Annual Review* describes research completed during FY 2011, 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

National Airspace System

Aviation is a vital resource for the United States (U.S.) because of its strategic, economic, and social importance. The aviation industry provides opportunities for business, job creation, 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 U.S. must not only maintain, but also continue to improve upon the NAS so that it remains responsive to 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 U.S. 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 facilitates the movement of 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, and hot air balloons); infrastructure (e.g., airports and airfields, air traffic management systems, and space launch and re-entry sites); and people (e.g., aircrews, air traffic controllers, system technicians, and ground personnel). Because the role and interaction of these elements determine the nature and performance of the system, it is important to consider all elements simultaneously in system design, development, and operation.

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 plays a significant role by paying taxes and fees that contribute to regulation of the aviation industry; support the development, maintenance, and operation of the air traffic management system; and provide for 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."[4]

---

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

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.

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

NextGen Mandate

Enacted in 2003 under Vision 100 – Century of Aviation Reauthorization Act[5], the Next Generation Air Transportation System (NextGen) is the ongoing transformation of the NAS to advance growth and increase safety while reducing aviation's environmental impact. It represents an evolution from a ground-based system of air traffic control to a satellite-based system of air traffic management. This transformation is being realized through the development of aviation-specific applications for existing, widely-used technologies, such as the Global Positioning System, and technological innovation in areas such as weather forecasting, data networking, and digital communications. In conjunction with innovative technologies is new airport infrastructure and new procedures, including the shift of certain decision-making responsibility from the ground to the cockpit[6].

To oversee planning and manage the partnerships designed to bring NextGen online, Congress created the Joint Planning and Development Office (JPDO). The JPDO is comprised of representatives from DoD, DOT, DHS, DOC, FAA, NASA, OSTP, as well as members from private-sector organizations and academia[7].

Planning Documents

The national goals challenge 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 has aligned its existing plans to achieve a balance between near-term goals and NextGen by working with other agencies to plan and refine the far-term goals for NextGen. This section explains how the FAA and JPDO plans and goals are connected and how the

---

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

[6] http://www.faa.gov/nextgen/

[7] http://www.jpdo.gov/

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.

Destination 2025

On August 25, 2011, *Destination 2025* replaced the *Flight Plan* as the FAA's strategic plan. *Destination 2025* provides a long-term strategic vision for the FAA, outlined across five key goal areas, capturing the anticipated transformation for the future of the NAS. While the document establishes a firm benchmark for the FAA to achieve NextGen related goals by 2025, it also sets clear performance metrics until 2018 and uses this date as an accessible midpoint for evaluating progress toward arriving at the longer-term 2025 destinations. The goals in *Destination 2025* are:

- Move to the Next Level of Safety
- Create Our Workplace of the Future
- Deliver Aviation Access through Innovation
- Sustain Our Future
- Advance Global Collaboration

For more information, see http://www.faa.gov/about/plans_reports/media/Destination2025.pdf.

Joint Planning and Development Office Plans

The JPDO supports the Office of the Secretary of Transportation and reports to its Senior Policy Committee, chaired by the Secretary of Transportation. 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* and *NextGen Integrated Work Plan*. The JPDO plans address the efforts of all NextGen participants, including the FAA, in the far-term. For more information, see http://www.jpdo.gov/.

FAA Enterprise Architecture

The FAA Enterprise Architecture (EA) has three components: NAS Regulatory EA, Non-NAS EA, and NAS EA. The NAS Regulatory EA includes systems and operational changes for NAS policy, certification, environment regulation, and safety management. The Non-NAS EA includes IT investments and operational changes for agency business processes such as strategic and financial planning. The NAS EA contains systems and operational changes for the command and control of the NAS. The NAS EA provides a set of technical roadmaps describing how the current NAS will transition to NextGen, including the near-, mid-, and far-term target architectures and the transition strategies to achieve these architectures. It contains milestones for planning purposes but it is not used as a tool for managing NextGen implementation. For more information on the NAS EA, see https://nasea.faa.gov/.

NAS Capital Investment Plan

The FAA *NAS Capital Investment Plan for Fiscal Years 2013-2017* (CIP) describes the planned investments in the NAS over the next five years for each budget line item in the facilities and equipment (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. However, the CIP includes only FAA F&E programs, whereas the NARP addresses the entire FAA R&D portfolio. Both documents present the F&E-funded programs in the FAA R&D portfolio. The CIP addresses all near- and mid-term FAA programs funded by the F&E appropriation, ties directly to *Destination 2025* goals and outcomes, identifies the NextGen investments funded by the F&E appropriation, and provides the NAS EA roadmaps. The CIP also supports the NAS modernization effort depicted in the NAS EA. For more information, see http://go.usa.gov/aXa/.

NextGen Implementation Plan

The *NextGen Implementation Plan* (NGIP) is the FAA's primary outreach document for updating the aviation community, Congress, the flying public, and other NextGen stakeholders on progress, while providing a summary overview of plans for the future. The NGIP, particularly the appendices, provides operators and airports with necessary information for NextGen deployments. The NGIP further offers partners in the international aviation community a summary of planning timelines in support of the agency's global harmonization efforts. The NGIP, which is updated annually, draws upon and informs a number of FAA planning documents, including the NAS EA, CIP, and *Destination 2025*. Chapter 3 of the NARP provides a summary of the NGIP and the seven solutions contained therein. For more information, see http://www.faa.gov/nextgen/.

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 *Destination 2025*, the NGIP, and the *NextGen Integrated Plan*. 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, human factors, and wake turbulence. For more information, see http://www.faa.gov/go/narp/.

Research and Development

The FAA uses R&D to support policy and planning, regulation, certification, standards development, and modernization of the NAS. It conducts applied research and development as defined by the Office of Management and Budget (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.[8]

Mission

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

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 and development.

[8] OMB Circular A-11, *Preparation, Submission and Execution of the Budget*, August 18, 2011, section 84, pages 11-12 (www.whitehouse.gov/OMB/circulars).

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 create 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 its R&D resources to help achieve the national vision of a transformed aviation system.

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 how the goals and performance targets of the *Flight Plan* and *NextGen Integrated Plan* connect and how the strengths of the FAA R&D portfolio might help achieve the goals of these two plans. Since *Destination 2025* has replaced the *Flight Plan* as the FAA's strategic plan, the R&D goals and performance targets will be re-examined to support the transformation of the Nation's aviation system by 2025. Updated R&D goals and performance targets that are fully aligned with the performance metrics of *Destination 2025* will appear in the 2013 NARP.

The FAA R&D portfolio can help transform the system by aiming for ideal future-state performance rather than by focusing on incremental improvements to current capabilities that may not achieve NextGen. The R&D goals challenge researcher sponsors and performers 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 former *Flight Plan* goals, *Destination 2025* goals, FAA R&D goals, and the far-term goals identified in the *NextGen Integrated Plan.* Each FAA R&D goal aligns with a *Destination 2025* goal.

Table 1.1: Alignment of Goals

Former *Flight Plan* Goals	***Destination 2025* Goals**	***NextGen Integrated Plan* Goals**	**FAA R&D Goals**
• Greater Capacity	• Deliver Aviation Access through Innovation	• Expand Capacity	• Fast, Flexible, and Efficient
	• Sustain Our Future	• Protect the Environment	• Clean and Quiet
• Increased Safety	• Move to the Next Level of Safety	• Ensure Safety	• Human-Centered Design • Human Protection • Safe Aerospace Vehicles • Separation Assurance • Situational Awareness • System Knowledge
--	--	• Secure the Nation • Ensure our National Defense	--
• International Leadership	• Advance Global Collaboration	• Retain U.S. Leadership in Global Aviation	• World Leadership
• Organizational Excellence	• Create Our Workplace of the Future	--	• High Quality Teams and Individuals

Chapter Two

Research and

The research and development (R&D) goals help the FAA align, plan, and evaluate its R&D portfolio. This chapter maps the R&D programs in FY 2013 to the current FAA R&D goals. It defines each R&D goal, identifies the corresponding R&D target, describes the method of validation, and identifies the funding requirements for each R&D goal. Milestones of each program are presented by R&D goal and significant progress achieved in 2011 is highlighted.

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 R&D targets are qualitative in nature and derived from guidance set forth in the Joint Planning and Development Office's (JPDO) *Next Generation Air Transportation System (NextGen) Integrated Plan, NextGen Implementation Plan,* and *Destination 2025*.

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 and a description of the methods (e.g., modeling, simulation, demonstration, initial standards) that will be used to validate the target. Financial tables are presented for each R&D goal that show the current enacted year (FY 2012) and request year (FY 2013) funding requirements for each program. This is followed by some of the milestones needed to reach the R&D goals. Most of the milestones represent detailed steps toward achieving each R&D target and are annotated with checkmarks if completed. Following the milestones are progress items that describe the significant results achieved in 2011 towards achieving each R&D goal.

The status of each of these milestones in this chapter is listed in Appendix D. The appendix notes any changes in the milestones from last year to provide the reader complete transparency and maintain continuity with previous editions of the NARP.

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 is to identify clear responsibilities so that each program focuses on a specific, limited number of R&D goals.

Table 2.1: Map of R&D Programs in 2013 to R&D Goals

Shaded boxes indicate program funding supports the R&D Goal.

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			
Aircraft Catastrophic Failure Prevention Research	A11.f			
Aircraft Icing/Digital System Safety	A11.d			
Airport Cooperative Research Program - Capacity	--			
Airport Cooperative Research Program - Environment	--			
Airport Cooperative Research Program - Safety	--			
Airport Technology Research Program - Capacity	--			
Airport Technology Research Program - Environment	--			
Airport Technology Research Program - Safety	--			
Airspace Management Program	1A01D			
Center for Advanced Aviation System Development (CAASD)	4A08A			
Commercial Space Transportation Safety	--			
Continued Airworthiness	A11.e			
Environment and Energy	A13.a			
Fire Research and Safety	A11.a			
Flightdeck/Maintenance/System Integration Human Factors	A11.g			Coordinate
Joint Planning and Development Office (JPDO)	A12.a		Coordinate	Coordinate
NextGen - Air Ground Integration Human Factors	A12.c			
NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	1A08A			
NextGen - Alternative Fuels for General Aviation	A11.m			
NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	1A08E			
NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	A13.b			
NextGen - New Air Traffic Management Requirements	1A08B			
NextGen - Operational Assessments	1A08H		Coordinate	
NextGen - Operations Concept Validation - Validation Modeling	1A08C			
NextGen - Self-Separation Human Factors	A12.d			
NextGen - Staffed NextGen Towers	1A08D			
NextGen - System Safety Management Transformation	1A08G			
NextGen - Wake Turbulence	A12.b			
NextGen - Wake Turbulence - Re-categorization	1A08F			
NextGen - Weather Technology in the Cockpit	A12.e			
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			
William J. Hughes Technical Center Laboratory Facility	A14.b			

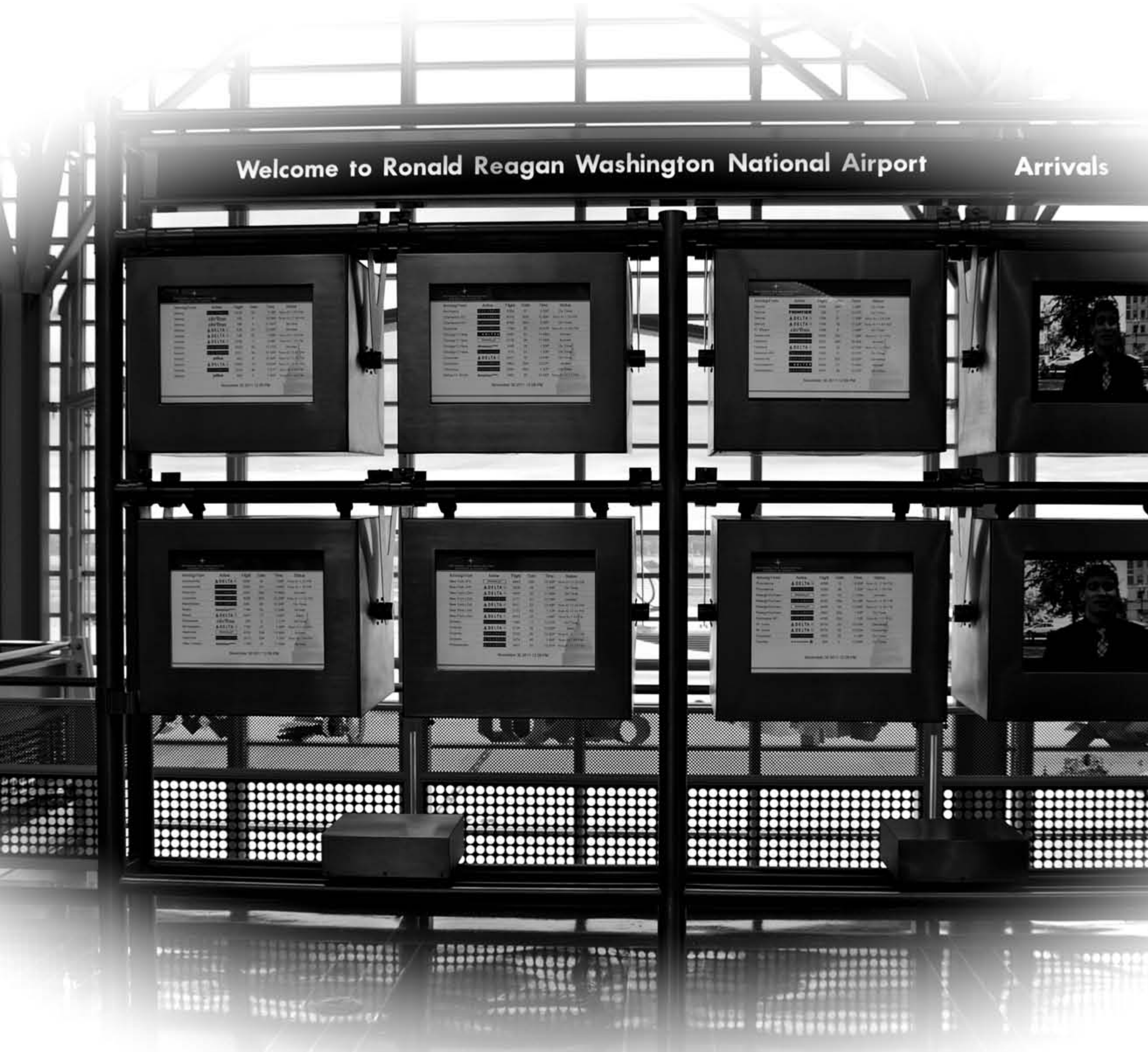
Table 2.1 (continued)

Goal 4 Human-Centered Design	Goal 5 Human Protection	Goal 6 Safe Aerospace Vehicles	Goal 7 Separation Assurance	Goal 8 Situational Awareness	Goal 9 System Knowledge	Goal 10 World Leadership	
	Coordinate						A11.c
					Coordinate		A11.j
Coordinate			Coordinate	Coordinate			A11.i
							A11.f
							A11.d
							--
						Coordinate	--
				Coordinate			--
							--
							--
							--
							1A01D
							4A08A
	Coordinate			Coordinate			--
							A11.e
						Coordinate	A13.a
						Coordinate	A11.a
			Coordinate	Coordinate			A11.g
Coordinate			Coordinate	Coordinate			A12.a
							A12.c
Coordinate						Coordinate	1A08A
							A11.m
							1A08E
						Coordinate	A13.b
				Coordinate		Coordinate	1A08B
							1A08H
							1A08C
						Coordinate	A12.d
							1A08D
						Coordinate	1A08G
						Coordinate	A12.b
Coordinate			Coordinate			Coordinate	1A08F
Coordinate						Coordinate	A12.e
							1A01C
							A11.b
							1A01A
							1A01B
							A14.a
Coordinate							A11.h
							A11.l
Coordinate							A11.k
							A14.b

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

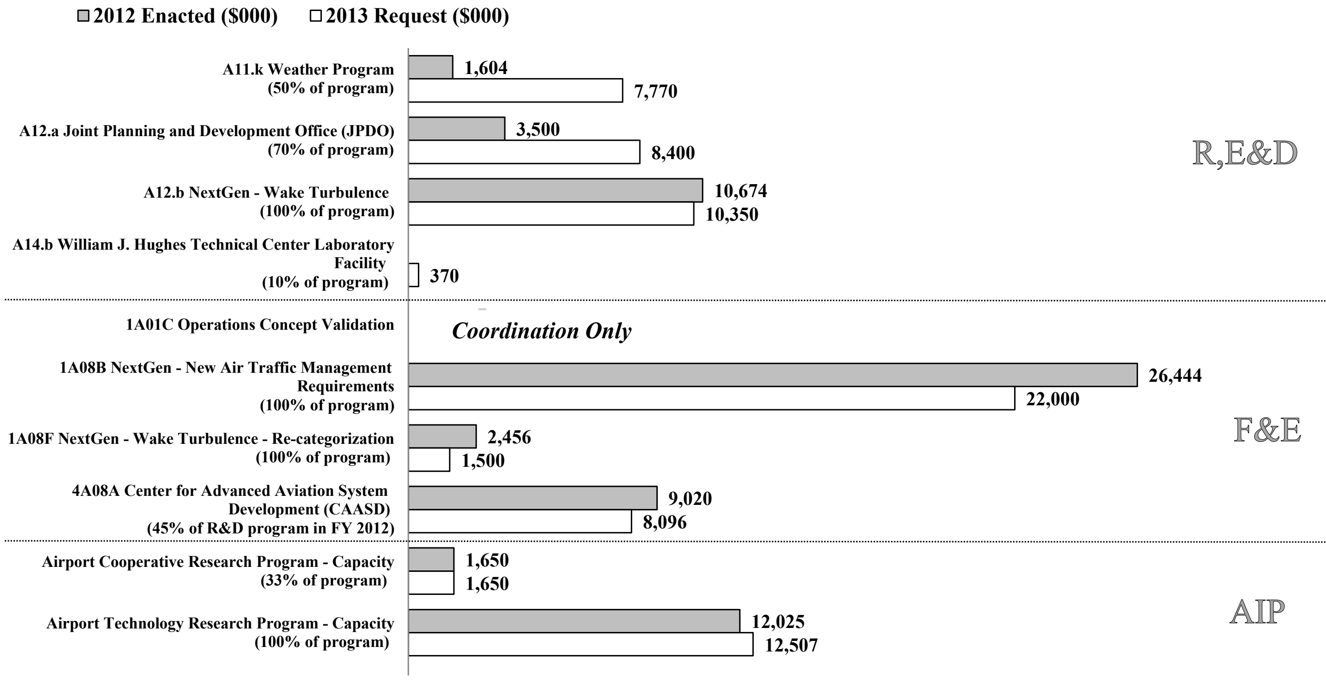
By 2016, demonstrate that the modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.

Method of Validation[9]

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



[9] 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 and is purposely aggressive, as R&D goals should be stretch goals.

Milestones

NextGen Demonstrations

Develop and demonstrate NextGen technologies and concepts.

Demonstrate Super-Density Operations. (NextGen Demonstrations and Infrastructure Development[10])

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.

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.

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

Airport Capacity

Increase airport capacity while reducing costs.

2008: Increase airport capacity. (Airport Cooperative Research Program - Capacity)

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

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

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

2015: Together with the European Organisation for the Safety of Air Navigation, deliver a more capacity-efficient set of wake separation standards to the International Civil Aviation Organization (Leader-Follower Pair-Wise Static). (NextGen - Wake Turbulence - Re-categorization)

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)

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)

---

[10] 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 (and pilot as needed) situational aircraft separation display concepts required for implementation of the NextGen Trajectory-Based Operation and High Density concepts. (NextGen - Wake Turbulence)

✓ **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 Trajectory-Based Operation and High Density concepts within the constraints of aircraft-generated wake vortices and aircraft collision risk. (NextGen - Wake Turbulence – Re-categorization)

2016: Develop the algorithms that will be used in the Air Navigation Service Provider (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.

✓ **2010**: Develop 0-8 hour advanced storm prediction algorithm. (Weather Program)

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

✓ **2011**: Demonstrate 0-8 hour advanced storm prediction algorithm. (Weather Program)

2012: Establish and justify quantitative requirements for terminal-area wind diagnosis and forecast capabilities to improve benefits from four-dimensional Trajectory Based Operations. (NextGen - Weather Technology in the Cockpit)

2013: Expand wind studies to more comprehensive environments and procedures, and more comprehensive assessment of benefits versus wind modeling error and evaluate weather prediction technology relative to wind modeling accuracy. (NextGen - Weather Technology in the Cockpit)

✓ **2013**: Transition 0-8 hour advanced storm prediction algorithm for implementation. (Weather Program)

2014: Transition in-flight icing Alaska forecast and analysis capability for implementation. (Weather Program)

2015: Provide accurate and timely wind information to the Flight Management System and Air Traffic Control systems, and demonstrate Trajectory-Based Operation benefits. (NextGen - Weather Technology in the Cockpit)

Progress in FY 2011: Fast, Flexible, and Efficient

Airport Airfield Capacity Analyses: Airport capacity is a critical evaluation component of most airport planning projects. With the many current and evolving factors and limitations that influence capacity at a given airport, capacity modeling tools and techniques are needed to assist airport operators and planners in making timely and cost-effective critical project funding decisions. In response to this need, the Airport Cooperative Research Program (ACRP) - Capacity developed a guidebook to assist the aviation industry with airfield and airspace capacity evaluation. The guidebook addresses airport airfield and airspace capacity planning at all types of airports. The guidebook includes an assessment of relevant methods and modeling techniques for evaluating existing and future capacity for airports beyond those outlined in the current FAA Advisory Circular 150/5060-5 Airport Capacity and Delay or the Airport Capacity Model. The guidebook also identifies the limitations of the existing techniques and presents capacity modeling guidelines that will improve the decision-making process for determining the appropriate level of modeling sophistication for a given planning study or capital improvement project and make the process more consistent from airport to airport. (Airport Cooperative Research Program)

Determination of an Initial Set of Optimal Aircraft Flight Characteristics and Weather Parameters for Use In Setting Wake Separation Minima: Aircraft flight characteristics (aircraft weight, aircraft type, trajectory, etc.) and weather observed by the aircraft (wind and its direction, turbulence of the atmosphere, humidity, temperature, etc.) are vital information elements for many future NextGen-era air traffic control (ATC) and management applications needed for efficient and safe use of constrained airspace and airport runways. Safe reduction of required wake vortex separations between aircraft is one application that promises significant enhancement to airspace and airport capacity. Determining the optimal parameters involved defining the parameters, prioritizing them in terms of benefit derived in enhanced capacity and safety, determining transmission rates and precision and gaining agreement among the FAA and the MITRE Corporation's Center for Advanced Aviation System Development (CAASD)-led Radio Technical Commission for Aeronautics (RTCA) Special Committee 206, Work Group 1 government and industry participants. If Work Group 1's foundational recommendations on aircraft and weather parameters are adopted and developed by RTCA, aircraft and avionics manufacturers will have defined requirements for linking the aircraft information elements needed for the NextGen era into aircraft data link broadcast messages. (NextGen - Wake Turbulence - Re-categorization)

Determination of Wake Separation Minima for Use with Boeing 747-8 Aircraft: A part of the services provided by FAA air traffic control is ensuring that aircraft are sufficiently separated from each other to minimize the risk of an aircraft encountering strong wake turbulence generated by the aircraft ahead. Wake separation minima for the B747-8 aircraft were developed prior to the aircraft's entry into service and permitted safe but smaller separation than established in the interim guidance for this aircraft prior to this evaluation. This work was accomplished by a work group comprised of the FAA Flight Standards Service, Boeing Company, FAA Air Traffic Organization, European Organisation for the Safety of Air Navigation (EUROCONTROL), Volpe National Transportation Systems Center, and European Aviation Safety Agency, among others. A similar effort to set the Boeing 787 Aircraft wake separation minima was completed earlier in 2011. This work benefits both the aircraft manufacturer and the world's Air Navigation Service Providers (ANSPs). For the ANSP they are minima that ensure safety but are not overly conservative to interfere with the efficient use of an airport's runways. For the manufacturer, the minimum safe wake separations prescribed for its new aircraft allow the aircraft to be viewed favorably by its potential customers. The smaller the required separations, the more desirable the aircraft becomes in terms of its impact on airport arrival and departure operations. This work also supports R&D Goal 10 – World Leadership. (NextGen – Wake Turbulence – Re-categorization)

Refinement of the Boundaries of the Proposed Six Weight Categories for the NAS: The last review of wake separation standards used by air traffic control occurred nearly 20 years ago, in the early 1990's. These current wake separation minima are safe but are outdated due to the dramatic change in the aircraft fleet mix at major airports, major advances in knowledge of aircraft wake transport and decay, and the development of air traffic control decision support tools that enable application of more capacity efficient wake separation processes. In 2010, a FAA/EUROCONTROL workgroup provided the International Civil Aviation Organization (ICAO) with a recommendation for replacing the current standards with one made up of six categories for wake separation minima. In 2011, the FAA/EUROCONTROL work group met with the ICAO Study Group tasked with the review of the six category wake standard recommendation, clarified and enhanced the recommendation's benefit and safety documentation as requested by the ICAO Study Group, and further refined the types of aircraft assigned to each of the six wake categories. Assessments have shown that the adoption of the six category recommendation will yield an average of 7% increase in the number of landings and take-offs that can be supported at U.S. capacity-constrained airports and a 3% to 4% capacity increase at Europe's capacity-constrained airports. This work also supports R&D Goal 10 – World Leadership. (NextGen - Wake Turbulence - Re-categorization)

0-8 Hour Advanced Storm Prediction Algorithm Demonstration and Evaluation: The FAA is developing an advanced storm prediction algorithm specifically designed to minimize flight delays caused by convective weather (i.e., thunderstorms). Reducing weather delays is a key element to achieving the Flight Plan Goal of Greater Capacity as well as NextGen Weather Operational Improvements (OIs). In FY 2010, a prototype 0-8 hour advanced storm prediction algorithm was first demonstrated in real-time to Air Traffic Management (ATM) users as part of an operational evaluation. The results of this evaluation, which were released in early FY 2011, showed that user opinions were favorable regarding the use of the algorithm's forecasts for strategic Traffic Flow Management planning. In addition, the benefits analysis showed that the algorithm's forecasts were incorporated in Playbook Routing, Airspace Flow Program planning, and improved situational awareness, yielding an estimated annual benefit of 10,000 hours of delay avoided with a cost savings of $26.8M.
The algorithm also performed well meteorologically – it outperformed the legacy capabilities in key areas and added detail to the lower resolution forecasts currently being used. In FY 2011, changes to improve the meteorological performance were incorporated into the 0-8 hour advanced storm prediction algorithm in response to user comments and the objective performance assessment from 2010. The improved prototype was demonstrated to ATM users for a second season, beginning June 2011, as part of a supplemental user evaluation. User feedback was gathered and the final report was completed in 2011. Future Convective Weather capabilities by FY 2016 will include probabilistic forecasts of convective hazards over the Continental United States (CONUS) and oceanic domains. (Weather Program)

R&D Goal 2

Clean and Quiet

A reduction of significant aerospace environmental impacts in absolute terms

R&D Target

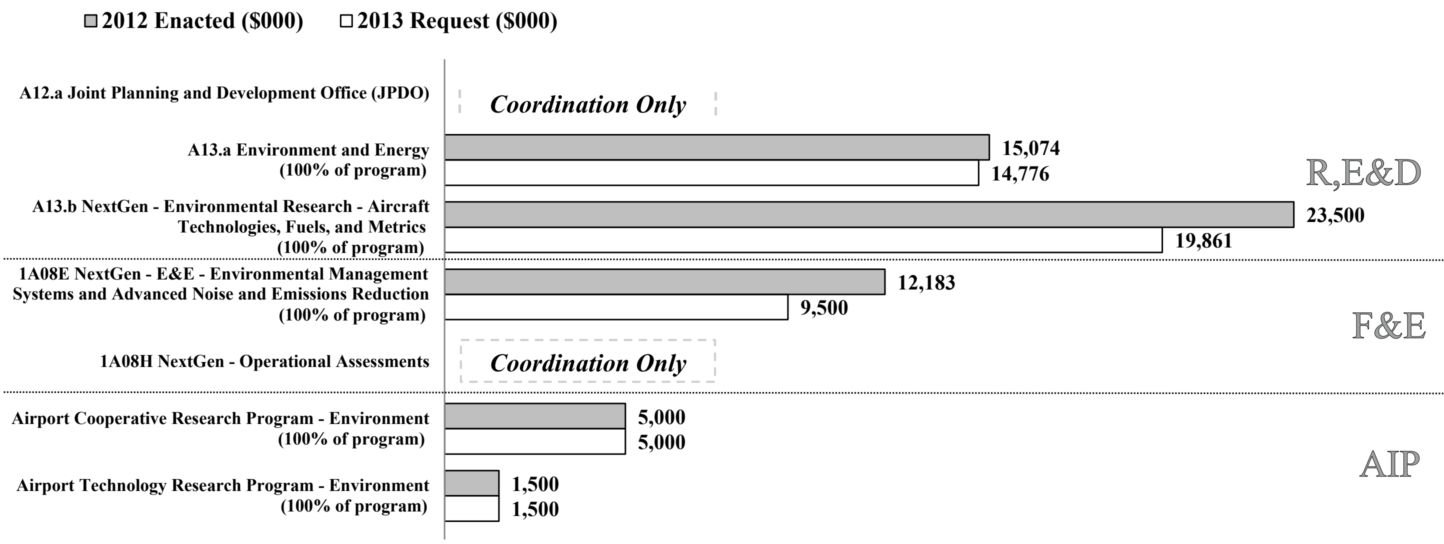
By 2016, demonstrate[11] that significant aviation noise and emissions impacts can be reduced in absolute terms (despite growth) in a cost-beneficial way, make progress toward achieving carbon neutral growth by 2020 from a 2005 baseline, and reduce uncertainties in particulate matter and non-carbon dioxide (CO_2) 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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



[11] 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.

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 Program - Environment)

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

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

2012: Initiate a project to study aircraft noise annoyance data and sleep disturbance around airports. (Airport Technology Research Program – Environment)

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

Threshold Levels

Determine acceptable levels of noise and emissions.

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

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

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

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

2011: Investigate feasibility of metrics for new aircraft standards for CO2 emissions. (Environment and Energy)

2013: Examine the suitability of aircraft noise and emissions metrics to establish environmental standards. (Environment and Energy)

Prediction

Develop models to predict the impact and benefits of changes.

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

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

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

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

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

2013: Refine the estimates of aircraft contribution to climate change. (Environment and Energy,

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

2013: Refine estimates of aircraft emitted particulate matter on climate, air quality and human health. (Environment and Energy, NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics)

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

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)

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

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

2013: Identify and pursue the development of a 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: 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: 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 Program - Environment)

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

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 the environmental benefits of the first round of Continuous Lower Energy, Emissions, and Noise 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 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 Environmental Management System performance tracking. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction)

Progress in FY 2011: Clean and Quiet

Guidebook on Preparing Airport Greenhouse Gas Emission Inventories: While approaches for computing noise and local air quality at the airport level are generally well established, there is no specific guidance or generally applied practice for computing airport-level greenhouse gas (GHG) emission inventories. Under international treaties, GHGs are addressed at a national or state level. However, in responding to local political concerns, cities and counties across the country are beginning to attempt to quantify the contribution of sources within their boundaries to local and regional GHG emissions without a basic common understanding and source of reference material. The wide variance in levels of the estimated local aviation contributions is most likely a result of the methodology used to quantify and compare emissions rather than actual level or variance in the type of activities. There is a growing need to provide airport operators with clear and cohesive information on the national inventory of airport-level GHG emissions. Given the rising level of interest regarding aviation's contribution to GHG emissions and ultimately to climate change, it is imperative that airports have the most up-to-date information necessary to address potential concerns. In response to this need, the ACRP – Environment has developed a guidebook that can be used to prepare airport source-specific inventories of GHG emissions. The guidebook provides methods to calculate airport GHG emissions inventories in a consistent manner and information on considerations that should be taken into account when scoping and preparing such inventories. This guidebook focuses on the following six GHG emissions that are widely recognized as relevant and quantifiable: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluoro compounds, and perfluorocarbons. (Airport Cooperative Research Program)

Reduction in Particulate Matter Emissions: FAA and the National Aeronautics and Space Administration (NASA) completed measurements of aircraft exhaust emissions from the combustion of renewable alternative fuels for existing aircraft engines. Emission measurements on the combustion of 50/50 blends and 100% renewable fuels showed significant reductions in particulate matter emissions. (Environment and Energy)

Addition of Alternative Bio-Derived Oil-based Jet Fuels: On July 1, 2011, the aviation community reached a major milestone when the American Society for Testing and Materials International approved a revision of the D7566 specification to add alternative jet fuels made from bio-derived oils. Known as HEFA (hydroprocessed esters and fatty acids) jet fuels, they can be made from renewable plant oils such as camelina, jatropha, and algae or waste fats which are then mixed with petroleum jet fuel up to a 50% blend level. This represents the culmination of more than three years of collaborative work by the FAA, Department of Defense (DoD), and industry, including the engine and aircraft manufacturers, airlines, and fuel suppliers. The approval assures the safety and performance of the fuel and is enabling, for the first time, the commercial use of biofuel by airlines globally. (NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics)

Development and Deployment of Sustainable Alternative Fuels: In partnership with industry, the FAA completed significant milestones towards developing and deploying sustainable alternatives fuels. Boeing completed a study on how alternative jet fuel affects rubber seals in aircraft fuel systems, and Honeywell demonstrated a jet biofuel blend that will not clog fuel systems at cold temperatures. Rolls-Royce completed laboratory testing of future jet biofuels under development by nine fuel companies. In partnership with the United States Department of Agriculture, the FAA developed a Feedstock Readiness Level Tool to assess the development and availability of various feedstock needed by biorefineries to produce jet biofuels. (NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics)

Operational Benefits of Surface Movement Optimization Strategies: The FAA conducted a field study at Boston Logan airport to evaluate the operational benefits of surface movement optimization strategies that reduce congestion while improving the environmental performance. The Massachusetts Institute of Technology research team targeted taxiing-out delays and improved surface operational efficiency by controlling the aircraft pushback rate at the gate. This field study showed an average reduction in gate-hold time of 4.3 minutes per aircraft pushback, resulting in a savings of 16-20 gallons of fuel burn per operation. This estimated fuel savings is roughly equal to the fuel savings from Continuous Descent Approach (which is now commonly known as Optimized Profile Descent) – an operational procedure which is widely used worldwide and was pioneered by the FAA. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emission Reduction)

Continuous Lower Energy, Emissions and Noise Program: In partnership with industry, the FAA focused the Continuous Lower Energy, Emissions and Noise (CLEEN) program on accelerating development of aircraft technologies that reduce noise, emissions, and fuel burn that will lead to commercial products beginning in 2015. Boeing completed wind tunnel tests of advanced wings and component tests of advanced, light-weight materials used for aircraft engines. General Electric (GE) continues to make progress on advanced engine combustors, demonstrating a 60% reduction in nitrogen oxide emissions and meeting a key CLEEN goal. This combustor will be used in CFM International's LEAP-X turbofan engine as parts of Boeing's re-engine 737 aircraft. GE has also conducted Open Rotor engine wind tunnel tests, demonstrating improved aerodynamic and noise performance. Rolls-Royce completed component tests of advanced, light-weight engine materials, demonstrating a reduction in weight and increase in engine fuel efficiency. (NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics)

NextGen Environmental Management System: Sustaining unconstrained future aviation growth implies that aviation stakeholders address environmental sustainability in their planning and operation. Therefore, the FAA is developing an Environmental Management System (EMS), which is a strategic framework to proactively manage the long-term environmental issues associated with NextGen. The EMS approach aims to maximize environmental benefits while ensuring efficient compliance with regulatory requirements. This year, work was performed on all three main components of the EMS framework development: approaches, outreach and communication, and data management and decision support. In particular, Phase I pilot studies were completed at Denver International Airport and Dallas-Fort Worth International Airport (DFW) and communication was initiated with a range of stakeholders (e.g., manufacturers, airport operators, air transport association, etc.). This year, the first EMS Forum was convened to strategize EMS development and implementation, identify best practices, and overcome challenges through interaction with stakeholders. (NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emission Reduction)

R&D Goal 3

High Quality Teams and Individuals

The best qualified and trained workforce in the world

R&D Target

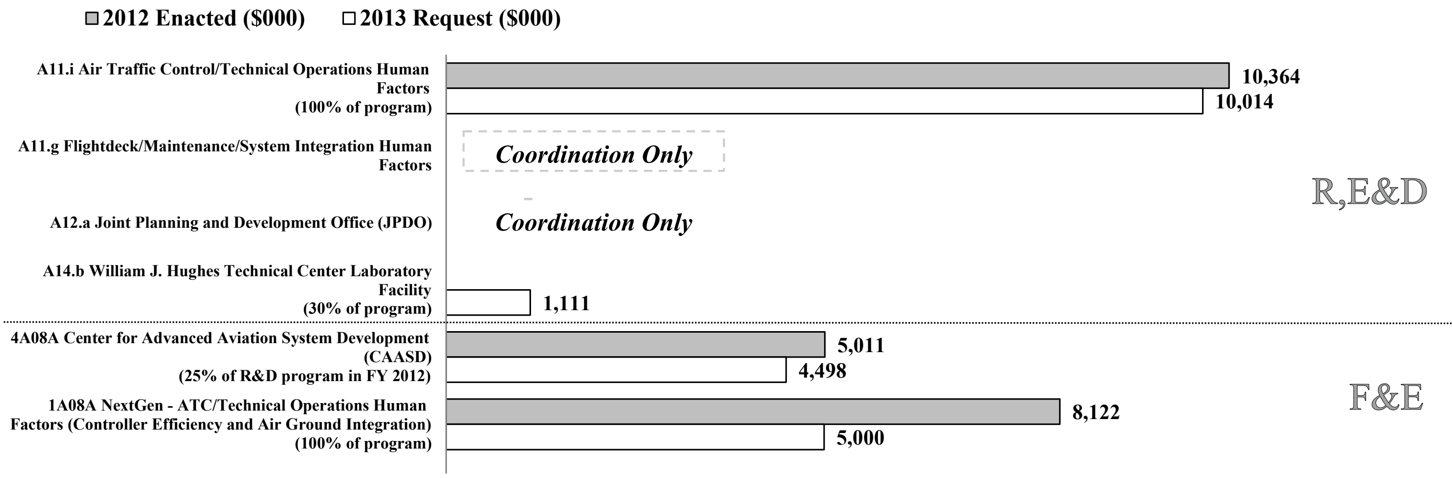
By 2016, demonstrate improvement in Air Navigation Service Provider efficiency (e.g., greater number of aircraft) and effectiveness (e.g., improvement of safety metrics) through automation and standardization of operations, procedures, and information.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



Milestones

Increase to 130 Percent[12]

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

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

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

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))

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))

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 Air Traffic Control 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 Air Navigation Service Providers. (NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

2013: Demonstrate increased Air Navigation Service Provider (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))

---

[12] 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.

2014: Provide a draft of a revised Human Factors Design Standard for human factors application to Air Traffic Control 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))

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.

Progress in FY 2011: High Quality Teams and Individuals

Survey on Use of "Front Line Manager Quick Reference Guide": In 2011 researchers administered a comprehensive survey to all En Route and Terminal Front Line Managers. The survey assessed the utility, usability, and perception of the consolidated "Front Line Manager Quick Reference Guide" (FLM QRG) which was deployed to all En Route and Terminal facilities in 2010. Survey results will be used to update and improve the QRG, assist the FAA in the development of FLM training and reference materials, and serve as a baseline to assess out-year organizational impacts. Since its deployment the QRG has received positive internal and external feedback; it has also been referenced in Congressional testimonies and newsfeeds. (Air Traffic Control/Technical Operations Human Factors)

Update to Job Analysis for Front Line Controllers: Researchers updated the job analysis for front line controllers to a new 2011 baseline, including the nature and use of current technology and support tools. They then evaluated the emerging technology drivers being brought into the air traffic control environment in the mid-term, including both improved information sources and decision support tools, and described the impact of these changes on how the controller will manage traffic. While the major functions and tasks being performed by the controllers in this timeframe remain the same, there are changes to the knowledge required, the skills used and the relative importance of some abilities. Results of this research have been provided to the training development organization, Human Resources, the service areas, and researchers involved in personnel selection and developing requirements for future workstations. The benefit and use of this research result is to provide a basis for determination if changes need to be made in personnel selection, to set the foundation for the development of new training, and to represent the human component of the NAS. (NextGen – Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

Meteorological Training for Pilots and Guidance Materials: The program completed a study on the education and training issues associated with general aviation (GA) pilots' use of meteorological (MET) information in the cockpit. The study found guidance documents that did not contain the latest MET knowledge nor include how atmospheric phenomena could affect aircraft performance. The study also found that the age range in MET guidance documents made them difficult to use as a set. Finally, the study includes recommendations for improved weather-related training and testing. The final report has been published and provided to the FAA Office of Aviation Safety (AVS) and is currently available by request through the NextGen - Weather Technology in the Cockpit (WTIC) program office. (NextGen - Weather Technology in the Cockpit)

R&D Goal 4

Human-Centered Design

R&D Target

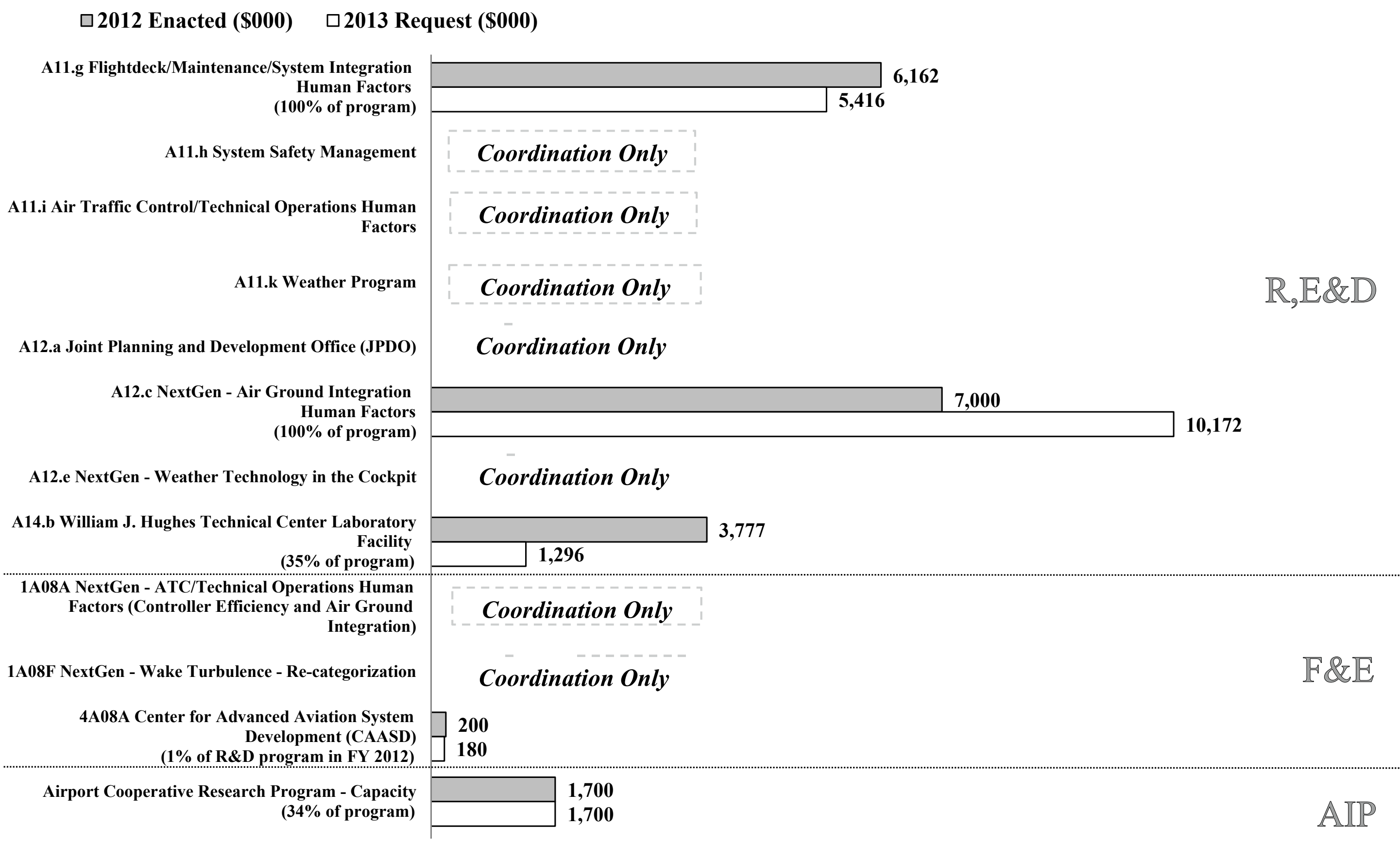
By 2016, demonstrate that operations (e.g., day and night, all weather), procedures, and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



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 Program - 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)

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 enabled Cockpit Display of Traffic Information 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)

2015: Demonstrations completed and data available to support the development of human factors standards, guidance, and procedures for the presentation and use of meteorological information in the cockpit. Specific measurable performance objectives verified for human factors design elements. (NextGen - Weather Technology in the Cockpit)

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; NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration))

2017: Functional simulation – simulate integrated pilot and controller functional capabilities.

Progress in FY 2011: Human-Centered Design

Ground Handling Training and Practices: Over the past few years, airports and airlines have been asked to develop comprehensive safety and operational training programs for ramp activities. In addition, the last ICAO audit of the FAA urged the agency to set up a regulatory program for ramp safety. However, there is a general absence of any industry standard or assessment of effective common practices. Thus, there is an overall lack of comprehensive information upon which to build future safety and operational guidance. The ACRP – Capacity has collected these practices and examined the rationale for each practice and the factors that influence that practice. The report describes the current state of ramp operational and safety techniques available to airports and their tenants, including airlines, ground handling agents, fuelers, caterers, and others having significant levels of ramp activity. The project included: (1) an investigation of the available literature on ramp safety operations and training to determine the state of current practice in the U.S., (2) reviews of past ramp and apron safety survey (such as the Airports Council International Ramp Safety Survey) results for relevant information, (3) new surveys and interviews of airports, airlines, ground handlers and others to determine current and effective practices. The target audience for this report is airport operations managers who manage or are considering managing a ground handling operation. (Airport Cooperative Research Program)

Advanced Technology for Terminal Air Traffic Control Training: To evaluate the use of advanced training technologies in the terminal environment, CAASD developed prototype Terminal Trainers for evaluation at the Miami Terminal Radar Approach Control Facilities (TRACON) and the Potomac Consolidated TRACON (PCT). The prototype presents ATC training curriculum in a web-based framework that includes voice synthesis, speech recognition, multimedia lessons, game-based training techniques, simulation, and interactive training tools. The prototype provides a research platform that can be used to assess the benefits of these automated capabilities and support capability evaluation and validation to reduce the FAA's risk in the eventual acquisition of specific technologies. Field evaluation at PCT began in September 2010 and continued through FY 2011. PCT evaluation results validated the results from the earlier Miami TRACON evaluations and have shown that the prototype is effective in training airspace at different facilities managing varying levels of airspace complexities. Students who completed all of their airspace training requirements using the prototype have demonstrated a significantly greater operational understanding of airspace design than students who used traditional methods. The technology and design requirements for the prototype's current set of airspace training capabilities were transferred to the FAA. (Center for Advanced Aviation System Development)

Electronic Flight Bag Technologies and Interfaces: This research is part of a multi-year program to gather data to help the FAA address human factors issues related to Electronic Flight Bags (EFBs) and support development and update of EFB-related policies and guidance. The EFB market continues to evolve, and the lines between Class 1, Class 2, and Class 3 EFBs are merging. Research in FY 2011 was conducted to understand the impact of these changes. Researchers continued to provide technical support to the Capstone 3 Electronic Flight Bag - Airport Surface Moving Map operational evaluation, which examined the impact of a Surface Moving Map with ownship position on a Class 2 or Class 3 EFB. This operational evaluation provides a means to gather human factors feedback on the EFB from commercial airline pilots via interviews and/or observations. The information gathered addresses topics such as EFB display location, display readability, information organization, and usability. In addition to the operational evaluation, usability studies were conducted to systematically identify potential human factors issues in an office (desktop) environment. The results of this research will be summarized in a report for the FAA Office of Aircraft Certification and FAA Office of Flight Standards. (Flightdeck/Maintenance/System Integration Human Factors)

Airport Map Displays: This research is part of a multi-year program to gather data to support the development and update of human factors regulatory and guidance material addressing flight deck integration of surface moving maps depicting ownship position and traffic information. Several advanced functions are under consideration, including display of surface traffic and alerts of potential runway incursions. Researchers are compiling FAA regulatory and guidance material, industry recommendations, and human factors research into one document to identify and address common human factors issues that may arise in the evaluation of airport surface moving maps. This document is intended to provide input and data to the FAA Office of Aircraft Certification on human factors and pilot interface issues such as colors, symbols, fonts, labels, workload, situational awareness, and errors as related to the airport moving map function. Additionally, researchers published a technical report that provides a preliminary glimpse into potential human factors concerns with the use of a surface moving map, traffic function, and the presentation of surface indications and alerts. The findings address the following topics: use of color, indications, alerts, symbols, information prioritization, airport database, and air-ground integration. The information is intended to support the development of minimum operational performance standards for surface conflict detection and alerting. This document was shared with the RTCA Special Committee-186 working group, which is developing the minimum operation performance standards for such a function. (Human Factors Considerations for the Integration of Traffic Information and Alerts on an Airport Surface Map, http://www.volpe.dot.gov/coi/hfrsa/docs/hf_guidance_traffic_info.pdf). (Flightdeck/Maintenance/System Integration Human Factors)

<u>Proactive Audit Approach to Support Safety Management System in Airline Maintenance and Ramp Operations</u>: Researchers are proactively studying airline maintenance and ramp operations during normal situations to develop maintenance and ramp Line Operations Safety Audit (LOSA) processes. The research team updated, expanded, and refined LOSA training materials based on feedback from field tests. The team wrote a literature review that provided an overview of previous LOSA efforts and the accomplishments of the FAA/Air Transport Association (ATA) LOSA team. Trained observers collected safety-related data on maintenance performance in a non-jeopardy environment at a major carrier and cargo operator. A multi-tier prototype database for storing and analyzing safety related LOSA data was tested and fielded. The results of the prototype testing are currently being used as the basis for the final database development. The team, with the assistance of the ATA's Human Factors Committee and other industry partners, will provide all materials to the public for implementation. (Flightdeck/Maintenance/System Integration Human Factors)

<u>Automatic Dependent Surveillance - Broadcast</u>: This research project is a multi-year program to provide human factors support for applications that use Automatic Dependent Surveillance - Broadcast (ADS-B), including Cockpit Display of Traffic Information (CDTI). In FY 2011, human factors research primarily addressed the design and evaluation of symbology for avionics displays that show ADS-B. The work was a follow-on activity to a Human Factors Program data collection experiment conducted in FY 2010 to examine whether symbols for CDTI should match symbols for the Traffic Alert and Collision Avoidance System (TCAS). In the experiment, researchers conducted simulations with pilots in dynamic traffic with and without the proximate status indication. The data analysis showed that pilots seem to perceive the most proximate aircraft as also the most threatening, but in actuality, this may not necessarily be the case. Additionally, researchers began a CDTI Industry Survey that is intended to gather information on the human factors aspects of CDTI displays (e.g., display resolution, alerts, and symbols). The information collected is intended to support the Office of Aircraft Certification and Office of Flight Standards. The results were summarized in a conference paper on the study, and a full technical report is being drafted. (Flightdeck/Maintenance/System Integration Human Factors)

<u>Relationship between Human Pilots and Controllers with Associated Automated Systems</u>: Two multi-year research efforts provided human factors technical information during FY 2011 to address the relationship between human pilots, controllers, and associated automated systems.

In the first, a university team developing a Human Automation Relationship Taxonomy (HART) for NextGen delivered an interim product that provides a comprehensive review of human factors scientific literature related to human-automation interaction and a detailed description of current flight deck automated systems. The

HART provides both a theoretical basis and a practical tool to support the FAA field office's analyses of human-automation interactions in support of aircraft equipment certification and operational approval for flight procedures in the NextGen context.

In the second, a major aircraft avionics manufacturer leveraged prior internal R&D efforts to provide the FAA with an analysis of the likely human factors implications and recommended mitigation strategies to improve flight crew-automation performance benefits and reduce potential adverse effects of adaptive automation flight deck technologies (i.e., non-deterministic automated systems). Guidelines and recommendations for design of adaptive flight deck systems are expected in early 2012.

Both projects support regulatory guidance for the pending new rule in 14 CFR 25.1302, *Installed Systems and Equipment for Use by the Flight Crew*. (NextGen – Air Ground Integration Human Factors)

<u>Cockpit Presentation of Meteorological Information</u>: The program completed the test plans for a human-over-the-loop evaluation to provide cloud top information to pilots in a collaborative decision environment, assessing the benefits and impacts of providing this information. If the anticipated benefits are successful in the current lab and planned flight demonstrations, the program will move forward to make cloud top information standard in the cockpit. In another project (assessing the impacts of the lack of standardization of MET presentations), the project plan was written and approved; the simulator, weather products, and MET displays were selected; and the effort to integrate products into the simulator was started. (NextGen - Weather Technology in the Cockpit)

<u>Standardized Meteorological Symbology and Support to SAE G-10</u>: The program completed a draft Cockpit MET Symbology verification procedure. The verification procedure is scheduled to be approved by FAA management in April 2012. The procedure will be used by the FAA to make a determination of the acceptability of the industry-developed (SAE G-10) and recommended standardized MET-symbology that is scheduled to be completed by September 2012. (NextGen - Weather Technology in the Cockpit)

<u>General Aviation Meteorological Information User Needs</u>: The program completed a GA Users' Needs study that identified the GA community's preferences for weather information services for preflight and during flight, and it identified their preferences for receiving this information. The final report is available from the WTIC program office. The expected benefits of this research are to identify the gaps between what the GA community currently has available and is readily using, and what they perceive as needed and preferential, and then implement efforts to fill the identified gaps. (NextGen - Weather Technology in the Cockpit)

R&D Goal 5

Human Protection

R&D Target

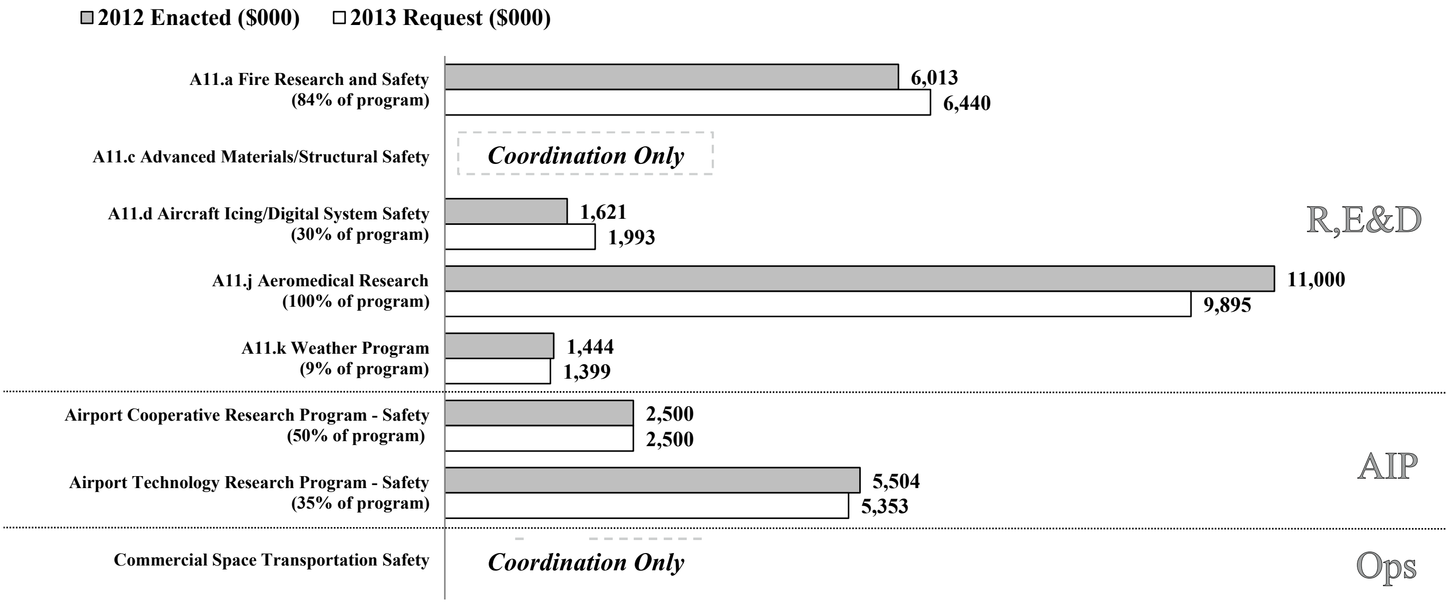
By 2016, demonstrate a significant reduction in the rate of aerospace-related fatalities and significant injuries.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



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 Program - 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)

2013: 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.

2012: Identify specific and recurring weather-related causes in reported safety incidents/accidents that identify weather as a primary cause. (NextGen - Weather Technology in the Cockpit)

2013: Develop and implement resolutions to prevent recurrence of reported weather-related safety incidents/accidents that were researched in FY 2012. (NextGen - Weather Technology in the Cockpit)

2013: Assess and quantify the safety benefits to the NAS of providing Graphical Turbulence Guidance, Eddy Dissipation Rate, and icing to the cockpit. (NextGen - Weather Technology in the Cockpit)

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

2015: Safety reporting systems indicate success of corrective actions and enhanced meteorological information (turbulence and icing) to reduce weather-related accidents/incidents. (NextGen - Weather Technology in the Cockpit)

Occupant Restraint

Improve occupant restraint systems to reduce injuries and fatalities. (Aeromedical Research; Advanced Materials/Structural Safety)

2014: Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain.

Airports

Prevent injuries and fatalities due to aircraft overrun. (Airport Technology Research Program - 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, to evaluate health and safety impacts on passengers and crew.

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

2014: 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.

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 volatile organic compounds 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.

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 Program - 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 system (Aerospace Accident Injury and Autopsy Data System) capable of compiling, classifying, assessing, and determining causal factors of aviation-related injuries. The system will link aviation-related injuries to autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic test results. (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 2011: Human Protection

<u>Assessing the Role of Airports and Airlines in the Spread of Vector-Borne Diseases</u>: Air travel has long been suspected of playing a role in transmitting and spreading insect-borne diseases. Considerable resources have been devoted to addressing the phenomenon of airport malaria (isolated cases of malaria in the vicinity of an international airport in a region in which malaria is not typically present). The assumption is that airport malaria is transmitted when a mosquito is transported during an international flight from a malaria-endemic region and then bites a human after landing. This theory has given rise to the practice of disinsection--using chemical pesticides to rid arriving aircraft of insects prior to disembarkation--which currently is required as a condition of landing by 20 countries (though not by the United States). To address these concerns, the ACRP – Safety has performed research to provide a better understanding of how the transmission and spread of insect-borne diseases are facilitated by air travel. The program has developed a user-friendly Geographic Information System-based tool on a CD-ROM to help better define the roles of airports and airlines in the transmission and spread of insect-borne human diseases. The tool shows the interrelationships among the global distribution of insect-borne infectious diseases, locations of known outbreaks, and international air service routes to identify seasonal risks of insect-borne infectious disease transmission and spread by air travel, and to help identify potential mitigation strategies. This research provides a basis for airports, airlines, and public health officials to assess the appropriateness and efficacy of current mitigation practices. (Airport Cooperative Research Program)

<u>Developing Improved Civil Aircraft Arresting Systems</u>: Currently, there is only one civil aircraft arresting system that meets FAA standards; that is the Engineered Material Arresting System (EMAS). EMAS uses a cellular material and has been installed at a number of airports where it has successfully demonstrated its ability to bring aircraft to a stop in several overrun incidents. However, at many airports, the land area at the end of a runway is inadequate to accommodate an EMAS system that meets FAA standards. Acquiring and installing the EMAS cellular material is labor-intensive and expensive. The ACRP – Safety has furthered the development of alternative civil aircraft arresting systems that safely decelerate an aircraft overrunning a runway. The program has produced a report that informs airport operators, planners, and engineers of (1) alternatives to the current civil aircraft arresting system, (2) steps required to pursue approval of such systems, and (3) tradeoffs involved in changing current aircraft arresting system design and performance parameters. (Airport Cooperative Research Program)

<u>Selection of Appropriate Child Anthropomorphic Test Dummies for Aviation Testing</u>: The FAA Civil Aerospace Medical Institute (CAMI) Biodynamics Research Team has evaluated the capabilities of the current anthropomorphic test dummies (ATDs) and has identified dummies that provide the best prediction of injury for the anticipated aviation impact environment. It was determined that the CAMI Newborn, Child Restraint Air Bag Interaction 12-month old, and Hybrid-III 3-year old were the best choice for evaluating a conventional, rigid shell child restraint system. Because the Q-Series 1-year old ATD has the skeletal features that normally carry belt loads and has instrumentation to assess chest compression injuries, it was selected for further evaluation. The findings were presented at the Triennial International Aircraft Fire and Cabin Safety Research Conference, October 25-28, 2010, NJ: http://www.fire.tc.faa.gov/2010Conference/proceedings.asp. (Aeromedical Research)

<u>Enhanced Emergency Evacuation of Passengers Using Modeling and Simulation</u>: The number of post-crash passenger fatalities is often directly correlated with the speed of emergency evacuation from the aircraft; the following research efforts were undertaken to aid in reducing the number of post-crash fatalities:

Grouped Passenger Behaviors during Emergency Evacuation - Grouped passenger behavior data were compiled and analyzed in a computer simulation study. Emergency evacuations of airplane with and without grouped passengers were compared in terms of total evacuation time and exit usage. The results of this research indicate that a group of passengers tends to egress more slowly than a similar number of individual passengers. Application of the results may be used to enhance survivability from aircraft accidents.

Aircraft Emergency Evacuation Study with Injured Passengers - Computer simulations were used to evaluate aircraft emergency evacuation involving injured passengers. Such passengers were modeled with different walking speeds during evacuation to simulate multiple levels of injury. The results of this research indicate that the seating location and degree of passenger injury may be used to enhance emergency evacuation models, equipment, guidance, and procedures so as to increase survivability from an accident.

Computer Simulations on Interior Access Vehicles for Emergency Evacuation – A new concept vehicle, called the Interior Intervention Vehicle (IIV), is being studied. The primary function of the IIV is to assist fire fighters to evacuate passengers, while simultaneously fighting the fuselage fire in a post-crash sequence. Research conducted indicated that while evacuation from narrow-body airplanes is much less likely to benefit from IIV, evacuations of wide-body aircraft could be enhanced if the IIV is deployed quickly.

The results of these research efforts were presented to the aviation safety community at the 6th Triennial International Aircraft Fire and Cabin Safety Research Conference, October 25-28, 2010, NJ. (Aeromedical Research)

<u>Biomarkers of Moderate Alcohol Ingestion</u>: Development of gene expression markers for aerospace medical factors requires that putative markers be validated by an alternative method. The Functional Genomics Research Team of the CAMI performed a screening study using microarray analysis for gene expression markers responsive to moderate alcohol use. The team successfully validated the results from the screening experiment for alcohol and established a lower limit of quantitation which can now be translated to marker validation for alcohol use, sleep deprivation, and hypoxia. A manuscript reporting these results has been completed. Kupfer D, et al, Characterization of gene expression changes in blood occurring during acute ethanol use. (Aeromedical Research)

<u>Radiation Exposure In-Flight</u>: The CAMI Radiobiology Research Team provided guidance for measuring and estimating radiation exposure during commercial aerospace activities and developed instructional materials on radiation exposure to humans during commercial aerospace travel. This information serves to educate crewmembers on the types and amounts of radiation received during air travel and how to manage their exposure. (Aeromedical Research)

<u>Medical Certification Process Review</u>: Personnel of the Aerospace Medical Research and Certification Divisions at CAMI conducted a review of 24 pilot applications with cases of heart disease that were processed for medical certification on January 2001 by an FAA Cardiology Panel. The objective of the study was to determine the aeromedical status of these 24 pilots during the 10 years following the panel review. Results of the study indicated that the airmen's aeromedical status was monitored successfully and their certification either lapsed or was denied, as appropriate. The results of this effort will aid the aviation medical community in the assessment of aeromedical decision making processes and harmonization of such standards. Abbas, R.J., Forster, E.M., Warren, S., Whinnery, J.E., and Silberman, W. *FAA Aeromedical Certification Cardiology Panel: 10-Year Review*. Proceedings from the 82nd Annual Scientific Meeting of the Aerospace Medical Association, Anchorage, May 11, 2011. (Aeromedical Research)

<u>Ischemic Heart Disease in Airline Transport Pilots</u>: The Aerospace Medical Research Division at CAMI conducted a study that addressed the characteristics of ischemic heart disease in airline transport pilots. The study's objective was to assess the medical certification of pilots with disqualifying pathologies such as coronary artery disease, a condition that can lead to incapacitation or impairment in-flight. The study was

performed in collaboration with National University of Colombia School of Medicine's residents in aerospace medicine. This collaboration promoted the harmonization of medical certification standards with other nations. Fajardo-Rodriguez, H.A., Forster, E.M., Valderrama, C., Malpica, D., and Garcia, D. *Cardiovascular Risk Factors in U.S. Airline Transport Pilots with Ischemic Heart Disease*. Proceedings from the 82nd Annual Scientific Meeting of the Aerospace Medical Association, Anchorage, May 11, 2011. (Aeromedical Research)

Analysis of Medications in Aircraft Accidents: Determining when various medications are present in fatalities resulting from aviation accidents can help establish the cause of the accident; in consequence, the following research efforts were conducted:

Prevalence of Benzodiazepines in U.S. Aviation - FAA aerospace medical researchers evaluated the prevalence of benzodiazepines in U.S. aviation accident pilot fatalities that occurred between 1990 and 2008. These medications are a commonly prescribed and a frequently abused group of drugs. Their side effects include drowsiness, dizziness, decreased alertness, and/or memory loss leading to impairment and a decreased ability to properly control an aircraft.

Postmortem Distribution of Citalopram from Aviation Accident Fatalities - The FAA Forensic Toxicology Research Team at CAMI developed a new analytical procedure for the analysis of citalopram (Celexa) in forensic biological specimens obtained from aircraft accidents. The FAA research study developed methods designed for difficult-to-analyze specimens (e.g., putrefied and/or contaminated tissue) so as to detect any level of the substance. The results of this research are described in the following publication: Lewis, R.J., Angier, M.K., Johnson, R.D., Rains, B.M., and Nepal, S. *Analysis of Citalopram and Desmethylcitalopram in Postmortem Fluids and Tissues Using Liquid Chromatography-Mass Spectrometry (DOT/FAA/AM-11/17)*. Federal Aviation Administration, Office of Aerospace Medicine: Washington, DC, 2011. (Aeromedical Research)

Quantifying Exposures to Pesticides on Aircraft: Two types of pesticide application procedures are currently practiced on aircraft: residual treatment (applied to empty planes but designed to leave an active film for at least 8 weeks) and top of descent spraying (applied while passengers are aboard). A validated sampling scheme has been developed for aircraft surfaces. Current studies on sampling from fifty additional routes along with sampling of the urinary pyrethroid metabolites from crew members is documenting the level and prevalence of pesticide exposures from spraying. These data will enable the appropriate design of an epidemiological study to address the concerns of the crew and passengers, particularly children and pregnant women, about exposure to pesticides on international flights. The results of this research effort are described in the following publication: Mohan, K.R. and Weisel, C.P. *Sampling Scheme for Pyrethroids on Multiple Surfaces on Commercial Aircrafts*. Journal of Exposure Science and Environmental Epidemiology 2010, 20, pp 320-325. (Aeromedical Research)

Bleed Air Contamination: Several research efforts were conducted in order to better understand the source and potential dangers of bleed air contaminants:

Evaluation of Commercial Sensors for Detection of Bleed Air Contaminants – The Airliner Cabin Environment Research (ACER) team at Auburn University and Boise State University evaluated commercial carbon monoxide and carbon dioxide sensors to determine their ability to detect and potentially measure evolved CO and CO_2 contaminants from thermal degradation of test fluids. Seven CO_2 and fifteen CO sensors from assorted manufacturers were procured and installed in the sensor analysis module. The built-in calibration processes for many of these sensors will present difficulties for their application on aircraft. Further testing will be done to quantify the effects of pressure on the sensors for various concentrations of the target gas. The results of this research will be described in the following publication: Klein, D., Loo, S.M., Kiepert, J., Pook, M., and Hall, J. *Survey of Sensor Technology for Aircraft Cabin Environmental Sensing*. Proceedings from the American Institute of Aeronautics and Astronautics 41st International Conference on Environmental Systems, Portland, July 17-21, 2011. (Aeromedical Research)

Development of Tri-cresyl Phosphate Sensing Technology for Aircraft Application – Potentially serious air contamination problems involve aircraft working fluids (e.g., hydraulic fluids, de-icer fluids, or engine oils) entering the aircraft cabin through contamination of the bleed air supply from the engines during flight or from the auxiliary power unit during ground operations. ACER researchers at Auburn University are developing a prototype tri-cresyl phosphate sensor system that will identify these containments as described in the following publication: Yang, X., Zitova, A., Kirsch, J., Hiremath, N., Fergus, J., Overfelt, R., and Simonian, A. *Electrochemical Sensing Technology for Detection of Tricresyl Phosphate*. Proceedings from the American Institute of Aeronautics and Astronautics 41st International Conference on Environmental Systems, Portland, July 17-21, 2011. (Aeromedical Research)

Development of Bleed Air Contamination Models – ACER scientists and engineers at Auburn University and Kansas State University have been collaborating with engineers from Boeing and Honeywell to understand and model the flow dynamics and thermal conditions representative of bleed air supplies for typical aircraft. These data are being integrated with models of droplet pyrolysis to quantify the expected generation of carbon monoxide, carbon dioxide, and unburned hydrocarbons to better predict expected passenger and crew exposures for specific amounts of working fluids contaminating the bleed air supply. The results of this research effort are described in the following publication: Haney, R.L., Siddiqui, N.A., Andress, J.R., Fergus, J.W., Overfelt, R.A., and Prorok, B.C. *Principal Component Analysis (PCA) Application to FTIR Spectroscopy Data of CO/CO_2 Contaminants of Air*. Proceedings from the American Institute of Aeronautics and Astronautics 41st International Conference on Environmental Systems, Portland, July 17-21, 2011. (Aeromedical Research)

Evaluation of New Airport Runway Pavement Groove Shape: The FAA conducted research to investigate a new runway groove shape designed to improve water runoff and reduce the chance of an aircraft hydroplaning during heavy rainfall. By decreasing the chance of hydroplaning, the risk of an aircraft overrunning the runway due to hydroplaning is also greatly reduced. In 2011, the FAA completed a draft FAA Technical Note report that includes details of all research conducted to evaluate the new pavement groove shape. This report was published early in 2012. (Airport Technology Research Program)

Composite Aircraft Fire Safety: Progress was made in FY 2011 toward the development of fire safety criteria for composite aircraft, as described in technical reports DOT/FAA/AR-09/58 and DOT/FAA/AR-11/6. In the former report, full-scale and small-scale fire tests were conducted to evaluate the toxic gases inside an intact aircraft subjected to a post-crash fire. It was shown that a composite fuselage resists fuel fire penetration for more than five minutes (length of test) as compared to an aluminum alloy fuselage which will melt through in less than one minute. Moreover, the toxic gas concentrations were lower than measured inside an aluminum fuselage fitted with an insulation fire barrier to impart penetration resistance. Based on scaling factors derived from a comparison of the full-scale and small-scale test results, toxic gas criteria measured in the small-scale test method were recommended to ensure survivability for five or more minutes during a postcrash fuel fire inside an intact composite fuselage or an aluminum fuselage with a fire barrier. In the latter report, instrumented composite and aluminum wing fuel tank test articles were heated from above, as might occur on a hot sunny day. Fuel tank vapor concentrations and temperatures were measured during heating and when the fuel tanks were tested in a wind tunnel under simulated flight conditions. It was shown that the composite fuel tank achieved higher temperatures and fuel vapor concentrations than the aluminum fuel tank during heating from above. However, air flow over the fuel tank in the wind tunnel caused rapid cooling and reduction in fuel vapor concentrations below the lower flammability limit. In addition, painting the tanks had a profound effect on the aluminum tank, which caused higher temperatures and fuel vapor concentrations comparable to the composite tank, but the painted tanks also experienced rapid cooling and reduction of vapor concentrations in the wind tunnel. Thus, it appears that wing fuel tanks, regardless of construction material, can be vulnerable to a fuel tank explosion during a hot sunny day while on the ground and shortly after take-off. This testing is continuing with different paint colors and composite thicknesses, and will be published in a technical report in 2012. (Fire Research and Safety)


DANGER

R&D Goal 6

Safe Aerospace Vehicles

R&D Target

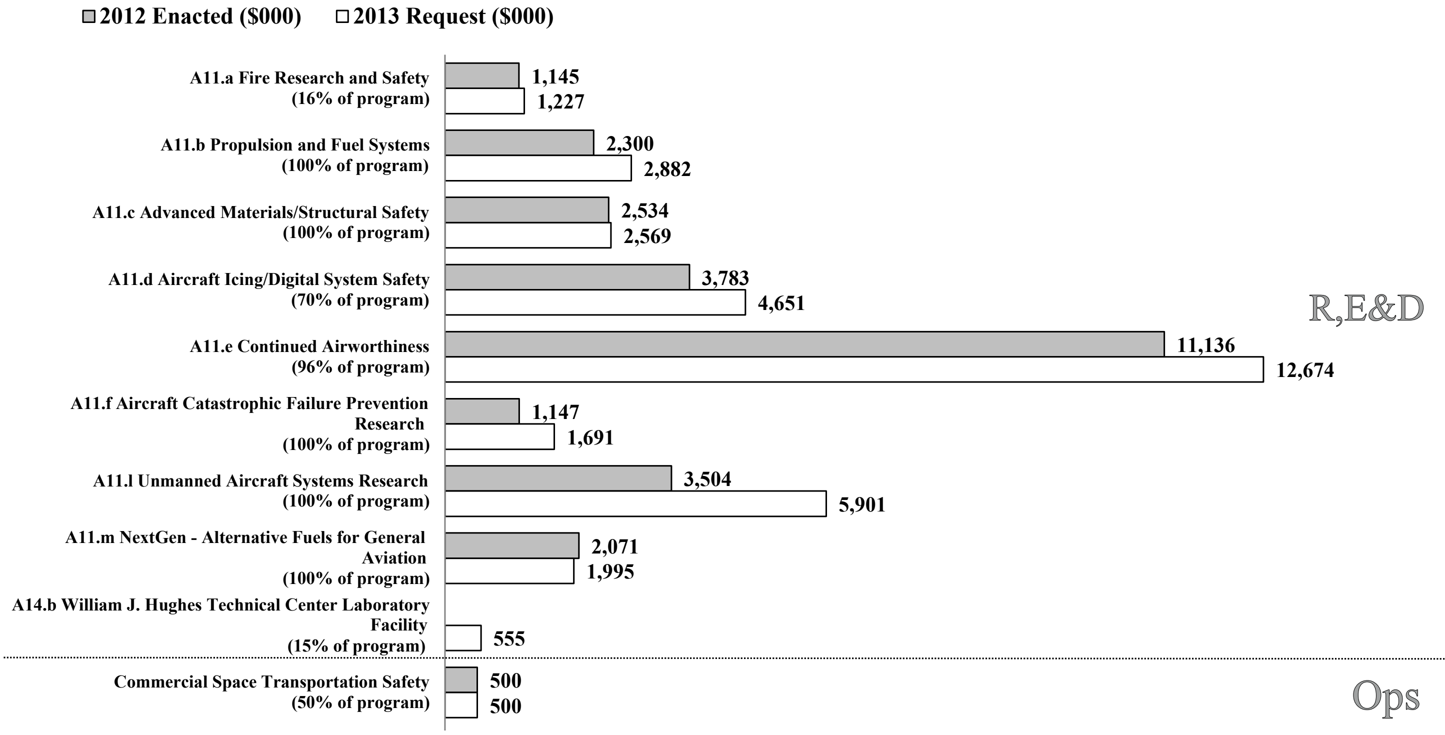
By 2016, demonstrate damage and fault tolerant vehicles and systems.

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 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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



Milestones

Engines

Prevent engine failures.

Engine and component structures

2015: Complete a certification tool[13] 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

2014: Develop and verify a generalized damage and failure model with regularization for aluminum and titanium materials impacted during engine failure events. (Aircraft Catastrophic Failure Prevention Research)

Structures

Prevent accidents due to structural failures or fire.

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

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

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

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)

2014: Develop technical data to assess the application of advanced aluminum-lithium metallic alloys for primary fuselage structure in transport category airplanes. (Continued Airworthiness)

2016: Develop technical data to assess the fatigue and environmental durability of bonded repairs to metallic structure (Continued Airworthiness)

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/Digital System Safety)

Flight Controls

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

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 technologies.

---

[13] Design Assessment of Reliability With INspection (DARWIN®)

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

2013: Identify the current technologies for small unmanned aircraft systems to establish a central repository of historical data used to track continuous airworthiness of life limited components.

2015: Identify recommended strategies for unmanned aircraft systems to compensate for missing sensory information at the control station and a method to assess performance requirements and methods of compliance for control stations.

2016: Conduct field evaluations of unmanned aircraft system technologies in an operational environment, including sense and avoid, 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 for usage credits. (Continued Airworthiness)

2016: Develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded aviation gasoline. (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).

✓ **2011**: 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 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.

2012: 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.

2012: 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.

Progress in FY 2011: Safe Aerospace Vehicles

Generalized Damage and Failure Model: Progress in the development of a generalized failure model is on track to complete material evaluations of aluminum and titanium in 2014. The MAT 224 framework has passed quality assurance checks and is implemented in the production version of explicit finite element code LS-DYNA. This milestone makes the model available for use by industry and academia. The production code allows more users to support the schedule for completing the aluminum and titanium models and verification for impact of turbine engine fragments in 2014. (Aircraft Catastrophic Failure Prevention Program)

Implications of Unmanned Aircraft Systems Operations in Controlled Airspace: The need for UAS access to the NAS is increasing. DoD operates UAS in U.S. airspace to test aircraft, test procedures, and train ground controllers. The Department of Homeland Security uses unmanned aircraft to patrol the nation's borders. Other agencies and organizations use them for activities such as disaster relief or scientific research. These missions often require UAS access to non-segregated airspace where they fly with manned aircraft and are managed by FAA air traffic controllers. CAASD conducted research on the impact of UAS on FAA controllers from a human factors perspective, and the effect of UAS on safety and capacity of the airspace. The research focused on Class A (high altitude en route) airspace where UAS are operating on instrument flight rule (IFR) flight plans, using discrete transponders code, and communicating with air traffic controllers. These UAS fly very complex routes, making it difficult for ATC to predict their paths and therefore complicating the task of separating UAS from other traffic. CAASD researchers used a sampling of voice data to further understand how controllers are affected by UAS flights. Voice data synchronized with radar was accessed through an FAA post-operations analysis tool called Falcon human-in-the-loop (HITL) experiments were continued from 2010 to explore the methods of indicating a loss of the command and control link to the controller. This research has begun to quantify some of the differences and similarities between UAS and manned aircraft from the perspective of the air traffic controller. Some key outcomes of the 2011 research include the identification of several research questions which must be answered prior to full UAS integration, as well as contributing input into the development of a mid-term concept of operations for UAS in the NAS. (Center for Advanced Aviation System Development)

Study On the Use of Operational Limitations and Inspection Requirements for Suborbital Reusable Launch Vehicles Comprised of Composite Materials: The Aerospace Corporation was tasked by the Volpe National Transportation Systems Center to provide technical support to the Federal Aviation Administration, Office of Commercial Space Transportation (FAA/AST), in developing guidance for AST and industry use on operational limitations and inspection requirements for suborbital reusable launch vehicles built using composite structures and subjected to a typical flight profile. Four representative suborbital flight profiles were selected from a previous study. A review of the literature was conducted, which included peer-reviewed journal articles, conference proceedings, and standards set forth by NASA, the American Institute of Aeronautics and Astronautics (AIAA), and ASTM, with the goal of identifying the operational environment phenomena, and their adverse effects on fiber-reinforced polymer matrix composites, and also considerations for maintenance of composites, including lessons learned in the use of composites by the aviation community. Additional contributions were obtained from interviews with various subject-matter experts at The Aerospace Corporation. Environmental phenomena, their adverse effects on composite structure, and mitigation techniques, were identified. The phenomena were not ranked, in part due to lack of substantiated and uniform fidelity and maturity of data for each, but also due to the potential for synergistic effects and for environment coupling. Additionally, further study and data are necessary to understand the influence of exposure time on the effects of these phenomena, and also the severity of their effect at a representative suborbital altitude. (Commercial Space Transportation Safety)

Rudder Control Systems in Transport Aircraft: Researchers completed a study to identify factors that may influence pilot commanded rudder over-controls, which could lead to potential airframe structural failures. The study was conducted in five parts: (1) studies of existing directional control standards, (2) literature and accident/incident reviews, (3) desktop flight simulation and analysis, (4) global transport-airplane pilot survey of in-flight rudder usage, and (5) real-time, full scale piloted simulations.

Results from this study indicate that currently certified rudder control system designs produce varying effects in pilot inputs as opposed to actual rudder movements. In addition, rudder-pedal feedback to the pilot and the actual load on vertical stabilizers varies as well. Experience indicates that variations in pilot training and pedal input characteristics may lead to the tendency of rudder over-control events that could overstress the airframe structure in some airplane designs.

Technical information with supporting data from this study were delivered to the proper FAA regulatory offices for considerations in developing rudder-control design standards and/or pilot training requirements, and the issues shown in the study are being considered by an Aviation Rulemaking Advisory Committee. (Continued Airworthiness)

Damage Detection Technologies: The FAA's Airworthiness Assurance Nondestructive Inspection Validation Center at Sandia National Labs, in conjunction with industry and airline partners, applied an in-situ crack detection system known as Comparative Vacuum Monitoring (CVM) to several large transport and regional jets to validate CVM technology as a standard non-destructive inspection practice and as a means of conducting structural health monitoring (SHM). CVM is a simple pneumatic-based sensor technology developed to monitor the onset and growth of structural cracking. Over the course of this research, a series of 26 sensors were mounted on structures in four different DC-9, B-757, and B-767 airplanes to validate the CVM sensors in actual operating environments. Another series of flight tests were also conducted on regional jets. Through the use of these in-situ CVM sensors, it was demonstrated that it is possible to remotely monitor the integrity of a structure in service by detecting onset incipient cracks before structural failures occur. A follow-on project to identify and streamline issues and technical challenges related to certification of SHM technologies for large transport airplanes will be conducted during FY 2012 and FY 2013. (Continued Airworthiness)

Damage Containment using Advanced Integral-Stitched Structure: A team of FAA, NASA, and Boeing researchers conducted a structural integrity test at the FAA's Full-Scale Aircraft Structural Test Evaluation and Research laboratory on September 21, 2011. This research was focused on the damage containment and arrest capabilities of the advanced stitched-composite technology concept of Pultruded Rod Stitched Efficient Unitized Structure (PRSEUS). Test results indicate that the PRSEUS concept is effective in arresting damage growth and improving the load carrying capacity. The panel was capable of sustaining loads exceeding the design ultimate load with a severe initial damage state consisting of a two-bay notch with the central stiffener severed. (Continued Airworthiness)

Survey of Structural Repairs and Alteration in Transport Category Airplanes: FAA researchers completed a survey of structural repairs, alterations, and modifications (RAM) on transport airplanes to better understand the risks that RAMs may pose for developing widespread fatigue damage (WFD). They conducted surveys on retired airplanes at aircraft salvage locations and on in-service airplanes at the operator's heavy maintenance locations. These will be compared to a similar survey conducted by the Airworthiness Assurance Working Group in the 1990s. Additionally, researchers acquired specimens from retired airplanes, performed in-depth teardown inspections to look for the presence of damage indicative of WFD, and developed a database to analyze the data for WFD risk assessments. Overall, the survey inspected 2,584 RAMs from 154 airplanes representing 16 models the U.S. domestic fleet of 5,014 aircraft. For the RAMs inspected, there was no evidence of WFD occurrence. The vast majority (99.0%) were installed properly and in good condition. There was limited number of questionable repairs (0.6%) that appeared deficient mainly due to poor workmanship. The database is currently being evaluated by FAA engineers to quantify safety risks that RAMs may pose for developing WFD. If the evaluation reveals that additional actions are needed to address risks for RAMs, the FAA will consider further rulemaking. (Continued Airworthiness)

Fire Safety of Lithium Batteries: Guidance on lithium battery fire safety in a safety alert for operators (SAFO 10017) was developed, issued, and documented in an FAA technical report (DOT/FAA/AR-10/31). Testing showed that halon will extinguish a fire caused by thermal runaway of a lithium ion battery, the more common rechargeable type of lithium battery. However, if the agent is dissipated, the fire will reoccur as thermal runaway propagates to adjacent batteries in a bulk shipment and the vented flammable electrolyte reignites. It was found that halon does not adequately cool down the batteries to prevent the spread of thermal runaway. Therefore, it was recommended that lithium ion batteries be shipped in Class C cargo compartments, which contain a halon system designed to maintain a prescribed concentration of halon throughout the flight, preventing re-ignition of the flammable electrolyte released from a battery in thermal runaway. Portable halon extinguishers cannot prevent lithium battery re-ignition because the agent will be dissipated. For this reason placing lithium ion batteries at a location accessible to the crew (e.g., in a Class E freighter main deck cargo compartment) is not recommended. It is recommended that lithium ion batteries be shipped in a container or package designed to contain the fire hazards of lithium ion batteries in thermal runaway. Tests showed that a container for safely shipping oxygen cylinders and generators (often called an overpack), compliant with hazardous material regulation HM224B previously developed by the FAA Fire Safety Team, successfully contained a lithium ion battery fire. HM224B was used as the basis for recommending a draft overpack performance standard for lithium ion batteries. Fire tests also showed that non-rechargeable or one-use type lithium batteries, called primary or metal batteries, are more hazardous than lithium ion batteries. Lithium metal battery fires involve burning lithium metal, which cannot be extinguished with halon, and create significantly higher pressure and smoke than lithium ion battery fires and molten metal fragments. Also, tests with sealed metal containers recommended by ICAO were ineffective because they failed due to overpressure, allowing the flaming lithium metal battery contents to be ejected large distances outside the container. Additional research is required to determine safe methods for the bulk shipment of lithium metal batteries that are currently prohibited from passenger carrying aircraft. (Fire Research and Safety)

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 material anomalies in the rotating components of aircraft gas turbine engines. Since the occurrence rates of these anomalies 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. New capabilities include automatic zone generation, time-dependent fatigue crack growth assessment, and parallel processing. In previous versions, human judgment was required to define zones and the orientation and boundaries of the associated fracture mechanics models, and risk results could vary considerably from analyst to analysis. The time-dependent assessment is especially important for components exposed to higher temperatures and longer mission times; and the parallel processing substantially reduces the computation time required for risk assessment of gas turbine engine components. 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. (Propulsion and Fuel Systems)

Safety Management System: A systems-level approach was used to analyze the safety impact of introducing UAS into the NAS. Using Safety Management Systems (SMS) principles and existing regulatory structure, a methodology was defined to determine a mandatory safety baseline for Sense and Avoid (SAA) in the NAS. The developed mandatory safety baseline can be used to determine UAS specific hazards and causal factors for the SAA problem domain. The final report titled *A Regulatory-Based Systems-Level Safety Analysis of Sense and Avoid for UAS (IFR Operations)* was delivered to the sponsor (AFS-407) in July 2011. (Unmanned Aircraft Systems Research)

R&D Goal 7

R&D Target

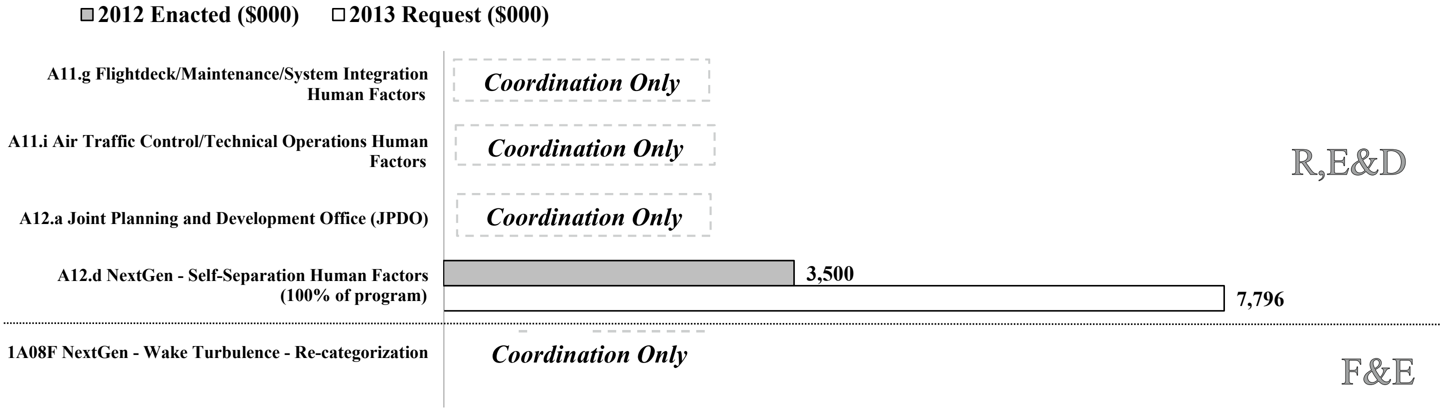
By 2016, develop initial standards and procedures for self-separation.

Method of Validation

The approach includes conducting R&D to support the standards, procedures, training, and policy required to implement the NextGen OIs 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 R&D 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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



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 Cockpit Display of Traffic Information to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff, departure and arrival phases of flight.

2015: Complete research to enable enhanced aircraft spacing for surface movements in low-visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures.

Reduced Separation

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

2012: Complete initial research to evaluate the impact and potential risks associated with use of the Traffic Alert and Collision Avoidance System 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)

2012: 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 2011: Separation Assurance

Wake Turbulence Avoidance Automation: In FY 2011 CAASD research used existing wake turbulence, aircraft, and meteorological data to model estimated wake characteristics. This modeling capability was used to drive displays of wake information on the pilot CDTI. When combined with other advanced technologies like ADS-B, potential improvements in situational awareness, safety, and capacity were defined. Three laboratory scenarios demonstrated the feasibility and benefits of incorporating wake information into a CDTI. Improvements to the wake displays identified during the additional applications of the display of wake information will be explored, including other capacity-enhancing concepts, incorporation of wake-avoidance alerts, and improvements that could be made to the NAS to more accurately predict wake turbulence. (Center for Advanced Aviation System Development)

Analysis of Deviations During Simultaneous Independent Approaches: The FAA developed standards for the conduct of simultaneous independent approaches to two parallel runways in the 1960s and added in the 1990s standards for closely-spaced simultaneous approaches using the Precision Runway Monitor (PRM). Initial safety analyses for simultaneous approaches were based on controllers preventing collisions after one aircraft deviated, or blundered, off of final approach. Although blunders were known to have occurred, there were little or no data available to estimate either their severity or rate of occurrence. Between FY 2008 and FY 2011, CAASD researchers monitored radar, arrival, and weather data at 12 airports to estimate the number of simultaneous approaches, number of deviations from final during these approaches, and severity of the deviations occurring under less than visual approach conditions. CAASD investigated more than 1.4 million simultaneous approaches and observed a total of 60 deviations of aircraft from their final approach courses that penetrated or nearly penetrated a No Transgression Zone. As a result of this data collection and 2011 analyses, the FAA can demonstrate that the rate and severity of deviations from final approach during simultaneous independent approaches is much less than was assumed in earlier analysis. The results of the study are being used in current analyses of approaches to potentially reduce the required spacing between parallel runways or to reduce the equipment and procedures required for the approaches. CAASD data collection and analysis is ongoing into FY 2012. (Center for Advanced Aviation System Development)

Human Factors Research in Support of Separation Assurance: The NextGen – Self-Separation Human Factors Program is a multiyear effort comprised of two dozen research projects to support its objective. Key products include descriptions of research and operational experience for each of the ADS-B/CDTI 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 charted and electronic depictions of Area Navigation / Required Navigation Performance instrument procedures, low visibility taxi charts, and the Navigation Reference System (NRS), a precursor waypoint grid system enabling trajectory operations under NextGen. In FY 2011, the research resulted in several products:

Researchers completed a simulation and most of the planned flight test activities for a study of Low Visibility Operations using Enhanced Flight Vision Systems (EFVS) and Synthetic Vision Systems. The results of this study will support AVS rulemaking to provide operational credit for EFVS beyond the existing limit of 100 feet using EFVS for instrument approaches in low visibility conditions. The results of the research were published in the following report: Bailey, R.E. *Awareness and Detection of Traffic and Obstacles Using Synthetic and Enhanced Vision Systems (NASA/TM-2012-217324)*. National Aeronautic and Space Administration, Langley Research Center: Hampton, VA, 2012.

Researchers completed a project that compared alternatives for NRS waypoint naming based on human factors principles. The report was provided to the Performance Based Navigation Integration Group within the FAA Mission Support Services Group (AJV) as they evaluate the NRS to formulate a policy for its use in NextGen performance-based navigation. (NextGen - Self-Separation Human Factors)

R&D Goal 8

Situational Awareness

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

R&D Target

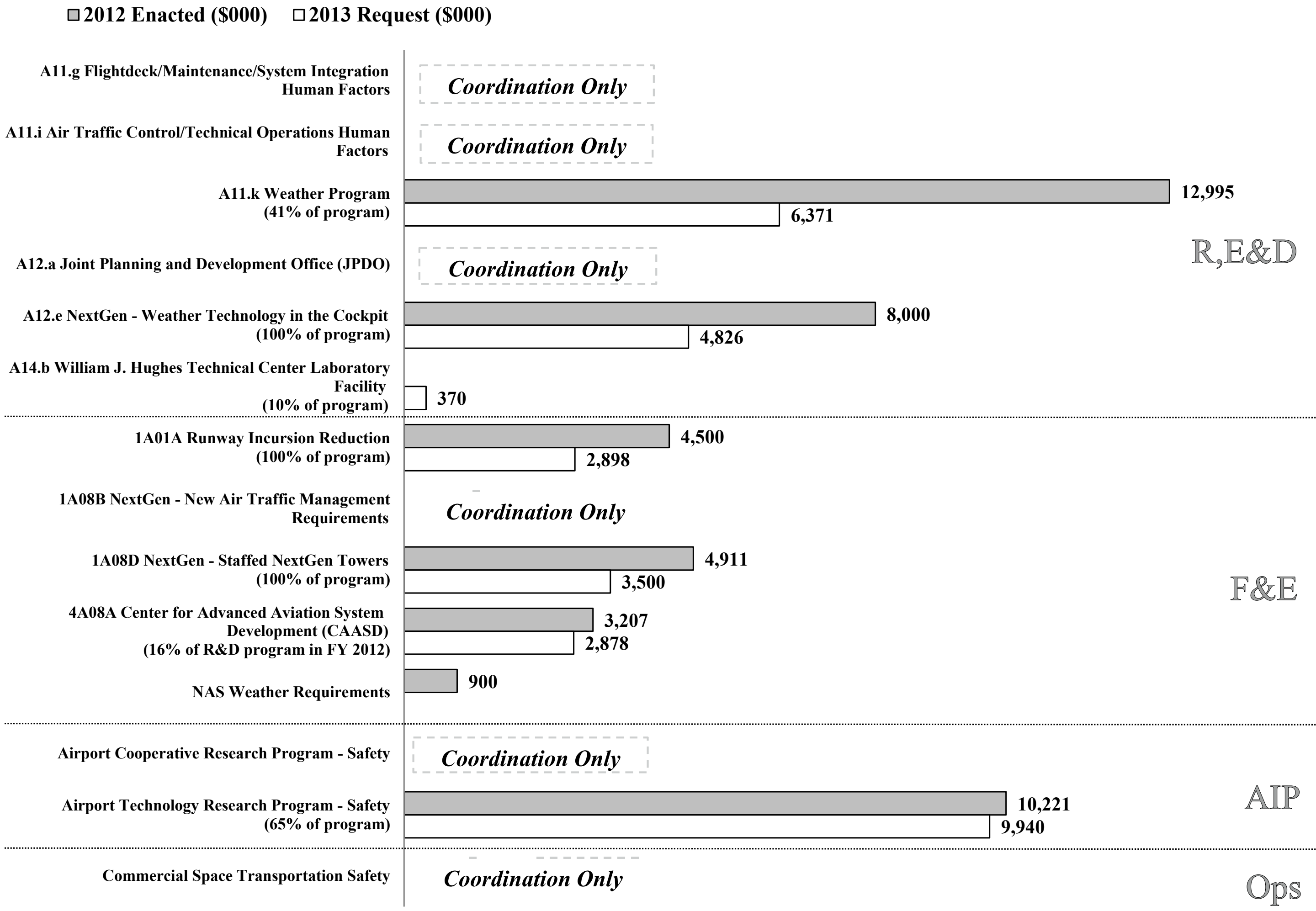
By 2016, demonstrate common, real-time awareness of ongoing air operations, events, crises, and weather in all phases of flight and at all types of airports by pilots and controllers.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



Milestones

Weather Situational Awareness

Develop common situational awareness for weather.

Weather Information Improvements (Weather Program)

2010: Develop Continental U.S. ceiling, visibility, and flight category forecast capability.

2012: Develop Continental U.S. ceiling and visibility forecast to merge with National Weather Service capability.

2014: Transition in-flight icing Alaska forecast for implementation.

2015: Demonstrate integrated FAA/National Weather Service ceiling and visibility forecast capability.

Weather Technology in the Cockpit[14] (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.

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

2012: Simulate and evaluate the benefits and impacts of presenting impact-oriented meteorological information in the cockpit in a collaborative decision environment.

2013: Develop NextGen Part 121, 135, and Part 91 concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit.

2013: Assess the impacts and benefits of mobile/portable devices for use in providing increased common meteorological situational awareness between the cockpit crew and ground based traffic managers.

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 Weather Technology in the Cockpit.

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

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

Airports

Ensure safe airport operations.

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

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

✓ **2011**: Continue development of Runway Status Lights system enhancements, install additional Low Cost Ground Surveillance pilot sites, and assess Runway Incursion mitigation programs via simulation. (Runway Incursion Reduction Program)

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

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

✓ **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.

✓ **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 to the radar wind profiler to obtain winds at greater altitudes than currently available.

Progress in FY 2011: Situational Awareness

Advisory Circulars for Visual Guidance for Pilots: The program completed recommendations for an Advisory Circular (AC) for visual guidance that defines new light emitting diode (LED) lighting chromaticity boundaries for aviation white. These new definitions will improve the identification of a light source as "white" as compared with the incandescent light source which has been confused for many years with yellow at low intensity settings. (Airport Technology Research Program)

Development of Performance Standards for Avian Radar Use On Airports: An FAA AC was published that provides performance standards for deploying avian radar systems on airports. The guidance in this AC is applicable to airport owners and operators and describes how airports can select, procure, deploy, and manage an avian radar system. Avian radar systems can be used by airports to supplement their existing Wildlife Hazard Management Plans by extending the detection capabilities of wildlife biologists during times of low visibility, at night, and at ranges far beyond the extent of the unaided human eye. Expected performance and necessary siting criteria are also covered in this AC. (Airport Technology Research Program)

Very High Frequency Digital Link Mode 2 Demonstration: The program completed a hardware demonstration to verify the Very High Frequency Digital Link Mode 2 simulation data and results from FY 2010. The laboratory demonstration verified that the coverage ranges and error rates from the simulations were accurate, but showed that the data rates were lower than those assumed in the simulations. The demonstration results indicated that to send the Current Icing Product and Graphical Turbulence Guidance to the cockpit in a timely manner requires full channel utilization which is deemed to be unrealistic since that requires virtually no contention on the channel (contention meaning that nothing else is contending for the bandwidth and the channel's bandwidth is completely allocated to the MET product). The benefit of this research is the verification of the bandwidth-intensive nature of sending these MET products in full to the cockpit. It also verified a paper analysis and some models that were used in that analysis. (NextGen - Weather Technology in the Cockpit)

Increased Situational Awareness through Runway Incursion Reduction: The Runway Incursion Reduction Program made significant progress in the evaluation of various technologies developed to increase situational awareness for pilots and controllers and reduce the rate of runway incursion incidents.

Runway Status Lights - Runway Intersection Lights were placed in operational evaluation (OpEval) status at Boston Logan International Airport (BOS). A successful OpEval report was published for BOS in February 2011. OpEvals of Runway Entrance Lights (REL) at BOS, DFW, Los Angeles International Airport (LAX), and San Diego International Airport (SAN) continued. In addition, OpEvals of Takeoff Hold Lights (THL) at BOS, DFW, and LAX were conducted. A new Field Lighting System at SAN was installed, and a pre-OpEval demonstration was performed using incandescent fixtures in March 2011. The incandescent fixtures have since been replaced with REL LEDs which are currently undergoing OpEval. A feasibility study was completed in September 2011 to determine whether Low Cost Ground Surveillance (LCGS) can operate as a potential sensor to drive the activation of Runway Status Lights (RWSL) safety logic, and initial results indicate that it can. RWSL system reliability monthly averages have been consistently above 95%, a marked increase over FY 2010 averages.

Low Cost Ground Surveillance - Four LCGS pilot sites were installed at Manchester Boston Regional Airport (MHT), Mineta San Jose International Airport (SJC), Reno-Tahoe International Airport (RNO), and Long Beach Airport (LGB). The demonstration site at Spokane International Airport (GEG) was expanded to include displays in the airport traffic control tower, and a final user evaluation for GEG was completed in September 2011. Technical evaluations were completed at MHT and SJC, and user evaluations are now underway. Technical evaluations have begun at RNO and LGB.

Runway Safety Assessment – Methods were developed to mitigate confusion between THLs and the red lights of an ALSF-2 (High Intensity Approach Lighting System with Sequenced Flashing Lights) in a displace threshold. HITL testing of these newly-developed methods was performed and the data collection took place at MITRE in the summer of 2011.

Enhanced Final Approach Runway Occupancy Signal – Enhanced Final Approach Runway Occupancy Signal hardware and software were developed for use with commissioned Precision Approach Path Indicator units and are undergoing an OpEval at DFW. (Runway Incursion Reduction Program)

<u>Ceiling and Visibility Analysis</u>: The most deadly of GA encounters results from inadvertent flight into Instrument Meteorological Conditions (IMC) by a Visual Flight Rules (VFR) pilot, or a poorly prepared IFR pilot, causing the most common type of weather accident. The FAA has developed a Ceiling and Visibility Analysis (CVA) capability that provides real-time analysis of current Ceiling and Visibility conditions, updated every five minutes with a 5 km grid, across the CONUS. In FY 2011 this capability underwent a successful scientific review as well as a safety assessment and is anticipated to be operationally implemented onto the web-based Aviation Digital Data Service (at the National Oceanic and Atmospheric Administration (NOAA) Aviation Weather Center in Kansas City) in FY 2012. As a safety tool to improve situational awareness, CVA targets the safety-of-operations needs of lower-end GA pilots. Further research by FY 2016 will entail collaboration with the National Weather Service. This will include the integration of a 1-12 hour CONUS ceiling, visibility, and flight category forecast capability with their Local Analysis MOS Product to form the basis of a gridded product. (Weather Program)

<u>Forecast Icing Product with Severity</u>: National Transportation Safety Board (NTSB) data indicates that in-flight icing causes more than 25 accidents annually, with more than half resulting in fatalities and destroyed aircraft. This equates to $100 million in injuries, fatalities, and aircraft damage each year. To address this problem, the FAA has developed Current and Forecast Icing Products (CIP and FIP), which provide more accurate and timely diagnosis and forecasts of atmospheric conditions leading to ice accretion on aircraft during flight. In FY 2011, Forecast Icing Product with Severity (FIP-Severity) was implemented operationally on the web-based Aviation Digital Data Service at the NOAA Aviation Weather Center in Kansas City. FIP-Severity is an update to the original FIP (which only provided uncalibrated icing potential) and provides forecasts of the probability of encountering icing, its expected severity, and the likelihood of large droplet icing conditions. This capability is especially beneficial to aircraft without ice protection and those that fly at relatively low altitudes where they are more likely to encounter atmospheric conditions conducive to icing. Further enhancements by FY 2016 will include forecast and analysis capabilities for Alaska. These capabilities will enhance safety especially for Alaskan GA pilots. (Weather Program)

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

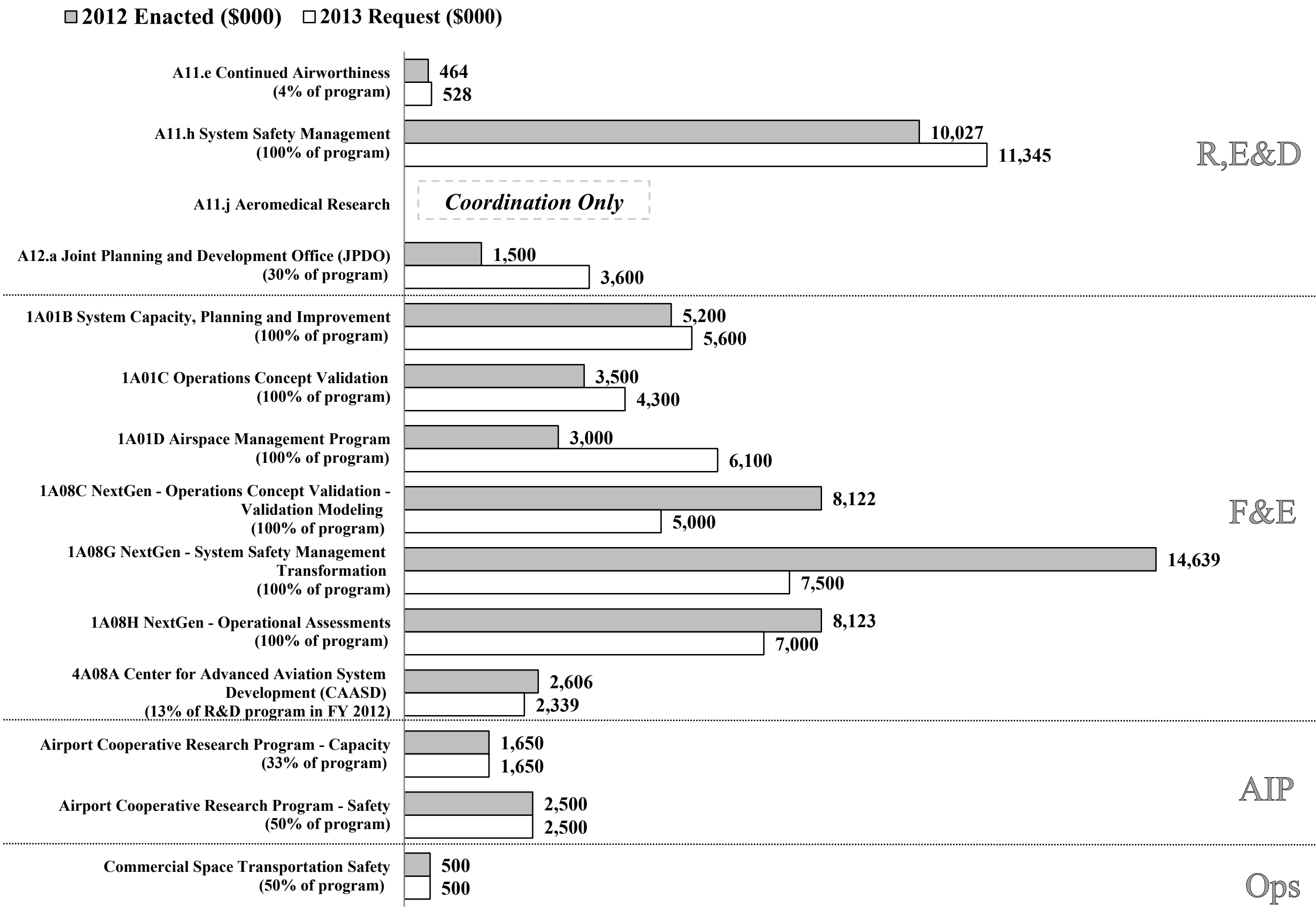
By 2016, understand economic (including implementation) and operational impact of system alternatives.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



Milestones

Information Analysis and Sharing

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

2009: Evaluate current information protection and assurance models and evaluate potential conflicts with privacy and consumer advocacy groups.

2012: Using the existing Aviation Safety Information Analysis and Sharing architecture, develop a proof-of-concept and prototype for the sharing of aviation safety information among Joint Planning and Development Office member agencies, participants, and stakeholders.

2013: Complete the Aviation Safety Information Analysis and Sharing system pre-implementation activities, including concept definition, with other Joint Planning and Development Office 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[15] 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.[16]

2008: Demonstrate capacity increase to 130% of baseline levels[17]. (NextGen - Operations Concept Validation - Validation Modeling; Operations Concept Validation; System Capacity, Planning and Improvement)

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)

---

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

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

[17] 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.

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 Program - Capacity)

2012: Develop a user interface and trend analysis capability that monitors NAS performance with respect to failures, risks, impact on Air Traffic Control and other off-nominal occurrences. (System Safety Management)

2012: Complete a pilot-in-the-loop evaluation of radius-to-fix turns during departure procedures. (System Safety Management)

2012: Complete representative stall model for upset recovery training. (System Safety Management)

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)

2016: Complete an evaluation of the reported runway slipperiness condition from all potential runway surface conditions and airplane configurations. (System Safety Management)

2016: Develop test criteria by varying motion characteristics to span the domain of the criteria and compare variations against subjective opinions of motion quality. (System Safety Management

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 Program - Safety)

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. (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.

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

Safety Evaluation[18]

Develop methods and metrics to measure progress in significantly reducing the rate of fatalities and significant injuries. (System Safety Management)

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

2012: Develop a quantitative and objective approach to prioritize new and evolving safety risks identified through analysis of multiple databases.

2015: Expand the Aviation Safety Information Analysis and Sharing system safety analysis to other domains (e.g., general aviation, rotorcraft, corporate, military).

2016: Establish safety metrics to align with NextGen system changes.

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 significant growth in demand.[19]

✓ **2009**: Develop and implement NAS-wide regional environmental analysis capability within the Aviation Environmental Design Tool. (NextGen – Operational Assessments)

✓ **2010**: Implement weather effects in Aviation Environmental Design Tool environmental analyses. (NextGen - Operational Assessments)

2013: Develop and implement NAS-wide demand forecasting, economic and environmental analysis capability with the Aviation Environmental Portfolio Management Tool. (NextGen - Operational Assessments)

2013: Explore options to integrate environmental assessment capability with NextGen NAS models. (NextGen - Operational Assessments)

2016: Employ the Aviation Environmental Design Tool and the Aviation Environmental Portfolio Management Tool for NAS-wide environmental analyses. (NextGen - Operational Assessments)

---

[18] 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.

[19] 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.

Progress in FY 2011: System Knowledge

Guidebook for Estimating the Economic Impact and Value of Air Freight Activities at Airports: The economic contribution of air cargo to airports and the communities they serve is significant. Therefore, it is important to provide effective tools and techniques to measure and value the contribution of air cargo activity to local, regional, and national economies, allowing improved response to changing global market conditions. The ACRP - Capacity has improved existing tools and techniques by developing a guidebook for use by airport operators and other air cargo industry stakeholders for measuring existing and future economic impacts of air cargo activities at a national, regional, and local airport level in the context of changing market, financial, security, and other conditions. Critical issues in measuring economic impacts of air cargo activity at a given airport include: (1) size of the air cargo market, (2) source and purpose of air cargo activity, (3) effect of changing fuel prices, (4) understanding complex linkages to changing economic conditions, (5) effect of increasing security requirements, and (6) availability and comparative cost of alternate cargo shipment modes. (Airport Cooperative Research Program)

Improved Models for Risk Assessment of Runway Safety Areas: The ACRP – Safety has developed and validated a user-friendly software analysis tool that can be used by airport and industry stakeholders to quantify risk and support planning and engineering decisions when determining Runway Safety Area requirements to meet an acceptable level of safety for various types and sizes of airports. This research expands on the research presented in ACRP Report 3, *Analysis of Aircraft Overruns and Undershoots for Runway Safety Areas*, by using many variables, not just those referenced in Table 7, page 28, of the report. The tool is interactive and versatile in order to help users determine the risk based on various input parameters. Risk is defined, in this project, as the probability of hull damage to aircraft, aircraft occupant injury, third-party injury, and property damage, as referenced in ACRP Report 3, Appendix B, Table B1-1, FAA Severity Definitions. (Airport Cooperative Research Program)

NAS-wide Environmental Impact Assessment for NextGen: This CAASD research project focused on bridging the gap between fast-time simulation tools and environmental models, to enable a more comprehensive NAS-wide benefits assessment capability. This research effort in FY 2011: (1) identified key research priorities for bridging the gap between fast-time NAS-wide simulation tools and environmental models; (2) proposed and tested solutions for bridging the gap; and (3) conducting a sample analysis to illustrate key findings. This research involved close collaboration with the FAA's Office of Environment and Energy and the Aviation Environmental Design Tool (AEDT) development team at the Volpe National Transportation Systems Center. Research priorities addressed in FY 2011 included improving the terminal area representation of flight paths from *systemwide*Modeler and proposing delay absorption mechanisms for translating en route delay information from the *systemwide*Modeler to the appropriate flight path information inputs for AEDT. The *systemwide*Modeler trajectories were augmented by introducing radar paths in the terminal area and delay vectors in the en route area. A library of historical radar track data was developed to support terminal area trajectory enhancements. A sample analysis was conducted on a city-pair basis to illustrate the key assembly blocks required to conduct an environmental assessment of operational changes. (Center for Advanced Aviation System Development)

Integrated Economy-Wide Modeling: NextGen has the potential to impact the U.S. economy beyond the air transport industry because productivity gains for cargo and passenger carriers are in part also realized, for example, as productivity gains to businesses that ship or move passengers via air. Most benefit studies to date have not attempted to capture this potential. In 2011 CAASD researchers completed work on a capability to connect operational modeling of congested NAS resources to the functioning of the U.S. economy. The ability to consistently model the relationship between efficiency gains in the NAS and the broader national economy opens the door to answering or informing a variety of important questions. This research was done in collaboration with Monash University, using the U.S. Applied General Equilibrium (USAGE) model. FY 2011 research enhanced the USAGE model in several ways to make it suitable for analyzing economy-wide impacts originating from the air transport industry. By connecting operational models of the NAS to the U.S. economy using a Computable General Equilibrium approach, economic impacts can be calculated at the broader economy level (variables like gross output, gross domestic product, impact on import and export) through industry level activity (industries that ship by air, serve air travelers, or produce components of air transport). (Center for Advanced Aviation System Development)

Commercial Space Transportation Research Road Map Document, v1.0: The final Commercial Space Transportation Research Road Map document was released before the end of 2011. Two workshops were held in support of this task, one in April on the campus of Stanford University and the second in August in Washington, DC. The document provides details of the four main research areas and a major by-product of this activity will be four R&D Research Plans (one for each of the four research areas) that will guide the R&D activities of the FAA. (Commercial Space Transportation Safety)

Small Airplane Continued Operational Safety: Researchers collected fatigue data from specific configurations of small airplanes to study the effects of material and structural variability and load complexity on fatigue life predictions of those airplanes, which are consistent with SMS principles. The research efforts also included statistical quantification of scatter factors for fatigue life analysis using Miner's rule and development of a methodology for safe life based probabilistic risk assessment and risk management for small airplanes. A Small Aircraft Risk Technology (SMART) software tool was developed. The methodology and SMART tool will assist in the development of fatigue management programs for small airplane owners, operators, and mechanics. The outcome of this research will promote early recognition of age-related safety issues and improve the continued operational safety decision-making process, which will lead to increased prevention and mitigation of age related accidents and incidents of the GA fleet. (Continued Airworthiness)

Aviation Environmental Design Tool Beta Software Tool: The beta version of FAA's first interdependent environmental analysis tool was completed. The inaugural AEDT beta software tool calculates aircraft performance and simultaneously computes the noise levels, fuel consumption, greenhouse gas emissions, and criteria pollutant emissions as one output. The AEDT software tool will be used to evaluate the environmental trade-offs associated with informing investment decisions for implementing NextGen technologies and procedural changes. The first public release of AEDT is planned for FY 2012. (Environment and Energy; NextGen - Operational Assessments)

Coupling of Terminal Area Route Generation, Evaluation, and Traffic Simulation and Aviation Environmental Design Tool: The FAA's Terminal Area Route Generation, Evaluation, and Traffic Simulation (TARGETS) tool was coupled with the FAA's new AEDT software tool to allow the assessment of more efficient aircraft procedures being developed under NextGen. The coupling of TARGETS with AEDT results in a highly efficient process to determine environmental trade-offs and consequences of aircraft noise exposure, emissions, and fuel consumption at the early design phase. Early identification of environmental consequences streamlines the environmental review process under the National Environmental Policy Act (NEPA), which saves time and resources to comply with NEPA requirements. (NextGen - Operational Assessments)

Future End-to-End Operational Concepts: A HITL simulation of Staffed NextGen Towers (SNT) was conducted as part of a series of simulations validating the SNT concept. It examined the ability of cameras to augment visual information for supplemental operations and provide visual surveillance during contingency operations. As part of SNT at Small & Medium Airports (SMA), a cognitive walkthrough assessed required visual elements for controlling airport traffic in the SMA environment. Controller and flight deck-centric HITLs were executed in 2011, supporting three-dimensional Path Arrival Management efforts. Results will be used to develop procedures, concept of operations (CONOPS), benefits cases, and system requirements for the ground automation tool under development by NASA. In July the FAA-NASA Research Transition Team held a close-out meeting for Flow Based Trajectory Management (FBTM), a key part of a plan to integrate seamless trajectory management within the NAS. FBTM researchers conducted two major en route HITLs, with results showing that the FBTM concept is feasible and beneficial. The NextGen mid-term CONOPS for the NAS was updated to reflect comments by the JPDO, RTCA, and FAA stakeholders. Twenty-six Nominal Operational Scenarios describing the mid-term environment were developed and posted to the NAS Enterprise Architecture. The mid-term CONOPS is a stepping-stone in a transition from the current NAS to the NextGen System envisioned in the JPDO CONOPS. (NextGen - Operations Concept Validation - Validation Modeling)

<u>NextGen Mid-Term Capacity and Efficiency Benefits</u>: The Air Traffic Service Concept Development & Validation Group had a 2011 NARP goal to demonstrate an increase in capacity and efficiency due to NextGen at 2018 forecasted traffic levels. To fulfill this goal, current and NextGen mid-term operations were simulated in the NAS-wide fast-time simulation model SWAC (System Wide Analysis Capability) using 2018 traffic levels. NextGen mid-term operations were simulated using projected runway improvements and a subset of mid-term OIs. Simulation output data was compared to obtain results including increased airport throughput, additional operations, and reduced delays. Results clearly show an increase in capacity and efficiency due to NextGen OIs. The busiest airports will experience increased throughput in the NextGen mid-term. On average, the core 30 airports will gain 719 arrival flights and 748 departure flights per year in 2018. In the NAS, NextGen will allow 30,660 additional flights per year in 2018. NextGen will also increase the efficiency of the NAS. In 2018, NextGen will reduce the total delay per year by 35.8% or 42.4 million minutes. It is important to note that the forecast year chosen for this study differs from the forecast year used in a similar study to obtain the benefits estimation found in the NGIP; therefore, differences in the results of these two studies are expected. (Operations Concept Validation; NextGen - Operations Concept Validation - Validation Modeling; System Capacity, Planning and Improvement)

<u>Staffed NextGen Towers Field Demonstration at Dallas Fort Worth International Airport</u>: The final field demonstration of SNT at DFW provided controllers an opportunity to evaluate the SNT concept using the Tower Flight Data Manager prototype in shadow-mode using live traffic. The SNT concept improves capacity limitations during low visibility and night conditions; maintains safety; and provides for cost-effective expansion of services as future traffic demands increase. The concept represents a paradigm shift from using the out-the-window view as the primary means for providing tower services to using surface surveillance approved for operational use. The field demonstration evaluated the suitability and acceptability of using cameras to augment visual information for supplemental operations and obtained controller feedback on using cameras for contingency operations. There were many individual differences among controllers and overall mixed reception to the cameras due to camera control, tracking, and image resolution limitations. For Supplemental Operations, results showed consensus on camera use for viewing blind spots and benefit for monitoring intersections and departure thresholds. For Contingency Operations, some controllers saw potential benefit of cameras as a secondary source of (visual) surveillance. (NextGen – Staffed NextGen Towers)

<u>Aviation Safety Information Analysis and Sharing System Phase 2</u>: In April 2009, the JPDO Safety Working Group developed and published a CONOPS for Phase 2 of the Aviation Safety Information Analysis and Sharing (ASIAS) system. Phase 2 ASIAS is to expand the sharing and collaboration of Phase 1 to include other Federal government partner departments and agencies and additional industry stakeholders that volunteer to participate. In 2010, the U.S. Air Force (USAF) volunteered to demonstrate the value of processing and sharing data from JPDO agencies as the first step in JPDO participation in ASIAS. The USAF Safety Center entered into a Memorandum of Understanding with ASIAS to furnish digital flight data from VIP Special Air Mission flights so ASIAS could compute the same benchmarks that were currently computed for existing ASIAS commercial airline participants. The team investigated four current ASIAS benchmarks: Unstable Approach, TCAS Resolution Advisories, Terrain Awareness Warning System, and Risk of Controlled Flight Into Terrain.

A final report of this activity was submitted in August 2011. (NextGen – System Safety Management Transformation)

Comprehensive Analysis of General Aviation Accidents: Research identified and analyzed the trends, distributions, initiating events, and associations with contributing factors of GA accidents from 1982 to 2009. The NTSB accident data were first analyzed nationally and then analyzed in each of the FAA's nine regions. The results from each region were compared with national results to identify the unique characteristics within each region. The trends and distributions of accidents over the time of day, month of year, phase of flight, and purpose of flight were identified, and top ten initiating events triggering the accidents were analyzed. The associations between accidents and pilot age, experience of pilots, as well as aircraft complexity were explored. Other factors contributing to the accidents were considered including light condition, flight phase, wind condition and aircraft characteristics, and so forth. The research provides a baseline for further GA safety improvement. Analysis was conducted for each FAA region and compared to the national results. For example, airspeed was determined to be the number one initiating cause in fatal accidents in both Eastern Region and nationwide. The top initiating causes of fatal GA accidents in Eastern region was found to be airspeed followed by VFR flight into IMC whereas the top initiating cause of fatal GA accidents at national level was airspeed followed by VFR flight into IMC. In addition, a statistical analysis of factors contributing to the fatal GA accidents, i.e., to find associations between factors contributing to fatal GA accidents on regional basis was conducted. (System Safety Management)

Aircraft Upset Prevention and Recovery Simulation: Research has been conducted to develop effective means to inform flight simulator users when a maneuver has traversed outside the validated math model region and/or when the structural integrity of the aircraft or its components has been compromised. Appropriate scenarios from the Upset Recovery Training Aid were evaluated concerning terminal area safety. The research team also investigated new scenarios to improve the surprise/startle factor in the simulation. A demonstration of proposed enhancements was conducted in the FAA's 737-800 full-flight simulator. Using the demonstration, members of the International Committee for Aviation Training in Extended Envelopes reviewed ideas for improving simulators for upset recovery training, including a subjective assessment of stall model enhancements, instructor station feedback improvements, accident playback scenarios, and startle scenarios. The hands-on demonstration allowed for subjective evaluations of the proposed improvements to make further recommendations. (System Safety Management)

General Aviation Flight Data Monitoring Demonstration Project: The accident and fatality rates in GA have remained higher and relatively unimproved over time when compared to the commercial aviation sector. Many commercial airlines have instituted Flight Data Monitoring (FDM) programs (known as Flight Operations Quality Assurance programs) and reported positive results. This research seeks to develop a prototype volunteer nationwide FDM safety assurance program, one of the underpinnings of SMS, for the diverse GA community. The GA FDM program will collect and analyze aggregate on-board flight data to identify accident precursors. Research issues for the GA FDM includes: low-cost flight recorders; willing operators; a centralized and useful data repository; privacy safeguards; usage protocols; design and deployment of online data analysis software; and maintenance necessary to accommodate widely disparate data input streams. The research team has upgraded the flight data recording capabilities for the integrated flight instrument system Garmin-1000 in eighty-three Cessna 172 aircraft, installed the Appareo Vision 1000 flight data recorders in two Cessna 172s and one Bell 206 helicopter, and is working to outfit two Cessna 172s with Alakai flight data recorders. To date, the prototype GA FDM program has captured over 20,000 hours of flight data and is collecting data at a rate of more than 70,000 flight hours annually. The research team has also released a document that details the data format and standard for 218 flight data parameters that can be tracked by the GA FDM to assist volunteers in the GA community who wish to contribute flight data. Efforts are underway to develop software tools for data analysis and to improve the GA FDM data server capabilities. (System Safety Management)

NAS Technical Analysis Capability: Research was conducted to identify, define, test, and validate standardized safety data and metrics for NAS Technical Operations and ATC Operations. Data driven, risk-based models developed from this research will be used by the Air Traffic Safety Oversight Service to measure reliability of the NAS. In the first phase, a proof-of-concept software prototype was developed to demonstrate safety indicators and the trend analysis capability. As part of this effort, research identified a set of facility operations safety measures (e.g., interruptions and down time). The safety data were extracted, evaluated, and analyzed. Sample data from January 1, 2008 through August 31, 2011 were used in the prototype. The next phase calls for the prototype to evolve into a facility and equipment operations module that includes a collection of information that provides a view of NAS equipment maintenance functions, combined with ATC baseline data, specific to NAS safety assessment. In addition, such a module will allow for the FAA to understand the impacts that facility service changes have on safety, as related to the general state of the NAS and the evolving NextGen plan and systems. (System Safety Management)

R&D Goal 10

World Leadership

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

R&D Target

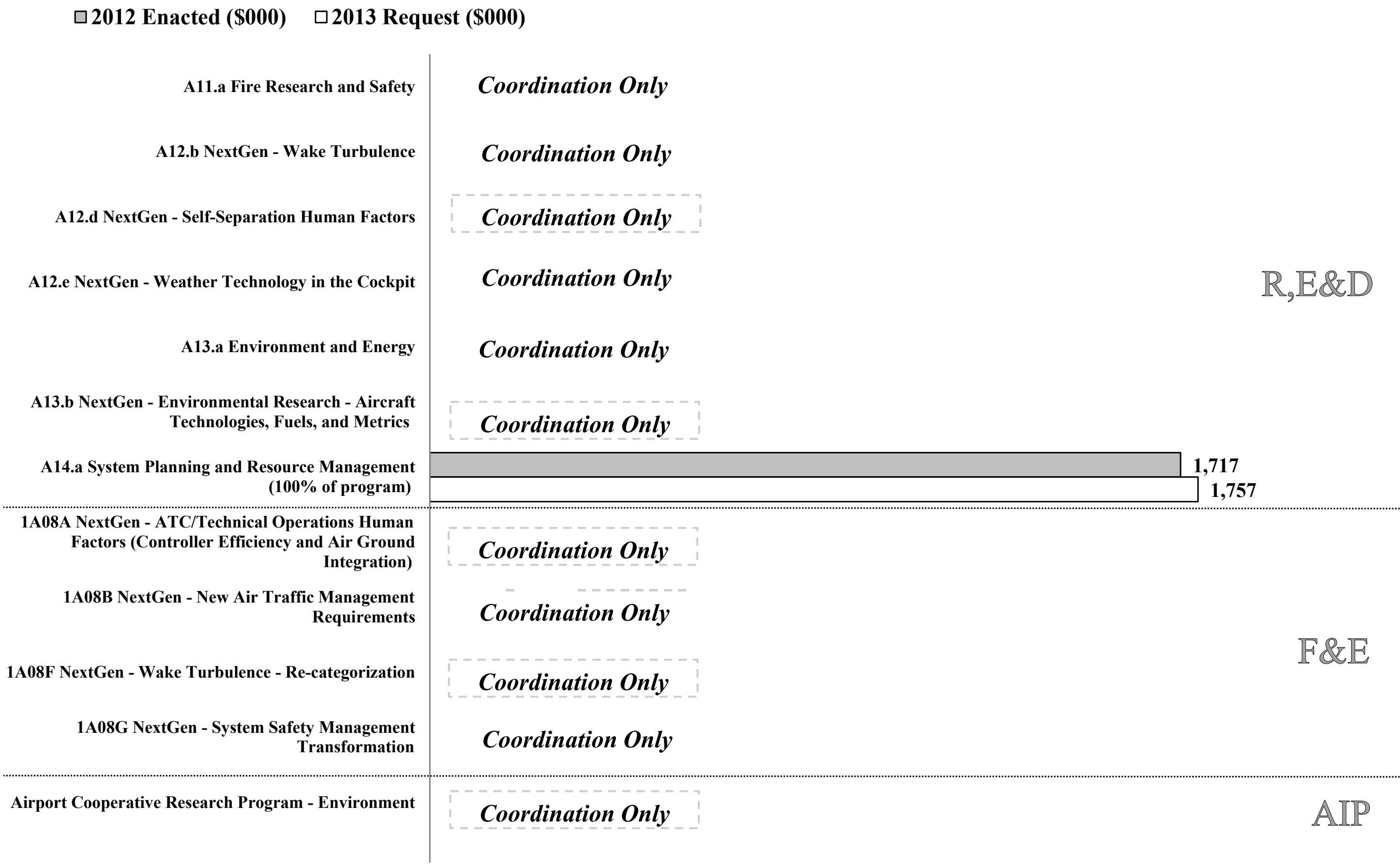
By 2016, demonstrate the value of working with international partners to leverage research programs and studies in order to improve safety and promote seamless operations worldwide.

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

Funding levels are listed for the current enacted (2012) and requested year (2013). Programs with zero funding listed support this goal with FAA staff resources only.



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.

✓ **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.

✓ **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.

✓ **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.

2012: Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2012-2017 FAA R&D plan.

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

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

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

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

2012: Measure quality, timeliness, and value of international research collaboration.

2012: Conclude final value of international research collaboration.

2016: Determine final value of international research collaboration.

Products

Leverage research results.[20]

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

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

✓ **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 Program - Environment)

---

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

2012: Using the existing Aviation Safety Information Analysis and Sharing architecture, develop a proof-of-concept and prototype for the sharing of aviation safety information among Joint Planning and Development Office member agencies, participants, and stakeholders. (NextGen - System Safety Management Transformation)

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

2015: Together with the European Organisation for the Safety of Air Navigation, deliver a more capacity-efficient set of wake separation standards to the International Civil Aviation Organization (Leader-Follower Pair-Wise Static). (NextGen - Wake Turbulence - Re-categorization)

2015: Enable reduced and delegated separation in oceanic airspace 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)

Progress in FY 2011: World Leadership

R&D Portfolio: The program provided guidance on the FAA FY 2013 R&D portfolio in October 2010. The R&D Executive Board developed the proposed FY 2013 R&D portfolio between November 2010 and February 2011. The five REDAC subcommittees reviewed the portfolio in March 2011, and the full REDAC provided its final review of the FY 2013 R&D portfolio during the meeting on April 20, 2011. REDAC recommendations were provided to the Administrator on June 8, 2011. The FAA provided a response to the REDAC recommendations on September 21, 2011. (System Planning and Resource Management)

National Aviation Research Plan: As required by Congressional direction, the 2011 NARP, along with the R&D Annual Review, was submitted to Congress in May 2011. The NARP describes the FAA five-year R&D portfolio that addresses the near-, mid-, and far-term research needs of the aviation community. The R&D Annual Review highlights the 2011 R&D accomplishments of the FAA and is a companion document to the NARP. (System Planning and Resource Management)

Evaluation Criteria for International Research Collaborations: This process started with obtaining all international travel records and international agreements within the Office of Aviation Research and Technology Development. International travelers and agreement leads were surveyed to collect data to measure the benefits of participation in international initiatives. The survey collected information such as objective of the activity or meeting, level of participation (exchange, coordinate, or collaborate), participation category, and benefits to the FAA. The data will be used to determine the value of international research collaboration. (System Planning and Resource Management)

FAA/EUROCONTROL Joint Initiative to Revise Outdated and Capacity Inefficient ICAO Wake Mitigation Separation Standards: The last review of ICAO wake separation standards currently applied worldwide by ANSPs occurred nearly 20 years ago in the early 1990's. These current wake separation minima are safe but are outdated due to the dramatic change in the aircraft fleet mix at major world hub airports, major advances in knowledge of aircraft wake transport and decay, and the development of air traffic control decision support tools that enable application of more capacity efficient wake separation processes. In 2010, a FAA/EUROCONTROL workgroup provided ICAO a recommendation for replacing the current standards with a single standard with six categories for wake separation minima. In 2011, the FAA/EUROCONTROL work group met with the ICAO Study Group tasked with the review of the six category wake standard recommendation, clarified and enhanced the recommendation's benefit and safety documentation as requested by the ICAO Study Group, and further refined the types of aircraft assigned to each of the six wake categories. Assessments have shown that the adoption of the six category recommendation will yield an average of seven percent increase in the number of landings and take-offs that can be supported at U.S. capacity-constrained airports; and, a three to four percent capacity increase at European capacity-constrained airports. (NextGen - Wake Turbulence - Re-Categorization)

Chapter Three

Alignment with NextGen

The Next Generation Air Transportation System (NextGen) is improving our NAS to make air travel more convenient and dependable, while ensuring flights are as safe, secure, and hassle-free as possible. The mission of NextGen is to realize the future vision of aviation by providing integrated strategies and solutions that achieve national and international goals.

The *NextGen Implementation Plan* (NGIP) is the FAA's primary outreach document for updating the aviation community, Congress, the flying public, and other NextGen stakeholders on progress, while providing a summary overview of plans for the future. The NGIP, particularly the appendices, provides operators and airports with necessary information for NextGen deployments. The NGIP further offers partners in the international aviation community a summary of planning timelines in support of the agency's global harmonization efforts. The NGIP, which is updated annually, draws upon and informs a number of FAA planning documents, including the NAS Enterprise Architecture, *NAS Capital Investment Plan*, and *Destination 2025*.

NextGen Solution Sets

The NGIP provides an overview of the FAA's ongoing transition to NextGen, explaining the agency's vision for NextGen now and into the mid-term. The plan defines NextGen's seven cross-cutting solution sets, summarized below.

<u>Initiate Trajectory-Based Operations</u>: The Trajectory-Based Operations (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.

<u>Increase Arrivals/Departures at High Density Airports</u>: The Arrivals/Departures at High Density Airports (HD) 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 HD 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.

<u>Increase Flexibility in the Terminal Environment</u>: The Flexibility in the Terminal Environment (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.

<u>Improve Collaborative Air Traffic Management</u>: 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 traffic 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.

<u>Reduce Weather Impact</u>: 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.

<u>Increase Safety, Security, and Environment</u>: Improving safety, security, and the environment (SSE) is an inherent part of the FAA's overall mission and is embedded in the activities of individual programs agency-wide. The SSE solution set involves activities directly related to ensuring that NextGen systems steadily contribute to reducing risks to safety and information security while mitigating adverse effects on the environment and ensuring environmental protection that allows sustained aviation growth.

<u>Transform Facilities</u>: 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 system-wide operations. 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, reduce aviation's impact on the environment, and 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 revised 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 Research, Engineering & Development (RE&D) and Facilities and Equipment (F&E) appropriations, the FAA NextGen R&D portfolio is a subset of the FAA R&D portfolio, as reported in the NARP, and also the FAA NextGen portfolio, as reported in the NGIP. The FAA NextGen R&D portfolio represents 40 percent of the total requested R&D budget reported in the NARP for FY 2013, and it represents 10 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 operational improvements (OIs) in the NextGen solution set timelines. These 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 NGIP 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 NGIP, 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 Research, Engineering and Development Programs

In addition to the System Development budget line item (BLI) under F&E, the FAA NextGen R&D portfolio includes seven BLIs under the RE&D appropriation. The seven programs or BLIs 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 Solution Sets

				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 - Staffed NextGen Towers	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	NextGen - Wake Turbulence - Re-categorization	NextGen - System Safety Management Transformation	NextGen - Operational Assessments
	OI#	Far-term	Operational Improvements/Capabilities	A11.m	A12.b	A12.c	A12.d	A12.e	A13.b	1A08A	1A08B	1A08C	1A08D	1A08E	1A08F	1A08G	1A08H
Initiate Trajectory Based Operations	101103	*	Provide Interactive Flight Planning from Anywhere					X									
	102108		Oceanic In-trail Climb and Descent				X								X	X	X
	102114		Initial Conflict Resolution Advisories														
	102117	*	Reduce Horizontal Separation Standards, En Route - 3 Mile		X		X	X							X		
	102118		Delegated Responsibility for In-trail Separation		X	X	X			X							
	102136	*	Reduced Oceanic Separation and Enhanced Procedures		X	X	X	X		X							X
	102137		Automation Support for Separation Management												X	X	X
	102146	*	Flexible Routing					X				X					
	102147	*	Self Separation Airspace - Oceanic					X									
	102148	*	Self Separation Airspace Operations														
	104102		Flexible Entry Times for Oceanic Tracks														
	104105	*	Automated Support for Trajectory Negotiation			X				X		X					
	104120		Point-in-Space Metering					X				X				X	X
	104121	*	Automated Negotiation/Separation Management			X				X	X						
	104126	*	Trajectory Based Management Gate-to-Gate					X				X					
	104127	*	Automated Support for Conflict Resolution														
	108105	*	Flow Corridors - Level 1 Static														
	108106	*	Flow Corridors - Level 2 Dynamic														
	108206		Flexible Airspace Management							X		X					
	108209		Increase Capacity and Efficiency using RNAV and RNP				X	X			X	X				X	X
	108213	*	Dynamic Airspace Performance Designation														
Increase Arrivals/Departures at High Density Airports	102141		Improved Parallel Runway Operations		X		X	X			X				X	X	X
	102142	*	Efficient Metroplex Merging and Spacing				X									X	
	102143	*	Delegated Responsibility for Horizontal Separation (Lateral and Longitudinal)				X										X
	102149	*	Delegated Separation - Complex Procedures				X										
	102150	*	Reduce Separation - High Density Terminal Less Than 3 Miles														
	102153	*	Limited Simultaneous Runway Occupancy														
	104117	*	Improved Management of Arrivals/Surface/Departure Flow Operations					X		X						X	X
	104122		Integrated Arrival/Departure Airspace Management							X							X
	104123		Time-Based Metering using RNAV and RNP Route Assignments									X				X	X
	104125	*	Integrated Arrival/Departure and Surface Traffic Management for Metroplex														
	104128		Time-Based Metering in the Terminal Environment					X				X					
	104206	*	Full Surface Traffic Management with Conformance Monitoring			X	X			X							X
	104208	*	Enhanced Departure Flow Opeations			X				X		X					X
	104209		Initial Surface Traffic Management									X				X	X
Increase Flexibility in the Terminal Environment	102138		Expanded Radar-Like Services to Secondary Airports														
	102140		Wake Turbulence Mitigation for Departures: Wind-Based Wake Procedures					X								X	X
	102144		Wake Turbulence Mitigation for Arrivals: CSPRs														X
	102145	*	Single Runway Arrival Wake Mitigation					X									X
	102151	*	Single Runway Departure Wake Mitigation					X									
	102152	*	Dynamic, Pairwise Wake Turbulence Separation					X									
	102154		Wake Re-Categorization														
	102406		Provide Full Surface Situation Information								X						
	102409	*	Provide Surface Situation to Pilots, Service Providers and Vehicle Operators for Near-Zero Visibility Surface Operations					X									
	103207		Improved Runway Safety Situational Awareness for Controllers							X						X	X
	103208		Improved Runway Safety Situational Awareness for Pilots							X						X	X
	104124		Use Optimized Profile Descents					X				X			X	X	X
	104207		Enhanced Surface Traffic Operations														
	107107		Ground Based Augmentation System Precision Approaches													X	X
	107115		Low Visibility/Ceiling Takeoff Operations				X							X		X	X
	107116		Low Visibility/Ceiling Departure 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
	107202		Low Visibility Surface Operations				X							X		X	X

Table 3.1 (continued)

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 - Staffed NextGen Towers	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	NextGen - Wake Turbulence - Re-categorization	NextGen - System Safety Management Transformation	NextGen - Operational Assessments					
A11.m	A12.b	A12.c	A12.d	A12.e	A13.b	1A08A	1A08B	1A08C	1A08D	1A08E	1A08F	1A08G	1A08H	Operational Improvements/Capabilities	Far-term	OI#		
								X						Provide Full Flight Plan Constraint Evaluation with Feedback		101102	Improve Collaborative Air Traffic Management	
														On-Demand NAS Information		103305	Improve Collaborative Air Traffic Management	
		X	X	X		X		X						Full Collaborative Decision Making	*	105207	Improve Collaborative Air Traffic Management	
							X	X				X		Continuous Flight Day Evaluation		105302	Improve Collaborative Air Traffic Management	
								X				X		Improved Management of Special Activity Airspace		108212	Improve Collaborative Air Traffic Management	
								X				X		Traffic Management Initiatives with Flight Specific Trajectories		105208	Improve Collaborative Air Traffic Management	
														Initial Improved Weather Information from Non-Ground Based Sensors		103116	Reduce Weather Impact	
				X										Initial Integration of Weather Information into NAS Automation and Decision Making		103119	Reduce Weather Impact	
				X										Full Improved Weather Information and Dissemination	*	103121	Reduce Weather Impact	
				X										Full Improved Weather Sensor Network	*	103122	Reduce Weather Impact	
				X										Full Integration of Weather Information into NAS Automation and Decision Making	*	103123	Reduce Weather Impact	
												X		Enhanced Emergency Alerting		106202	Increase Safety, Security, and Environmental Performance	Safety
												X	X	Safety Information Sharing and Emergent Trend Detection		109303	Increase Safety, Security, and Environmental Performance	Safety
												X		Enhanced Safety Information Analysis and Sharing		109304	Increase Safety, Security, and Environmental Performance	Safety
												X	X	Improved Safety for NextGen Evolution		109305	Increase Safety, Security, and Environmental Performance	Safety
														Increased International Cooperation for Aviation Safety		109306	Increase Safety, Security, and Environmental Performance	Safety
												X	X	Improved Safety Across Air Tansportation System Boundaries		109307	Increase Safety, Security, and Environmental Performance	Safety
												X	X	Automated Safety Information Sharing and Analysis Scope and Effectiveness		109308	Increase Safety, Security, and Environmental Performance	Safety
														Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk-Based Assessment		109302	Increase Safety, Security, and Environmental Performance	Security
														Operational Security Capabilitity with Dynamic Flight Risk Assessment for Improved Security Airspace Planning and Management	*	109317	Increase Safety, Security, and Environmental Performance	Security
					X					X				Implement EMS Framework - Phase II		109310	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Implement NextGen Environmental Engine and Aircraft Technologies - Phase I		109315	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Increased Use of Commercial Aviation Alternative Fuels - Phase I		109316	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Implement NextGen Environmental Engine and Aircraft Technologies - Phase II		109318	Increase Safety, Security, and Environmental Performance	Environment
					X			X		X				Environmentally & Energy Favorable Air Traffic Management Concepts and Gate-to-Gate Operational Procedures - Phase I		109319	Increase Safety, Security, and Environmental Performance	Environment
					X					X				NextGen EMS Framework Implementation - Phase III	*	109320	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Increased Use of Commercial Aviation Alternative Fuels - Phase II		109321	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Environmentally & Energy Favorable Air Traffic Management Concepts and Gate-to-Gate Operational Procedures - Phase II		109322	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Increased Use of Commercial Aviation Alternative Fuels - Phase III	*	109323	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Implement NextGen Environmental Engine and Aircraft Technologies - Phase III	*	109324	Increase Safety, Security, and Environmental Performance	Environment
					X					X				Environmentally & Energy Favorable Air Traffic Management Concepts and Gate-to-Gate Operational Procedures - Phase III	*	109325	Increase Safety, Security, and Environmental Performance	Environment
														NAS Wide Sector Demand Prediction and Resource Planning		105104	Transform Facilities	
									X			X		Remotely Staffed Tower Services		109402	Transform Facilities	
												X		Automated Virtual Towers	*	109404	Transform Facilities	
														Business Continuity Services	*	109405	Transform Facilities	

Table 3.2 – NextGen R&D Funding Levels

Project Number	FY 2013 BLI	Program	2012 Enacted ($000)	2013 Request ($000)	2014 Estimate ($000)	2015 Estimate ($000)	2016 Estimate ($000)	2017 Estimate ($000)	R&D Goals
		NextGen - System Development Programs							
G1M.02-01	1A08A	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	8,122	5,000	5,000	5,000	5,000	5,000	3
G1M.02-02	1A08B	NextGen - New Air Traffic Management Requirements	26,444	22,000	22,000	22,000	22,000	29,000	1
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	8,122	5,000	5,000	5,000	5,000	5,000	9
G3M.04-01	1A08D	NextGen - Staffed NextGen Towers	4,911	3,500	2,000	6,000	6,000	6,000	8
G6M.02-01	1A08E	NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	12,183	9,500	10,000	10,000	10,000	10,000	2
G6M.02-02	1A08F	NextGen - Wake Turbulence - Re-categorization	2,456	1,500	1,500	1,500	1,500	3,000	1
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	14,639	7,500	8,000	8,000	8,000	8,000	9
G7M.02-02	1A08H	NextGen - Operational Assessments	8,123	7,000	8,000	8,000	8,000	8,000	9
		F&E TOTAL	**85,000**	**61,000**	**61,500**	**65,500**	**65,500**	**74,000**	
		NextGen RE&D Programs							
111-160	A11.m	NextGen - Alternative Fuels for General Aviation	2,071	1,995	2,026	2,069	2,099	2,142	6
027-110	A12.a	Joint Planning and Development Office (JPDO)	5,000	12,000	12,226	12,510	12,738	13,024	1,9
111-130	A12.b	NextGen - Wake Turbulence	10,674	10,350	10,516	10,742	10,907	11,132	1
111-110	A12.c	NextGen - Air Ground Integration Human Factors	7,000	10,172	10,332	10,552	10,711	10,930	4
111-120	A12.d	NextGen - Self-Separation Human Factors	3,500	7,796	7,920	8,089	8,213	8,381	7
111-140	A12.e	NextGen - Weather Technology in the Cockpit	8,000	4,826	4,912	5,022	5,109	5,220	8
111-150	A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	23,500	19,861	20,185	20,622	20,946	21,382	2
		RE&D TOTAL	**59,745**	**67,000**	**68,117**	**69,606**	**70,723**	**72,211**	
		NextGen R&D Programs TOTAL	**144,745**	**128,000**	**129,617**	**135,106**	**136,223**	**146,211**	

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


A42-L360


STRIKE AIRCRAFT TEST
STRIKE AIRCRAFT TEST

This chapter summarizes the FAA R&D portfolio according to its FY 2013 budget submission. The chapter explains what the FAA is doing (programs), how much it is spending (budget), how it leverages capabilities (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, NextGen, and Policy, International Affairs and Environment. The Research and Development Management Division (ANG-E4) under the Assistant Administrator for NextGen manages the FAA R&D portfolio for the Agency.

Programs

Four appropriation accounts fund the R&D portfolio: Research, Engineering and Development (RE&D); Facilities and Equipment (F&E); Airport Improvement Program (AIP); and Operations (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.[21] R&D programs funded under the F&E account include R&D concept development and demonstration prior to an FAA investment decision. The AIP provides grants to local and state airport authorities to help ensure the safety, capacity, and efficiency of U.S. airports. Through the AIP, the agency funds a range of activities to assist in airport development, preservation of critical facilities, economic competitiveness, and environmental sustainability.[22] 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 2013 R&D President's Budget Request, grouped by funding account. Appendix A of the NARP provides detailed information for each program including: the program's funding request and its planned accomplishments, a description of activities and performance linkages, the need for the program, the criteria for success, and justification for the requested funding.

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 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.

---

[21] 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

[22] FAA FY 2013 President's Budget Submission, Section 3D – Grants-in-Aid for Airports, page 11

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.

Aircraft Icing/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 National Transportation Safety Board (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 Safety Management System 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 research to leverage new technologies and procedures that enhance pilot, aircraft and operational safety in terminal and en route domains.

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 unmanned aircraft systems (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 general aviation (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 Air Navigation Service Provider (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 executes research projects to develop, verify, and validate requirements to support airworthiness standards for enabling availability and improving the quality and quantity of meteorological (MET) information to the aircraft for the support of NextGen operational improvements. When enabled, this shared and relevant MET information will enhance common situational awareness. The research performed by this program also results in the development of 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. The research also addresses 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 Continuous Lower Energy, Emissions, and Noise (CLEEN) Program to reduce noise and emissions at the source level. It assesses, demonstrates, and supports qualification of alternative aviation fuels that reduce emissions that impact air quality and climate change. Availability of alternative aviation fuels also increases energy security. The program also supports research to determine the appropriate goals and metrics to manage NextGen aviation environmental impacts needed to support environmental management systems (EMS).

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 William J. Hughes Technical Center sustains and supports the Human Factors Research and Development Laboratory, Airborne Laboratories, and Simulation Laboratories that 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 separations responsibilities and controller efficiencies, and analysis, evaluation, and validation of R&D milestones.

Facilities and Equipment (F&E)

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 develops and validates operational concepts that are key to the air traffic modernization programs and NextGen. The work includes developing and maintaining detailed second level concepts that support validation and requirements development. These concepts identify the personnel and functional changes to provide customer service in ways that increase productivity and reduce net cost.

Airspace Management Program (1A01D): 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 significantly increase 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 and validates 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 identifies procedures that can decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS.

NextGen - Staffed NextGen Towers (1A08D): The Staffed NextGen Tower (SNT) concept provides for a shift from using the out-the-window view as the primary means for providing tower control services to using surface surveillance approved for operational use. SNT is planned for high density airports as these airports are likely to have the surveillance infrastructure and most aircraft equipped with avionics that will support SNT operations.

NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08E): 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 (1A08F): 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 - 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 - Operational Assessments (1A08H): 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.

Center for Advanced Aviation System Development (CAASD) (4A08A): 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 Program - 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 Program - 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 Program - 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 Program - 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 Program - 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 Program - 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 the FAA R&D budget by appropriation, program sponsor, R&D category, and performance goal. It presents the FAA R&D enacted budget for FY 2012, the FY 2013 President's Budget request and planned funding for FY 2014 through 2017, which are estimates and subject to change.

Appropriation Account: Table 4.1 shows the FAA R&D enacted budget for FY 2012, budget request for FY 2013, and the four-year plan through FY 2017, 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), 4A08A. 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 enacted budget for FY 2012, budget request for FY 2013, and the four-year plan through FY 2017, 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 the Office of Management and Budget (OMB) Circular A-11[23]. 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 2017.

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 2013. 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 2013.

[23] OMB Circular A-11, "Preparation, Submission and Execution of the Budget," August 18, 2011, section 84, pages 11-12 (www.whitehouse.gov/OMB/circulars).

Table 4.1: Planned R&D Budget by Appropriation Account

Project Number	FY 2013 BLI	Program	Appropriation Account	2012 Enacted ($000)	2013 Request ($000)	2014 Estimate ($000)	2015 Estimate ($000)	2016 Estimate ($000)	2017 Estimate ($000) /1
Research, Engineering and Development (R,E&D)									
061-110	A11.a	Fire Research and Safety	R,E&D	7,158	7,667	7,822	8,009	8,167	8,358
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	2,300	2,882	2,935	3,002	3,055	3,123
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	2,534	2,569	2,614	2,672	2,716	2,776
064-110/111	A11.d	Aircraft Icing/Digital System Safety	R,E&D	5,404	6,644	6,749	6,893	6,998	7,141
065-110	A11.e	Continued Airworthiness	R,E&D	11,600	13,202	13,404	13,686	13,886	14,165
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,147	1,691	1,717	1,753	1,779	1,815
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	6,162	5,416	5,542	5,685	5,817	5,965
060-110	A11.h	System Safety Management	R,E&D	10,027	11,345	11,512	11,750	11,914	12,149
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,364	10,014	10,232	10,486	10,711	10,972
086-110	A11.j	Aeromedical Research	R,E&D	11,000	9,895	10,117	10,372	10,602	10,865
041-110	A11.k	Weather Program	R,E&D	16,043	15,539	15,722	16,020	16,193	16,480
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,504	5,901	5,977	6,094	6,166	6,280
111-160	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	2,071	1,995	2,026	2,069	2,099	2,142
027-110	A12.a	Joint Planning and Development Office (JPDO)	R,E&D	5,000	12,000	12,226	12,510	12,738	13,024
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,674	10,350	10,516	10,742	10,907	11,132
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	7,000	10,172	10,332	10,552	10,711	10,930
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	3,500	7,796	7,920	8,089	8,213	8,381
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	8,000	4,826	4,912	5,022	5,109	5,220
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,074	14,776	14,979	15,280	15,477	15,773
111-150	A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	23,500	19,861	20,185	20,622	20,946	21,382
011-130	A14.a	System Planning and Resource Management	R,E&D	1,717	1,757	1,775	1,810	1,827	1,859
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,777	3,702	3,786	3,882	3,969	4,068
		***R,E&D* TOTAL**	**R,E&D**	**167,556**	**180,000**	**183,000**	**187,000**	**190,000**	**194,000**
Facilities & Equipment (F&E)									/2
S09.02-00	1A01A	Runway Incursion Reduction	F&E	4,500	2,898	5,000	5,000	5,000	5,000
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	5,200	5,600	6,000	6,000	6,000	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	3,500	4,300	4,000	4,000	4,000	4,000
M08.28-04	1A01D	Airspace Management Program	F&E	3,000	6,100	5,000	5,000	5,000	5,000
M08.27-01		NAS Weather Requirements	F&E	900	0	0	0	0	0
		Subtotal	**Line 1A01**	17,100	18,898	20,000	20,000	20,000	20,500 /3
G1M.02-01	1A08A	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	F&E	8,122	5,000	5,000	5,000	5,000	5,000
G1M.02-02	1A08B	NextGen - New Air Traffic Management Requirements	F&E	26,444	22,000	22,000	22,000	22,000	29,000
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	8,122	5,000	5,000	5,000	5,000	5,000
G3M.04-01	1A08D	NextGen - Staffed NextGen Towers	F&E	4,911	3,500	2,000	6,000	6,000	6,000
G6M.02-01	1A08E	NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	12,183	9,500	10,000	10,000	10,000	10,000
G6M.02-02	1A08F	NextGen - Wake Turbulence - Re-categorization	F&E	2,456	1,500	1,500	1,500	1,500	3,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	14,639	7,500	8,000	8,000	8,000	8,000
G7M.02-02	1A08H	NextGen - Operational Assessments	F&E	8,123	7,000	8,000	8,000	8,000	8,000
		Subtotal	**Line 1A08**	85,000	61,000	61,500	65,500	65,500	74,000 /4
M03.02-00	4A08A	Center for Advanced Aviation System Development (CAASD)	F&E	20,045	17,990	19,275	19,275	19,275	19,275 /5
		***F&E* TOTAL**	**F&E**	**122,145**	**97,888**	**100,775**	**104,775**	**104,775**	**113,775**
Airport Improvement Program (AIP)									
--	--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000 /6
--	--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Technology Research Program - Capacity	AIP	12,025	12,507	12,507	12,507	12,507	12,507 /7
--	--	Airport Technology Research Program - Environment	AIP	1,500	1,500	1,500	1,500	1,500	1,500
--	--	Airport Technology Research Program - Safety	AIP	15,725	15,293	15,293	15,293	15,293	15,293
		***AIP* TOTAL**	**AIP**	**44,250**	**44,300**	**44,300**	**44,300**	**44,300**	**44,300**
Operations (Ops)									
--	--	Commercial Space Transportation Safety	Ops	1,000	1,000	1,000	1,000	1,000	1,000
		***Ops* TOTAL**	**Ops**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
		GRAND TOTAL		**$334,951**	**$323,188**	**$329,075**	**$337,075**	**$340,075**	**$353,075**

Notes:

/1 The funding levels listed for years 2014 to 2017 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 four 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 25.7% in FY 2012.
/6 The three programs in the Airport Cooperative Research Program (AIP) are combined into a single narrative write-up in Appendix A.
/7 The three programs in the Airport Technology Research Program (AIP) are combined into a single narrative write-up in Appendix A.

Table 4.2: Planned R&D Budget by Requesting Organization

Project Number	FY 2013 BLI	Program	Appropriation Account	2012 Enacted ($000)	2013 Request ($000)	2014 Estimate ($000)	2015 Estimate ($000)	2016 Estimate ($000)	2017 Estimate ($000) /1
Aviation Safety (AVS)									
061-110	A11.a	Fire Research and Safety	R,E&D	7,158	7,667	7,822	8,009	8,167	8,358
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	2,300	2,882	2,935	3,002	3,055	3,123
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	2,534	2,569	2,614	2,672	2,716	2,776
064-110/111	A11.d	Aircraft Icing/Digital System Safety	R,E&D	5,404	6,644	6,749	6,893	6,998	7,141
065-110	A11.e	Continued Airworthiness	R,E&D	11,600	13,202	13,404	13,686	13,886	14,165
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,147	1,691	1,717	1,753	1,779	1,815
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	6,162	5,416	5,542	5,685	5,817	5,965
060-110	A11.h	System Safety Management	R,E&D	10,027	11,345	11,512	11,750	11,914	12,149
086-110	A11.j	Aeromedical Research	R,E&D	11,000	9,895	10,117	10,372	10,602	10,865
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,504	5,901	5,977	6,094	6,166	6,280
		Subtotal	**R,E&D**	60,836	67,212	68,389	69,916	71,100	72,637
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	14,639	7,500	8,000	8,000	8,000	8,000
		***AVS* TOTAL**		**75,475**	**74,712**	**76,389**	**77,916**	**79,100**	**80,637**
Air Traffic Organization (ATO)									
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,364	10,014	10,232	10,486	10,711	10,972
041-110	A11.k	Weather Program	R,E&D	16,043	15,539	15,722	16,020	16,193	16,480
027-110	A12.a	Joint Planning and Development Office (JPDO)	R,E&D	5,000	12,000	12,226	12,510	12,738	13,024
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,674	10,350	10,516	10,742	10,907	11,132
011-130	A14.a	System Planning and Resource Management	R,E&D	1,717	1,757	1,775	1,810	1,827	1,859
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,777	3,702	3,786	3,882	3,969	4,068
111-160	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	2,071	1,995	2,026	2,069	2,099	2,142
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	7,000	10,172	10,332	10,552	10,711	10,930
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	3,500	7,796	7,920	8,089	8,213	8,381
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	8,000	4,826	4,912	5,022	5,109	5,220
		Subtotal	**R,E&D**	68,146	78,151	79,447	81,182	82,477	84,208
S09.02-00	1A01A	Runway Incursion Reduction	F&E	4,500	2,898	5,000	5,000	5,000	5,000 /3
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	5,200	5,600	6,000	6,000	6,000	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	3,500	4,300	4,000	4,000	4,000	4,000
M08.28-04	1A01D	Airspace Management Program	F&E	3,000	6,100	5,000	5,000	5,000	5,000
M08.27-01		NAS Weather Requirements	F&E	900	0	0	0	0	0
G1M.02-01	1A08A	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	F&E	8,122	5,000	5,000	5,000	5,000	5,000 /4
G1M.02-02	1A08B	NextGen - New Air Traffic Management Requirements	F&E	26,444	22,000	22,000	22,000	22,000	29,000
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	8,122	5,000	5,000	5,000	5,000	5,000
G3M.04-01	1A08D	NextGen - Staffed NextGen Towers	F&E	4,911	3,500	2,000	6,000	6,000	6,000
G7M.02-02	1A08H	NextGen - Operational Assessments	F&E	8,123	7,000	8,000	8,000	8,000	8,000
G6M.02-02	1A08F	NextGen - Wake Turbulence - Re-categorization	F&E	2,456	1,500	1,500	1,500	1,500	3,000
M03.02-00	4A08A	Center for Advanced Aviation System Development (CAASD)	F&E	20,045	17,990	19,275	19,275	19,275	19,275 /5
		Subtotal	**F&E**	95,323	80,888	82,775	86,775	86,775	95,775 /2
		***ATO* TOTAL**		**163,469**	**159,039**	**162,222**	**167,957**	**169,252**	**179,983**
Airports (ARP)									
--	--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000 /7
--	--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Technology Research Program - Capacity	AIP	12,025	12,507	12,507	12,507	12,507	12,507 /6
--	--	Airport Technology Research Program - Environment	AIP	1,500	1,500	1,500	1,500	1,500	1,500
--	--	Airport Technology Research Program - Safety	AIP	15,725	15,293	15,293	15,293	15,293	15,293
		***ARP* TOTAL**		**44,250**	**44,300**	**44,300**	**44,300**	**44,300**	**44,300**
Policy, International Affairs, and Environment (APL)									
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,074	14,776	14,979	15,280	15,477	15,773
G1M.02-01	A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	23,500	19,861	20,185	20,622	20,946	21,382
		Subtotal	**R,E&D**	38,574	34,637	35,164	35,902	36,423	37,155
G6M.02-01	1A08E	NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	12,183	9,500	10,000	10,000	10,000	10,000
		Subtotal	**F&E**	12,183	9,500	10,000	10,000	10,000	10,000 /2
		***APL* TOTAL**		**50,757**	**44,137**	**45,164**	**45,902**	**46,423**	**47,155**
Commercial Space Transportation (AST)									
--	--	Commercial Space Transportation Safety	Ops	1,000	1,000	1,000	1,000	1,000	1,000
		***AST* TOTAL**		**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
		GRAND TOTAL		**$334,951**	**$323,188**	**$329,075**	**$337,075**	**$340,075**	**$353,075**

Notes:

/1 The funding levels listed for years 2014 to 2017 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 four 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 25.7% in FY 2012.
/6 The three programs in the Airport Technology Research Program (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: Planned R&D Budget by Research Category

Project Number	FY 2013 BLI	Program	Appropriation Account	2012 Enacted ($000)	2013 Request ($000)	2014 Estimate ($000)	2015 Estimate ($000)	2016 Estimate ($000)	2017 Estimate ($000) /1
Applied Research									
061-110	A11.a	Fire Research and Safety	R,E&D	7,158	7,667	7,822	8,009	8,167	8,358
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	2,300	2,882	2,935	3,002	3,055	3,123
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	2,534	2,569	2,614	2,672	2,716	2,776
064-110/111	A11.d	Aircraft Icing/Digital System Safety	R,E&D	5,404	6,644	6,749	6,893	6,998	7,141
065-110	A11.e	Continued Airworthiness	R,E&D	11,600	13,202	13,404	13,686	13,886	14,165
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,147	1,691	1,717	1,753	1,779	1,815
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	6,162	5,416	5,542	5,685	5,817	5,965
060-110	A11.h	System Safety Management	R,E&D	10,027	11,345	11,512	11,750	11,914	12,149
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,364	10,014	10,232	10,486	10,711	10,972
086-110	A11.j	Aeromedical Research	R,E&D	11,000	9,895	10,117	10,372	10,602	10,865
041-110	A11.k	Weather Program	R,E&D	16,043	15,539	15,722	16,020	16,193	16,480
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	3,504	5,901	5,977	6,094	6,166	6,280
111-160	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	2,071	1,995	2,026	2,069	2,099	2,142
027-110	A12.a	Joint Planning and Development Office (JPDO)	R,E&D	5,000	12,000	12,226	12,510	12,738	13,024
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	10,674	10,350	10,516	10,742	10,907	11,132
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	7,000	10,172	10,332	10,552	10,711	10,930
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	3,500	7,796	7,920	8,089	8,213	8,381
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	8,000	4,826	4,912	5,022	5,109	5,220
091-110/111/116	A13.a	Environment and Energy	R,E&D	15,074	14,776	14,979	15,280	15,477	15,773
111-150	A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	23,500	19,861	20,185	20,622	20,946	21,382
011-130	A14.a	System Planning and Resource Management	R,E&D	1,717	1,757	1,775	1,810	1,827	1,859
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,777	3,702	3,786	3,882	3,969	4,068
		Subtotal	**R,E&D**	167,556	180,000	183,000	187,000	190,000	194,000
--	--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000 /2
--	--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	--	Airport Technology Research Program - Capacity	AIP	12,025	12,507	12,507	12,507	12,507	12,507 /3
--	--	Airport Technology Research Program - Environment	AIP	1,500	1,500	1,500	1,500	1,500	1,500
--	--	Airport Technology Research Program - Safety	AIP	15,725	15,293	15,293	15,293	15,293	15,293
		Subtotal	**AIP**	44,250	44,300	44,300	44,300	44,300	44,300
--	--	Commercial Space Transportation Safety	Ops	500	500	500	500	500	500 /4
		Subtotal	**Ops**	500	500	500	500	500	500
		***Applied Research* TOTAL**		**212,306**	**224,800**	**227,800**	**231,800**	**234,800**	**238,800**
		***Applied Research* PERCENT**		**63.4%**	**69.6%**	**69.2%**	**68.8%**	**69.0%**	**67.6%**
Development									
S09.02-00	1A01A	Runway Incursion Reduction	F&E	4,500	2,898	5,000	5,000	5,000	5,000 /5
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	5,200	5,600	6,000	6,000	6,000	6,500
M08.29-00	1A01C	Operations Concept Validation	F&E	3,500	4,300	4,000	4,000	4,000	4,000
M08.28-04	1A01D	Airspace Management Program	F&E	3,000	6,100	5,000	5,000	5,000	5,000
M08.27-01		NAS Weather Requirements	F&E	900	0	0	0	0	0
G1M.02-01	1A08A	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	F&E	8,122	5,000	5,000	5,000	5,000	5,000 /6
G1M.02-02	1A08B	NextGen - New Air Traffic Management Requirements	F&E	26,444	22,000	22,000	22,000	22,000	29,000
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	8,122	5,000	5,000	5,000	5,000	5,000
G3M.04-01	1A08D	NextGen - Staffed NextGen Towers	F&E	4,911	3,500	2,000	6,000	6,000	6,000
G6M.02-01	1A08E	NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	12,183	9,500	10,000	10,000	10,000	10,000
G6M.02-02	1A08F	NextGen - Wake Turbulence - Re-categorization	F&E	2,456	1,500	1,500	1,500	1,500	3,000
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	14,639	7,500	8,000	8,000	8,000	8,000
G7M.02-02	1A08H	NextGen - Operational Assessments		8,123	7,000	8,000	8,000	8,000	8,000
M03.02-00	4A08A	Center for Advanced Aviation System Development (CAASD)	F&E	20,045	17,990	19,275	19,275	19,275	19,275 /7
		Subtotal	**F&E**	122,145	97,888	100,775	104,775	104,775	113,775 /8
--	--	Commercial Space Transportation Safety	Ops	500	500	500	500	500	500 /4
		Subtotal	**Ops**	500	500	500	500	500	500
		***Development* TOTAL**		**122,645**	**98,388**	**101,275**	**105,275**	**105,275**	**114,275**
		***Development* PERCENT**		**36.6%**	**30.4%**	**30.8%**	**31.2%**	**31.0%**	**32.4%**
		GRAND TOTAL		**$334,951**	**$323,188**	**$329,075**	**$337,075**	**$340,075**	**$353,075**

Notes:

/1 The funding levels listed for years 2014 to 2017 are estimates and subject to change.
/2 The three programs in the Airport Cooperative Research Program (AIP) are combined into a single narrative write-up in Appendix A.
/3 The three programs in the Airport Technology Research Program (AIP) are combined into a single narrative write-up in Appendix A.
/4 The Commercial Space Transportation Safety Program is 50 percent applied research and 50 percent development.
/5 The four programs in the ADT&P line (1A01) are combined into a single narrative write-up in Appendix A.
/6 The eight programs in the NextGen - Systems Development line (1A08) are combined into a single narrative write-up in Appendix A.
/7 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 25.7% in FY 2012.
/8 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.

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

Project Number	FY 2013 BLI	Program /1	Appropriation Account	FY 2013 Contract Costs ($000)	FY 2013 Personnel Costs ($000)	FY 2013 Other In-house Costs ($000)	FY 2013 Total Request ($000)
1. Safety							
061-110	A11.a	Fire Research and Safety	R,E&D	3,694	3,673	300	7,667
063-110	A11.b	Propulsion and Fuel Systems	R,E&D	1,683	1,099	100	2,882
062-110/111	A11.c	Advanced Materials/Structural Safety	R,E&D	1,604	841	124	2,569
064-110/111	A11.d	Aircraft Icing/Digital System Safety	R,E&D	4,723	1,748	173	6,644
065-110	A11.e	Continued Airworthiness	R,E&D	9,770	3,070	362	13,202
066-110	A11.f	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,248	399	44	1,691
081-110	A11.g	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	1,698	3,459	259	5,416
060-110	A11.h	System Safety Management	R,E&D	8,742	2,343	260	11,345
082-110	A11.i	Air Traffic Control/Technical Operations Human Factors	R,E&D	3,978	5,671	365	10,014
086-110	A11.j	Aeromedical Research	R,E&D	3,590	5,970	335	9,895
041-110	A11.k	Weather Program	R,E&D	14,445	748	346	15,539
069-110	A11.l	Unmanned Aircraft Systems Research	R,E&D	5,122	664	115	5,901
111-160	A11.m	NextGen - Alternative Fuels for General Aviation	R,E&D	1,919	34	42	1,995
011-130	A14.a	System Planning and Resource Management	R,E&D	439	6	8	954 /2
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	415	732	47	2,507 /2
		Subtotal	**R,E&D**	63,070	30,458	2,880	98,221
S09.02-00	1A01A	Runway Incursion Reduction	F&E	2,898	0	0	2,898
		Subtotal	**F&E**	2,898	0	0	2,898 /4
--	--	Airport Cooperative Research Program - Safety	AIP	4,889	111	0	5,000
--	--	Airport Technology Research Program - Safety	AIP	13,143	2,150	0	15,293
		Subtotal	**AIP**	18,032	2,261	0	20,293
--	--	Commercial Space Transportation Safety	Ops	1,000	0	0	1,000
		Subtotal	**Ops**	1,000	0	0	1,000
		1. Safety TOTAL		**85,000**	**32,719**	**2,880**	**122,412**
2. Economic Competitiveness							
027-110	A12.a	Joint Planning and Development Office (JPDO)	R,E&D	9,219	2,448	333	12,000
111-130	A12.b	NextGen - Wake Turbulence	R,E&D	9,657	345	348	10,350
111-110	A12.c	NextGen - Air Ground Integration Human Factors	R,E&D	9,671	300	201	10,172
111-120	A12.d	NextGen - Self-Separation Human Factors	R,E&D	7,275	329	192	7,796
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	3,885	746	195	4,826
011-130	A14.a	System Planning and Resource Management	R,E&D	440	6	10	454 /2
011-140	A14.b	William J. Hughes Technical Center Laboratory Facility	R,E&D	415	732	47	1,195 /2
		Subtotal	**R,E&D**	40,562	4,907	1,325	46,793
M08.28-00	1A01B	System Capacity, Planning and Improvement	F&E	5,600	0	0	5,600
M08.29-00	1A01C	Operations Concept Validation	F&E	4,300	0	0	4,300
M08.28-04	1A01D	Airspace Management Program	F&E	6,100	0	0	6,100
G1M.02-01	1A08A	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	F&E	5,000	0	0	5,000
G1M.02-02	1A08B	NextGen - New Air Traffic Management Requirements	F&E	22,000	0	0	22,000
G1M.02-03	1A08C	NextGen - Operations Concept Validation - Validation Modeling	F&E	5,000	0	0	5,000
G6M.02-01	1A08E	NextGen - Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	9,500	0	0	9,500
G6M.02-02	1A08F	NextGen - Wake Turbulence - Re-categorization	F&E	1,500	0	0	1,500
G7M.02-01	1A08G	NextGen - System Safety Management Transformation	F&E	7,500	0	0	7,500
G7M.02-02	1A08H	NextGen - Operational Assessments	F&E	7,000	0	0	7,000
M03.02-00	4A08A	Center for Advanced Aviation System Development (CAASD)	F&E	17,990	0	0	17,990 /3
		Subtotal	**F&E**	91,490	0	0	91,490 /4
--	--	Airport Cooperative Research Program - Capacity	AIP	4,889	111	0	5,000
--	--	Airport Technology Research Program - Capacity	AIP	10,748	1,759	0	12,507
		Subtotal	**AIP**	15,637	1,870	0	17,507
		2. Economic Competitiveness TOTAL		**147,690**	**6,777**	**1,325**	**155,790**
4. Environmental Sustainability							
091-110/111/116	A13.a	Environment and Energy	R,E&D	12,192	1,883	701	14,776
111-150	A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	18,201	1,182	478	19,861
011-130	A14.a	System Planning and Resource Management	R,E&D	338	5	6	349 /2
		Subtotal	**R,E&D**	30,731	3,070	1,185	34,986
G3M.04-01	1A08D	NextGen - Staffed NextGen Towers	F&E	3,500	0	0	3,500
		Subtotal	**F&E**	3,500	0	0	3,500 /4
--	--	Airport Cooperative Research Program - Environment	AIP	4,889	111	0	5,000
--	--	Airport Technology Research Program - Environment	AIP	1,289	211	0	1,500
		Subtotal	**AIP**	6,178	322	0	6,500
		4. Environmental Sustainability TOTAL		**40,409**	**3,392**	**1,185**	**44,986**
		GRAND TOTAL		**273,099**	**42,888**	**5,390**	**323,188**

Notes:

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

/2 System Planning and Resource Management 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 54.3%; Economic Competitiveness at 25.9%; and Environmental Sustainability at 19.8%. William J. Hughes Technical Center is considered part of Mission Support; it is pro-rated between Safety at 67.7% and Mobility at 32.3%.

/3 The amount shown for CAASD includes only the R&D portion of the total CAASD base funding amount. R&D represents 25.7% in FY 2012.

/4 The amounts shown for F&E programs reflect only R&D activities. They exclude acquisition, operational testing, and 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 support 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: MOU/MOA 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) or written agreements between the FAA and other agencies in which the FAA agrees to receive or exchange supplies or services with the other agency. Appendix B lists FAA MOUs, MOAs, and IAs that were active in FY 2011.

Joint Planning and Development Office: The JPDO provides government-wide planning and coordination for NextGen. The JPDO members include the Department of Defense (DoD), the Department of Transportation (DOT), the Department of Homeland Security, the Department of Commerce, the FAA, the National Aeronautics and Space Administration (NASA), and the Office of Science and Technology Policy (OSTP). Its mission is to coordinate federal aviation R&D and focus 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 the FAA is aligned with partner government agencies and other stakeholders that contribute to NextGen. 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, the FAA works with the Environmental Protection Agency to address air quality and emissions issues facing aviation. For more information, see http://www.epa.gov/geoss/.

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. The FAA does this through the following groups and mechanisms:

Commercial Aviation Safety Team: Founded in 1998, the Commercial Aviation Safety Team (CAST) has developed an integrated, data-driven strategy to reduce the commercial aviation fatality risk in the United States and promote new government and industry safety initiatives throughout the world. The CAST charters working group stakeholders to conduct in-depth analysis of the top accident categories in commercial aviation for which safety enhancements are identified. Successes of CAST prove that the concept of industry and government working together on common commercial air travel accident prevention strategies is highly effective. Members of CAST (not all-inclusive) include Airbus, Boeing, GE Aviation, Air Line Pilots Association, Allied Pilots Association, International Civil Aviation Organization, Flight Safety Foundation, International Air Transport Association, European Aviation Safety Authority, FAA, NASA, National Air Traffic Controllers Association, Regional Airline Association, Transport Canada Civil Aviation, and DoD.

General Aviation Joint Steering Committee: As part of the Safer Skies Focused Safety Agenda launched in 1998, the FAA and the GA community agreed to a goal of reducing the overall GA fatal accident rate. The General Aviation Joint Steering Committee (GAJSC), co-chaired by the FAA and the Aircraft Owners and Pilots Association (AOPA) Air Safety Institute, is the primary conduit for government and aviation industry cooperation, communication, and coordination for aircraft accident mitigation. The GAJSC conducts its activities through three working groups: personal/sport aviation, technically advanced aircraft/automation, and turbine aircraft operations. Members of GAJSC include the FAA, AOPA, AOPA Air Safety Institute, Experimental Aircraft Association, General Aviation Manufacturers Association, Helicopter Association International, National Air Transportation Association, National Business Aviation Association, NTSB, and the National Weather Service.

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, and state and local government agencies. Appendix B provides a list of active CRDAs for FY 2011. 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, demonstrate, test, and develop prototypes of 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. Inventions, including those protected by patents, are one of the most transferred type of intellectual property. 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 leverages the nation's significant investment in basic and applied research and 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 2011.

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 the grants awarded in FY 2011 for 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://www.avsi.aero/.

International

The FAA uses cooperative agreements with European and North American aviation organizations to participate in aviation safety and Air Traffic Management (ATM) modernization programs and to leverage research activities that harmonize operations and promote a seamless and safe air transportation system worldwide.

The European Organisation for the Safety of Air Navigation: The European Organisation for the Safety of Air Navigation (EUROCONTROL) is a civil and military organization with the goal of developing 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 safety and environmental factor harmonization. For more information, see http://www.eurocontrol.int/.

Atlantic Interoperability Initiative to Reduce Emissions: Established in 2007, the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) provides a foundation for cooperation between the FAA and the European Commission to promote and harmonize environmental initiatives and procedures in European and North American airspace. In addition to facilitating transatlantic interoperability between aviation authorities and industry partners, such as aircraft manufacturers, air operators, and providers of aviation navigation services, AIRE promotes information sharing and demonstration of procedures and practices that reduce noise and environmental emissions. Demonstrations have occurred annually since 2008 and include optimizations in all phases of flight: airport surface, terminal area, and en route oceanic. Demonstrations have resulted in fuel savings and emissions across all three of these domains. For more information, see: http://www.faa.gov/nextgen/portfolio/trans_support_progs/aire/.

Transport Canada: In the spring of 2004, Transport Canada joined FAA and NASA as a sponsor of the PARTNER (Partnership for AiR Transportation Noise and Emissions Reduction) Center of Excellence. Transport Canada has studied and will continue to study air quality at Canadian airports to develop and implement practices that reduce air pollution from airports. Canada, as a member state of the International Civil Aviation Organization, 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.

The Asia and Pacific Initiative to Reduce Emissions: The Asia and Pacific Initiative to Reduce Emissions (ASPIRE), established in 2008, is a partnership of Asia and Pacific ANSPs focused on environmental stewardship in the Pacific Ocean region. Under ASPIRE, current and future partners pledge to adopt and promote best practices to reduce fuel consumption and engine emissions. ASPIRE demonstrations have consisted of green flights which use existing efficiency procedures in an ideal, unconstrained air traffic environment. As a result of these successful demonstration flights, ASPIRE-Daily was launched in 2011 to promote the utilization of best practices such as user-preferred routing, Dynamic Airborne Reroute Procedures, and optimizations during arrival and departure between selected city pairs to promote daily fuel-savings. For more information, see: http://www.aspire-green.com/.

International Helicopter Safety Team: Attendees at the 2005 International Helicopter Safety Symposium agreed upon the need to reduce the helicopter accident rate by 80% by 2016. To achieve this goal, the attendees agreed to form an independent group modeled after the CAST - known as the International Helicopter Safety Team (IHST). To facilitate a data-driven approach to safety, the IHST initiates joint government and industry teams to analyze accidents, conduct causal analyses, and recommend intervention implementation strategies.

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 Research and Development Management Division 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 R&D Executive Board (REB) provides portfolio approval. The REB includes senior executives representing the major FAA R&D sponsors. 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.[24] A maximum of 30 members can serve on the REDAC and represent corporations, universities, associations, consumers, and government agencies.

During 2011, the REDAC held two committee meetings and nine 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/.

---

[24] 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. DOT on matters relating to the U.S. commercial space transportation industry, including R&D activities. Currently, the Committee has twenty-five members. The Administrator recommends members to the Secretary of Transportation, who appoints them. 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 2011, the COMSTAC held two full committee meetings and eight working group meetings, as well as several teleconferences. The Committee produced one set of recommendations and several findings at its May 2011 meeting. The recommendations focused on export controls and urged FAA to communicate to the State Department COMSTAC's support for export control reform and public release of Commodity Jurisdiction requests and advisory opinions. 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 Airport Cooperative Research Program (ACRP) for the FAA with program oversight and governance provided by representatives of airport operating agencies.

The ACRP Oversight Committee announced their FY 2012 projects in August 2011. The 29 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/.

Acronyms and Abbreviations

Acronym	Definition
A	
AC	Advisory Circular
ACER	Airliner Cabin Environment Research
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance-Broadcast
AEDT	Aviation Environmental Design Tool
AIAA	American Institute of Aeronautics and Astronautics
AIP	Airport Improvement Program Appropriation
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
ANSP	Air Navigation Service Provider
AOPA	Aircraft Owners and Pilots Association
ASIAS	Aviation Safety Information Analysis and Sharing
ASPIRE	Asia and South Pacific Initiative to Reduce Emissions
AST	Office of Commercial Space Transportation
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATC	Air Traffic Control
ATD	Anthropomorphic Test Dummy
ATD&P	Advanced Technology and Development and Prototyping
ATM	Air Traffic Management
ATSP	Air Traffic Service Provider
AVS	Aviation Safety
B	
BLI	Budget Line Item
BOS	Boston Logan International Airport
C	
CAASD	Center for Advanced Aviation System Development
CAMI	Civil Aerospace Medicine Institute
CAST	Commercial Aviation Safety Team
CATM	Collaborative Air Traffic Management
CDTI	Cockpit Display of Traffic Information
CH_4	Methane
CIP	Capital Investment Plan
CIP	Current Icing Product
CLEEN	Continuous Lower Energy, Emissions and Noise
CO_2	Carbon Dioxide
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
CONOPS	Concept of Operations
CONUS	Continental United States

Acronym	Definition
CRDA	Cooperative Research and Development Agreement
CVA	Ceiling and Visibility Analysis
CVM	Comparative Vacuum Monitoring
D	
DARWIN®	Design Assessment Of Reliability With Inspection
DFW	Dallas-Fort Worth International Airport
DHS	U.S. Department of Homeland Security
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
E	
EA	Enterprise Architecture
EFB	Electronic Flight Bag
EFVS	Enhanced Flight Vision Systems
EMAS	Engineered Material Arresting System
EMS	Environmental Management System
EUROCONTROL	European Organization for the Safety of Air Navigation
F	
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FAC	Transform Facilities
FBTM	Flow Based Trajectory Management
FDM	Flight Data Monitoring
FIP	Forecast Icing Product
FIP-Severity	Forecast Icing Product with Severity
FLEX	Flexible Terminals and Airports
FLM	Front Line Manager
FY	Fiscal Year
G	
GA	General Aviation
GAJSC	General Aviation Joint Steering Committee
GE	General Electric
GEG	Spokane International Airport
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GPS	Global Positioning System
H	
HART	Human Automation Relationship Taxonomy
HD	High Density
HEFA	Hydroprocessed Esters and Fatty Acids
HITL	Human-in-the-Loop
HSI	Human-System Integration
I	

Acronym	Definition
IA	Interagency Agreement
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
IHST	International Helicopter Safety Team
IIV	Interior Intervention Vehicle
IMC	Instrument Meteorological Conditions
J	
JPDO	Joint Planning and Development Office
JRC	Joint Resources Council
L	
LAX	Los Angeles International Airport
LCGS	Low Cost Ground Surveillance
LED	Light Emitting Diode
LGB	Long Beach Airport
LOSA	Line Operations Safety Audit
M	
MET	Meteorological
MHT	Manchester Boston Regional Airport
MOA	Memorandum of Agreement
MOC	Memorandum of Cooperation
MOU	Memorandum of Understanding
N	
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAS EA	National Airspace System Enterprise Architecture
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
NGIP	NextGen Implementation Plan
NSTC	National Science and Technology Council
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxide
NRS	Navigation Reference System
NSTC	National Science and Technology Council
NTSB	National Transportation Safety Board
N_2O	Nitrous Oxide
O	
OI	Operational Improvement
OMB	Office of Management and Budget
Opeval	Operational Evaluation
Ops	Operations Appropriation
OSTP	Office of Science and Technology Policy
P	

Acronym	Definition
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PCT	Potomac Consolidated TRACON
PRM	Precision Runway Monitor
PRSEUS	Pultruded Rod Stitched Efficient Unitized Structure
Q	
QRG	Quick Reference Guide
R	
R&D	Research and Development
RAM	Repairs, Alterations, and Modifications
RE&D	Research, Engineering and Development Appropriation
REB	Research and Development Executive Board
REDAC	Research, Engineering, and Development Advisory Committee
REL	Runway Entrance Lights
RLV	Reusable Launch Vehicle
RNO	Reno-Tahoe International Airport
RTCA	Radio Technical Commission for Aeronautics
RWSL	Runway Status Lights
S	
SAA	Sense and Avoid
SAE	Society of Automotive Engineers
SAN	San Diego International Airport
SF_6	Sulfur Hexafluoride
SHM	Structural Health Monitoring
SJC	Mineta San Jose International Airport
SMA	Small & Medium Airports
SMART	Small Aircraft Risk Technology
SMS	Safety Management System
SNT	Staffed NextGen Towers
SSE	Safety, Security, and the Environment
SWAC	System Wide Analysis Capability
T	
TARGETS	Terminal Area Route Generation, Evaluation, and Traffic Simulation
TBO	Trajectory-Based Operations
TCAS	Traffic Alert and Collision Avoidance System
TFM	Traffic Flow Management
THL	Takeoff Hold Lights
TRACON	Terminal Radar Approach Control Facility
TRB	Transportation Research Board
U	
UAS	Unmanned Aircraft System
USAF	United States Air Force
USAGE	U.S. Applied General Equilibrium
USGCRP	U.S. Global Change Research Program

Acronym	Definition
U.S.	United States
U.S.C	United States Code
V	
VFR	Visual Flight Rules
W	
WFD	Widespread Fatigue Damage
WTIC	Weather Technology in the Cockpit

Photo Credits

Kent Williams

Cover, iii, vi, 7, 8, 12, 18, 25, 26, 32, 40, 49, 50, 58, 62, 68, 77, 78, 83, 84, 87, 91, 92

www.Army.mil

31, 39

Wikipedia Commons

57

HQ-121522

Federal Aviation Administration

2012
National Aviation Research Plan (NARP)

Appendices

March 2012

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

Appendix A: Program Descriptions

Table of Contents

Detailed Justification for
A11.a Fire Research and Safety

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

FY 2013 – Fire Research and Safety

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.a Fire Research and Safety	$7,158,000	$7,158,000	$7,667,000	+$509,000

For FY 2013, $7,667,000 is requested for Fire Research and Safety. Major activities and accomplishments planned include:

Improve Aircraft Fire Protection and Occupant Fire Survivability

- Define fire safety performance criteria for cargo containers used for the bulk shipment of lithium batteries.
- Determine the effectiveness of Halon 1301 in controlling bulk shipments of rechargeable lithium batteries under full-scale cargo compartment fire test conditions.
- Develop a standard test procedure for lithium battery fire suppression in the Minimum Performance Standard (MPS) for halon replacement agents in cargo compartments.
- Evaluate the effectiveness of FAA certification criteria to prevent cockpit smoke build-up during an in-flight fire.

Improved Flammability Standards for Aircraft Materials

- Develop a flammability test method for seat structure incorporating potentially combustible materials such as magnesium alloys.
- Upgrade Aircraft Materials Fire Test Handbook in support of rulemaking to revamp FAA flammability regulations.

For FY 2013, FAA 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 transportation of lithium batteries will be emphasized by the evaluation of available agents and systems to extinguish lithium battery fires and the development of fire-hardened containers to ship lithium batteries. Work will continue to meet deadlines proposed by the International Civil Aviation Association (ICAO) to ban halon – an ozone depleting and global warming chemical – used extensively in aircraft fire extinguishing systems. Particular emphasis will be placed on the evaluation of environmentally-friendly replacement agents under full-scale fire test conditions in cargo compartments – by far, the largest and most challenging application for halon.

FAA will continue to develop and standardize new flammability tests to reduce the risk from an uncontrollable in-flight fire, improve existing flammability tests, and develop new tests for novel applications of material that may impact fire safety. This work supports unprecedented FAA rulemaking activity to improve and simplify the flammability requirements for materials. Effective fire tests and performance criteria are needed for hidden area materials (wiring, ducting), fuselage structural composites, and the novel application of magnesium alloy in seat structure.

Research in support of improving the flammability standards for aircraft materials will focus on the development of computational models to predict the impact of material substitutions and ultra-fire resistant materials on cabin fire safety and occupant survivability. Researchers will also continue to develop and evaluate non-hazardous ultra-fire resistant materials for a fire proof cabin.

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 ongoing 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. Systems fire protection and materials fire safety focuses on near-term improvements in fire test methods and materials performance criteria, fire detection and suppression systems, and hazardous materials fire safety. 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.
- American Society for Testing and Materials (ASTM) - FAA works with ASTM to update and maintain a new flammability test method based on the FAA microscale combustion calorimeter, codified as ASTM D7309.

Fire Research and Safety Program R&D partners include:

- FAA-sponsored International Systems Fire Protection Working Group – R&D involves lithium battery fire hazards, freighter aircraft safety, hidden fire safety, fire and smoke detectors, halon replacement, and fuel tank protection.
- FAA-sponsored International Aircraft Materials Fire Test Working Group – R&D involves development and standardization of improved material fire tests.
- 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.
- Research consortia with Fortune 100 companies and other agencies to share cost of developing new fire-resistant materials and numerical fire models.

In FY 2012, major activities and accomplishments planned include:

Improve Aircraft Fire Protection and Occupant Fire Survivability

- Completed tests in engine fire simulator to determine the fire extinguishing effectiveness and performance criteria for novel, environmentally friendly dry powder agent.
- Developed a cost-effective halon (an ozone depleting and global warming chemical) replacement system for hand-held extinguishers.
- Evaluated the effectiveness and safety (toxicity) of hand-held extinguishers discharging contaminated halon.
- Determined the capability of existing airline hazardous materials containers for preventing the hazards of a lithium battery fire from spreading outside of the containers.
- Studied novel agents and systems for the suppression of cargo fires in freighter aircraft.
- Extended the FAA ThermaKin burning model to two-dimensional burning of layered and structural composite materials.
- Down-selected computational fluid dynamics models for full-scale aircraft cabin fire model.
- Validated and implemented National Institute of Standards and Technology (NIST) computational fluid dynamics model for cargo compartment fires to assess fire detection, suppression and mitigation (flight plan) strategies.
- Determined the effect of altitude (pressure) and oxygen concentration (partial pressure) on burning rate of plastics in order to develop mitigation strategies (e.g., flight plan, inerting) for in-flight cargo fires.
- Developed a probabilistic model for flame (Bunsen burner) and fire (rate of heat release apparatus) test results using FAA microscale combustion calorimeter data to predict compliance with test criteria (pass/fail).

Improved Flammability Standards for Aircraft Materials

- Defined composite fuselage fire safety design criteria.
- Developed an improved next generation burner test method for the fireworthiness of engine components.

Research continued on in-flight fire safety in both freighter (all cargo) and passenger-carrying aircraft. Related to freighter aircraft, fire extinguishing tests were conducted with promising agents toward the development of a practical and cost-effective suppression system. Also, fire tests evaluated available agents and systems to extinguish lithium battery fires and supported the development of a fire-hardened container to ship lithium batteries. This work was driven by 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 addition, because of deadlines proposed by the International Civil Aviation Organization (ICAO), more full and large-scale tests were 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, discovery of contamination in recycled halon required testing to determine the effect on extinguishment effectiveness and safety (toxicity).

The FAA also continued 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 was adapted for powerplant component fire tests because the existing antiquated burner produces variable results. Also, new fire tests and performance criteria were developed for structural composite fuselages, such as the new Boeing 787. Work will be continued on the development of computational models to predict the effect of material substitutions and ultra-fire resistant materials on aircraft fire safety and occupant survivability.

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 computational models to support 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 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.

The FAA Fire Research and Safety Program 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 900 incidents of odor and smoke occur each year in the United States in large transport aircraft); 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.

As described earlier, there are very significant opportunities for a serious fire in a large transport aircraft. Although the likelihood of such a fire is rare, the consequences can be great. For example, the most catastrophic in-flight fire in the history of aviation caused 301 fatalities (Saudia L-1011, 1980). The goals of the Fire Research and Safety Program are to prevent in-flight fires and fuel tank explosions, and to improve survivability in the event of a postcrash fire. Saving lives and preventing property losses are the obvious benefits of this program. Practically every major fire safety improvement implemented in transport aircraft throughout the world over the past 30 years has been a product of this program. Over the years these improvements have undoubtedly saved many lives. For example, on August 2, 2005 an Airbus A340 with 297 passengers and 12 crewmembers landing at Toronto International Airport during a thunderstorm, ran off the end of the runway, came to a stop in a ravine and was destroyed by an ensuing fire. Similarly, on December 20, 2008 a Continental 737 with 110 passengers and 5 crewmen veered off the runway at Denver International Airport during attempted take-off in a strong crosswind, experienced a postcrash fire and was extensively damaged. Although there were some injuries, none of the 424 occupants of the two airplanes involved in these very serious accidents were killed, likely due at least in part to fire safety improvements that were products of the Fire Safety and Research Program.

In an attempt to quantify the improvement in fire safety over the past 40 years, 672 world-wide survivable accidents involving large transport turbojet and turboprop airplanes were analyzed from 1968 to 2007. It was determined that survivability improved markedly over the study period with a greater proportion of accidents being survivable and a marked increase in the proportion of occupants surviving the accident. In fact, the probability of dying in an aircraft fire has been reduced (improved) by a factor of three. The study is described in the FAA report, "Trends in Accidents and Fatalities in Large Transport Aircraft", which is accessible at http://www.fire.tc.faa.gov/reports/listresults.asp?searchList=DOT%2FFAA%2FAR-10%2F16&listSubmit=Submit.

If the program were not funded potential future improvements in fire safety may not be realized. The large number of unknown smoke and odor incidents – over 900 annually in the United States – continues to be a great concern. New technologies such as composite structure or magnesium seat components would be introduced without adequate safeguards. In addition, the risk of a fire caused by the shipment of hazardous cargo such as lithium batteries would be greater. The major aircraft manufacturers such as Boeing and Airbus do not have programs to increase aircraft fire safety. However, they closely monitor and are dependent upon the FAA's fire safety research and work cooperatively with FAA to evaluate and develop improvements.

4. How Do You Know The Program Works?

Over the past 30 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. As previously discussed, 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. Major 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. Also, in 2010, based on FAA fire safety R&D, (1) a Safety Alert for Operators (SAFO) was issued entitled "Risks in Transporting Lithium Batteries in Cargo by Aircraft", (2) a proposed revised advisory circular "Hand-Held Fire Extinguishers for use in Aircraft' was published in the Federal Register, and (3) a final rule became effective for the fire-safe shipment of oxygen cylinders and generators.

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. In 2009, 17 publications were authored by fire safety researchers, which accounted for about 30% of the publications by researchers at the FAA's William J. Hughes Technical Center.

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. The Subcommittee on Aircraft Safety (SAS), in particular, is the arm of the REDAC that oversees and critiques the FAA's aircraft safety R&D programs. Over the years the SAS has been complimentary and supportive of the Fire Research and Safety Program. The following SAS commentary illustrates the generally positive assessment of this program by the SAS: "The Safety Subcommittee believes that fire facility and personnel at the Tech Center are truly world-class, and it continues to provide meaningful benefits to the FAA, industry, and traveling public. The Safety Subcommittee believes that the FAA needs to ensure that this research capability is retained in the future and that its facilities are identified and maintained as critical national resources. The Ultra-fire Resistant Polymer program appears to be producing amazing results for very little resource expenditure. This is an excellent example of a proactive research approach and capability development."

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

The Fire Research and Safety Program develops the enabling technology to improve fire safety in transport aircraft. The products of the research are implemented into aviation by rulemaking, advisory materials and technology transfer. It is the only comprehensive program of this type and the researchers are recognized throughout the world as the experts in aircraft fire safety. Reductions in funding could would delay the implementation of fire safety improvements and increase the risk of an accident caused or accompanied by fire and the likelihood of fire fatalities.

Specific items in the program that could be impacted by a reduction in funding, depending on the actual level, that have a direct bearing on aircraft fire safety include the following:

- Performance criteria for lithium battery shipment containers.
- Efficacy of Halon 1301 in controlling a large shipment of rechargeable lithium batteries.
- Development of a cost effective fire suppression system for the main cargo compartments of freighter aircraft.
- Effectiveness of current aircraft design and operational procedures in preventing the accumulation of visibility-impairing smoke in the cockpit during an in-flight fire.
- Flammability test method for magnesium alloy seat structure.
- Standardization of more stringent and realistic fire test methods for aircraft wiring and ducting.
- Development of computational cabin fire models for predicting the impact of material substitutions on cabin fire safety and survivability.
- Determining the impact of a proposed ban on a class of fire retardants on the ability of industry to adhere to current material flammability regulations.

Identification of environmentally acceptable halon replacement agents, through full-scale fire testing, that effectively extinguish, suppress, or control in-flight fires (should the availability of halon in the near future become problematic to the aviation community).

Detailed Justification for
A11.b Propulsion and Fuel Systems

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

FY 2013 – A11.b Propulsion and Fuel Systems

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.b Propulsion and Fuel Systems	$2,301,000	$2,300,000	$2,882,000	+$582,000

For FY 2013, $2,882,000 is requested for Propulsion and Fuel Systems. Major activities and accomplishments planned include:

Incorporate Damage Tolerance into the Safe Life Rotor Design Process

- Release an enhanced version of DARWIN® (Design Assessment of Reliability with Inspection), the probabilistic rotor design and life management code.

The Probabilistic Design for Rotor Integrity (PDRI) program continues to address material and manufacturing anomalies that can increase the risk of failure of critical rotating turbine engine parts by advancing DARWIN®, the probabilistically-based turbine engine rotor design and life management code 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 also continues 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 program also contributes to the continued airworthiness of turbine engines by developing additional fleet assessment capabilities within DARWIN®.

2. What Is This Program?

FAA establishes rules for the certification and operation of aircraft engines, fuels, and airframe fuel management systems. 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 agency uses the results of this research to generate ACs and various other forms of technical information detailing acceptable means of compliance to guide certification and airworthiness specialists and inspectors.

The Propulsion and Fuel Systems Program supports the FAA Flight Plan 2009-13 Goal 1 (Increased Safety), Objective 1 (Reduce commercial air carrier fatalities).

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.

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 (TCRGs) – 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:

- PDRI Program – Southwest Research Institute has teamed with Pratt and Whitney, General Electric, Honeywell, and Rolls Royce to develop DARWIN®, the probabilistic-based rotor life and risk management certification tool.
- The AIA working subcommittees on rotor integrity and rotor manufacturing.

In FY 2012, major activities and accomplishments planned include:

Incorporate Damage Tolerance into the Safe Life Rotor Design Process

- Continued the enhancement of the DARWIN® probabilistic rotor design code.

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. The research goal is:

- By FY 2015, develop a certification tool that will predict the risk of failure of rotor disks containing material and manufacturing anomalies.

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 Delta Airlines Flight 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. This research has yielded a probabilistic damage tolerant rotor design and life management code (DARWIN®) to determine the risk of fracture of turbine engine rotor disks containing undetected material anomalies which is used by many of 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 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.

The initial version of the DARWIN® code was developed to address the subsurface defect known as hard alpha and to meet the requirements of a new AC on "Damage Tolerance for Turbine Engine Rotors", 33.14-1. Another version of DARWIN® addressed surface damage in bolt holes and provided the basis for AC 33.70-2, "Damage Tolerance of Hole Features in Turbine Engine Rotors". DARWIN® is an acceptable means of compliance to both of these new ACs.

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

A reduction would delay implementation of new ACs on surface damage in blade slots and on turned surfaces of turbine engine rotors, due to the fact that new versions of DARWIN® will provide the basis and an acceptable means of compliance to these new ACs.

Detailed Justification for
A11.c Advanced Materials/Structural Safety

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

FY 2013 – Advanced Materials/Structural Safety

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.c Advanced Materials/Structural Safety	$2,534,000	$2,534,000	$2,569,000	+$35,000

For FY 2013, $2,569,000 is requested for Advanced Materials/Structural Safety. Major activities and accomplishments planned include:

Advanced Materials

- Damage Tolerance of Composite Structures
  - Characterize and quantify the threats to composite aircraft structures while at the service gate and on the flight line.
  - Document accepted certification methodology for damage tolerance and fatigue, including full-scale test and analysis protocols for repeated loads and damage threats.
- Composite Maintenance Practices
  - Develop training and conduct workshops to review progress in damage tolerance, adhesive joints, and maintenance.
- Environmental and Aging Effects for Composite Structures
  - Develop information on the effect of environmental and heat exposure on structural properties and durability of composite structures.
- Structural Integrity of Adhesive Joints
  - Provide detailed background research addressing gaps testing and validation of durability of bonded structures.
  - Gain consensus from industry and regulators from around the world on standard durability substantiation methodology certification and continued airworthiness.

In 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.

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. This program is divided into two related structural research areas: Advanced Materials and Structural Safety.

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 recently published, advances in technologies and materials require periodic updates and expansion of safety information. These updates are contained in research workshops and reports which provide immediate information to the aviation community and a suite of policy and guidance documents pertaining to composite structures that are under constant revision. 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. This data exchange allows regulatory processes to keep pace with industry advances and benefit from state-of-the-art technology and design. This efficiently provides safety and certification information to the FAA certification service and industry.

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, the Commercial Aircraft Composite Repair Committee (CACRC), ASTM, and Society for the Advancement of Material & Process Engineering).

The Interagency Advanced Structures Working Group, which consists of FAA, NASA and the Department of Defense, 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.

The FAA has established an Interagency Agreement with NASA to collaborate on safety issues for composite research.

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

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. 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:

- 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 (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 alternative means of compliance for existing rules.
- The Joint Center of Excellence for Advanced Materials and Structures led by Wichita State University and the University of Washington – The Advanced Materials/Structural Safety Program benefits from a close working relationship with the Center. The research performed under this program is leveraged by the monetary and intellectual contributions of its partners including many major commercial aviation companies.
- Interagency Agreement with NASA – The FAA is collaborating with NASA on safety issues for composite research.

In FY 2012, major activities and accomplishments planned include:

Advanced Materials

- Damage Tolerance of Composite Structures
  - Conducted a study for the types of threats to composite aircraft structures while at the service gate and on the flight line.
  - Documented an accepted certification methodology for damage tolerance and fatigue, including full-scale test and analysis protocols for repeated loads and damage threats.
- Composite Maintenance Practices
  - Expanded developments in composite training with the initial emphasis on levels of safety awareness for structural engineering and manufacturing.
  - Developed training and conducted workshops to review progress in damage tolerance, adhesive joints, and maintenance.
- Advanced Materials and Processes
  - Evaluated the safety of new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures.

Structural Safety

- Crash Impact Response
  - Developed 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.
  - Supported new rulemaking and guidance development for Part 25 composite and metallic aircraft crashworthiness for structural substantiation certification.

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 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 2015, evaluate existing and emerging bonded airframe technology to update guidelines and standards.

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 to provide safe aircraft for civilian applications. In the last decade, this has been accelerated due to the rapid expansion of the use of composites 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/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 (TC) 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; and aging and environmental effects.

4. How Do You Know The Program Works?

The 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 Advanced Materials/Structural Safety Program would decrease funds to the work done in Environmental and Aging Effects for Composite Structures. It would extend the schedule by several months. This estimate of the delay is contingent on restoring expected funding levels in subsequent years. While this delay is small, the availability of information on current structural certification protocols adequacy to assure safe design of type certificate applicant data will not be available, possibly allowing less safe designs though the certification process. Furthermore, this would stop the work and extend the schedule for investigation of aging effects and certification requirement adequacy in addressing the aging effects on currently operational composite structures, for approximately 15 months. This impact is a combination of work stoppage and restart which would be required after a year without activity on that project. It is expected that the investigators would not be available after the layoff period requiring additional training for the new investigators. The availability of information on current structural certification protocols adequacy to assure safe design of TC applicant data would be delayed an extended period of time, possibly allowing less safe designs through the certification process.

Detailed Justification for
A11.d Aircraft Icing/Digital System Safety

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

FY 2013 – Aircraft Icing/Digital System Safety

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.d Aircraft Icing/Digital System Safety	$6,534,000	$5,404,000	$6,644,000	+$1,240,000

For FY 2013, $6,644,000 is requested for Aircraft Icing/Digital System Safety. Major activities and accomplishments planned include:

Aircraft Icing

- Research on Ice Crystal and Other Appendix C Exceedance Conditions
  - Conduct full field campaign out of Darwin, Australia to collect atmospheric data necessary for high fidelity facility and analytical simulation of High Ice Water Content (HIWC) ice crystal conditions (Note: Funding under A11.d supplements funding provided under the A11.k Weather Program. Effective simulation, the primary goal of the activity listed here, is not possible without high quality atmospheric data, so the two efforts are intimately intertwined.)
- Safe Operations and Take-off in Aircraft Ground Icing Conditions
  - Complete data and information package needed to update annual winter notice providing guidance for formulation of ground de-icing plans as required by airlines in CFR 121.629.
- Simulation Methods Development/Validation to Support Appendix C Icing Certification and Continued Operational Safety
  - Complete development of 3D model for testing of ice accretion/aerodynamic effects of ice on 3-D lifting surfaces.
- Rotorcraft Flight in Known Icing Compliance Criteria
  - Identify candidate minimum required icing instrumentation requirements, flight and wind tunnel test points required for verification of ice protection systems on rotorcraft.

The major activity planned for FY 2013 is the HIWC ice crystal field campaign out of Darwin, Australia. The data collected will be used in the development and evaluation of facility and analytical simulation tools and in the assessment and possible improvement of the proposed ice crystal regulatory atmospheric envelopes. The ground icing research results are incorporated into the annual winter notice needed by the airlines. The rotorcraft research is a new initiative which is expected to be completed by FY 2014, resulting in improved guidance to the industry on certification of rotorcraft for icing conditions.

Digital System Safety

- Onboard Network Security and Integrity
  - Provide initial (Phase 1) input for the development of RTCA SC-216 Subgroup 3 Aircraft Systems Cyber Vulnerability-Prevention Recommended Practices.
  - Perform an additional phase of work in the development of the airborne network security simulator that integrates industry and government aeronautical simulators to assess and identify network security threats in an airborne network environment.

- Software Development Techniques and Tools
  - For Phase 2, determine assurance case applicability to digital systems by examining previously developed assurance cases in various regulated sectors for approaches, successes, failures, and providing a comparison to existing development assurance standards (e.g., RTCA/DO-178B and RTCA/DO-254).
  - For Phase 1, assess, validate, and clarify DO-178C criteria for model-based development.
- Airborne Electronic Hardware Techniques and Tools
  - Investigate airborne electronic hardware (AEH) design assurance in the initial category of commercial off-the-shelf (COTS) electronic hardware.
  - Assess alternative approaches to electronic hardware design assurance for complex custom micro-coded devices and identify candidate approaches for further study.

Digital System Safety researchers will continue to evaluate onboard network security and integrity, system considerations for complex digitally intensive systems, software development techniques and tools, and integrity, AEH design techniques and tools, and COTS reliability and continued operational safety.

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/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/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/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 2012, major activities and accomplishments planned include:

Aircraft Icing

- Research on Ice Crystal and Other Appendix C Exceedance Icing Conditions in Support of Rulemaking
  - Continued experimental work on the physics of engine icing in high ice water content (HIWC) environments.
  - Completed first phase of fundamental research work on ice crystal physics studies to determine physical parameters of importance for ice crystal accretion formation mechanisms that will support simulating these conditions inside engine compressors.
- Simulation Methods Development/Validation to Support Appendix C Icing Certification and Continued Operational Safety
  - Continued research on aerodynamic effects of ice on 3-D lifting surfaces.
- Safe Operations and Take-off in Aircraft Ground 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 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

- Onboard Network Security and Integrity
  - Pursued efforts to cover cyber security effects on aircraft network security, such as Phase 6 onboard network security and integrity work on insuring consistency with aircraft safety and certification.

  - Identified certification issues, including security vulnerabilities introduced by network connectivity to multiple aircraft systems, and potential mitigation techniques.
- Software Development Techniques and Tools
  - Researched software development techniques and tools, such as verification of adaptive systems.
- Airborne Electronic Hardware Design Techniques and Tools
  - Investigated airborne electronic hardware (AEH) design techniques and tools, such as AEH design assurance.
- System Considerations for Complex Digitally Intensive Systems
  - Evaluated systems considerations for complex intensive systems, such as system architecture virtual integration.
- COTS Reliability and Continued Operational Safety
  - Studied commercial off-the-shelf reliability and continued operational safety, such as obsolescence and life cycle maintenance of avionics.
  - Developed COTS electronic hardware reliability prediction tools and techniques for the latest generation of the COTS electronic components.

Aircraft Icing/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

- By FY 2014, complete second phase of fundamental research work on ice crystal physics studies to determine physical parameters of importance for ice accretion formation mechanisms that will support simulating these conditions inside engine compressors.
- By FY 2014, complete processing and primary analysis of the ice crystal cloud data from field campaigns 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 2015, 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 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.
- By FY 2014, evaluate approaches to AEH COTS component design assurance.

3. Why Is This Particular Program Necessary?

Aircraft Icing

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 research 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 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.

Ground icing research is used each year in the development of guidance is published annually in the FAA's ground deicing notice, which is needed by airlines to formulate their required ground icing plans for the coming winter. In-flight atmospheric research was used in the development of the envelopes included in the notice of proposed rulemaking which was published in June 2010 for supercooled large drop (freezing drizzle and freezing rain aloft in and out of clouds and at the surface) conditions. A final rule is anticipated in the first half of 2012. A GAO report entitled *Improved Planning Could Help FAA Address Challenges Related to Winter Weather Operations* was published in July 2010. This report covered all aspects of the FAA's policies and activity in the area of aircraft icing, and a portion was devoted to research. The report praised the FAA's research investment strategy with its icing research partners, NASA and NCAR in particular.

The SDS research has provided numerous inputs to the certification authorities in the development of policy, guidance, rules, and regulations. Object oriented technology research provided input to RTCA Special Committee-205/WG-71 for DO-178C development and object oriented technology in aviation handbook development, training input, and handbook tools. Research on COTS avionics and software provided inputs for FAA ACs and orders. Research on Data Network Evaluation Criteria and Ethernet-Based Aviation Databuses provided handbook tool and input to databus evaluation criteria that was used by industry. For Flight Critical Data Integrity Assurance for Ground-Based COTS Components, provided input to Rotorcraft Directorate level for knowledge and security-related items in LANs in aircraft research and RTCA SC-216. For Software Development Tools and Software Verification

Tools, research provided input to DO-178C. Research into Networked Local Area Networks in Aircraft Safety, Security, and Certification Issues, and Initial Acceptance Criteria provided input to RTCA SC-216.

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

Any reduction in funding would restrict the full HIWC ice crystal field campaign in Darwin, Australia. This would likely take the form a shortened campaign or less support from our research partners, who are partially dependent on FAA for funding support for their participation. This could result in a substantially smaller ice crystal atmospheric database than is needed to develop high fidelity facility and analytical simulation tools.

A reduction could also adversely impact the testing to determine ground anti-icing allowance times and other guidance for ice pellet conditions, including ice pellets mixed with other forms of precipitation. Guidance is published annually in the FAA's ground deicing notice, which is needed by airlines to formulate their required ground icing plans for the coming winter. This is an area where there are issues that have led to strong expression of concern by some airlines, concerns that need to be resolved.

If funding for Digital Systems Safety were reduced, the ability of the FAA and industry to evaluate emerging, highly-complex, digital hardware and software for use in advanced flight controls and aircraft systems would be negatively impacted. Consequently, certification specialists would find it difficult to properly assess proposed aircraft and systems designs which employ this technology for flight-essential and flight-critical applications. Further, the FAA would not be able to determine if certification policy, criteria, or training would be needed to accommodate new technologies or methodologies. A further risk of not performing this research is the reduced ability to develop, validate, and improve certification methods and the inability to reduce time and cost to both FAA and industry in certifying aircraft employing advanced digital airborne systems.

Detailed Justification for
A11.e Continued Airworthiness

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

FY 2013 – Continued Airworthiness

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.e Continued Airworthiness	$10,632,000	$11,600,000	$13,202,000	+$1,602,000

For FY 2013, $13,202,000 is requested for Continued Airworthiness. Major activities and accomplishments planned include:

Health Monitoring of Structures and Complex Flight Critical Systems

- Evaluate the safety impact and other potential benefits related to the more wide-spread application of health usage monitoring technology across all air vehicle systems.

Stall Departure Identification, Recognition, and Recovery

- Develop criteria to categorize and quantify stall departure characteristics for transport category airplanes.

Envelope Awareness and Protection Legacy Transport Airplanes

- Gather incident, accident, and research data, to quantify the required timeliness of low speed alerting system, necessary for in flight recovery of transport category airplanes...

Advanced Nondestructive Inspection (NDI) Methods for Composite Structures

- Develop and publish the protocol for the validation of legacy and advanced NDI methods for detection of hidden flaws in complex, solid composite laminates.

Nondestructive Evaluation (NDE) for Critical Engines Components

- Develop AMS specification for industrial ultrasonic forging inspection for critical engine components.

Rotorcraft Health and Usage Monitoring Systems (HUMS)

- Develop methods with direct and indirect evidence approaches guided by Advisory Circular 29-2 MG15 for the certification of HUMS for rotorcraft usage credits.

Advanced Control Systems

- Investigate and define new and unique rotorcraft hazards associated with advanced control systems incorporating non-traditional control methodologies.

Risk Assessment and Risk Management Methods for Small and Transport Airplane Continued Operational Safety (COS)

- Publish a report on feasibility/applicability of Probabilistic Risk Analysis (PRA) approach for transport airplane corrosion problems.
- Develop data and methodologies for structural life evaluation of small airplanes.

Development of Control Surface and Stabilizer Freeplay Limits to Preclude Flutter

- In collaboration with other aerospace stakeholders, including USAF, NASA, Navy and Industry, develop a joint research plan to establish modern freeplay limits.

Emerging Technology – Active Flutter Suppression

- Initiate a survey of flutter and aeroservoelastic research involving active flutter suppression systems, including military application of the technology and NASA/industry research.

MMPDS Support and Design Values for Emerging Materials

- Lead the Metallic Materials Properties Development and Standardization (MMPDS) steering group in updating the metallic materials properties handbook.

Damage Tolerance and Durability Issues for Emerging Technologies

- Continue survey and testing to assess application of advanced aluminum-lithium alloys for aircraft primary structure.
- Continue testing and analysis to assess environmental durability of bonded repair technology.

In FY 2013, the above planned major activities and accomplishments focus on six technical areas: Electrical Systems (ES); Flight Controls and Mechanical Systems (FCMS), Maintenance and Inspections (M&I), Propulsion Systems (PS), Rotorcraft Systems (RS), and Structural Integrity Metallic (SIM).

Research in the ES will be focused on health monitoring of structures and complex flight critical systems, which will enable the insertion of health monitoring (HM) technologies of structural, mechanical, and electric systems in commercial transport airplanes for current and future applications. The research will be done in collaboration with other technical areas in this Program such as SIM, FCMS, and PS.

In the FCMS effort, the study on stall departure identification, recognition, and recovery will leverage existing industry and NASA data and available methods to generate technical information to support the development of guidance and means of compliance to prevent stall departure. Research in envelope awareness and protection legacy transport airplanes will focus on supporting standard development and rulemaking on envelope awareness and protection for new and legacy transport airplanes.

Maintenance and Inspection (M&I) research will develop advanced NDI methods for composite structures. It will include validation of NDI methodology to determining bond strength; generation of reliability data on capabilities of various NDI methods, and support updating training materials as required by relevant parts of the rules for maintenance and repairs. Research activities will be coordinated and in collaboration with the SIM research effort as well as the Advanced Materials and Structure Safety Program.

NDE research effort in the PS technical area will develop and evaluate inspection methods for critical engine component. It will generate technical information to support the development, validation, and issuance of standards for various NDE techniques to improve inspection and monitoring capabilities on manufacturing induced anomalies on critical high energy rotating components.

The RS technical area has two separate efforts: HUMS and advanced controls. In the HUMS effort, research will be focusing on the development of methodologies, direct and indirect evidence approaches, in determining usage credit of rotorcraft dynamic components and/or mechanical systems. It will also evaluate advanced technologies and develop methods with the guidance of the Advisory Circular. The advanced control system is a new requirement and initial effort will focus on the development of a research plan with technology status, existing regulatory requirements, available standards, technical challenging areas, and proposed research initiatives.

The SIM technical area consists of five requirements for both transport and small airplanes. Although the legacy requirements of MMPDS and damage tolerance are essential to support the airframe structural safety and continued airworthiness, research initiatives have been expanded into emerging technologies such as damage tolerance and durability issues of new aluminum-lithium alloys, new and emerging alloys to be studied for inclusion of MMPDS, and risk management methods to support the Aircraft Certification Services Monitor Safety/Analyze Data (MSAD) initiative, which is a data-driven, risk-based continued operational safety decision-making process. Research effort will also include studies of control surface freeplay limits and predictive analytical methods, and investigation of active flutter suppression systems using existing fly-by-wire technology to actively eliminate and suppress flutter.

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, the FAA also works with industry and other government agencies 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:

- 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 13 joint Aircraft Airworthiness and Sustainment Conferences (formerly known as Aging Aircraft Conference) with FAA.

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 2012, major activities and accomplishments planned include:

Risk Assessment and Risk Management Methods for Small and Transport Airplane COS

- Completed 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.

MMPDS Support and Design Values for Emerging Materials

- Continued to lead the Metallic Materials Properties Development and Standardization (MMPDS) steering group in updating the metallic materials properties handbook.

Damage Tolerance and Durability Issues for Emerging Technologies

- Continued damage tolerance and durability research for emerging structural technologies to ensure safety, support maintenance, and support future FAA policies and guidance.
- Enhanced FAA's Full-scale Aircraft Structural Test and Evaluation facility capabilities and demonstrated residual strength of panels fabricated from advanced materials.

Rotorcraft Health and Usage Monitoring Systems (HUMS)

- Developed HUMS database for commercial rotorcraft operations in order to assess its application in usage credit determinations.

NDE for Critical Engines Components

- Continued to develop data to support a specification for industrial ultrasonic forging inspection.
- Completed the evaluation of thermal acoustic technology as an inspection technique for engine disks

Advanced NDI Methods for Composite Structures

- Completed assessment of baseline POD curves for portable ultrasonic devices for detection of hidden flaws in complex, solid composite laminates.
- Assess performance of an advanced inspection system for identifying environmental damage of composite structures caused by heat, chemical, and ultraviolet sources.

Advanced Control Systems

- Define mechanical and electrical maintenance inspection criteria to maintain continued operational safety

Health Monitoring of Structures and Complex Flight Critical Systems

- Continued research to assess the performance of prognostic and health monitoring systems that are in use or under development for transport airplanes.

Stall Departure Identification, Recognition, and Recovery

- Continued research to develop enhanced models of full stall departure characteristics for transports.

Flight Critical Systems Design Assurance

- Began addressing improvement of the design development processes for flight critical systems to assure that design errors in complex flight critical system designs are found before certification, rather than in service through incidents or accidents.

GA Automation and Envelope Protection

- Completed research on basic envelope protection. Technical data will support development of FAA guidance and policies for general aviation autopilot systems.

Envelope Awareness and Protection for Legacy Transport Airplanes

- Continued research to develop enhanced models of full stall departure characteristics for transports.
- Start to determine appropriate thresholds for low speed awareness, data available to trigger threshold indication, appropriate indications pilot impact of such information, and parameters available to determine threshold encroachment.

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 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 2013, assess the feasibility and benefits of determining bond strength of repair as compared to original manufactured strength.
- By FY 2013, develop technical data on rotorcraft to establish more detailed guidance for certification of HUMS for usage credits.
- By FY 2013, develop a predictive methodology and tools 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

- By FY 2014, develop technical data to assess the application of advanced aluminum-lithium alloys for aircraft primary structure
- By FY 2016, develop technical data to assess the fatigue and environmental durability of bonded repairs to metallic structure
- By FY 2016, develop technical data to assess methods to preclude and suppress flutter

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. Although research results from this research program have been implemented to support the issuances of aging aircraft related rules, policies, and guidance materials, recent in-flight incidents, such as Southwest Airlines flights 2294 in 2009 and 812 in 2011, demonstrate the technical challenges of maintaining continued airworthiness, predicting potential failures, and determining inspection intervals. The program 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 Safety. 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?

Requested funding levels are based on the research requirements prioritized by the end-user organization within the FAA Office of Aviation Safety. Reduction in funds to any of the technical areas listed in the Program Schedule within the Continued Airworthiness program will delay the completion of some or all of the anticipated accomplishments as outlined in Section 1. A reduction in funding would delay 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 2013 – Aircraft Catastrophic Failure Prevention Research

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.f Aircraft Catastrophic Failure Prevention Research	$1,147,000	$1,147,000	$1,691,000	+$544,000

For FY 2013, $1,691,000 is requested for Aircraft Catastrophic Failure Prevention Research. Major activities and accomplishments planned include:

Advanced Analysis and Risk Assessment Methods for Rotor Burst and Blade Release

- Develop and verify an update to a new material model for the LS-DYNA finite element model for aluminum (MAT224).
- Develop a new generalized damage and failure model with regularization for titanium materials impacted during engine failure events.
- Issue Aerospace Guidelines for LS-DYNA through the LS-DYNA Aerospace Users Group.
- Develop improvements to the existing Uncontained Engine Debris Damage Assessment Model (UEDDAM) to address industry feedback.

FAA engineers and industry need publicly available tools to standardize the analysis of engine and aircraft for rotor burst and fan blade containment. All new commercial engines require a full scale destructive test for FAA certification to verify that an engine can survive a single blade failure at the most critical location. Besides being extremely expensive, this test offers limited capability for demonstrating margins of safety especially when subsequent design changes are incorporated into an existing engine. Finite element modeling offers much more insight but historically, an increasing number of engine and aircraft projects are relying on proprietary analysis tools to show compliance, complicating the FAA task of making compliance findings and allowing potential variation in the standard of safety. In addition, new companies with limited turbine engine experience are now entering the aircraft industry. These companies do not have the benefit of years of blade release testing and model simulations. A need exists for publicly available analysis methods and standardization for the FAA to be able to approach certification by analysis for engine containment.

Many derivative engines based on already certified engines use analysis to show compliance to the fan blade containment regulations on a case by case basis. New concept fan containment configurations may only be tested once for the baseline engine. The goal is to have a public tool with standardized generic models, user guides, training, software quality control process, and validated public material models. This will allow engineers to validate the proprietary tools, streamline the certification process, and help mitigate fatalities and injuries when these events occur.

Regarding research related to uncontained engine failure mitigation, this program has developed an uncontained engine Debris Damage Assessment Model (UEDDAM) to improve new aircraft designs in being able to mitigate damage from uncontained engine events. A large numbers of small jet powered aircraft in the process of being certified and proposed for certification, each with special challenges for engine rotor burst mitigation. These aircraft have composite fuselage sections with diameters on the same order as the engine diameters, limiting the traditional approach of using system separation to minimize the rotor burst effects. Research will develop improvements to the UEDDAM model to address these issues.

2. What Is This Program?

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 engine containment systems and 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. 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 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 goals of the focused research endeavors are:

- 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.
- By FY 2013, issue Aerospace Guidelines for LS-DYNA through the LS-DYNA Aerospace Users Group.
- By FY 2015, refine the LS-DYNA Quality Control regiment for Aerospace Users based on improved Aerospace generic models based on new requirements and lessons from industry.
- By FY 2016, complete development of material models for planned metal materials.
- By FY 2017, develop plan for modeling of aerospace composite impact problems.

For FY 2012, major activities and accomplishments include:

Advanced Analysis and Risk Assessment Methods for Rotor Burst and Blade Release

- Completed all material testing to support a new material model for titanium in LS-DYNA.
- Issued improvements to the Uncontained Engine Debris Assessment Damage Model (UEDDAM) code in collaboration with the Naval Air Warfare Center (NAWC) Weapons Division China Lake.
- Research continued on the FAA/NASA/industry-sponsored quality control program for modeling aircraft problems in manufacturers-supported finite-element code (referred to as LS-DYNA).
- Research continued on the NASA/FAA/industry program for modeling aircraft engine failures in LS-DYNA. The FAA, NASA, and academia continued to evaluate improved material models and incorporated them into LS-DYNA upon acceptance by the Aerospace Users Group. Users' guidelines and training continued to be developed and made available through George Washington University.
- Additional research continued on developing a generalized damage and failure model with regularization for titanium materials impacted during engine failure events. Also, research continued on material characterization tests to support development of damage and failure models for aircraft materials.

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

- 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 Quality Assurance 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 Quality Assurance 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.

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 primarily related to uncontained engine failure. In addition, research has included: 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 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 material characterization testing was completed. In 2012 titanium material characterization testing was completed and by 2014, Inconel 718 testing 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 Aircraft Catastrophic Failure Prevention Program has been in existence since 1990. During that time, the major thrust of the program has been research into preventing catastrophic aircraft failures associated with engine failures with primary emphasis on engine uncontained failures. The research has produced the UEDDAM tool kit which allows new aircraft designs to be analyzed for vulnerability to uncontained engine fragments. The UEDDAM code has been released to industry and is being used on a volunteer basis by industry for commercial designs. The military is also requiring UEDDAM be used in the design of aircraft.

The joint FAA/NASA sponsored LS-DYNA Aerospace Users Quality Assurance Group has members from government, the aerospace industry, and academia all working together to address aerospace modeling problems associated with aircraft impact events, i.e., engine containment/uncontainment, bird strike, water landings, tire failure, ice impact, etc. The establishment of an LS-DYNA Aerospace Quality Control System has identified several problems and solutions in the LS-DYNA software and compatibility with different computer platforms and compilers that were causing errors in the results. In addition, an LS-DYNA aerospace user's guideline manual is being developed by the group which will guide LS-DYNA aerospace users to use correct industry practices in the modeling. The draft guidelines are already being used by industry.

The new material models being developed under this research program are extremely valuable to industry and the FAA in modeling impacts from engine uncontained failures. They surpass the research limitations identified in pre-research models that were limited in predicting failure modes. The new models will be able to establish benchmarks for FAA engineers and industry in evaluating and designing for engine containment and aircraft shielding. When used in conjunction with the UEDDAM model (or similar vulnerability model), the new material models can be used to better predict impact resistance in specific areas identified and needing protection.

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?

The funding requested will fund multiple universities and subcontractors to develop the material models necessary to support FAA certification. All of the universities and subcontractors work as a team to deliver parts of the models and /or testing to support the models. A modest reduction will cause the program to reduce their staff and delay completion of the material models and validation by one to three months. A larger reduction will most likely cause the program to be unable to complete the material models and validation since there is a team depending on the results of other team members.

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 2013 – Flightdeck/Maintenance/System Integration Human Factors

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.g Flightdeck/Maintenance/System Integration Human Factors	$7,083,000	$6,162,000	$5,416,000	-$746,000

For FY 2013, $5,416,000 is requested for the Flightdeck/Maintenance/System Integration Human Factors Program. Major activities and accomplishments planned include:

Flight Training Methods for Jet Upset Prevention, Detection and Recovery

- Develop and test new models to increase the flight envelope that can be simulated with today's technologies.

ADS-B Human Factors – AIR & AFS Equipment Design, Evaluation, and Operational Approval Guidance

- Develop human factors regulatory and guidance material on issues associated with ADS-B integration with current generation TCAS (e.g., alert thresholds, symbology, display installation).

A Multi-Disciplinary Approach to Fatigue Risk Management in Maintenance

- Provide validation evidence and metrics necessary for interpreting calculated risk with a fatigue risk management assessment tool.

UAS Control Station

- Develop human factors regulatory and guidance material for FAA inspectors and engineers who must evaluate and approve UAS ground control station designs and "pilot"/operator training programs.

Avionics: EFB, Moving Maps, and Multi-Function Display Issues

- Develop human factors regulatory and guidance material to support use and implementation of new evaluation checklist, developed in FY 2012, to identify 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.

Flight Crew Error and Inadvertent Operation Means of Compliance

- Provide recommendations for issues and recommended practices for flightdeck systems complying with new flight crew error regulation 14 CFR 25.1302.

Research continues to produce human factors input for Flight Standards and Aircraft Certification to develop design, evaluation and operational approval guidance for ADS-B enabled implementations; to assist Aircraft Certification in identifying, assessing, and remediating human performance issues involving electronic flight bags, moving map displays and multi-function displays; to support the Unmanned Aircraft Program Office by providing human factors recommendations for the design and operation of unmanned aircraft systems control stations; and to 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 supports the DOT STRATEGIC safety goal from the DRAFT FY 2010 – FY 2015 U.S. DOT STRATEGIC PLAN. It 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.

A major goal of the program is to improve pilot, inspector and maintenance technician task performance. Research results support enhanced methods for training and evaluating performance especially associated with new technologies and aircraft systems. Performance and evaluation capabilities are also enhanced through research that facilitates an improved understanding and application of risk and error management strategies in flight and maintenance operations.

The Flightdeck/Maintenance/System Integration Human Factors Program collaborates with industry and other government programs including:

- 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. Information is shared regarding similar areas of concern, for example training for automation, synthetic and enhanced vision systems, and head up displays.
- 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 2012, major activities and accomplishments planned include:

Flight Training Methods for Jet Upset Prevention, Detection and Recovery

- Reported on literature review to assess the state of the art in scenario modeling and execution for jet upset prevention, detection and recovery.

ADS-B Human Factors – AIR & AFS Equipment Design, Evaluation, and Operational Approval Guidance

- Analyzed 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.

UAS Ground Control Station

- Provided analyses and human factors recommendations for unmanned aircraft system control stations to ensure safe and effective operator performance.

Avionics: EFB, Moving Maps, and Multi-Function Display Issues

- Provided 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.
- Completed 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.

Head-up and Head-Mounted Displays: Certification Requirements and Operational Approval Criteria

- Completed literature review and product review addressing human factors aspects of head-up and head-mounted displays.

Flight Crew Error and Inadvertent Operation Means of Compliance

- Provided analysis and recommendations for issues and recommended practices for flight deck systems complying with new flight crew error regulation 14 CFR 25.1302.

Pilot System Interface and Human Factors Issues and Guidance for the Certification of Advanced Autopilots and Related Automation Technologies in General Aviation Airplanes

- Completed literature review and product review addressing aspects of advanced autopilots and automation technologies in small airplanes.

A Multi-Disciplinary Approach to Fatigue Risk Management in Maintenance

- Provided validation evidence necessary for interpreting calculated risk with a fatigue risk management assessment tool.

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. Additionally, the Human Factors Aircraft Certification Job Aid provided guidance to the Aircraft Certification Flight Test Pilots, Engineers, and Human Specialists who must evaluate new aircraft and old aircraft with new displays and/or controls. The Job Aid compiled over 100 human factors research and reference reports and tied them to the regulations. This database tool was instrumental in providing a structured way to evaluate systems submitted for FAA approval. Similarly, the electronic flight bag checklist provides a structured way to identify human factors issues with new EFBs submitted for approval. These tools have provided human factors and human performance data on which our FAA staff can make approval decisions.

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. The HF Subcommittee was briefed on the FY 2013 Flightdeck/Maintenance/System Integration Human Factors Program and found the research program was appropriate to FAA's mission and covered the area of need as understood by the subcommittee.

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 in the FY 2013 requirement entitled "A Multi-Disciplinary Approach to Fatigue Risk Management in Maintenance" and the associated deliverables that support the development of regulatory and guidance material on fatigue risk management for aircraft maintenance personnel.

Detailed Justification for
A11.h System Safety Management

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

FY 2013 – System Safety Management

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.h System Safety Management	$11,694,000	$10,027,000	$11,345,000	+$1,318,000

For FY 2013, $11,345,000 is requested for System Safety Management. Major activities and accomplishments include:

System Safety Management

- Aviation Safety Information Analysis and Sharing (ASIAS)
  - Expand ASIAS to new aviation communities (e.g., general aviation, rotorcraft, corporate, and military).
  - Incorporate new digital sources, such as Automatic Dependent Surveillance-Broadcast (ADS-B) and Air Traffic Control (ATC) voice data.
  - Initiate development of vulnerability detection capabilities that monitor each ASIAS database for potential safety issues, analyzing disparate data drawn from multiple sources, and enhancing discovery and identification of safety risks.
  - Develop a modeling capability that is able to assess potential vulnerability of anomalous behavior discovered from the databases using a knowledge-based approach.
  - Transport Airplane Risk Analysis Evaluative Metrics
  - Further development of a quantitative risk analysis methodology for transport airplane continued operational safety (COS) and the data necessary to perform such analyses.
- Prognostic Air Traffic Analysis Capability for Operational Safety (referred to as Prognostic Safety Analysis of Air Traffic Control Operations with ASIAS in FY 2012)
  - Develop a capability that integrates air traffic databases and permits prognostic trend analysis of air traffic safety performance for operational oversight.
  - Complete the development of a user interface and trend analysis capability for equipment performance.
  - Test the equipment module for facility performance.
- Operational Safety Measurement of Future Systems
  - Conduct safety impact analysis of the NAS due to the future improvements for each NAS operational domain, such as tower, TRACON, enroute, or for each phase of flight, such as taxi, departure, climb, cruise, approach, and landing.
- Facility Risk Assessment Tool (FRAT)
  - Initiate development of a capability that can identify and prioritize risk areas of ATC facilities warranting further analysis and intervention strategies.

Terminal Area Safety

- Develop Models that Enhance the Ability to Use Advanced Flight Simulators for Advanced Maneuvers
  - Determine data requirements to improve the mathematical models of stalls, and conduct research on damping values and control effectiveness in the roll and yaw axis to match the in-flight values.
- Determining Runway Friction from Airplane Data

   - Evaluate methods to determine the runway friction level or runway slipperiness condition by using data obtained from an airplane's flight data or quick access recorder.

- Simulator Motion Cueing Criteria
   - Conduct research to investigate errors across simulators by replicating testing conditions with same sensors and their placement for developing criteria for achieving more uniform training across today's fleet of simulators.

In summary, research projects in the System Safety Management Program are designed to increase system safety through the use of safety information. This will occur with the development of enhanced methods of data collection and analysis spanning a wide range of operational areas (e.g., Part 121, Part 135, Part 91), aircraft types (e.g., Part 23, 25, 27, 29), as well as across the certification lifecycle from the development of initial regulations and guidance through actions associated with continued operational safety. Projects also include the development and enhancement of technologies aimed at increasing the level of safety specifically in the terminal area; current projects are focused on technologies that address events associated with the highest accident and fatality rates.

2. What Is This Program?

The System Safety Management Program will release in 2013 an infrastructure that enables the free sharing and analysis of de-identified safety information that is derived and protected from government and industry sources. This infrastructure will be enhanced with additional capabilities, i.e., vulnerability discovery, improved data fusion and expanded data sources and users. In addition, the program provides methodologies, research studies, and guidance material that provide 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 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 2012, major activities and accomplishments planned include:

System Safety Management

- Aviation Safety Information Analysis and Sharing (ASIAS)

- Expanded the ASIAS prototype 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.
- Initiated testing of 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.
- Conducted safety analytical studies and safety assessments using ASIAS and other aviation safety data.

- Transport Airplane Risk Analysis Evaluative Metrics
  - Further developed a quantitative risk analysis methodology for transport airplane continued operational safety (COS) and the data necessary to perform such analyses.
  - Reviewed and analyzed existing historical and ongoing transport airplane operational and design data; research, identification, and collection of new transport airplane data; directed research to develop risk analysis supporting data; the statistical analysis of such data; and compilation of the data into the form and format best suited for efficient use in transport airplane risk analysis.
- Operational Oversight of NAS Facilities through ASIAS (referred to Integrating NAS Facility Services Data into ASIAS for Operational Safety Oversight in FY 2011)
  - Completed development of a facility/equipment operations module that includes a collection of information that provides a view of NAS equipment maintenance functions, combined with ASIAS/ATC baseline data, specific to NAS safety oversight.
- Prognostic Safety Analysis of Air Traffic Control Operations with ASIAS
  - 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.
  - Conducted an analysis of the requirements resulting from the intended uses of data for safety oversight.

Terminal Area Safety

- Develop Models that Enhance the Ability to Use Advanced Flight Simulators for Advanced Maneuvers
  - Identified methods to model unusual attitude encounters outside the normal operating envelope.
- Performance Based Navigation
  - Completed initial evaluation regarding the connection of required navigation performance (RNP)/performance based navigation (PBN) paths for terminal area operations by using human-in-the-loop simulations.
- Determining Runway Friction from Airplane Data
  - Completed preliminary analysis of 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.
- Cockpit Advanced Systems
  - Identified new cockpit-centric navigational technologies and data for the development of new procedures to enhance safety and capacity within the terminal area.

The System Safety Management Program supports the DOT strategic goal of Safety by reducing transportation related injuries and fatalities for both commercial air carrier and general aviation operations. This will occur through development of 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 in the domain of aviation safety information are:

- 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 2014, 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, expand ASIAS system safety analysis to other domains (e.g., general aviation, rotorcraft, corporate, military).
- By 2016, develop a capability that can identify and prioritize risk areas of ATC facilities warranting further analysis and intervention strategies.
- By 2017, enhance vulnerability assessment capabilities of discovery, identification, and evaluation of safety risks not currently known to the aviation community.

Goals specific to Terminal Area Safety research are:

- By 2014, identify initial credit granted for synthetic or enhanced vision system installation and the level of operations.
- By 2014, develop modeling techniques that result in changes to the math model structure to match flight data in aerodynamic stalls.
- By 2016, complete the evaluation of the reported runway friction level from all potential runway surface conditions and airplane configurations.
- By 2016, develop test criteria by varying motion characteristics to span the domain of the criteria and compare variations against subjective opinions of motion quality.

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.

Along these lines, the System Safety Research Program responds to several GAO studies that call for the FAA to collect better data and improve its effort to identify and address safety issues. For FY 2013, development will continue to enhance ASIAS capabilities through developing capabilities, tools and software that will improve safety oversight of the NAS, and through conducting analytical studies and safety assessments using ASIAS and other safety aviation data. Also, research will continue in the development of empirically derived transport airplane data to be used by the Transport Airplane Directorate in their development of safety metrics.

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 respond to several NTSB safety recommendations:

- A-04-62: Evaluate issues concerning the level of automation appropriate to teaching upset training and develop and disseminate guidance that will promote standardization and minimize the danger of inappropriate simulator training.

- A-07-64: Demonstrate the technical and operational feasibility of outfitting transport-category airplanes with equipment and procedures required to routinely calculate, record and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll. If feasible, require operators of transport-category airplanes to incorporate use of such equipment and related procedures into their operations.

For FY 2013, research will include the collection and analysis of motion data on existing platforms and the development of more accurate simulator models to enhance simulator training, as well as the development of technologies to enhance the accuracy of runway friction data.

4. How Do You Know The Program Works?

Through ASIAS, the agency has been able to promote 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. Directed studies commissioned by the Commercial Aviation Safety Team, e.g., Terrain Awareness and Warning System and Traffic Alert/Collision Avoidance System have led to the development of intervention strategies that have been implemented and are currently being monitored for effectiveness.

Within the Risk Management Decision Support project, recent research output has been used in the development of the Transport Airplane Directorate Risk Assessment Methodology (TAD RAM) provides Aviation Safety Engineers (ASEs) with guidance for estimating the risk associated with airworthiness concerns. TAD RAM also provides guidance on how ASEs can use estimated risk as a consideration in making unsafe condition determinations and in evaluating corrective actions.

Prior year research outputs have been used in the development of an Advisory Circular on aircraft maintenance tool calibration program; the preparation of recommended best practices for inspection and maintenance of GA aircraft exhaust system to prevent carbon monoxide leakage; and the preparation of FAA Order 8300.14 "Repair Specification Approval Procedures."

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?

Funding at the requested level is necessary to enable FAA to fully address safety issues. Were funding not possible at the requested level, the following initiatives may be compromised:

The Operational Safety Oversight of the NAS through ASIAS research: The FAA is to conduct research to develop an automated tool, i.e., FRAT that collects stores and analyzes both operational resources and event data. The tool will evaluate controllers deployed, procedures used, complexity, traffic counts, and multiple human factors issues. In addition, tool will analyze incidents, pilot deviations, near mid-air collisions, operational error/deviation, and runway incursions. The purpose of FRAT is to identify and prioritize risk areas of NAS facilities warranting further analysis and intervention strategies. A reduction in the System Safety Management budget will delay delivery of an automated capability that would Optimize FAA resources in support of safety in the NAS. This would force the FAA Office of Aviation Safety to continue a manual process of analyzing both operational and safety data with respect to NAS facilities.

The Terminal Area Safety research, particularly the simulator motion cueing research task: The FAA is to conduct research to determine the appropriate objective criteria for flight simulator platform motion. Having validated motion criteria will help standardize motion platform responses and allow users to decide whether or not motion cues are sufficient for safety performing given tasks. Should a drastic reduction in funding occur, the FAA will postpone this research in reducing the motion deficiencies which were identified as a contributor to fatal accidents such as USAir 427 and American Airlines 587.

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 2013 – Air Traffic Control/Technical Operations Human Factors

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.i Air Traffic Control/Technical Operations Human Factors	$10,364,000	$10,364,000	$10,014,000	-$350,000

For FY 2013, $10,014,000 is requested for Air Traffic Control/Technical Operations Human Factors. Major activities and accomplishments planned include:

Advanced Air Traffic Systems

- Develop human factors color guidance for air traffic control displays that can be used in the acquisition of future ATC systems.
- Revise five chapters of the Human Factors Design Standard.
- Generate human factors design guidance for Air Traffic Control Tower Alerts.
- Demonstrate a prototype of a Design Process Guide that will provide human factors design requirements for the ergonomic aspects of workstation and workplace design.

Individual and Team Performance

- Conduct an experiment to measure the effects of time on task, workload intensity, break duration, and break activities on the recovery from mental fatigue and associated decrements in air traffic control task-related performance.
- Develop an evaluation methodology for the fatigue mitigation strategies that educate air traffic controllers and managers about the factors that affect fatigue.
- Develop a plan for a field study leading to better management of fatigue risk from air traffic controller job tasks that may increase susceptibility to fatigue.

Personnel Selection and Training

- Implement Air Traffic Color Vision (ATCOV) test revision at Regional Flight Surgeon offices that incorporates ERAM requirements.

Advanced Technical Operations Systems

- Develop technical operations Graphical User Interface guidelines.
- Generate a draft standard that will be used to guide the development of acronyms/abbreviations for future Technical Operations systems.

The program will continue to make progress on sponsor requirements in the areas of Advanced Air Traffic Systems, Advanced Technical Operations Systems, Individual and Team Performance, as well as Personnel Selection and Training. As the National Airspace System moves toward modernization under the NextGen plan, this program will emphasize the development of human factors design standards for ATC systems and determine the feasibility of applying a design process guide for these systems. In the domain of technical operations, the program will continue the development of standards for multi-media maintenance publications and documentation to enhance maintenance procedures and reduce the probability of human error. The program will also continue research examining various strategies to minimize fatigue-related degradations in controllers' ability to monitor and control traffic. Finally, the program will continue to validate and improve selection tests to help reduce the costs to the agency of hiring Air Traffic Control Specialists (ATCS) by refining selection. Better selection will reduce the number trainees who are unable complete training and increase the number of applicants who would make good ATCSs, but are not currently being selected.

The effort to develop a Human System Integration road map for the technical operations domain will continue through FY 2013. This new working environment will drive a need for alterations in personnel selection, training, and management of human error as the consequences of errors become more far-reaching in terms of National Airspace System (NAS) availability. Related to this effort is a project to revise the maintainer job task analysis to determine if there is a need and valid basis to add medical screening (e.g.: color vision) and basic skill requirements (keyboard and computer use) to the selection process.

2. What Is This Program?

The Air Traffic Control/Technical Operations (ATC/TO) Human Factors Program provides leadership and products to motivate 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 and mitigation principles that must be mitigated to enable the humans in the system to manage the future NAS traffic flow
- Assessments of the effectiveness of fatigue-risk-management strategies.
- 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 the Department of Transportation's safety and economic competitiveness goals 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 2013 will emphasize the concept of human-system integration (HSI) and safety aspects of the functions performed by air traffic controllers and technical operations (maintainer) 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 workstations and enhances our understanding of the role that system design plays in mitigating human error, which is a major contributor to 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 safety by:

- 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 economic competitiveness:

- 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, and decrease the probability of system outages.

- 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 air traffic in the NAS.
  - 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 Air Traffic Organization (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 developing human factors standards to be applied in system
- 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 groups recommend research to evaluate and improve personnel selection and training
- Collaborative research with the National Aeronautics and Space Administration that 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, St. Louis University, Ohio State University, and The American Institutes for Research

In FY 2012, major activities and accomplishments planned include:

Advanced Air Traffic Systems

- Continued development of a human factors color standard for Air Traffic Control (ATC) displays that is harmonized with the color vision testing used during controller selection.
- Continued development of an ATC symbology and style guide to aid the efficient development of ATC display details.
- Continued work on a revised Human Factors Design Standard that can be cited as a design requirement during ATC system procurements.

Individual and Team Performance

- Reported on the effectiveness of the ATC Quick Reference Guide for supervisor best practices.
- Continued the Preventive Maintenance Tasks Vulnerable to Human Error study that seeks to identify and prevent human errors resulting in ATC system outages.
- Performed fatigue research measuring the effectiveness of fatigue risk management interventions that are scheduled for implementation.

Advanced Technical Operations Systems

- Continued a project to evaluate multi-media documentation in the technical operations domain to enhance efficiency in field maintenance.

Personnel Selection and Training

- Continued longitudinal validation of ATC selection instruments.
- Documented the effectiveness of a selection battery to place controllers by option (i.e., tower versus radar positions) and match skills to optimal placement.
- Continued a study of controller entry and retirement age.
- Concluded a grant regarding potential approaches to increase the efficiency of air traffic controller training and staffing.

3. Why Is This Particular Program Necessary?

The safety and performance of the National Airspace System (NAS) is directly linked to the performance of human operators. Among the most complex problems facing aviation today are those involving human error. To achieve quantifiable improvements in aviation safety and economic competitiveness, 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 economic competitiveness will involve the development of techniques and tools that increase controller efficiency. Some of these tools and techniques involve augmenting the human decision maker with a recommendation generated by automation. This program addresses the required balance between reliance on the automation and assuring that the human, who has a much better ability to make decisions in the presence of incomplete information or multiple simultaneous competing priorities, can and will take the correct action when necessary. 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 requirement to include the human component in the development of the NAS is being addressed by this research program.

The Air Traffic Control/Technical Operations Human Factors Program provides a unique service for the Air Traffic Organization and other FAA organizations. The program gathers the various organizations' research requirements and develops integrated research products. If this program was not funded, the organizations named in Area 2 above would not be able to address the important human factors issues cited above. The personnel and laboratories funded by this program are unique national assets and not available elsewhere. There is ample historical evidence in the agency that prior to the availability of these research products, the consequences of a lack of application of human factors research resulted in cost and schedule overruns on acquisition programs such as STARS. The application of our personnel selection and training products has resulted in a more efficient screening process that reduces the time and cost of controller selection and training. The AT-SAT screening test for controllers is a product of this research program, as is the ATCOV test to assure that candidates with job-related color vision deficiencies do not enter the workforce.

4. How Do You Know The Program Works?

This program is reviewed by two Research, Engineering and Development Advisory Committee (REDAC) Subcommittees: Human Factors and NAS Operations. The 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 RE&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.

After the REDAC Human Factors (HF) Subcommittee was briefed on the Air Traffic Control Human Factors programs, the subcommittee found that the FY 2013 research portfolios and their underlying structure were appropriate to FAA's mission and covered the area of need as understood by the subcommittee. In particular, the HF Subcommittee was impressed that other entities within the FAA are actively coordinating with, or seeking human factors input from, specialists in human factors including the FAA Human Factors Research and Engineering Group (HFREG, AJP-61), especially related to NextGen activities. The subcommittee recommended that the HF community within FAA continue their work in the areas presented, and that the funding continue at (at least) current levels.

There is ample evidence that the program works as illustrated in the following examples. Every candidate for a controller position entering the workforce from the general public is now taking the Air Traffic Selection and Training screening test to enhance the probability of success during training and on the job. The ATCOV test is now in use during the medical screening process to assure that new controllers with job-related color vision deficiencies are selected out of the workforce. The Front Line Manager Quick Reference Guide that is a recent output of this program has been strongly endorsed by the ATO service units and has been distributed by the ATO Safety organization to every front line manager in the ATO. It is also being used as course material in the FAA academy and other FAA management courses. The Human Factors Design Standard is a robust document containing human factors design criteria that is cited in every FAA acquisition contract that has a human interface.

Satisfaction surveys are one of several methods utilized to ensure that project sponsors are satisfied with the program. The survey attempts to determine the effectiveness of the project team during the acquisition process and receives a critique of the program manager's performance.

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

The human component of the NAS (i.e., the people in the ATO) is arguably the most important, most complex, and most expensive element and the most critical portion of the NAS to accomplish the mission. Without our controllers, maintainers, traffic flow coordinators and other people in the NAS it would be impossible to deliver services to users of the airspace. This program is dedicated to enhancing human performance in the conduct of our mission. A reduction in the requested level of funding will cancel or delay major elements of the program. For example, important research on controller fatigue would be delayed at least one year, and fatigue research data collection for the Technical Operations maintainer community delayed at least two years. The area of controller fatigue is a high visibility topic and our sponsors in ATO Safety have recently generated a large number of research requirements to respond to recent initiatives for fatigue countermeasures. This research program recently invested substantial resources into a survey of the state of fatigue of the controller work force (which was initiated prior to the recent controller fatigue-related events) to support the ATO Fatigue Risk Management System. The Air Traffic Control/Airway Facilities Human Factors program would continue to make investments in fatigue research, but at a slower pace and spaced further apart under a reduced funding level. The Human Factors Design Standard used during acquisition programs to reduce human factors risk would be updated at a later date. 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.

One of the critical elements of this program relates to the human performance aspects of safety in the NAS. Our efforts to assure that the human component to safety risk management is reflected in system and airspace development have not kept pace with the changes in the NAS. We are attempting to mitigate this shortcoming, but will be unable to do so at a more austere funding level. Important agency metrics such as loss of separation events and runway incursions are usually the outcome of human error. Decisions on the acquisition of new systems to enhance safety and the application of new or modified procedures to reduce the likelihood of human error should be based on human performance research that is the output of this program. A reduction of funding to this program will have a negative impact on our ability to support these decisions and respond to the safety and human factors engineering needs of our sponsors in the ATO.

Detailed Justification for
A11.j Aeromedical Research

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

FY 2013 – Aeromedical Research

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.j Aeromedical Research	$11,098,000	$11,000,000	$9,895,000	-$1,105,000

For FY 2013, $9,895,000 is requested for Aeromedical Research. Major activities and accomplishments planned include:

Civil Aerospace Medical Institute (CAMI) Aeromedical Research Program

- Aeromedical Systems Analysis
  - Assess accident investigation cases involving atrial fibrillation relative to aeromedical decision making processes.
  - Evaluate aeromedical hazard trends in fatal accidents based on the integrated aeromedical review of individual cases assessing forensic toxicology, autopsy, and medical records information.
  - Determine the prevalence of vision deficits and eye pathologies in accident pilots.
- Accident Prevention and Investigation
  - Evaluate frequency of the presence of tricyclics (used to treat mood disorders) in pilots involved in fatal aviation accidents to determining whether their use was a contributing factor to the accident.
  - Investigate the feasibility of hypoxia biomarkers in rapid decompression studies to elucidate the effects of this stressor on gene expression and further develop mitigation strategies.
- Crash Survival
  - Develop anthropometric test dummy (ATD) calibration methods and dummy modifications that will ensure consistent lumbar load measurements during seat certification tests.
- Aviation Physiology
  - Investigate the feasibility of hypoxia biomarkers in rapid decompression studies to elucidate the effects of this stressor on gene expression and further develop mitigation strategies.
  - Develop educational materials for suborbital flight crew concerned with the radiation environment during suborbital space travel.
- Prevention of Injuries that Impede Egress
  - Determine human impact tolerance levels and methods for predicting occupant unconsciousness and leg injuries that can occur during a survivable crash.
  - Investigate enhanced means of mitigating injury causing mechanisms for the brain and leg.
- Evacuation Analytical Tools
  - Develop and maintain analytical tools, empirical data and scientific expertise to support regulatory actions, standards development, accident investigations, and enhanced safety of airplane interior arrangements and emergency equipment/operations.

Airliner Cabin Environment Research Program

- Airliner Cabin Environment: Purification of Environmental Control System Air Supplies; Bleed Air Contamination

- Develop and test systems and techniques that reliably provide in-flight detection of lubricating oil and hydraulic fluid bleed air contamination air quality incidents.

CAMI will conduct aeromedical research pertaining to the human aspects of protection and survival from exposure to hazardous conditions relative to civil aerospace operations. Research activities will develop new and innovative ways to support FAA regulatory and advisory missions to improve the safety, security, health, and survivability of aviators, cabin crew, and the flying public. There are four research requirement areas: (1) Aeromedical Systems Analysis, (2) Accident Prevention and Investigation, (3) Crash Survival, and (4) Aviation Physiology. The research requirements "Prevention of Injuries that Impede Egress" and "Evacuation Analytical Tools" are Fire and Cabin Safety requirements performed under Crash Survival.

The goals of the Aeromedical Systems Analysis research requirement are to: a) Analyze medical certification, accident, and other biological data to derive methods, recommendations, and/or tools to enhance aircrew health, medical certification decision-making processes, and AME education programs, b) Evaluate trends in physiological, human factors, and clinical findings from civil aviation aircraft accidents and incidents to support accident investigation processes and develop strategies to mitigate aeromedical risks, c) Develop and maintain comprehensive aeromedical research databases towards an Aeromedical Safety Management System and the development of Probabilistic Risk Analysis Methodologies. Support the development of safety policy by providing evidence-based aeromedical recommendations and manage safety risk by reporting emerging health problems that would impact medical certification processes or technology Safety Risk Management, Safety Assurance, and Safety Promotion, an d) Investigate current and anticipated aeromedical issues and technology that may impact human performance in aviation activities.

The goals of the Accident Prevention and Investigation research requirement are a) Develop advanced toxicological and biochemistry methodologies to analyze human biological samples for emerging drugs, toxins, and other substances that may impact pilot performance or assist in determining accident causality. As a result of this effort, provide technical reports, procedures, recommendations, criteria, and associated products that would assist the aeromedical scientific, drug abatement, and certification communities; accident investigation personnel (AAI, NTSB, DOT); and FAA legal counsel (AGC) in realizing their goals and b) Develop gene expression (biomarker) methodologies to quantify the effects of alcohol, drugs, fatigue, hypoxia, and other environmental or aeromedical stressors relating to pilot performance and accident investigation. Determine collection methods, develop and assess analytical procedures and technologies, and ultimately provide an approach to identify or predict these effects, towards a "genomics black box."

The goals of the Crash Survival research requirement are a) Develop design and certification test methods and criteria to ensure occupant survival at maximum airframe impact tolerance. Address seats, seat cushions, seat restraints, air bags, and related devices, b) Develop and validate mathematical models to simulate, facilitate, and improve (A); validate these models in conjunction with biodynamic testing, provide recommendations for the development of industry-wide standards; and coordinate/participate in these standardization efforts through professional associations and workshops to ensure industry understanding, c) Develop safety and emergency equipment standards, procedures, and criteria to ensure evacuation capability for all aircraft occupants from all aircraft incidents and survivable aircraft accidents, and d) Provide recommendations for the development of industry-wide standards and coordinate/participate in these standardization efforts through professional associations and workshops.

The goals of the Aviation Physiology research requirement are to a) Investigate the effects of ionizing and non-ionizing radiation on living systems; identify radiation hazards in the aviation environment; and develop methods of protection from such hazards and b) Investigate environmental factors that influence human physiology and performance in aerospace environments.

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 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 Aeromedical Research and ACER 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 2012, major activities and accomplishments planned include:

CAMI Aeromedical Research Program

- Aeromedical Systems Analysis
  - Examined and modeled aviation accidents in Alaska over time. The model will provide a way of assessing risk within the Alaskan aviation community.
  - Reported 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.
  - Assessed 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.
- Accident Prevention and Investigation
  - Analyzed and distributed zolpidem, a prescription medication used for the short-term treatment of insomnia, in postmortem specimens from aviation accident fatalities.
  - Reported on the effects of exposure to combustion gases (CO and hydrogen cyanide) in support of investigation of aviation accidents involving fire/smoke.
  - Developed procedure to validate potential biomarkers by special biochemical methods. These biomarkers will assist in identifying fatigue and other aviation stressors.
- Crash Survival
  - Developed anthropometric test dummy (ATD) calibration methods and dummy modifications that will ensure consistent lumbar load measurements during seat certification tests.
  - Determined human impact tolerance levels and methods for predicting occupant unconsciousness and leg injuries that can occur during a survivable crash. Investigate enhanced means of mitigating injury causing mechanisms for the brain and leg.
  - Continued development of evacuation analytical tools.
- Aviation Physiology
  - Provided guidance for measuring and estimating radiation exposure during commercial aerospace activities and developed instructional materials on radiation exposure to humans during commercial aerospace travel.
  - Evaluated the performance of current aircrew oxygen regulators installed on commercial aircraft.

Airliner Cabin Environment Research Program

- Airliner Cabin Environment: Purification of Environmental Control System Air Supplies; Bleed Air Contamination
  - Assessed 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.
  - Quantified the relative importance for disease transmission on aircraft due to: (i) airborne transmission, (ii) indirect contact through surfaces.
  - Compared the risk of infection in different stage of air operations such as boarding, taxiing, flying, and de-boarding.
  - Developed techniques to model chemical reaction kinetics of high temperature degradation of aircraft engine oil and hydraulic fluids.

- Selected specific commercial sensing technologies for application to aircraft.
- Developed a conceptual framework for intelligent integration of the sensors with software controls.

- Evaluation of Aircraft Air Contaminants from Cabin Materials
  - Evaluated the extent of biological contamination of surfaces in the aircraft cabin.
  - Studied controlled exposures to evaluate emissions of hazardous air contaminants as well as uptake and release of compounds from aircraft materials.
  - Conducted a preliminary assessment of PBDEs in typical aircraft cabins.

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 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.

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 two 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.

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 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 and the Cabin Environment Research program is principally outsourced. A reduction in funding will extend research time to assess critical aeromedical issues and cabin environment issues such as 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.

Detailed Justification for
A11.k Weather Program

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

FY 2013 – Weather Program

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.k Weather Program	$16,143,000	$16,043,000	$15,539,000	-$504,000

For FY 2013, $15,539,000 is requested for the Weather Program. Major activities and accomplishments planned include:

Aviation Weather Forecasting

- Perform preliminary analysis to utilize in-flight icing forecasts to enhance or replace AIRMETs.
- Update high ice water content (HIWC) algorithm to support FY 2013 full flight campaign.
- Commence development and test of probability-based model forecasts utilizing the time-lagged high resolution rapid refresh.
- Commence development of probabilistic turbulence forecasts.
- Document convective storm forecast uncertainty needs of NextGen.
- Develop integration plan and techniques for inclusion of national ceiling and visibility forecasts as value-added to National Weather Service (NWS) terminal area forecasts.
- Develop initial set of performance requirements for volcanic ash.
- Verify and assess weather forecast capabilities utilizing the verification requirements and monitoring capability.
- Use the enhanced aviation weather simulation and demonstration environment at the William J. Hughes Technical Center (WJHTC) to evaluate various aviation weather forecast products.
- Develop capability to measure the quality of information on aviation constraints which have been translated from weather information.

Safety-Driven Weather Requirements for Wake Mitigation

- Select and incorporate real-time wake models into Monte Carlo simulation to determine results sensitivity of wake encounters to weather accuracy.

Terminal Area Icing Weather Information System

- Develop final Terminal Area Icing Weather Information System (TAIWIS) operational definition and identification of key technologies.

Mitigating the Ice Crystal Weather Threat to Aircraft Turbine Engines

- Conduct full flight campaign out of Darwin, Australia using HIWC and particle size measurement instrumentation.

Lower Visibility for CAT 1 Approaches and RVR Conversion

- Evaluate runway visual range (RVR) to ASOS/AWOS and determine new RVR to visibility equivalents.

The Weather Program will continue to develop and enhance forecast and nowcast capabilities to support the 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. Additional turbulence forecast capabilities will be developed to enhance en route safety and capacity. An advanced probabilistic storm prediction capability will be developed to enhance terminal and en route capacity.

Additionally, the Helicopter Emergency Medical Services (HEMS) weather tool will be enhanced to provide additional altitude and location specific data to increase safety. The FAA will continue to partner with NASA, Transport Canada, Environment Canada, and the Australian Bureau of Meteorology to address mitigation of ice crystal weather threats to aircraft turbine engines.

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. 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 NextGen Weather 4D functional and performance requirements document. 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 the FAA provide the following benefits:

- Depiction of current and forecasted in-flight icing areas – enhances safety and regulatory adherence
- Interactive data assimilation, editing, forecast, and dissemination tools – improves aviation advisories and forecasts issued by the NWS as well as accessibility to users of aviation weather information
- Depiction of current and forecast precipitation type and rate – enhances safety in the terminal area
- Depiction of current and forecast terminal and en route convective weather – enhances terminal and en route capacity
- Short-term prediction and forecast of ceiling and visibility in the national area – enhances en route safety
- In-situ, remote detection, and forecast of en route turbulence, including clear-air turbulence – enhances en route safety

The Weather Program supports NextGen goals via applied research and development of the advanced forecast capabilities in support of the NextGen Weather operational improvements. 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 2012, major activities and accomplishments planned include:

Aviation Weather Forecasting

- Commenced development of in-flight icing forecast for Alaska.
- Updated HIWC algorithm to support FY 2012 trial field program.
- Evaluated rapid refresh ensemble with 3 km Continental United States (CONUS) and Alaskan nests at National Centers for Environmental Prediction (NCEP).
- Transitioned turbulence forecast capability including mountain-waves for implementation.
- Enhanced the baseline configuration against which convective weather forecast improvements can be measured.
- Developed prototype national ceiling and visibility forecast to improve gridded forecast products in collaboration with the NWS.
- Developed volcanic ash concept of operations and initial set of functional requirements.
- Developed verification techniques and approaches that assess research capabilities in support of the research transition process.

- Enhanced the aviation weather simulation and demonstration environment at the WJHTC.

Terminal Area Icing Weather Information System

- Developed Terminal Area Icing Weather Information System concept design documents including description of operational use.

Mitigating the Ice Crystal Weather Threat to Aircraft Turbine Engines

- Conducted research trial field program using high ice water content and particle size measurement instrumentation.

Helicopter Emergency Medical Services (HEMS) Weather Tool Improvement

- Tested and implemented observation trending and locale specific data capability to HEMS weather tool.

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 2015, 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 now-casting 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 tools.

4. How Do You Know The Program Works?

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. Specifically the Graphical Turbulence Guidance 2 (GTG2), which was operationally implemented at the NOAA Aviation Weather Center in FY 2010, is providing 0-12 hour forecasts of turbulence above 10,000 feet enhancing NAS safety and capacity. GTG2 also uses as an input, in-situ eddy dissipation rate (EDR) data downlinked from aircraft which provides enhanced forecast accuracy. The EDR metric as a result of AWRP funded efforts was approved as an International Civil Aviation Organization standard. Additionally the Forecast Icing Product with severity, which was operationally implemented at the AWC in FY 2011, provides 0-12 hour forecasts of atmospheric conditions conducive to inflight icing including severity and the probability of supercooled large drops, enhancing NAS safety and capacity. The Weather Program has developed an advanced storm forecast algorithm known as CoSPA. It was demonstrated at the Air Traffic Control System Command Center and for other air traffic users during the summer of FY 2010. CoSPA forecasts were found to be equal or better than current operational forecast capabilities and provided information critical for air traffic management. A critical data input for CoSPA is the High Resolution Rapid Refresh (HRRR) model, also developed under the auspices of the Weather Program. The HRRR provides the high resolution granularity for thunderstorm structure depiction needed by air traffic management decision-makers. Additional model efforts of the Weather Program have focused on the Weather Research and Forecasting (WRF) model which was developed to promote closer ties between research and operations while providing improved forecasts of aviation weather hazards. Enhancements to this model have resulted in the WRF Rapid Refresh which will be replacing the Rapid Update Cycle model when it is implemented into operations at the NWS, 4th quarter FY 2011. The Weather Program also sponsored development of a Helicopter Emergency Medical Services (HEMS) weather tool which provides critical low-level ceiling and visibility information to HEMS operators.

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 the Weather Program budget would impact the program's ability to move forward effectively and provide capabilities needed to meet safety and capacity requirements.

Specific impacts are as follows:

Funding for Turbulence research would be reduced. There were more than 5,000 encounters of severe turbulence in 2009. Implementation of a probabilistic turbulence forecasting algorithm for all flight levels has been estimated to provide annual safety benefits in excess of $35M. Elimination of turbulence funding will delay completion of a turbulence probabilistic forecast for all flight levels.

Funding for Ceiling and Visibility research would be reduced. There are more than 60 fatalities per year due to adverse ceiling and visibility conditions within the general aviation and Air Taxi communities resulting in more than $400M per year in fatalities, injuries, and aircraft damage. A national ceiling and visibility probabilistic forecast capability is currently under development in collaboration with the National Weather Service. This funding elimination will delay completion of a ceiling and visibility probabilistic forecast.

Funding for In-flight Icing research would be reduced. The in-flight icing accident rate for GA and Air Taxi operations in Alaska is four times higher than in the CONUS (based on the accident rate/million hours of operations) and results in more than $1M per year in fatalities, injuries and aircraft damage. Forecast and diagnosis capabilities for Alaska are currently under development. This funding reduction will delay completion of an Alaskan in-flight icing capability.

Funding for Convective Weather research would be reduced. Convective weather is the leading cause of weather delays in the NAS (75%). Avoidable delays due to thunderstorms provide a $16 billion (FY 2009 dollars) benefits pool for a 20-year life cycle. The reduced funding in FY 2013 would delay the development of a probabilistic forecasting capability that is critical to enhanced ATM decision making.

Funding for the Volcanic Ash research effort would be reduced. Development of an initial set of performance requirements in coordination with NOAA and ICAO, critical to the development of improved warning and forecast tools for enhanced safety and capacity, would be delayed.

Detailed Justification for
A11.l Unmanned Aircraft Systems Research

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

FY 2013 – Unmanned Aircraft Systems Research

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.l Unmanned Aircraft Systems Research	$3,635,000	$3,504,000	$5,901,000	+$2,397,000

For FY 2013, $5,901,000 is requested for Unmanned Aircraft Systems Research. Major activities and accomplishments planned include:

Sense and Avoid (SAA) System Certification Obstacles

- Identify the major SAA system certification obstacles, including systems and equipment requirements for an alternate means of compliance to 14 CFR Part 91 to replace pilot see and avoid operational requirements certificated through knowledge testing, practical test standards and flight evaluations of pilot performance.
- Develop technical requirement statements that can be used to derive specific concepts for development of systems and equipment for alternate means of compliance to 14 CFR 91 see and avoid operational requirements.
- Continue to provide FAA flight test support for airborne SAA systems, as needed, to facilitate and learn from their development.

UAS Control and Communication (C2) – Time Critical Low Latency Control Response for UAS with Low Levels of Autonomy

- Model and simulate UAS C2 architectures to assess ability to safely manage trajectory of aircraft during critical phases of flight despite potential delays between control station control inputs and aircraft responses.
- Model and simulate various UAS operational scenarios to validate TT95 for non-critical pilot control actions.
- Perform operational safety, hazard and performance analyses along with interoperability assessments to determine the impact on safety and efficiency of UAS in the NAS with the TT95 validated through other modeling and simulation analyses as noted above.

Sense and Avoid (SAA) System – Certification Considerations for Requirements Based Testing and Validation of Non-deterministic Data Processing

- Determine certification considerations for SAA requirements-based testing and validation of non-deterministic surveillance data processing, tracking, threat declaration and maneuvering logic.

UAS Acceptable Communication Delay Values Associated with Step-ons

- Evaluate impact of C2 technologies on UAS communication and delay values associated with "step-ons" for both line of sight and beyond line of sight communication architectures.

FY 2013 funding will support the UAS program to conduct research on UAS technologies which directly impact the safety of the NAS. The program is focused on sense and avoid and command and control 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:

- 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.
- 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 a Memorandum of Cooperation.
- Cooperative Research and Development Agreement (CRDA) with industry to jointly study UAS regulatory compliance issues, e.g., type design, airworthiness, operation, maintenance, and repairs.

In FY 2012, major activities and accomplishments planned include:

Minimum Necessary Sense and Avoid (SAA) Information Required for an Unmanned Aircraft (UA) Pilot to Execute a Collision Avoidance Maneuver

- Determined performance characteristics and operational requirements for SAA technologies.
- Initiated study of minimum necessary SAA information required for a UAS pilot to execute a collision avoidance maneuver, including specific flight path guidance and traffic information, if necessary.
- Continued flight test support of SAA systems to facilitate and learn from developments of airborne SAA systems.

UAS Command, Control and Communication - Time Critical Low Latency Control Response For UAS With Low Levels of Autonomy

- Modeled UAS C2 architectures to assess ability to safely manage trajectory of aircraft during critical phases of flight despite potential delays between control station control inputs and aircraft responses.

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 conduct research to develop airworthiness standards, devise operational requirements, establish maintenance procedures, and conduct safety oversight activities. The goals of the focused research endeavors are:

- By FY 2013, analyze data and identify potential system safety implications related to communications latency, which will be used to determine the stability and safety of flight trajectory management transaction time requirements and reduce incidents and accidents.
- By FY 2016, conduct field evaluations of UAS technologies in an operational environment, including SAA, C2, and contingency management. The documented results will be used to develop various certification standards.
- By FY 2017, define SAA systems and equipment certification obstacles to a level of detail sufficient to develop specific concepts for development of SAA systems and equipment.

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.

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 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?

Delays in FAA UAS safety research will impede the timely and safe integration of UAS into the NAS. Demand for NAS access is growing from multiple operators including DoD, public use agencies, and the private sector.

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 2013 – NextGen – Alternative Fuels for General Aviation

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A11.m NextGen – Alternative Fuels for General Aviation	$998,000	$2,071,000	$1,995,000	-$76,000

For FY 2013, $1,995,000 is requested for NextGen – Alternative Fuels for General Aviation. Major activities and accomplishments planned include:

- Complete initial study regarding the use of high aromatic additives for octane enhancement
- Complete initial study determining the assessment criteria for use of bio-mass derived fuels.
- Establish capability to measure lead emissions from piston aircraft engines operating on ultra-low lead and low-lead fuels.
- Complete testing to characterize the impact of fuel-system and combustion chamber lead deposits on unleaded fuel detonation performance.
- Complete durability study and lubricating oil analyses test on proposed high-aromatic component in a high-compression engine.

Research will support the R&D roadmap and framework being developed by the newly formed Unleaded Aviation Gasoline Transition Aviation Rulemaking Committee (UAT-ARC). The post-ARC R&D framework will involve government and industry cooperative guidance and/or research to safely transition the fleet to an unleaded aviation gasoline. Research will focus on the safety impact from deviation from the current leaded aviation fuel specification properties from use of a new unleaded fuel. Supporting research to address feasibility or impact of reducing high-octane lead additives in aviation gasoline and how that will impact fleet performance and certification. Test data and laboratory analyses of high aromatic 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 fit-for-purpose safety critical performance metrics from increased aromatic limits in the low-lead fuel for octane enhancement

The assessment of the impact on safety and operating performance from the use of the traditional 100Low Lead (100LL) 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 unleaded fuel and additives specification development protocol task force at ASTM international. This task force was set up to develop guidance to a potential fuel or additive sponsor for performing the necessary specification property and fit-for-purpose properties research to obtain an ASTM fuel or additive approval specification.

Research will also address performance and safety from use of high aromatic fuels throughout the full operating envelope for a high-output turbocharged fleet representative engine. Development of new engine, rig, and laboratory test methods necessary to evaluate fuels which differ from traditional hydrocarbon, refinery based fuels. The data from that testing will be used to support the update of FAA guidance materials for detonation testing and fuel and lubricants approval.

Testing to address the capability to measure lead emissions and bulk gas exhaust emissions from general aviation (GA) engines will be performed. Additionally, research will also examine the impact to safety and operational changes from technologies that could be used to modify the GA legacy piston engines to run on significantly reduced octane unleaded fuels.

2. What Is This Program?

This program will provide data and support to 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 provide data and research to support the safe transition of the fleet to an unleaded aviation gasoline and 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:

- Unleaded Aviation Gasoline Transition Aviation Rulemaking Committee and the follow-on post-ARC government and industry framework.
- 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 and Society of Automotive Engineers (SAE).
- Academia and national laboratories.

Partnerships include:

- Unleaded Aviation Gasoline Transition Aviation Rulemaking Committee and the follow-on post-ARC government and industry framework.
- 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.

- 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 guidance protocol for unleaded fuel and additive (ASTM) specification approval.
- Cooperative Research and Development Agreements with engine, airframe, and fuel OEMs and enabling technology developers.

In FY 2012, major activities and accomplishments planned include:

- Evaluated the performance of a fleet representative, naturally aspirated engine on ultra-low lead fuels.
- Evaluated the impact based on approved fuels on the GA fleet from the reduction and eventual removal of lead from aviation gasolines.
- Evaluated the safety and performance of high compression engines on unleaded, mid-octane aviation alkylate fuel.
- Completed a flight-test plan for in-flight detonation and performance safety evaluation of turbocharged fleet representative engine using unleaded, high-octane fuel.

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 provide data and research to support the development of 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 provide data and research to support the development of qualification and certification methodologies for those fuels. Longer term research includes full-operating envelope 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 2014, complete feasibility assessment criteria for 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 2014, establish capability to measure lead emissions from piston engines operating on ultra-low lead and low lead fuels.
- By FY 2015, complete analyses to extrapolate lead emissions over GA fleet.
- By FY 2015, develop methodology and acquire tools for full-operating envelope 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 2016, complete testing to be used to update FAA guidance and regulatory materials regarding detonation testing and fuel and lubricant approval.
- By FY 2017, develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded avgas.
- By FY 2018, complete test engine emission evaluation of existing biomass derived and high-aromatic, high-octane fuels.
- By FY 2018, 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 growing need to find a replacement for current leaded avgas (100LL). Recently, there have been significant actions by the Environmental Protection Agency to reduce ambient air lead emissions. General Aviation now accounts for 45% of all ambient air lead emissions.

The replacement fuel should perform as well as 100LL in 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. Unleaded fuel suggestions for replacing the current leaded aviation gasoline have focused on removing the lead and using alkylate, to adding specialty chemicals to as much as half the fuel volume. Both of these proposed solutions will have significant safety impact to the existing fleet. Simply removing lead additives from aviation gasoline would leave a fuel with substantially reduced octane resulting in significant safety impact to the current fleet, with a large percentage of the fleet being unable to be utilized. Attempts to replace the octane that the current lead additive provides have resulted in the need to use very high percentages of specialty chemicals. Use of these specialty chemicals, often as much as 50% of the blend, has resulted in the new fuel being unable to meet the many other safety critical specification and fit-for-purpose properties for which the fleet was designed.

Research will evaluate and characterize new alternative fuel formulations that will have maintained the current level of safety and protected the environment while sustaining growth in air transportation. Research will also evaluate the safety of potential technological additions to aircraft to allow safe operation on fuel with significantly reduced octane.

4. How Do You Know The Program Works?

Recent FAA engine and fuel test data have been used to pass the inclusion of a very-low-lead aviation gasoline specification at ASTM to help states comply with the recent EPA reduction in lead NAAQS. FAA data has been used extensively by the Coordinating Research Council to develop unleaded fuel octane model response matrices to predict full-scale engine behavior of a sub-class of unleaded fuels to its octane value.

Almost all of the work is planned and directed toward the development and improvement of current FAA regulations and guidance for approval of unleaded fuels. Further, the NextGen – Alternative Fuels for GA program will publish reports and present findings at peer reviewed councils and standards bodies.

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 for the NextGen - Alternative Fuels for General Aviation Program could delay the empirical testing and assessments needed to produce data to determine the certification impact and safety assessment of whether the near term reduction in lead content of aviation gasoline could meet the estimated EPA target. More specifically, the EPA's October 2008 90% reduction in National Ambient Air Quality Standard (NAAQS) for allowable ambient air lead inventory included specific regulatory requirements for lead monitoring at and around airports. By Jan 2017 all states have to be in compliance with the new NAAQS regulations. Very recently a major environmental group in California announced their intent to sue every distributor and retailer of leaded aviation gasoline in California, including major oil producers and small airports. Sited for the suit was a 2008 EPA report on the negative health and welfare effects from leaded avgas. Slight reductions in funding will delay the completion of significant testing that is foundational for follow-on research. As an example, lack of funding to complete the lead memory testing to address the real impact of combustion lead deposits on unleaded fuels will result in significant increases to certification, cost, schedule, and testing burden to the aviation community.

Moderate to severe budget cuts will result in a significant impact to the industry as the safety research will not be completed to support the necessary development and modification of existing regulatory guidelines for recertification of the entire fleet on a new unleaded aviation gasoline. This would likely push the completion of this necessary research past the Jan 2017 lead NAAQS deadline and result in significant curtailing of aviation operations. Due to the economic benefit of general aviation to our country this could have measureable employment and economic impact.

Detailed Justification for
A12.a Joint Planning and Development Office

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

FY 2013 – Joint Planning and Development Office (JPDO)

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A12.a Joint Planning and Development Office	$13,792,000	$5,000,000	$12,000,000	+$7,000,000

For FY 2013, $12,000,000 of funding is requested for the JPDO to provide the following activities:

National Goals for UAS Integration

- Formulate the strategic National program plan for UAS integration
- Refine NextGen partner agencies' requirements for UAS operation
- Conduct cost, benefit and risk assessments using modeling and simulations of relevant scenarios to establish possible transition steps and milestones
- Analyze policy options and implications for UAS integration

Interagency Data Exchange Definition and Policies

- Continue to identify information data sharing requirements, processes, and applications that can be applied within specific functional areas (such as surveillance) which can then be shared for use by all NextGen partner agencies.
- Utilize the virtual interagency test environment to address the UAS information sharing and infrastructure requirements, policies, and standards of all agencies (Federal, Local, and State) without impacting the operational environment upfront.

NextGen Research Priorities

- Continually identify, define and coordinate research gaps related to UAS and Trajectory Based Operations (TBO)
- Review technology developments and innovation to recommend opportunities for technology transfer among Federal entities and/or industry
- Apply program management and integration to ensure research content (needs and priorities) is updated within the Joint Planning Environment, a database framework that supports interagency decision-making and plans

Public/Private Partnerships

- Engage industry stakeholders via the NextGen Institute
- With the Institute, continue to develop, test, review and document stakeholder perspectives on NextGen concepts and analyses including the Trajectory Based Operations (TBO) safety case, weather and harmonization of global implementation of air transportation
- Define and conduct a series of stakeholder engagement forums to formulate the UAS program plan across Federal entities
- Convene the Senior Policy Committee (SPC) for the Secretary of Transportation

Federal Requirements for Surveillance Data and Sensors (Integrated Surveillance)

- Define and conduct a series of forums to identify independent activities of the surveillance mission partners that should be synchronized.
- Conduct technical and policy analyses to support governance of joint surveillance capabilities
- All of the above activities will ultimately result in Federal surveillance systems that communicate with each other thereby ensuring common situational awareness that avoids conflicting efforts and costs

2. What Is This Program?

The JPDO executes collaborative processes to ensure efficient coordination between all Federal partners whose decisions impact NextGen, namely the Federal Aviation Administration (FAA), NASA, and the Departments of Defense, Homeland Security and Commerce. The JPDO provides a National "big-picture" perspective that encompasses a broad Federal view of NextGen. The Office is developing a framework for NextGen planning and development, identifying and prioritizing key multi-agency concerns, and driving consensus in the development of investment choices and decisions thereby improving efficiencies, ensuring cross-Federal compatibility, and reducing costs.

In the completion of its work, the JPDO conducts and disseminates a wide variety of studies including cost, benefit and risk assessments; policy analysis; modeling and simulation; and program management and integration. The JPDO was established in 2003, when Congress enacted NextGen under Vision 100 – Century of Aviation Reauthorization Act (P.L. 108-176). Maintaining the NextGen vision and facilitating a public/private partnership to manage critical collaborations needed to make NextGen a reality are among the JPDO's responsibilities.

The JPDO convenes the SPC to provide strategic policy guidance for NextGen. For example in FY 2011, SPC direction enabled the JPDO to engage more than 60 experts from five agencies to initially describe the current, Government-wide research plan for UAS. The SPC is chaired by the Secretary of Transportation and its members include the heads of the participating departments and agencies, as well as the Director of the Office of Science and Technology Policy and the Office of the Director of National Intelligence (ex officio). In support of the SPC, the JPDO governance structure has a Board, chaired by the JPDO Director, whose members are executives from each department/agency who meet quarterly and work continuously to resolve issues directed by the SPC.

The JPDO is comprised of employees from FAA and the other Federal partners. This ensures that all the partners may benefit from a multi-departmental perspective when developing future plans, contract requirements, technical specifications, etc. The JPDO workforce actively facilitates and engages researchers, program managers and executives from among the partner agencies to formulate the interagency view.

The private sector is also an integral part of JPDO's work. In 2006, the NextGen Institute was established as an alliance of major aviation stakeholder communities to ensure industry engagement. The Institute, together with nine government/industry Working Groups, helped formulate the vision for NextGen. Today, the Institute continues to host public/private forums and to bring the right experience and range of viewpoints to inform NextGen analyses. With the Institute, the JPDO has taken steps to ensure NextGen will work seamlessly with other global aviation systems focusing on stakeholder priorities.

The JPDO work directly links to the DOT Strategic Goal of Economic Competitiveness and the FAA's "Destination 2025" goals.

Activities and planned accomplishments for FY 2012, representing a significantly de-scoped research plan for the JPDO compared to prior years, include:

- Formulate the national program planning approach for UAS integration into NextGen emphasizing interagency requirements and gap assessment.
- Leverage NASA resources to conduct cost, benefit and risk assessments directed toward UAS, weather and information data sharing.

- Refine interagency concepts for surveillance sensors and data (called Integrated Surveillance) that will ultimately lead to cost-effective acquisitions addressing civil aviation, defense and homeland security missions.
- Archive all net-centric testbed prototypes that demonstrate how aviation data can be securely accessed by all agencies in the conduct of their missions and promote best practices across Government. Some mature activities will be transitioned for single-agency leadership.
- Streamline stakeholder engagement under the NextGen Institute by replacing standing working groups with an efficient "study team" model. Complete and document existing working group activities in areas such as security, net-centric operations, environment, aircraft certification and operations while continuing TBO safety case planning and weather customer forums under the new structure of study teams and workshops. Our study team model ensures that all points of view are considered and stakeholder priorities are known at the inception of strategic concept definition.

For FY 2013, activities will build on the FY 2012 transition.

National Goals for UAS Integration

UAS play an increasing role in both federal and civil missions including homeland security, national defense, law enforcement, weather monitoring and surveying. To date, analysis has focused on identifying and defining research programs to address the technical barriers to their interoperation with manned vehicles in the NAS. In FY 2011, the JPDO partner agencies collaborated on the development of a UAS Research and Development Roadmap. With all partner agencies contributing expertise, the JPDO produced and delivered to OMB a comprehensive roadmap which identified the research gaps and opportunities for UAS integration in the NAS.

In FY 2013 with $3,149 thousand, the JPDO will undertake a new effort and lead the NextGen partner agencies in the formulation, development and tracking of a program plan that identifies National goals for UAS integration into the NAS. This program plan will include agency requirements, transition steps, coordinated activities and milestones in order to accelerate strategic decision making on UAS implementation issues.

Interagency Data Exchange Definition and Policies

Information data sharing among federal networks and systems is critical for the transition to NextGen. Full NextGen capabilities cannot be realized without ensuring that the right parties have the right information at the right time. The JPDO has facilitated the development of an information sharing approach that focused on shared understanding, incorporating technical components and leveraging existing interagency infrastructures. The JPDO has developed the NextGen Information Sharing Environment (NISE) which is a holistic and cyclical framework to identify the common set of requirements the community will use to facilitate information sharing across the enterprise.

In FY 2013, with $1,687 thousand, the JPDO will use its interagency collaboration best practices to maintain the management role and governance of the NISE. This role will facilitate the continued development of communities of interest, define enterprise information sharing support agreements, direct configuration control of the environment and sustain shared understanding development. This effort will result in cost savings to the Nation by reducing duplicative efforts in information sharing activities.

NextGen Research Priorities

Trajectory based operations (TBO) is a king pin to achieving the ultimate NextGen vision. TBO will provide additional capacity and increase flexibility through precision performance against agreed to and predictable flight paths that are managed by automation to ensure safety. Automation will monitor aircraft performance against a known flight path and detect and resolve potential conflicts, freeing the human from detecting and correcting these situations as they arise. The automated nature of this approach will enable more predictable flights thereby increasing capacity.

The JPDO and its partner agencies recognize the potential benefits of TBO and are simultaneously executing various efforts. In FY 2012, the JPDO deferred refinement of long-term research priorities for trajectory based operations, including human systems integration, air/ground automation, software verification and validation and cyber-security unless they are directly related to UAS integration in the NAS.

In FY 2013 with $1,316 thousand, the JPDO will lead the effort with the partner agencies to identify the necessary research priorities needed to recognize a full TBO environment. The JPDO will provide an overall map with associated interagency budget requirements identifying where activities are required and develop an interagency TBO program plan for execution. This interagency TBO program plan will indicate required research items, policy issues, requirements for implementation and cross organizational agreements. By documenting this interagency TBO program plan, the partner agencies can address issues before they become impediments to progress. The interagency TBO program plan will be incorporated into the Joint Planning Environment.

Public/Private Partnership
In FY 2013 with $1,592 thousand, will continue to forge private/public partnerships, most notably, convening the Senior Policy Committee (SPC) for the Secretary of Transportation. JPDO staff will organize the Committee's agenda, apply technical knowledge to prepare briefings for Committee Members, document actions and carry out those actions that are fully interagency in nature.

Also notable, the NextGen Institute will continue to provide a mechanism for private sector engagement in the definition of NextGen though study teams, workshops, information sharing forums and potentially, funded tasks. To support the JPDO's FY 2013 activities, the private sector will likely be asked to participate in UAS workshops on refining capability maturity, TBO Safety study teams or workshops to define gaps in TBO safety related issues, a TBO Concept of Operations definition effort, and forums related to weather and harmonization of global implementation of air transportation. Other activities may be added as they are determined.

Federal Requirements for Surveillance Data and Sensors (Integrated Surveillance)
Individual departments and agencies need data and sensors to see all aircraft (cooperative and threats) to meet its own mission. The JPDO led the development of the Integrated Surveillance Support Office (ISSO) at the direction of the SPC. The ISSO acts as the dedicated technical support capability for the governance of national air surveillance. The intent behind the ISSO is to provide independent technical analysis to support collaborative efforts of the partner agencies.

In FY 2013, with $1,817 thousand, the JPDO will continue its efforts to coordinate partner agency activities in the development of technical planning documents which will lead to a formal interagency coordination process for research and development, requirements development and validation, and acquisition of IS capabilities. Specifically, in 2013, the JPDO/ISSO will perform analysis leading to two joint DOT/DHS/DOD/DOC decisions: (1) national surveillance sensor capabilities for non-cooperative aircraft and (2) software that will enable all mission partners to share a common operating picture.

3. Why Is This Particular Program Necessary?

The JPDO provides the multi-agency governance that guides the development of the Nation's air transportation system. The JPDO convenes the Senior Policy Committee, comprised of Cabinet-level Secretaries, to develop goals, align resources, and ensure that stakeholders are involved in decision-making. This dialogue will help prevent duplication and will ensure NextGen systems will work with those of the other Federal partners. The JPDO ensures research coordination with the international community so that NextGen will work seamlessly with other global aviation systems.

The FAA's main focus needs to be NextGen implementation and its normal operational issues. The JPDO is "future" focused and provides coordination among all the Federal partners affected by NextGen decisions. In the future, use of airspace will be more integrated, considering civil aviation, defense and homeland security. This need for integration will make airspace more complex while all missions must operate together. Further, the pace of technology is unfolding rapidly requiring all departments to have full situational awareness of new developments. The JPDO provides the common view.

The JPDO is comprised of employees from both FAA and the other Federal partners (FAA employees represent about 50 percent of the JPDO Federal workforce). This ensures all the partners have the benefit from a multi-Departmental perspective when developing plans. It is more difficult for the FAA to properly consider the implications of its decisions on other Federal systems. The JPDO provides a broader perspective and insights that help Departmental decision-makers in reviewing FAA's NextGen related resource requests and in considering the impact of NextGen decisions on other Administration entities.

The JPDO, working together with partner agencies and industry, defines the capabilities and mechanisms that enable the national air transportation system to accommodate a wide range of customers. The JPDO has a strategic view, assessing needs for research, technologies and policies in a dynamically changing global environment. Because the JPDO is not a research performer, implementer or operator, its role is well-suited to analyze a range of possible solutions and guide the Federal partners to one successful solution that best meets the needs of all the partners.

In recent studies, the Government Accountability Office (GAO) and Office of the Inspector General (OIG) have reported the need for technology transfer, research into human factors and weather, development of integrated surveillance capabilities and integration of UAS. The JPDO's work plan is actively emphasizing these key areas with government and industry partners.

4. How Do You Know The Program Works?

The following items are recent examples to illustrate how JPDO efforts translate into technology transfer and agency action:

- The SPC, a cabinet-level decision-making body chaired by DOT, relies on JPDO support. In 2010, the SPC endorsed the JPDO's Integrated US Air Surveillance Governance Report and called for its expedited implementation as part of the Air Domain Awareness initiative led by DHS. During 2011, the JPDO demonstrated efficient surveillance information exchanges among agencies utilizing a combination of operational and prototype net-centric implementations that forged new partnerships between agencies and industry. Importantly, areas were identified where agencies can now realize potential cost-savings through consolidation of systems and capabilities.
- The SPC charged the JPDO with leading interagency coordination of research toward integration of UAS into the airspace. In 2011, every NextGen partner participated in the initial development of a UAS R&D Roadmap. As stated in the report, FAA's progress to define a clearer path toward certification and routine UAS operations can be accelerated by leveraging research at NASA and DOD while these partners also benefit from stronger FAA involvement in their research programs.
- Prior JPDO analyses identified human factors research, including the balance of human and automation roles for NextGen, as a gap. This gap, if not addressed, would constrain the roles of human operators to current tasks and prevent efficiency gains that automation can provide. During 2010, the JPDO worked with NASA and the FAA to produce a Human Factors Research Coordination Plan. The agencies are executing according to that plan during the current budget formulation cycle.
- In 2008, the JPDO, FAA and NASA established Research Transition Teams to facilitate transfer of research in four areas. In 2011, one of those teams, Flow Based Trajectory Management, successfully completed their effort. The team had defined a common outcome, agreed on roles, and developed means to evaluate, monitor, and report results. Specifically, proven NASA prototype capabilities were mapped to the particular automation systems on which FAA will evaluate implementation strategies.
- The JPDO works with DOC, FAA and DOD on developing a vision for aviation weather management that is focused on the aviation user. The JPDO regularly facilitates a senior executive panel, known as the NextGen Executive Weather Panel, who oversaw the development of a joint program plan. Aligned with the joint plan and its weather information governance structure, during FY 2011 the FAA and the National Weather Service demonstrated the ability to share and discover many types of weather data within an interagency, net-centric environment.
- In 2010, the JPDO conducted a study on flight prioritization and outlined a framework for best equipped best served options, a concept of critical importance to airline operations that was not well-defined in the early NextGen vision. The JPDO's policy analysis and strategic framework provided the basis for discussion by the FAA's NextGen Advisory Committee to identify the single preferred option for the airlines.

The Research, Engineering and Development Advisory Committee (REDAC) endorsed this level of funding for the JPDO. The 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.

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

Without the requested funding, the JPDO may cease to exist. In FY 2012, the JPDO managed a severe budget reduction through re-prioritization, reduction and/or elimination of every task, activity and job position for ongoing or planned FY 2012 research. Every existing JPDO contract task order was modified in scope or performance period during FY 2012, and backfill of vacant FAA positions was deferred several months to save costs. The JPDO continued a few high priority activities in FY 2012 through judicious management of prior year funds and unexpired contracts. Partner agency contributions (personnel or funding) for the JPDO, which depend on matching FAA resources, were also reduced in FY 2012. These one-time strategies will enable the JPDO to produce a few quality products during FY 2012; however, the FAA cannot repeat this strategy. Plans call for no unexpended funds for the JPDO beyond October 2012.

The JPDO ensures efficient coordination and collaboration among NextGen partner agencies. It addresses key interagency priorities identified by the SPC for NextGen. Without the benefit of a dedicated, co-located interagency entity, the Nation can expect increased costs due to both the duplication of systems and the development of systems that will not work together for all missions (civil, defense and homeland security). The JPDO maintains a future focus and is able to provide the broader perspectives and insights that are necessary for Department decision-makers to review and assess NextGen investment and policy decisions. For example:

- Demand for UAS access to the National Airspace System (NAS) is increasing rapidly with the US Government expected to invest more than $19B for UAS during the next three years. JPDO will lead efforts with the NextGen partners to develop a program plan that identifies the National goals for UAS integration into the NAS including agency requirements, transition steps, coordinated activities and milestones.
- Every agency needs data and sensors to see all aircraft (cooperative and threats) to meet its own mission. JPDO will ensure there is an understanding of individual agency mission needs, capabilities, and requirements, resulting in coordinated solution decisions. Without cross-agency requirements and implementation plans, duplication, inefficiency and gaps will exist resulting in individual and uncoordinated solutions. Consequently, there is an increased risk to national security.
- Information is the backbone of NextGen. The capabilities detailed in the NextGen Concept of Operations will not be successful without ensuring that the right parties have the right information at the right time. The JPDO will coordinate with partner agencies to identify information exchange requirements which will reduce the cost of having multiple stove-piped systems that cannot quickly communicate.
- National aviation-related policy issues that the partner agencies have identified as important in NextGen implementation will not be addressed without this program, leading to uncoordinated FAA NextGen decisions which will have a negative impact on other Federal systems.

Detailed Justification for
A12.b NextGen – Wake Turbulence

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

FY 2013 – NextGen - Wake Turbulence

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A12.b NextGen - Wake Turbulence	$10,664,000	$10,674,000	$10,350,000	-$324,000

For FY 2013, $10,350,000 is requested for NextGen - Wake Turbulence research. Major activities and accomplishments planned include:

- Develop high level concept for practical application of dynamic wake separations in air traffic control.
- Provide analysis support to airports with closely spaced parallel runways (parallel runways with less than 2500 feet between their center lines) to identify needed changes to enable better arrival capacity when weather causes them to shift to instrument flight rules operation.
- Collaborate with the European participants of the Single European Sky ATM Research (SESAR) program in developing wake turbulence mitigation solutions for the NextGen/SESAR era operations.
- Conduct experiments, develop analysis tools and host aviation community forums to define, in terms of a wake turbulence hazard, unacceptable level of wake turbulence for an encountering aircraft.
- Conduct data collection and analysis to determine the characteristics of wake vortices generated by aircraft – statistical foundation for wake separation standards and wake modeling enhancements.
- Incorporate wake turbulence data analysis results into wake transport-and-decay models and utilize models to review proposed air route and terminal airspace change proposals.
- Develop modeling and other analysis tools required for evaluation of wake encounter risks of Trajectory-Based and other NextGen era operational concepts.
- Continue development of crosswind based concept feasibility prototype for use in determining reduced air traffic control wake mitigation separations to be applied between aircraft arriving to a single runway.
- Provide wake turbulence evaluation support in determining wake separation standards to be for new aircraft being introduced into the NAS.

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 2013, 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 at airports and capacity for more flights in high-usage airspace
- Providing more capacity-efficient wake separations to aircraft with the same or reduced safety risk

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 air navigation service provider (ANSP) decision support tool that adjusts required wake separations based on wind conditions would allow ANSP 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.

This program supports the DOT Strategic Plan 2010-2015 Goal "Economic Competitiveness" in the following areas:

- Maximum Economic Returns on Transportation Polices and Investments in Aviation – NextGen-Wake Turbulence research will provide the information and develop the technology for safe, capacity efficient wake separation standards as a component of DOT's commitment to "Implement procedures with supporting infrastructure to increase the efficiency of individual flights, deliver capacity for high density operations, and maintain capacity in low-visibility conditions. (see page 37 of DOT's Plan)
- Advance U.S. Transportation-Related Economic Interests in Targeted Markets Around the World – NextGen – Wake Turbulence research accomplishes by its work in obtaining globally accepted air traffic control wake separation standards and procedures a component of DOT's commitment to: "…advocate worldwide adoption of harmonized standards and global technical regulations (GTR) through participation in bilateral and regional forums or international organizations at the ministerial and working levels." (see page 41 of DOT's Plan)

Specific goals set for the NextGen – Wake Turbulence research in support of the strategic DOT/FAA goals are:

- By FY 2013, develop as requested, airport specific instrument flight rules (IFR) closely spaced parallel runways (CSPR) approach procedures that would insure wake safety and increase IFR capacity of the airport's CSPR.
- By 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.

This research 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 research 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 include pilots, air traffic control personnel, air carrier operations, and airport operations. Stakeholders include the 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 contributors:

- 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

In FY 2012, major activities and accomplishments planned include:

- Maintained and added to the world's most extensive aircraft wake transport data and analysis database – statistical foundation for wake separation standards and wake modeling enhancements.
- Obtained RTCA agreement on weather observation parameters to be transmitted from aircraft – vital to the development of dynamic wake separation processes.
- Incorporated wake transport and decay as well as aircraft navigation performance analysis results into FAA wake-encounter risk models.
- Initiated development of wake turbulence mitigation processes/procedures to support the NextGen era operational environment.
- Continued development of crosswind based concept feasibility prototype for use in determining reduced air traffic control wake mitigation separations to be applied aircraft arriving to the same runway.
- Collaborated with European participants of the Single European Sky ATM Research (SESAR) program in developing wake turbulence solutions for the NextGen/SESAR.
- Evaluated reports of wake turbulence encounters as part of the FAA Safety Management System assurance process for changes to Air Traffic Control (ATC) procedures.
- Continued to conduct experiments, develop analysis tools, and host aviation community forums to define, in terms of a wake turbulence hazard, what is an unacceptable level of wake turbulence for an encountering aircraft.
- Provided analysis support to airports with closely spaced parallel runways to identify needed changes to enable better arrival capacity when weather causes them to shift to instrument flight rules operation.
- Continued development of wake turbulence transport and decay modeling tools for use in evaluating proposed Trajectory-Based and other NextGen era operational concepts.
- Provided wake turbulence evaluation support in determining wake separation standards for new aircraft being introduced into the NAS.

In FY 2012, the FAA continued 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 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.

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 has produced airport specific procedures and safety analyses to bring a new air traffic control wake mitigation capacity enabling procedure into everyday operation at airports with closely spaced parallel runways (CSPR). More airports are requesting similar analysis support to allow their use of the dependent 1.5 nm diagonal approach procedure on their CSPR when instrument approach procedures are required. The requested FY 2013 funding will support this activity.

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. Aircraft manufacturers, airports and air carriers agree that squeezing in more operations onto an airport's existing runway structures results in major savings in flight delays during bad weather and time period directly following a major weather event.

The requested FY 2013 NextGen - Wake Turbulence research funding will further explore using predicted and monitored approach corridor crosswinds to allow reduced wake separations between aircraft landing behind each other onto a single runway. This is the next development step after the research's prior work on capacity enabling wake separation solutions for airport CSPR. A wake solution for safely reducing wake separation during instrument flight rule operations to a single runway will allow more operations at an even greater number of the nation's busiest airports.

In 2013, research will continue on wake mitigation solutions that will be needed to effectively achieve the operational benefit of NextGen Trajectory Based and Flexible Terminal Operations. NextGen – Wake Turbulence research will provide safe capacity efficient wake mitigation procedures and processes that must be integrated into the design of future air traffic control tools that implement these concepts. Without NextGen era wake mitigation procedures and processes, the NextGen objective of putting more aircraft through a given airspace or onto a runway will not be fully realized.

4. How Do You Know The Program Works?

The FAA NextGen – Wake Turbulence research applies wake vortex scientific knowledge, technology and modeling to developing feasible safe capacity efficient improvements to the current air traffic control procedures and processes used to mitigate the risk that an aircraft will encounter a hazardous wake generated by another aircraft.

Recent evidence that the research is working is the publishing of FAA Order 7110.308, "1.5-Nautical Mile Dependent Approaches to parallel Runways Spaced Less than 2,500 Feet Apart" in CY2008 with subsequent changes (change 2, September 2010) that have added more airport runway pairs that are allowed use of this airport capacity enhancing wake separation procedure. The order is based on this program's wake data collection and analysis work at Lambert – St. Louis International Airport and other airports in the US and Europe.

Another evidence of the research's effectiveness is the expected operational use in FY11 of an air traffic decision support tool that will advise controllers at George Bush Houston intercontinental Airport when to safely reduce the wake mitigation delay time between departures on the airport's CSPR. NextGen – Wake Turbulence research constructed the operational concept for the decision support tool plus generated the crosswind prediction and monitoring logic for the decision support tool.

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. This research is reviewed annually by the REDAC's NAS Operations Subcommittee, with its most recent review occurring March 1, 2011. Results of the Subcommittee's review were that the research was vital to the FAA and the aviation community and the NextGen – Wake Turbulence research planned for FY 2013 was appropriate for delivering the research products needed by FAA and other stakeholders (airports, air carriers, aircraft manufacturers, controller, and pilot unions).

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

The NextGen – Wake Turbulence research addresses both the FAA's near term needs (capacity enhancing wake mitigation procedures/processes) for current operations and developing wake mitigation solutions that will be needed as FAA transitions to Trajectory Based and Flexible Terminal Operations. The FY 2013 requested funding will provide the needed wake solution concepts and underlying technology, collected data and analyzes in a feasible time frame. Increasing the research funding will not result in the getting the solutions sooner, since there are limited number of researchers that are qualified to work in this problem area and many of them are working the solutions because of this research program. Priority for the research is developing wake separation capacity enhancing changes for today's air traffic control operational environment. A significant reduction in funding would impact the FAA's progress in developing NextGen era wake mitigation procedures/processes and supporting technology/models – specifically delaying the development of the concepts and supporting technology for potential reduction of wake separations during instrument flight rule operations to a single runway.

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 2013 – NextGen – Air Ground Integration Human Factors

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A12.c NextGen – Air Ground Integration Human Factors	$5,603,000	$7,000,000	$10,172,000	+$3,172,000

For FY 2013, $10,172,000 is requested for NextGen – Air Ground Integration Human Factors. Major activities and accomplishments planned include:

Data Communications - Guidance for certification and flight standards personnel

- Displays and User Interface: Recommend minimum requirements for alternative and supplemental data communication displays and controls in the flight crew forward field of view to reduce head-down time.
- Automation: Recommend minimum FMS integration requirements for NextGen 4D trajectory clearances.
- Procedures and Operations: Evaluate and recommend pilot-ATC procedures for negotiations and shared decision making NextGen activities.
- Shared Situation Awareness: Recommend procedures to mitigate loss of available party line information in air/ground radio communications as data communications increase.
- Message Set: Provide recommended human factors improvements to the RTCA SC-214 message set and recommended ICAO training requirements for non-native English speaker proficiency in reading and writing to ensure comprehension and compliance with ATC clearances and instructions transmitted via data communications.

Error Detection and Correction - Guidance for certification and flight standards personnel

- Provide assessment of current design and training methods to support human error detection and correction in NextGen operations.
- Recommend minimum flight deck design requirements and training methods to mitigate mode errors and unintended uses of flight deck equipment in NextGen operations.

Information Requirements - Guidance for certification and flight standards personnel

- Provide inventory of cognitive tasks, associated information needs and recommended display methods for flight deck tasks that require shared flight deck-ATC information.
- Identify human factors issues and mitigation strategies for the use of legacy avionics in NextGen procedures.
- Provide guidelines to address human-automation integration issues regarding the certification of pilots, procedures, training and equipment necessary to achieve NextGen capabilities.

The program continues 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 by 2017. Each of these research areas, although general in nature, continued 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 continued to enable safe and effective changes to pilot and ATC roles and responsibilities for NextGen procedures and also continued 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 continued 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 supports the DOT Safety Strategic Goal and 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. Through use of modeling, simulation, and demonstration, the program assesses interoperability of tools, develops design guidance, determines training requirements, and verifies procedures to support certification and flight standards and ATO service units for ensuring safe, efficient and effective human system integration in transitions of NextGen capabilities.

Research goals 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

The program provides integration of air and ground capabilities that address 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. Program benefits accrue to pilots and air traffic service providers, and those who perform certification and regulatory oversight of these NAS operators.

The program addresses 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 program focus includes changes in the NextGen environment such as 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 partnerships include researchers who 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 2012, major activities and accomplishments planned include:

Roles and Responsibilities

- Completed 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.
- Developed 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

- Determined 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.
- Completed 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.
- Completed 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

- Completed 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, developed 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

- Completed research to develop flight crew training recommendations for flight deck automation supporting NextGen operations for single pilot and two pilot crews.
- Conducted research to support guidance for data communications procedures, training, displays and alerts.

Risk and Error Management

- Developed 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.
- Assessed 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.

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 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 (AVS) 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 vision includes a shift to management of traffic by trajectories (Trajectory-Based Operations). 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 at least one required time of arrival (RTA). 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.

Data communications permit exchanges concerning complex 4DT clearances. Data communications also 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 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?

Products from the NextGen - Air Ground Integration Human Factors R&D program inform and support critical NextGen technologies and applications. For example, a human factors analysis of the RTCA SC-214 message set produced recommendations that were incorporated at ICAO. The program is reviewed and evaluated by the Research, Engineering and Development Advisory Committee (REDAC), and in particular the Human Factors subcommittee. 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.

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 2014 the planned FY 2013 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 2013 – NextGen – Self-Separation Human Factors

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A12.d NextGen – Self-Separation Human Factors	$5,260,000	$3,500,000	$7,796,000	+$4,296,000

For FY 2013, $7,796,000 is requested for NextGen – Self-Separation Human Factors. Major activities and accomplishments planned include:

ADS-B Applications

- Recommend air traffic and flight deck procedures and operating limitations based on human factors research to address cockpit display of traffic information (CDTI) applications such as Closely Spaced Parallel Operations, In Trail Procedures, Enhanced Visual Approach, Interval Management, and Surface Alerting.

Advanced Vision Technologies for Low Visibility Operations

- Conduct human factors simulation and flight trials to evaluate and recommend safe decision height and flight crew qualification and training requirements to allow operations beyond current 14 CFR 91.175 use of Enhanced Flight Vision Systems (EFVS) for approach below minimums to 100 ft., such as operational credit for EFVS for approach to touchdown and operational credit for use of Synthetic Vision Systems (SVS) to 100 ft. in low visibility conditions.
- Apply human factors techniques to determine minimum characteristics for aircraft equipage and operational procedures for approval to use EFVS and SVS technologies for additional operations, including surface movement, rollout and takeoff, merging and spacing, or in lieu of certain infrastructure requirements.

Instrument Procedure Design and Use

- Through human factors analysis, identify and evaluate instrument procedure design factors leading to flight crew error in RNAV departures and arrivals.
- Conduct human factors analytical techniques to recommend instrument procedure design guidance, and flight crew procedural and training approaches to mitigate flight crew errors related to characteristics of instrument procedures.
- Develop human factors guidance for procedure designers, including general human factors considerations, procedure naming conventions, and linkage of RNAV/RNP procedures to conventional procedures such as SIDs and STARs.
- Provide human factors recommendations for improved charting to enable complex NextGen operations using paper and electronic depictions of instrument procedures and related NAS navigation infrastructure, such as NRS waypoints, Q routes, T routes, and Taxi routes.

The program continued 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 2019. Research priorities address the implementation of RTCA NextGen Task Force recommendations as described in the NextGen Implementation Plan. Research continued 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.

2. What Is This Program?

The NextGen – Self-Separation Human Factors Program supports the DOT Safety Strategic Goal and 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.

Research goals include:

- Evaluating and developing recommendations for operational credit for advanced vision technologies. Because today's scheduling is based on VFR conditions, capacity is significantly reduced with IFR conditions. EFVS and SVS can reduce the impact of weather on the national air transportation system by providing additional information to the pilot despite deteriorated weather/visibility conditions. Human factors research will enable recommendations for policy and rulemaking leading to greater operational credit with low minimums, in direct alignment with the goal of increasing capacity within the national air transportation system.
- Recommending air traffic and flight deck procedures which apply ADS-B technology with CDTI displays to increase safety and efficient operations in high density airspace. ADS-B is a new technology on which the FAA has had very little human factors guidance in the Advisory Circulars and Technical Standard Orders. Although a rule has been issued for ADS-B out, very large gaps exist in regulations, guidance, and standards regarding how ADS-B will be used. CDTI-based applications continue to be developed at a rapid pace, yet these applications have very little or no human factors research behind them. By addressing human factors issues, this research will generate guidance that will help prevent unsafe displays of traffic information and help prevent unsafe operational use of these displays, so that the intended safety benefits of ADS-B can be realized.
- Developing requirements for better depiction of instrument procedures. Research is needed to produce a set of human factors guidelines for design of instrument procedures and associated charts that are usable and flyable by appropriately qualified pilots without being susceptible to making errors. The guidelines should address known difficulties with use of instrument procedures, and also address future instrument procedure requirements. Research results inform regulatory guidance and orders such as FAA Order 8260.3 (TERPS) and associated guidance material for flight checking and operational approval documents (AC 90-100 and AC 90-101), and charting guidelines.

Program partnerships include researchers who 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 - Self-Separation Human Factors 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 2012, major activities and accomplishments planned include:

Surface/Runway Operations Awareness

- Conducted 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.
- Initiated 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.
- Conducted 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

- Conducted 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, initiated 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 included 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

- Initiated 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).
- Continued 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, continued research to support development of training guidance for NextGen applications and technologies.
- Continued research to develop risk and error management strategies to identify and mitigate human-system errors.
- Initiated research to develop recommendations for location and grouping of NextGen related displays relative to the primary field of view.

Research will 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 2013, evaluate approach decision heights and recommend certification and regulatory changes to allow EFVS and SVS operational credit consistent with human performance factors.

- By 2015, evaluate and recommend minimum display standards and operational procedures for use of CDTI to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff and departure phases of flight.

- By 2016, complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment.
  - By 2014, complete initial research to provide recommended guidance for design of cockpit displays and alerts to support delegated separation.
  - By 2015, complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings, including closely spaced parallel operations.
  - By 2016, enable reduced and delegated separation in oceanic airspace and en route corridors.
- 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 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 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 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 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 NextGen - Self-Separation Human Factors products inform and support critical NextGen technologies and applications. For example, NASA completed a human factors analysis of the Navigation Reference System (NRS) waypoint nomenclature identified a number of critical human factors issues that are being addressed to minimize error potential in NextGen 4D trajectory operations. The program is reviewed and evaluated by the Research, Engineering and Development Advisory Committee (REDAC), and in particular the Human Factors subcommittee. 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.

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, and enhanced vision operations in lower visibility conditions than were previously possible. Reduction in funding would defer until FY 2014 the planned FY 2013 completion of development of guidance to support 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. Reduction in funding would also defer achievement of operational capabilities to apply these technologies in high density and low visibility environments by one year.

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 2013 – NextGen - Weather Technology in the Cockpit

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A12.e NextGen - Weather Technology in the Cockpit	$2,507,000	$8,000,000	$4,826,000	-$3,174,000

For FY 2013, $4,826,000 is requested for NextGen - Weather Technology in the Cockpit (WTIC). Major activities and accomplishments planned include:

- Development of Functional Requirements for integrating meteorological (MET) information into the cockpit based on the WTIC ConOps and User Needs studies.
- Perform feasibility study and initial benefits identification of exchanging weather radar between aircraft.
- Methodology for translating meteorological (MET) information into Weather Avoidance Fields and the integration of the translated information into the cockpit.
- Develop user needs and functional requirements for integrating and presenting observation data.
- Perform initial flight demonstrations with real time uplinked presentations of cloud tops and turbulence.
- Perform Human in the loop (HITL) verification of MET symbology set developed by SAE G-10.
- Support RTCA Special Committee 206 development of a MASPS.
- Complete research on Wind Diagnosis and Forecasting requirements to support TBO in the terminal area and FMS optimized profiles.

2. What Is This Program?

Weather-related goals of NextGen include reducing weather delays via increasing capacity and efficiency under adverse weather conditions, enhancing Air Traffic Management (ATM) and aircraft re-routing flexibility to avoid adverse weather, reducing the number of weather-related accidents and incidents, and reduction of emissions through lower fuel consumption resulting from optimized routing and rerouting during adverse weather. To support NextGen in realizing these goals, the overall objective of the NextGen - WTIC Program is to enable availability and enhance the quality and quantity of MET information available to the aircraft to enhance safety and efficiency in commercial, business, and general aviation operations.

The specific goals of the WTIC Program are:

- Reduce Pilot/Flight Crew/ATM workloads to support efforts to increase NAS capacity.
- Support NextGen and other near/mid/far term programs needs for the availability of enhanced MET information.
- Eliminate MET information gaps and meet user needs.
- Make more efficient use of existing data link bandwidth.
- Reduce ambiguity in transmitted MET information.
- Support increased efficiency via timelier decisions in adverse weather, and more optimum routes from enhanced wind and temperature information.
- Reduce the likelihood of recurrence of specific weather-related incidents including those reported in the Aviation Safety Reporting System (ASRS) as well as other safety reporting systems.

WTIC addresses the need to enable better weather decision making and use of MET information in the transformed NAS. This includes integrating MET information tailored for decision support tools and systems into NextGen operations. The project will research the best weather technology to bring MET information into the cockpit and MET information from the cockpit to the ground and cross linked to local aircraft. The project will define the necessary MET information and its presentation to safely and efficiently incorporate it into collaborative decision making relative to adverse weather decisions. It also establishes standards for a "common weather picture" to establish common situational awareness between pilots, controllers, air traffic managers, local aircraft, etc. The project will define Human Factors guidance for effective rendering of MET information to pilots, define required pilot training, and it will use RTCA SC206, SC214, SC223 and SAE G10 to further the project objectives. WTIC will also enhance the global harmonization of MET and Aeronautical Information (AIM) data links and provide recommended guidance for more efficient use of existing data link bandwidth. Through the efficient use of data links, the project will provide a reply/request and contract capability. These data link capabilities enable benefits of increased NAS efficiency and capacity via fewer flight diversions by reducing dependency on voice and paper MET information, timelier decisions in adverse weather, and more optimum routes from enhanced MET information in the cockpit.

Initial WTIC research evaluated the overarching NextGen ConOps and requirements for NextGen MET integration on the flight deck and it identified the current capabilities to meet NextGen requirements. WTIC is currently evaluating planned and funded development of new weather support capabilities and the gaps between NextGen requirements and these developing capabilities. Since WTIC requires data links to support the dissemination of MET information to users in various coverage environments, the program is researching required data link capability for bandwidth, security, quality of service, and reliability. Based on the results of WTIC research, the program will develop functional and performance requirements for cockpit integration of MET information, guidance on the rendering of MET information in the cockpit, and recommended data link architectures for uplinking, downlinking, and cross linking MET information.

In addition, the WTIC 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. The HF research will attempt to identify shortcomings in current capabilities in order 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 the development of aircraft certification 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, WTIC will demonstrate that technology and automation, combined with policy, procedures, and regulatory oversight, enables NextGen to meet the weather-related goals listed at the beginning of this section. Demonstrations will show the technology and automation used in the cockpit provides pilots and aircrews with safe and efficient routes and re-routes for aircraft traversing areas impacted by adverse weather conditions.

The germane characteristics of the technology defined 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. In the far term, it will migrate to automated processing via machine-to-machine interfaces between ground-based and aircraft systems. As a result, the NextGen ConOps differs dramatically from current operations regarding weather procedures.

The NextGen - WTIC 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 WTIC 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 2012, major activities and accomplishments planned include:

- Developed WTIC ConOps for Part 121 and 135, and GA aircraft.
- Developed capability to efficiently disseminate turbulence products to the flight deck.
- Evaluated 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.
- Demonstrated and assessed the usefulness of the uplinking turbulence eddy dissipation rates (EDR) to the flight deck.
- Benefits analyses of in situ turbulence observations, downlinking turbulence data to enhance ground based models, and uplinking turbulence data to enhance cockpit situational awareness.
- Research and analysis of needs and use of portable devices and observation data.
- Assessed improvements in situational awareness of Multiple Radar Multiple Sensor (MRMS) application in cockpits and aircraft inputs to MRMS.
- Researched pilot decision making in the cockpit using probabilistic weather forecasts and demonstrations with convective weather products integrated into the laboratory simulator.
- Completed initial report of Part 121 User Needs Study to identify use of MET information in the cockpit today and planned use in the future.
- Supported RTCA SC206 to develop architecture and minimal aviation system performance standards for datalink weather products.
- Researched impact of weather on wake turbulence and wake dissipation.
- Simulated and validated data-linked bandwidth, quality of service, security, and latency standards requirements for disseminating graphical turbulence and icing products to the cockpit.

The NextGen - WTIC 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 2013, develop MET symbology set (SAE G-10).
- By FY 2013, identify human factors interfaces and automated prototype weather information integration modules for flight deck technologies (e.g., FMS, EFB, etc.).
- By FY2013, complete CALLBACKS and analysis of 100 weather-related incident reports in the Aviation Safety Reporting System (ASRS).
- By FY 2014, simulate and verify cockpit use of data-linked weather decision support tools, including probabilistic forecasts.
- 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 2014, demonstrate the ability to uplink wind information to the FMS.
- By FY 2015, developed recommended datalink architecture to support uplink, downlink, and cross link of MET information to provide common situational awareness and to support the MET information needs of related systems and NextGen activities.
- 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.
- By FY 2016, demonstrate capability to disseminate winds and other MET information from the 4D Weather Cube to the cockpit.
- BY FY 2017, identify guidelines, technology, and procedures for secure on-demand interactive NAS demand weather information services.
- By FY 2018, demonstrate dissemination of weather radar data over aircraft MET-network.

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)". Having access to more MET information in the cockpit does not 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 WTIC program plans to research why the introduction of state-of-the-art weather information products has not dramatically improved the safety of GA operations concerning weather.

The WTIC Program research will enable the adoption of cockpit, ground, and communication technologies, practices, and procedures that will enhance situational awareness. WTIC is necessary to address the lack of MET information standardization since it results in potential safety concerns and a lack of common situational awareness. The lack of standardized MET information and standardized presentation of MET data results in susceptibility to misinterpretation of information and ambiguities.

WTIC is also necessary to research improvements to address a NTSB safety alert related to thunderstorm encounters. In this alert, the NTSB stated that investigations of recent GA aircraft weather-related accidents revealed that aircraft were in contact with ATM, pilots were either not advised or were misinformed about adverse weather conditions, and that the pilots had alternatives available that would have likely averted the accidents. The implication of this alert is that verbalizing a ground MET display to a pilot is difficult. A goal of WTIC is resolve this performance gap.

WTIC is necessary to reduce the use of paper by Part 121 aircraft since it printed text is not conducive to decision making in the cockpit. In addition, the printed text typically contains extraneous MET information and latencies that can make it difficult to interpret.

Other sources of MET information, such as FIS-B, are not suited for inflight pilot decision making due to latencies, a lack of resolution, and susceptibility to misinterpretation since the data presented is not temporally or spatially tailored to specific aircraft. In addition, FIS-B does not replace printed text or voice since it is not intended for primary use.

Finally, WTIC is necessary for global harmonization of AIS/MET datalinks. WTIC will perform research to resolve datalink limitations outside the NAS and incorporating the aircraft was a node in the MET network.

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 the WTIC FY 2013 total funding will impact at least 14 NextGen Enterprise Architecture (EA) Operational Improvements (OIs) that are linked to four different NextGen Solution Sets. WTIC research is a key element to successfully implementing these 14 OIs, and potentially other OIs. If WTIC is not funded to the requested level, the program will have to reduce the scope of its goals and objectives resulting in incomplete or insufficient research inputs to the OIs supported by the program.

In addition, a reduction in WTIC FY 2013 funding will put at risk the benefits of already completed research to support the dissemination of safety critical inflight icing and graphical turbulence products since the required follow-on evaluations to develop the standards is substantial and would not be effective if partially funded.

One of the main goals of the WTIC program is to provide for a common MET situational awareness between the air and ground. A reduction in funding and the resulting reduction in program scope and goals could result in a divergence of MET situational awareness that may prove to be more costly in the future.

In many cases, WTIC research cannot adequately provide required research on schedule to supported Solution Sets if the research is delayed or not fully funded. Many of the WTIC efforts include flight and laboratory demonstrations and proof of concepts that are not conducive to incremental or partial funding. Since WTIC is a centralized program that researches capabilities to provide MET information to the cockpit, the inability of WTIC to successfully complete efforts on time could result in decentralized projects. A decentralization of the research could result in duplicative research efforts being conducted by the various supported Solution Sets to meet their schedule needs thus resulting in higher total costs to NextGen.

Detailed Justification for
A13.a Environment and Energy

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

FY 2013 – Environment and Energy

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A13.a Environment and Energy	$15,074,000	$15,074,000	$14,776,000	-$298,000

For FY 2013, $14,776,000 is requested for Environment and Energy. Major activities and accomplishments planned include:

Noise and Emissions Analyses and Interrelationships

- Evaluate and expand model architecture for noise, emissions and fuel burn modules interfaces.
- Evaluate and validate methodologies used in environmental analysis tools for noise exposure, and aviation emissions and their impact on air quality.
- Forecast future global aircraft emissions and noise.
- Expand environmental analysis capability of AEDT, APMT and EDS.
- Harmonize AEDT, APMT and EDS databases and integrate cost and socioeconomic data.
- Evaluate AEDT for its public release in 2014.
- Perform integrated noise and emissions impacts analysis.

Aircraft Noise

- Assess technological and scientific basis to support future ICAO aircraft stringent noise standards.
- Develop alternative, simplified aircraft noise certification test procedures and related implementation guidance materials.
- Assess land use practices and investigate mitigation strategies beyond 65 dB DNL.
- Develop noise modeling capability for all phases of aircraft operations.
- Develop protocols to acquire noise exposure data for noise effects field studies.
- Conduct pilot studies to develop relationships between noise exposure and health and welfare impacts.
- Investigate metrics for noise exposure from non-conventional open rotor and supersonic aircraft.
- Update noise research roadmap.

Aircraft Emissions

- Assess technological and scientific basis to support future ICAO aircraft and engine emissions standards.
- Develop alternative, simplified engine exhaust emissions certification test procedures and related implementation guidance materials.
- Develop measurement/sampling protocol and expand database for aircraft engine emissions.
- Validate modeling capability for dispersion of chemically reactive aircraft plume.
- Develop methodologies to quantify and assess the impact of aircraft emissions on climate.
- Assess air quality and health impacts due to full flight emissions.

- Use data directly measured from aircraft Hazardous Air Pollutants (HAPs) and PM emissions to replace, to the extent possible, approximation methods and factors used in modeling tools.

In FY 2013, 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 characterize, 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 2014 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 2014 to 12 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 2013 Target is 11 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 2012, major activities and accomplishments planned include:

Noise and Emissions Analyses and Interrelationships

- Completed annual assessment of noise exposure and fuel burn.
- Developed integrated architecture for noise and emissions modules communications.
- Developed model for assessing global exposure to noise from transport aircraft.
- Validated methodologies used to assess aviation noise exposure and impacts as well as emissions and their impacts on air quality and climate change.
- Developed guidance document for estimating and reducing emissions from airport ground-support equipment.
- Continued integration and harmonization of databases across tools and code management protocols.
- Continued 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.

- Enhanced a preliminary planning version of Aviation Environmental Design Tool (AEDT) for integrated assessment of noise, emissions and fuel burn inventories at the local, regional, and global levels.
- Developed methodology for use in AEDT to analyze open rotor aircraft noise and tradeoffs.

Aircraft Noise

- Continued 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.
- Assessed land use practices and investigate mitigation strategies beyond 65 dB DNL.
- Continued investigation of feasibility of more stringent international noise certification standards for transport category and subsonic jet airplanes.
- Designed protocols for pilot studies to develop relationships between noise exposure and health and welfare impacts.
- Advanced methodologies to model noise propagation and structural response for current and potential future unconventional aircraft configurations.
- Investigated metrics for noise exposure from non-conventional open rotor and supersonic aircraft.
- Advanced methodologies to incorporate potential health impacts of aircraft noise exposure within APMT.
- Assessed potential global benefits of using newly developed noise-reduction technologies and identify technology goals for long-term reduction of aircraft noise.
- Updated noise research roadmap.
- With the Aviation Emissions activity, conducted two COE-focused sessions at a national and an international conference.
- Published COE PARTNER research findings.

Aircraft Emissions

- Assessed technological and scientific basis to support future ICAO engine emission standards.
- Advanced science-developed metrics and quantified uncertainties in assessment of regional and global climate impacts of aviation.
- Advanced and exercised multiscale air quality analysis models for impacts of airport and full flight aircraft emissions.
- Evaluated and published sampling, measurement and analyses techniques and procedures for aircraft emissions testing and certification that are both harmonized and simplified.
- Developed measurement and sampling protocols and expanded databases for aviation emissions of Hazardous Air Pollutants (HAPs) and PM.
- Validated modeling capability for dispersion of chemically reactive aircraft plume.
- Applied methodologies to incorporate air quality and health impacts of aircraft emissions within APMT.
- Assessed potential global benefits of using newly developed emissions-reduction technologies, and identified technology goals for long-term reduction of aircraft engine emissions and fuel burn.
- With the Aircraft Noise activity, conducted two COE-focused sessions at a national and an international conference.
- Published COE PARTNER research findings.

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:

Noise and Emissions Analysis

- By FY 2013, evaluate and expand model architecture for noise, emissions and fuel burn modules interfaces.
- By FY 2013, evaluate and validate methodologies used in tools for noise exposure, and aviation emissions and their impact on air quality.
- By FY 2013, forecast future global aircraft emissions and noise.
- By FY 2013, expand environmental analysis capability of AEDT, APMT and EDS.
- By FY 2013, harmonize AEDT, APMT and EDS databases and integrate cost and socioeconomic data.
- By FY 2013, evaluate AEDT for its public release in 2014.
- By FY 2013, perform integrated noise and emissions impacts analysis.

Noise Characterization and Metrics

- By FY 2013, assess technological and scientific basis to support future ICAO aircraft stringent noise standards.
- By FY 2013, develop alternative, simplified aircraft noise certification test procedures and related implementation guidance materials.
- By FY 2013, assess land use practices and investigate mitigation strategies beyond 65 dB DNL.
- By FY 2013, develop noise modeling capability for all phases of aircraft operations.
- By FY 2013, develop protocols to acquire noise exposure data for noise effects field studies,
- By FY 2013, conduct pilot studies to develop relationships between noise exposure and health and welfare impacts.
- By FY 2013, investigate metrics for noise exposure from non-conventional open rotor and supersonic aircraft.
- By FY 2013, update noise research roadmap.

Emissions Characterization and Metrics

- By FY 2013, assess technological and scientific basis to support future ICAO aircraft and engine emissions standards.
- By FY 2013, develop alternative, simplified engine exhaust emissions certification test procedures and related implementation guidance materials.
- By FY 2013, develop measurement/sampling protocol and expand database for aircraft engine emissions.
- By FY 2013, validate modeling capability for dispersion of chemically reactive aircraft plume.
- By FY 2013, develop methodologies to quantify and assess the impact of aircraft emissions on climate.
- By FY 2013, assess air quality and health impacts due to full flight emissions.
- By FY 2013, use directly measured from aircraft Hazardous Air Pollutants (HAPs) and PM emissions data to replace, to the extent possible, approximation methods and factors used in modeling tools.
- By FY 2014, enhance analytical capabilities of AEDT, APMT and EDS for integrated environmental analyses from aircraft to global domain.
- By FY 2014, advance scientific understanding to characterize aircraft noise and emissions and associated risks.
- By FY 2014, Assess technological and scientific basis to support future ICAO aircraft and engine emissions standards.
- By FY 2014, Revise emissions certification test procedures and related implementation guidance materials.

- 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 FY 2015, advance multiscale air quality modeling capability for aviation health impacts and employ for environmental cost-benefit analyses.
- By FY 2015, advance characterization of aviation noise and related health and welfare impacts and employ for environmental cost-benefit analyses.
- By FY 2016, Advance scientific approaches and methodologies for improved integrated analysis of noise and emissions inventories and impacts.
- By FY 2017, enhance analytical capabilities of AEDT, APMT and EDS for integrated environmental analyses from aircraft level to global domain.
- By FY 2017, advance scientific understanding to characterize aircraft noise and emissions and associated environmental impacts and risks.
- By FY 2017, assess technological and scientific basis to support future ICAO aircraft and engine emissions standards.
- By FY 2017, revise emissions certification test procedures and related implementation guidance materials.

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 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. Budget reduction will also limit our understanding of source level aircraft noise and emissions as well as their impacts which will in turn compromise our ability to inform international standard settings for noise and emissions as well as development of environmental mitigation solutions.

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 2013 – NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A13.b NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics	$20,060,000	$23,500,000	$19,861,000	-$3,639,000

For FY 2013, $19,861,000 is requested for NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics. Major activities and accomplishments planned include:

Technology Maturation

- Perform system level assessment of CLEEN aircraft technologies.
- Perform aircraft level noise and emissions reduction performance of CLEEN aircraft technologies.
- Identify technical issues impacting commercialization of CLEEN technologies.
- Perform detailed design review of system components and configurations.
- Perform validation testing and analysis to verify technology performance and environmental impacts predictions.

Alternative Turbine Fuels

- Conduct fuel characterization testing and environmental assessments of additional "drop-in" renewable alternative fuels.
- Conduct sustainability analysis of renewable fuels.
- Assess mechanisms for increasing commercial use of aviation alternative fuels.
- Initiate process for ASTM International approval of additional alternative fuel blends.

Metrics, Goals and Targets

- Refine and evaluate noise and emissions impacts metrics for use in NextGen environmental analysis.
- Reduce key uncertainties in climate impacts of aviation.
- Conduct evaluation of advanced analytical approaches for noise and emissions impacts assessment.
- Refine intermediate targets towards meeting NextGen environmental goals performance targets for Destination 2025 and perform gap analysis.

In FY 2013, 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 focused on safety, performance, and environmental assessments for qualification of renewable alternative fuels. Activities were also initiated to assess production capacity and fleet infusion for alternative fuels. On the Metrics, Targets and Goals front, activities continued to refine and evaluate metrics for NextGen environmental impacts, advance capability for and assessment of environmental noise, air quality and climate impacts. This also included improved climate impacts assessment under second phase of ACCRI activities. The work also continued 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 (CO_2) 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.
- 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.
- 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 2012, major activities and accomplishments planned include:

Noise reduction, emissions and fuel burn reduction technology maturation

- Fabricated advanced aircraft component level flight test hardware.
- Integrated advanced low NOx combustor on engine demonstrator.
- Began integration of flight management system with air traffic management system for flight simulations of operational and environmental benefits.
- Conducted component level engine rig tests.
- Completed preliminary design review of advanced engine configuration for demonstration.
- Conducted engine tests of advanced turbine blades and ceramic matrix composite turbine blade tracks.

Alternative Turbine Fuels

- Conducted fuel characterization testing of renewable alternative fuels.
- Conducted sustainability assessment of renewable alternative fuels.
- Conducted performance and environmental assessment of additional candidates for "drop-in" renewable alternative fuels.
- Assessed production capacity and impacts of commercial fleet infusion of aviation alternative fuels.
- Identified additional candidates for "drop-in" aviation alternative fuels.

Metrics, Goals and Targets

- Evaluated noise and emissions impacts metrics for use in Next Generation Air Transportation System (NextGen) environmental analysis.
- Performed integrated NextGen noise and emissions impacts analysis.

- Assessed climate impacts of aviation climate impacts and underlying uncertainties.
- Refined and assessed intermediate targets towards meeting NextGen environmental goals.

The NextGen – Environmental Research – Aircraft Technologies, Fuels, and Metrics program supports DOT strategic goal of environmental sustainability by increasing the use of environmentally sustainable 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 2017, 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 initiate the second phase of CLEEN program.

Airframe and engine technologies supporting milestones:

- By FY 2013, perform system level tests and demonstrations of CLEEN aircraft technologies.
- By FY 2013, perform aircraft level noise and emissions assessments of CLEEN aircraft technologies.
- By FY 2013, identify technical issues impacting commercialization of CLEEN technologies.
- By FY 2013, perform detailed design review of system components and configurations.
- By FY 2013, perform validation testing and analysis to verify technology performance and environmental impacts predictions.
- By FY 2014, characterize and test aircraft technologies for noise reduction.BY FY 2014, perform ground tests for advanced engine configurations.
- By FY 2014, perform tests of advanced aircraft Flight Management System.
- By FY 2014, develop plans for demonstration and environmental assessment of additional aircraft technologies in a potential second phase of CLEEN.
- By FY 2015, perform tests and assessment for advanced engine and airframe configurations.
- By FY 2015, conduct a market survey of additional aircraft technologies for a second phase of CLEEN.
- By FY 2016, develop and issue a solicitation for a second phase of CLEEN to demonstrate and assess additional aircraft technologies that reduce fuel burn, emissions and noise.
- By FY 2017, award cost share agreements with industry to demonstrate and assess additional aircraft technologies in a potential second phase to CLEEN.
- By FY 2016, 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 2013, conduct fuel characterization testing and environmental assessments of additional "drop-in" alternative fuels.
- By FY 2013, conduct sustainability analysis of renewable fuels.
- By FY 2013, assess mechanisms for increasing commercial use of aviation alternative fuels.
- By FY 2013, initiate process for ASTM International approval of additional alternative fuel blends.
- By FY 2014, conduct engine demonstrations for additional "drop-in" alternative fuels.
- By FY 2014, complete environmental assessment of additional "drop-in" renewable alternative fuels.
- By FY 2015, conduct flight test demonstrations for additional "drop-in" renewable alternative fuels.
- By FY 2015, secure ASTM International approval of additional "drop-in" renewable alternative fuels.
- By FY 2016, identify potential of non-drop-in fuels and develop plans for development and demonstration.

- By FY 2016, conduct initial feasibility study, including economic feasibility, environmental impacts, and assessment of potential for non-drop-in alternative aviation fuels.
- By FY 2017, initiate fuel characterization tests and assessments of a non-drop-in alternative aviation fuel.
- By FY 2017, investigate metrics, uncertainties on aviation emissions health and welfare and climate impact to facilitate NextGen EMS implementation.

Metrics supporting milestones:

- By F Y2013, refine and evaluate noise and emissions impacts metrics for use in NextGen environmental analysis.
- By FY 2013, reduce key uncertainties in climate impacts of aviation.
- By FY 2013, conduct evaluation of advanced analytical approaches for noise and emissions impacts assessment.
- By FY 2013, refine intermediate targets towards meeting NextGen environmental goals performance targets for Destination 2025 and perform gap analysis.
- 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.
- By FY 2017, refine estimates of interim NextGen environmental targets and perform gap analyses.

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 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 further 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 reduction in climate impacts uncertainties under ACCRI. Delay in advancing progress in these areas will further 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. Finally, reduction in Environment and Energy specific NextGen R&D activities will cause delay in development of proven technology based environmental mitigation solutions which will result in billions of dollars of operational, human health, welfare and opportunity cost to government, industry and public. It will allow environmental concerns to become limiting factor and prevent us from full realization of expected NextGen benefits – which will eventually limit aviation growth. In other words, we will not be able to use full potential of ATM and NextGen capabilities without clean operating fleet that will allow environmental sustainability.

Detailed Justification for
A14.a System Planning and Resource Management

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

FY 2013 – System Planning and Resource Management

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A14.a System Planning and Resource Management	$1,727,000	$1,717,000	$1,757,000	+$40,000

For FY 2013, $1,757,000 is requested for System Planning and Resource Management. Major activities and accomplishments planned include:

R,E&D Portfolio Development

- Prepare the FY 2015 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 2015.
- Support the REDAC in its preparation of other reports, as requested by the FAA.
- Deliver the 2013 National Aviation Research Plan (NARP) to the Congress with the President's FY 2014 Budget.

Research Partnerships

- Coordinate R&D activities with internal and external partners.
- Conduct 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 2015 program, review the proposed FY 2015 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 2013, work will continue on measuring quality, timeliness, and value of collaboration, expanding upon work done in prior years.

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.

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 2012, major activities and accomplishments planned include:

R,E&D Portfolio Development

- Prepared the FY 2014 R,E&D budget submission.
- Managed FAA's R,E&D portfolio to meet efficiency goals.
- Obtained Research Engineering, and Development Advisory Committee (REDAC) recommendations on planned R,E&D investments for FY 2014.
- Supported the REDAC in its preparation of other reports, as requested by the FAA.
- Delivered the 2012 National Aviation Research Plan (NARP) to the Congress with the President's FY 2013 Budget.

Research Partnerships

- Coordinated R&D activities with internal and external partners.
- Began preparations 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

- Measured quality, timeliness, and value of international research collaboration.

FAA continued supporting the work of the REDAC in its task to advise the Administrator on the R&D program. In particular, it sought the counsel and guidance of the committee for the FY 2015 program, reviewed the proposed FY 2015 program prior to submission of the budget requirements to the DOT, and sought the committee's guidance during the execution of the R&D program. The agency published, as required by Congress, the NARP and submitted it to Congress concurrent with the FY 2014 President's Budget Request.

The program reviewed the President's R&D criteria, ensuring that the agency's R&D program remains viable and meets national priorities. It also published program activities and accomplishments, as well as fostered external review of and encouraged customer input to the R&D program.

The program managed the FAA R&D portfolio, identified high value products being produced by the R&D program, and promoted the use of these products globally to benefit the international market. In FY 2013, this initiative continued measuring quality, timeliness, and value of collaboration, expanding upon work done in prior years.

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 2013, 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 2013, publish the NARP, which documents the annual R&D budget portfolio, describes activities of the REDAC, and contains the FY 2013-2017 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 and submit the mandatory plan for the FAA research and development to Congress each year.

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?

Further 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 2013 – William J. Hughes Technical Center Laboratory Facility

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
A14.b William J. Hughes Technical Center Laboratory	$3,680,000	$3,777,000	$3,702,000	-$75,000

For FY 2013, $3,702,000 is requested for the William J. Hughes Technical Center (WJHTC) Laboratory Facility. Major activities and accomplishments planned include:

Simulation Facilities

- The Simulation Team will integrate the Target Generator Facility (TGF) with the AFTIL tower display.
- The Simulation Team will develop Rotorcraft and lighter than air models for the TGF.
- The Simulation Team will continue work with Aircraft Intent Description (AIDL), and trajectory prediction in support of TBO.

Flight Program's Airborne Laboratories

- The Flight Program will seek Final Investment Decision to replace two Convair Flight Test Aircraft.
- The Flight Program will complete Flight Testing of Un-Leaded Aviation Fuel in support of the Alternate Fuel Program.
- The Flight Program will design, develop and fabricate a generic Data Acquisition System to support future programs without such capabilities.

Concepts and Systems Integration – Human Factors

- Separation Management 2 – Human-in-the Loop (HITL) Simulation - After the completion of the first separation management experiment (SepMan1), we will continue development of concepts and prototypes within the separation management project. The Human Factors Field Team is creating prototypes of separation management functions that include variable separation standards, lateral offset, and support for nonsurveillance areas, integration of conflict probe functions on the radar console, and integration of automation functions across the radar and data positions.
- Data Communication Failure HitL Simulation – Test impact of data communication failure.
- Future Tracon Workstation/Tracon Data Communication HitL Simulation – Evaluation of NextGen concepts in the Tracon environment and using data communication.
- High Altitude Generic Airspace Project – Research into the generic airspace sector concept and what information the controller will need using En Route Information Display System.

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 Human Factors Laboratory.

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 (GBAS) 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 Louisville, KY. 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 Louisville, KY, the Gulf of Mexico and Philadelphia, PA, 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 Boeing to develop an Aircraft Intent Description Language (AIDL) which is a key component for NextGen 4D trajectory prediction..

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
- UAS
- ADS-B Concept Evaluation

Research & Development Flight Program – Airborne Laboratories

- Satellite Communications and Navigation Programs
- Separation Standards
- Ground-based Augmentation System – GBAS (LAAS)
- TERPS
- Safety
- Runway Incursion
- NextGen
- Satellite-based Augmentation System – SBAS (WAAS)
- ADS-B
- Common Automated Radar Terminal System

Concepts and System Integration Facilities – Human Factors Laboratory

- ATC Human Factors
- Airway Facilities Human Factors
- NextGen Concept Validation Studies
- Unmanned Aerial Systems
- ADS-B
- Data Communications (Data Comm)

In FY 2012, major activities and accomplishments planned include:

Simulation Facilities

- The Simulation Team achieved four fully functional cockpit simulators in the Cockpit Simulation Facility.
- The Simulation Team fully integrated Target Generator Facility (TGF) into the Next Generation Air Transportation System (NextGen) Integration and Evaluation Capability (NIEC) simulation environment.
- The Simulation Team supported FAA involvement in the Research Park located near the William J. Hughes Technical Center.

Flight Program's Airborne Laboratories

- The Flight Program installed a fully certified Future Air Navigation System (FANS) in support of the 4D Trajectory program.
- The Flight Program installed an Enhanced Vision System into the Bombardier Global 5000 aircraft in support of the Airport Lighting Program.
- The Flight Program continues to support NextGen through long term flight testing of ADS-B and related systems.
- The Flight Program will continue working with the program office and the US Air Force to support Unmanned Aerial Systems (UAS) tests.

Concepts and Systems Integration

- Supported 4DT profiles.
- Integrated Traffic Flow Management Auxiliary Platform into the NIEC.
- Developed 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 continued to modify, configure, and sustain these research facilities located at the WJHTC to support its R&D program goals.

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 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 contractors available to support further modifications to the air traffic control simulation software which is vital to the human in the loop simulations done by the Concepts and Systems Integration – Human Factors team. Funding reductions will also impact contract support to the Target Generation Facility and the development of various air models for simulations.

Detailed Justification for
1A01 Advanced Technology Development and Prototyping

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

FY 2013 – Advanced Technology Development and Prototyping

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
1A01 Advanced Technology Development and Prototyping	$15,100,000	$17,100,000	$18,898,000	+$1,798,000

R&D Activities	FY 2013 Estimated Cost
Runway Incursion Reduction Program	$2,898,000
System Capacity, Planning and Improvements	$5,600,000
Operations Concept Validation	$4,300,000
Airspace Management Program	$6,100,000
Total	$18,898,000

For FY 2013, a total of $18,898,000 is requested for the activities shown above.

The FAA's mission is to provide the safest and most efficient aerospace system in the world. As the leading authority in the international aerospace community, FAA is responsive to the dynamic nature of customer needs and economic conditions. A key element of this mission is the safe and efficient use of airspace. To accomplish this mission, FAA's Advanced Technology Development and Prototyping program develops and validates technology and systems that support air traffic services. These initiatives support the goals, strategies, and initiatives of the agency's Flight Plan, including the requirements associated with the evolving air traffic system architecture and improvements in airport safety and capacity.

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 (RIL) logic, Light Emitting Diode (LED) technology, Low Cost Ground Surveillance (LCGS) Pilot, and Final Approach Runway Occupancy Signal (FAROS) for high density airports. When appropriate, investment analyses will be performed to support acquisition and implementation of selected solutions.

The requested funding will support delivery of performance targets outlined in the FAA Flight Plan and ATO Safety Business Plan. Specifically, the funds will support (1) the completion of the RIL operational trials; (2) the sustainment of RWSL test beds until replaced by a production program; (3) the completion of LCGS pilot program operational trials; (4) the development of a low cost RWSL system design; and (5) the delivery of PAPI/FAROS modification kits to select sites.

Key Outputs:

- Sustain RWSL test beds, LCGS pilot sites, and other test beds.
- Develop all artifacts required under the FAA Acquisition Management System to support investment decision for national LCGS deployment.
- Develop RWSL RIL requirement documents.
- Develop FAROS requirements documents.
- Conduct initial testing of RI prevention logic using LCGS surveillance input at a LCGS pilot site.
- Conduct operational evaluation of RWSL LED fixtures at San Diego.
- Conduct in cockpit simulations at MITRE CAASD HITL testing to respond to HF, safety logic, aircraft performance, or any uncertainty or deficiency pertaining to surface based RI indications.
- Conduct evaluation and testing of camera, acoustic, and other emerging runway incursion detection and prevention systems proposed for eventual deployment in the NAS.
- Test safety logic enhancements to any RI detection and prevention products or procedures.
- Support direct to cockpit indication and alerting capability development, demonstration and testing.

Key Outcome**:** The above Key Outputs result in Reduced Runway Incursions, which supports the Flight Plan Goal of Increased Safety.

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.

Airspace Management Program

This program 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 communication 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?

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 Joint Resources Council 2A decision.

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.

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.

Airspace Management Program

Airspace Redesign is the FAA initiative that ensures all airspace related capacity benefits facilitated by the Airspace Management Program (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 of the new flows associated with the new runway in Chicago (ORD).

4. How Do You Know The Program Works?

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.

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 (OOOI) 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.

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 ATDP 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.

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, thus ensuring project efficiency and success to the NAS.

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

$18,898,000 is required to continue all activities within the Advanced Technology Development and Prototyping (ATDP) budget line item. A reduction to ATDP could slow achievement of programmatic milestones.

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 2013 – Next Generation Transportation System (NextGen) – System Development

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
1A08 Next Generation Transportation System (NextGen) – System Development	$60,400,000	$85,000,000	$61,000,000	-$24,000,000

R&D Activities	**FY 2013 Estimated Cost**
NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	$5,000,000
NextGen - New Air Traffic Management Requirements	$22,000,000
NextGen - Operations Concept Validation – Validation Modeling	$5,000,000
NextGen – Staffed NextGen Towers (SNT)	$3,500,000
NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	$9,500,000
NextGen - Wake Turbulence – Re-categorization	$1,500,000
NextGen - System Safety Management Transformation	$7,500,000
NextGen - Operational Assessments	$7,000,000
Total	$61,000,000

For FY 2013, $61,000,000 is requested to provide for the following:

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

- Conduct demonstration simulations of integrated ATC workstations showing the phased introduction of NextGen decision support tools and new capabilities.
- Determine the information requirements for ATC as UAS are integrated in the NAS in a less restricted manner than is currently used.
- Manage safety risk associated with human performance in the NextGen environment.
- Develop a tech ops integrated work environment in the NextGen maintenance environment.
- Continue development of the Human System Integration Roadmap in support of the human element in the NAS Enterprise Architecture.
- Conduct simulations of major air-ground simulation human factors issues.

NextGen - New Air Traffic Management Requirements

- Weather Transition
  - Coordinate NextGen Weather Requirements with the International community (e.g., ICAO, SESAR).
  - Conduct policy analyses on FAA/NWS roles and responsibilities.

  - Conduct requirements allocation and validation with NWS.
  - Conduct service analysis activities to address operational problems (e.g., Path Based Shear, Ground Deicing, Time-of-Wind-Return, and Terminal Haze).
  - Provide weather information demonstration and evaluation support for concept maturity and technology development (CMTD) activities (e.g., Concept of Operations).
- TCAS
  - TCAS/ADS-B Compatibility/Future Requirements
  - Future CAS Logic Development/Future Surveillance Requirements
  - CAS Logic Assessment/Avionics Model
- Airborne SWIM
  - Acquisition planning to support requirements levied on NAS systems by uses of AAtS
- Trajectory Modeling
  - Development of NAS trajectory performance requirements
  - Development of NAS trajectory interoperability requirements
  - Development of NAS trajectory information requirements
  - Trajectory Concepts Alternative Analysis
  - Initial Trajectory information items for Flight Object
- New Radar Requirements (Surveillance and Weather)
  - Deliver initial report on Full-Antenna Aperture Performance Model for Multifunction
  - Deliver report on Industry Solutions for Multifunction Radar Backend Architecture
  - Concepts and Requirements Definition (CRD) Team Kick-off
  - Deliver CRD Plan
  - Deliver Technical/Cost Trade Offs Report

NextGen - Operations Concept Validation – Validation Modeling

- Continue process of developing and validating high priority Mid-Term operational concepts and conducting research to reduce the risk of NextGen programs being implemented before flawed operational concepts are identified.
- Simulation and modeling needed to validate concepts described in concept documents and scenarios will occur as dictated by research gaps that exist in programs transitioning to an implementation phase.
- Benefits associated with concepts will also be modeled in 2013 to determine the level of capacity and efficiency benefits that can be attributed to NextGen operations.
- Development of operational requirements for validated concepts

NextGen - Staffed NextGen Towers (SNT)

- Program requirements update
- Surface surveillance operational suitability (formerly ASDE-X Certification) documentation
- Initial procedures for surface surveillance operational suitability
- System safety analysis for surface surveillance operational suitability

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction

- Development and enhancement in provisions of NextGen EMS in coordination with stakeholders
- Advance NextGen EMS framework through pilot studies, data collection for decision support analyses and scope out development of EMS tracking and IT system.
- Explore NextGen EMS adoption incentivization options.
- Assessment of NAS-wide benefits of NextGen Aircraft and Alternative Fuels Technologies through tests, demonstration and simulation analyses
- Exploration and demonstration of Environmentally and Energy Favorable Operational procedures
- Assessment of NAS-wide benefits of environmental standards and market based measures
- Implement EMS Framework including elements of multi-year activities on analysis of EMS environmental impacts and metrics, EMS communication and outreach, refinement of decision support tools, EMS testing and pilot studies, EMS tracking and IT system, analysis of EMS incentivization and NEPA compliance, EMS prioritization and implementation.
- Elements of multi-year activities exploring, environmentally efficient gate to gate operational procedures
- Investigate NAS-wide benefits of potential aircraft CO2 emissions standard metrics aviation specific market based measures..

NextGen - Wake Turbulence - Re-categorization

- Begin engineering assessments for incorporating leader/follower pair-wise static wake separation standards into the FAA ATC automation platforms.
- Continue to support implementation of six category wake separation standards into the FAA ATC automation platforms.

NextGen - System Safety Management Transformation

- SMS - Implement an integrated hazard tracking capability across all AVS services and offices with oversight responsibility.
  - SMS DAH capability with hazard tracking oversight software
- SRM - Initiate annual FAA-wide safety risk management (SRM) training requirements, implementation and coordination works.
  - RARM Annual FAA-wide safety risk management training
- SSA - Implement and validate the ability to calculate periodic system risk baselines for surface operations (all 35 major airports).
  - Baseline software acquisition and deployment
  - Baseline system wide fatigue modeling
- Implement integrated system risk analysis program and analyze potential impacts of other domestic safety initiatives.
  - System safety metrics (all airports)
  - Integrated system risk analysis (System Wide)

NextGen - Operational Assessments

- Develop, evaluate and implement enhancements in AEDT to cover study fidelity for local airport to regional NAS-wide NextGen environmental analysis
- Develop, evaluate and implement enhancements in APMT-Economics for domestic/ regional NAS-wide NextGen environmental analysis

- Refine analysis and assessment of NAS-wide NextGen environmental mitigation and cost-beneficial options for decision support
- Integrate AEDT environmental assessment capabilities with NextGen NAS simulation models
- Update the overall cost estimates for the government's NextGen investment, to reflect the latest technology and procedures development plans and the approved budget
- Update the NextGen avionics costs estimates to reflect the latest industry trends, traffic forecasts, industry costs, and technology readiness
- Continue to modernize FAA's System Wide Analysis Capability (SWAC), a state-of-the-art simulation of the NAS used to estimate the operational benefits of NextGen
- Update the NextGen benefits estimates to reflect modeling improvements, revised development plans, and new traffic and fleet forecasts
- Update the overall NextGen business case, to reflect the updated cost and benefits estimates
- Conduct an operational evaluation of NextGen operational capabilities deployed in 2012

2. What Is This Program?

The FAA operates arguably the safest, most efficient, and most cost-effective air traffic control (ATC) system in the world, while handling more traffic and controlling more airspace than any other air navigation service provider (ANSP). Yet we endeavor to do more. The goal of NextGen is to provide new capabilities that make air transportation safer and more reliable while improving the capacity of the National Airspace System (NAS) and reducing aviation’s impact on our environment. The achievement of these goals will be extremely challenging. The NextGen System Development program provides cross-cutting research, development, and analysis to help achieve these goals, in such areas as human factors research, requirements development, environmental and operational modeling and analysis, and safety research and analysis. The specific activities of the program are described below.

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 2013, the program will focus on five areas: Weather Transition, TCAS, Airborne SWIM, Trajectory Management, and New Radar Requirements (Surveillance and Weather).

Weather Transition ensures that weather concepts coming from the Aviation Weather Research Program are matured and technically developed under the FAA guidelines for Concept Maturity Technology Development (CMTD) to a level of appropriate readiness for transition to NAS operational production. Weather Transition will manage appropriate CMTD activities to include the creation, testing and evaluation of prototypes and operational demonstrations for the purpose of defining and refining an appropriate operational use concept. The Weather Transition program will also ensure that any risk inherent in the introduction of a new weather product to the NAS is done so in accordance with ATO Safety Risk Management guidelines.

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, concepts of use (ConUse) for 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. . In addition, international collaboration will be an integral part of trajectory based operations, as other regions of the world shift toward the same goal.

New Radar Requirements (Surveillance and Weather) is a concept maturity and technology development initiative in support of the NextGen Surveillance and Weather Radar Capability. The objective of this effort is to identify viable solution implementation alternatives that could provide for FAA's aircraft and weather surveillance radar needs and weather surveillance radar needs of both FAA and NOAA. It will include identifying the technical challenges, evaluating cost models, developing technology approaches and proposed solutions, and concept demonstration through modeling and prototyping. The overall project includes four major areas: Multifunction Phased-Array Antenna Maturation, Engineering Studies – Technology Assessment, Multifunction Radar Backend Definition, and Concept and Requirements Definition. The outcome of this body of work will result in an initial Antenna and Radar Backend specification. The information gained through this effort will support an FAA investment analysis readiness decision (IARD) in 2014 and will provide the government a greater capability of defining specific requirements for a potential joint radar acquisition.

NextGen - Operations Concept Validation – Validation Modeling

The NextGen - Operations Concept Validation – Validation Modeling program addresses developing and validating future end-to-end (flight planning through arrival) operational concepts with special emphasis on researching changes in roles and responsibilities between the FAA and airspace users (e.g., pilots and airlines), as well as the role of the human versus systems, that will increase capacity and improve efficiency and throughput. It will identify procedures that can decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS. 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 provides an end-to-end NAS Operational Concept and a complete set of scenarios for the mid-term 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.

NextGen - Staffed NextGen Towers (SNT)

The Staffed NextGen Tower (SNT) concept provides for a paradigm shift from using the out-the-window (OTW) view as the primary means for providing tower control services to using surface surveillance approved for operational use.

SNTs will provide for improved safety and increased capacity at night and during periods of inclement weather when impaired visual observation from an air traffic control tower results in delays or a reduced level of access to the airport. SNT will also allow the FAA to expand its service to meet projected increases in Air Traffic Control Tower (ATCT) operations.

SNT is planned for high density airports as these airports are likely to have the surveillance infrastructure and most aircraft equipped with avionics that will support SNT operations.

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction

There are two environmental projects that support this program: Environmental Management System (EMS) and Environment and Energy.

The NextGen Environmental Management System (EMS) will manage NextGen environmental impacts and help to define and identify optimum mitigation actions and assess their benefits in order to achieve NextGen environmental goals. This subprogram will develop, refine and evaluate EMS framework, support implementation as well as communication and coordination strategies, decision support tools, and environmental impacts metrics and analysis approaches.

Environment and Energy - Advanced Noise and Emission Reductions: Three main components of this subprogram are: Evaluate potential NAS-wide environmental benefits of mitigation solutions i.e. new aircraft technologies matured under CLEEN (Continuous Lower Energy, Emissions and Noise) for reduction in noise, emissions and fuel burn through testing, demonstration and benefits analysis, aviation alternative fuels, potential and viable policy, and environmental standards and market based measures; explore and assess new optimized operational procedures for energy efficiency and improved environmental performance; and identify ways to integrate environmental impacts mitigation options with the NAS infrastructure and demonstrate any NAS adaptation required to implement these solutions and to maximally benefit from NextGen provisions.

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. Associated work is incorporating new aircraft (i.e. Boeing 787, Airbus A-380, Boeing 747-8 and others) in this ongoing development of safe capacity efficient wake separation standards.

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 pair-wise static 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 - 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 - Operational Assessments

The NextGen - Operational Assessment program focuses on two areas: Systems and Environmental Analysis.

The transition to NextGen requires NAS operational assessments to ensure that safety, environmental, and system performance considerations are addressed throughout the integration and implementation of NextGen. Such assessments are particularly important as the NextGen program evaluates current airspace design and develops new procedures to be implemented within the NAS. This 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 impacts 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. This project will contribute to system safety enhancements across the NAS, reducing aircraft emissions and noise, and improving capacity, efficiency, and delay reduction.

The focus of the Environmental program is to enhance local to NAS-wide environmental assessment capability within Aviation Environment Design Tool (AEDT) and within Aviation Environment Portfolio Management Tool (APMT) tools and to integrate environmental assessment capability with NAS design tools, simulation models and performance monitoring systems. It also involves application of NAS-wide environmental assessment models to assess environmental benefits of NextGen NAS-wide mitigation options for decision support. This environmental assessment capability will be used to support Environmental Management System so that evolving environmental state of aviation system can be continually quantified, appropriate targets can be developed and adjusted towards meeting NextGen environmental goals and the effectiveness of mitigation solutions can be quantified in order to develop guidance for adaptations.

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 (FOS) 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.

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 Systems Development solution set encompass the entirety of the airspace and airports within the NAS. Since its beginning SYSDEV 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)

- Completed Integrated NG En Route Workstation - Initial midterm NextGen En Route Workstation Human Factors Requirements
- Completed cross-cutting Automation Requirements - Initial Human Factors Automation Guidelines and Requirements
- Completed development of Initial Air/Ground Integration Simulation Roadmap

NextGen - New Air Traffic Management Requirements

- Delivered the latest version of FIP Severity and GTG2 to Aviation Digital Data Service (ADDS)
- Investigate the feasibility of ADS-B message content as an input for future Collision Avoidance Systems
- AAtS Final Integrated Operational and Technical Requirements Document
- Trajectory Synchronization Demonstration
- Final Airborne SWIM Concept of Use
- Initial Multifunction Radar Backend Architecture definition

NextGen - Operations Concept Validation – Validation Modeling

- Time Based Flow Management Integrated Research Plan
- Time Based Flow Management (TBFM) Transient Analysis Results on the effectiveness of various alternatives to mitigate the impact of transient events on TBFM
- Final Data Communications Segment 2 Requirements in support of data communications investment decisions

NextGen - Staffed NextGen Towers (SNT)

- Completion of Field Demo 2 at DFW
- Preliminary Program Requirements
- Updated concept of operations

NextGen - Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction

- Application of EMS for NextGen to manage environmental performance and its development in coordination with stakeholders
- Assessment of NAS-wide benefits of aviation environmental standards for aircraft emissions and noise and market based measures
- Demonstration of control algorithms for environmentally and energy favorable gate to gate operational procedures
- Assessment and demonstration of NAS-wide benefits of CLEEN aircraft and alternative fuels technologies

NextGen - Wake Turbulence - Re-categorization

- New 6 Category air traffic control wake separation airport capacity enhancing standards submitted to ICAO; and, FAA has initiated the process for implementing them.
- Concept for using Leader/Follower Pair-Wise Static air traffic control wake separation standards has been developed – potential additional airport runway capacity increase of 4 percent.

NextGen - System Safety Management Transformation

- SSA - Baseline risk assessments for system-wide risks associated with current operations in (1) terminal area airspace (2) transition airspace or (3) en route airspace
- SMS - Design Approval Holder (DAH) SMS requirements

NextGen - Operational Assessments

- AEDT Integration
- Updated NextGen cost analysis
- Updated NextGen benefits analysis
- Annual NextGen Performance Assessment
- Updated NextGen business case
- Analysis of the potential benefits of Collaborative Air Traffic Management (CATM), using a stochastic NAS-wide model incorporating Traffic Flow Management (TFM) procedures
- Improved modeling capability, incorporating Low Instrument Meteorological Conditions (IMC) representation, dynamic Ground Delay Program (GDP) representation, surface congestion model, and simple weather re-routes

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

$61,000,000 is required to allow for continued execution of work within the System Development solution set. The FY 2013 work will support strategies to meet future aviation demand in an environmentally sustainable manner, 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. System Development provides the research and development required to resolve these potential problems. In addition, an increase in demand could cause an increase in the number of accidents, aircraft noise and 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.

Detailed Justification for
4A08A Center for Advanced Aviation Systems Development

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

FY 2013 – Center for Advanced Aviation Systems Development

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
Center for Advanced Aviation Systems Development	$20,812,000	$20,045,000	$17,990,000	-$2,055,000

For FY 2013, $17,990,000 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 25.7% of the total program requested FY 2013 budget ($70,000,000). The Federally Funded Research and Development Center (FFRDC) Executive Board has approved the seventh edition of the FAA CAASD Long Range Plan (FYs 2012 – 2016).

What Is This Program?

The Center for Advanced Aviation System Development (CAASD) is a Federally Funded Research and Development Center (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 National Airspace System (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. The CAASD Product Based Work Plan and FAA CAASD Long Range Plan (FY 2012 – 2016), 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 R&D activities include:

<u>NAS and NextGen Systems Integration and Evolution</u> - Research and develop an approach to valuing changes in predictability that can be implemented in the FAA's cost-benefit guidance and used by the aviation community; conduct research toward implementation of route-choice and aircraft-choice algorithms in the TAF-M framework for longer term (+5 year) forecasting.

<u>Performance-Based NAS</u> - Research new concepts for achieving a performance-based NAS; provide technical and engineering analysis, and prototyping and modeling to inform and contribute to FAA's requirements to develop, implement, and validate new PBN criteria, understand operational impacts, and address mid-term and far-term PBN requirements of NextGen; continue to develop and refine prototypes, models, and databases that provide the ability to estimate benefits, validate Flight Standards procedure development tools, identify problems that emerge in the implementation of RNP and RNAV procedures and recommend resolutions, and analyze and model all aspects of the FAA's navigation assets.

<u>En Route Evolution</u> - Develop integrated operational concepts and prototypes to demonstrate and evaluate new en route capabilities and procedures for NextGen; develop and validate operational en route evolution plans that are integrated and aligned with the other domains including terminal and traffic flow management; 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 NextGen mid-term capabilities; evaluate the CAASD-developed prototype Approach Control Training Module to demonstrate the specific training capabilities that are needed to support ongoing NextGen training for the ATC workforce.

Terminal Operations and Evolution - Research emerging terminal operational capabilities, concepts, and concept gaps in current plans in order to better inform terminal planning and evolution activities that support mid-term terminal operations; enhance the terminal training prototype, focusing on skill based training capabilities that can be applied and evaluated more generally across most TRACON facilities; conduct additional field evaluations of the prototype; continue to integrate into the prototype real-time performance assessment and feedback capabilities, and automated speech recognition to provide for an interactive and realistic operational training environment.

Airspace Design and Analysis - Conduct research, modeling, and analysis to inform FAA decisions on mid-term and long-term airspace concepts and capabilities; provide research, modeling, and analysis to support the development and evolution of the strategic plan for airspace and procedures (the National Airspace and Procedures Plan).

NAS System Operations - Research, develop, and prototype analysis techniques for evaluating en route sector traffic characteristics and improving techniques used for identification and management of en route congestion with a focus on enhancing the safety and efficiency of en route operations; prototype real time prediction capabilities needed for Traffic Flow Management to assist with identifying en route congestion issues focusing on improvements in predictive capabilities through the inclusion of additional data sources and improvements to underlying algorithms and methods; evolve the initial prototype Terminal Workload modeling capabilities and expand the ability of the model to evaluate workload at additional sites.

Traffic Flow Management (TFM) Operational Evolution - Explore concepts, prototype, and develop Collaborative Air Traffic Management (CATM) strategic Flow Contingency Management (FCM) capabilities that can be leveraged in the mid-term, focusing on capabilities that apply to specific tactical flight adjustments for the enroute environment; refine the concepts of tactical Traffic Flow Management (TFM) constraint identification, planning and execution in the en route environment; refine the En Route Flow Planning Tool (EFPT) prototype and conduct additional concept exploration through Human in the loop (HITL) lab experiments; conduct research that extends the scope of terminal TFM activity to achieve integrated decision support automation over the TFM terminal domain, especially in the area of managing arrival and departure traffic flows to achieve maximum efficiency and throughput of NAS resources.

Aviation Safety - Develop metrics and processes that allow FAA to proactively identify potential safety issues with both operations and architecture; identify risks before they lead to incidents or accidents; and identify and assess the feasibility of new or advanced capabilities and standards that mitigate safety issues in the NAS; study changes in runway standards that may support improved access to runways and airports by smaller general aviation aircraft, through the application of vertically guided approaches and the resulting availability of precision approach guidance; research and evaluate empirical human performance data in the Tower environment to identify key operations variables that impact response time when tower-based surface safety systems generate alerts for potential runway incursions; prototype algorithms and develop requirements for safety metrics that can be computed and reported on a regular basis to track and monitor the safety of the National Airspace System; investigate issues related to the collection, delivery, processing and fusion with threaded tracks of controller-pilot voice communications audio to support the creation of a large scale voice communications archive which will support incident analysis, data mining, tracking and trending of ATC operations with the intent of improving aviation safety through reduced Controller-pilot miscommunication; investigate improving safety by applying automated speech recognition, data fusion and other technologies to help identify and mitigate late and missing landing clearances and possibly other voice communications related errors; conduct research leading toward operational performance standards for the Enhanced Surface Indications and Alerts (SURF IA) flight deck-based direct pilot warning system.

Mission Oriented Investigation and Experimentation (MOIE) - Conduct forward thinking research and experimentation in two thrust areas (1) modeling, simulation and prototyping, and (2) future concepts and technologies to identify and mature innovative solutions to system problems. Modeling, simulation, and prototyping research projects include: Measuring the Safety of NextGen Runway Operations, NAS-wide Environmental Impact Assessment for NextGen, and Strategic Planning for Flow Contingency Management. Future concepts and technologies projects include: Implications of Unmanned Aircraft System (UAS) Operations in Controlled Airspace, Wake Turbulence Avoidance Automation, Reinventing High Density Area Departure/Arrival Management, Staffed NextGen Towers Block Occupancy Display, and Arrival/Departure Runway Integration Scheduler.

Broadcast and Surveillance Services – Research ADS-B ground and cockpit-based solutions that will permit the FAA to deploy ADS-B throughout the entire NAS in a cost effective and timely manner, while reducing the cost of ownership for FAA surveillance infrastructure and ATC, and improving safety for all NAS users; prototype basic and advanced ADS-B applications that will result in improved efficiency and capacity for FAA and the airlines.

Special Studies, Laboratory and Data Enhancements - Provide the CAASD work program with a research environment where prototypes and capabilities can be brought together with the appropriate mixture of fidelity and development flexibility to facilitate integration investigations, compressed spiraling of operational concepts and procedure development; provide the CAASD work program with the capabilities of the Aviation Integration Demonstration and Experimentation for Aeronautics (IDEA) Laboratory that provides an integrated end-to-end evaluation environment to support realistic assessments of new operational concepts and procedures before moving forward with operational field demonstrations; provide the CAASD work program with a data repository system that allows analysts more efficient access to aviation data and associated tools to support data analysis resulting in more useful products across the work program at a lower cost to our customers; and provide the CAASD work program with a flexible model of the NAS capable of quickly and reliably estimating the high-level impacts of new technologies, procedures, or infrastructure improvements on key system performance metrics.

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 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 several 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?

MITRE/CAASD conducts high quality research, systems engineering, and analytical capabilities that help FAA meet the technically complex challenges in the NAS. CAASD efforts support all strategic 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 2013 - Airport Cooperative Research Program

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
Airport Cooperative Research Program	$15,000,000	$15,000,000	$15,000,000	-$0

R&D Activities	**FY 2013 Estimated Cost**
Airport Cooperative Research Program - Capacity	$5,000,000
Airport Cooperative Research Program - Environment	$5,000,000
Airport Cooperative Research Program - Safety	$5,000,000
Total	$15,000,000

For FY 2013, FAA requests $15 million, 2 positions and 2 FTE. Pay Inflation will be absorbed within the requested level.

Funding in FY 2013 will support the following key outputs and outcomes:

- ACRP will select approximately 30 research topics to fund in FY 2013. 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 administers 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:

- Common Airport Pavement Maintenance Practices
- Guidebook for Developing and Managing Airport Contracts
- Guidebook of Practices for Improving Environmental Performance at Small Airports

- Planning for Offsite Airport Terminals
- Resource Guide to Airport Performance Indicators
- Impact of Jet Fuel Price Uncertainty on Airport Planning and Development

Anticipated FY 2013 accomplishments include:

- ACRP awards contracts for the topics selected for funding in FY 2012.
- ACRP Board of Governors will meet to select projects to fund in 2014.
- TRB will appoint project technical panels for new projects selected in FY 2013.

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. 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?

Each year ACRP receives approximately 150 suggested topics for research. Each study costs on average about $300,000. Reducing funds below the $15 million request will result in fewer studies.

Detailed Justification for
Airport Technology Research Program

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

FY 2013 - Airport Technology Research Program

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
Airport Technology Research Program	$22,472,000	$29,250,000	$29,300,000	+$50,000

R&D Activities	**FY 2013 Estimated Cost**
Airport Technology Research Program - Capacity	$12,507,000
Airport Technology Research Program - Environment	$1,500,000
Airport Technology Research Program - Safety	$15,293,000
Total	$29,300,000

For FY 2013, the Associate Administrator for Airports request $29.3 million, 23 positions and 23 FTE to fund the Airport Technology Research program. 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 continue 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 2013 Airport Technology Research Program Projects ($000)

Research Project	FY 2012 Enacted	FY 2013 Request	Increase/ Decrease
Advanced Airport Pavement Design	300	300	0
Pavement Design & Evaluation Methodology	1,000	2,018	1018
National Airport Dynamic Tests	3,000	3,027	27
Airport Pavement Test Vehicle	500	2,107	1607
Field Instrumentation & Testing	750	636	-114
Improved Paving Materials and Lab	2,000	1,716	-284
Non-Destructive Pavement Testing	1,500	1,892	392
Center of Excellence	250	250	0
Airport Planning	500	500	0
Airport Design	700	700	0
Operation of New Large Aircraft (NLA)	700	700	0
Composite Materials Firefighting	500	500	0
Airport Wildlife Hazards Abatement	2,550	2,550	0
Airport visual guidance/runway incursions reduction	3,900	3,029	-871
Aircraft Safety Technologies	2,100	1,026	-1074
Aircraft Braking friction	2,250	2,220	-30
Aircraft Noise Annoyance Data and Sleep Disturbance Around Airports	1,500	1,009	-491
Surface Operations	300	300	0

FY 2013 Airport Technology Research Program Projects ($000)			
Research Project	**FY 2012 Enacted**	**FY 2013 Request**	**Increase / Decrease**
Rescue and Fire Fighting	700	700	0
Subtotal—Contracts	**25,000**	**25,180**	**180**
In-House (FTEs,)	4,250	4,120	-130
TOTAL	**29,250**	**29,300**	**50**

The FY 2013 request includes decreases and increases in several research areas that reflect completion of several projects, continuation of an existing project and two major new initiatives. Major changes are detailed below.

DECREASES:

Decrease of $114,000 Field Instrumentation: We have completed the pavement instrumentations at several airports and do not anticipate any new starts in FY 2013. These projects were initiated to study long-term pavement behavior in the field under different climates and operational conditions.

Decrease of $284,000 Materials and Testing Laboratory: The Materials Testing Lab should be well outfitted by FY 2012, therefore a reduction of funding is requested. The Alkaline Silica Reactivity Affected Concrete Slabs project will be nearing completion and should only have report writing and minor monitoring of slabs. The Asphalt Mix Design of the Gyratory Compactor project will be nearing completion and should be in the final report writing phase. The reflective cracking tests will continue but the construction of the test apparatus will be complete, and the initial learning curve associated with the first few reconstruction cycles will have been overcome, anticipating a more efficient process for reconstructions. The Effects of Sub-base Quality for Flexible Pavements project will be complete and therefore will no longer be funded. Testing support for ERDC IA will be reduced as their involvement with the Asphalt Mix Design of the Gyratory Compactor project will be completed.

Decrease of $491,000 Airport Sleep and Noise Data: FY 2013 funding will be sufficient to meet objectives of this effort. In FY 2012, we initiated a new effort 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.

---

[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.

<u>Decrease of $871,000 in Visual Guidance/Incursions Reduction Program:</u> The reduction of $871,000 in funding request in FY 2013 from FY 2012 level is predicated on completion of all critical Vertical Flight Visual Guidance projects required to update the Heliport Design Advisory Circular.

<u>Decrease of $2,044,000 in Airport Safety Technology Projects:</u> This reduction in funding is due to completion of Visual Guidance Test Bed in FY 2012, and completion of the Radiant Heating Project in FY 2012.

INCREASES:

<u>Increase funding for an existing project:</u> We are requesting an additional $1,607,000 over the FY 2012 base for the Airport Pavement Test Vehicle (APTV). The APTV was procured for $ 2.4 million in FY 2011. The APTV was acquired to conduct performance tests on pavement surface layers as a function of high tire pressure and high wheel loads under high temperatures; it is easier and more economical to insulate and heat the test pavement under the APTV. The National Airport Pavement Test Facility (NAPTF), where we conduct performance testing to evaluate the effects of landing gear configurations, is an indoor facility and there are limitations on achievable high pavement temperatures. The trend in aircraft industry is to produce aircraft with extended range capability, which results in higher gross weights and higher tire inflation pressures. This makes it imperative to study the effects of high tire pressures on the Hot Mix Asphalt (HMA) surface and also develop HMA mix design procedures to produce mixes that can withstand these anticipated higher tire pressures. Full-scale tests at high surface temperatures are very crucial for the success of these projects. The requested funding will be invested in three areas: construction of the housing for the APTV, construction of the test pavements, and acquisition of instrumentation and data collection system.

The major portion ($1,369,000) of this increase is for the construction of the building to house APTV ($609,000), and the construction of test pavements ($760,000) to meet research objectives in greener / sustainable pavement technology as outlined and prioritized by FAA RE&D sub-committee.

The building is needed to protect the test sections from the rain/snow/ice and sun and to provide a controlled environment for meaningful testing. The building will be a steel frame tensioned fabric structure 300-feet long by 150-feet wide.

Six test pavements (each 245-foot long by 20-feet wide) will be constructed using greener/sustainable pavement technologies such as warm mix asphalt (WMA), asphalt overlays of PCC, Stone Matrix Asphalt (SMA), Recycled Asphalt Pavement (RAP), Polymer Modified Bitumen (PMB), and geosynthetics.

The remaining funding ($238,000) will be used for acquiring sensors and gages, data acquisition system, spare parts for APTV, pavement testing, developing database, processing and analyzing data, APTV operation, and for APTV maintenance.

We expect much smaller funding requests to maintain the APTV in the years beyond FY 2013.

<u>New Initiative #1: Heated Pavements:</u> We are requesting $1,018,000 in FY 2013 (under Aircraft Safety Technologies) for a new initiative for research on heated pavements. This effort was initiated on a smaller scale in FY2010. Events of this winter have brought this initiative in a sharper focus. Severe weather of the past winters (December 2010 thru February 2011) resulted in significant flight delays and cancellations around the country. One current study (based on an article in Wall Street Journal) placed the cost to an airline at $7,000 per cancelled flight. Almost 20,000 flights were cancelled in one week (based on a news article) alone when snow blanketed hub airports across the country. While some of the cancelled flights resulted from the inability to actually fly in bad weather conditions, it is probably realistic to assume that at least half of the cancelled flights were a result of snow removal operations at airports costing airlines $70 million in lost revenue. Actual costs to airline passengers are much more

difficult to quantify. Recent studies at University of California, Berkeley have estimated this number at approximately twice the cost to airlines. So the total cost to passengers for the week in question equates to a loss of $140 million to passengers for the week. When combined, the total cost is $210 million for the week. These costs are substantial and warrant further investigation into heated pavements.

The premise of this initiative is that if runway surfaces can be efficiently and economically heated, the buildup of snow can be avoided, thereby eliminating the need for snow removal operations. The most promising current methods of heating pavement take advantage of "green energy" to reduce operational costs and carbon footprint. Ideally, a pavement heating system should have a dual use to offset the cost of the system while in standby mode during times of the year when pavement temperatures are above freezing. For example, geothermal heat exchangers can be used to heat fluids for pavement de-icing when needed around apron areas while also providing nearby airport facilities with low cost heating and cooling for the remainder of the year. Solar panels will be able to produce electrical energy throughout the year and not only when needed to heat pavements. On-site power generation through the use of gas turbines, micro turbines, or fuel cells could produce the electricity required for a heated pavement installation without the need for major infrastructure investments. Nano-technology also holds some promising potential for applications into heated pavements. New materials to conduct electricity at lower costs may become available through research. Likewise better insulation and thermal conducting materials included into the pavements could greatly reduce the energy required to operate a heated pavement.

We have already started research in this area in FY 2010 and to continue through FY 2012: In 2010 we provided funding for two projects to begin research into heated pavements. One project at the Greater Binghamton Airport is exploring hydronic heating by designing and installing piping under a portion of concrete apron. Another project at the University of Arkansas is using solar energy along with battery banks to heat an electrically conductive pavement. Our FY 2012 funding will be used to fund the construction of the geothermal wells, pump house and equipment necessary to complete the apron project at the Greater Binghamton Airport as well as provide support funding to analyze the efficiency of the system.

The FY 2013 funding request of $1,018,000 is needed to conduct advanced research in heated pavements in the following areas:

- Study Heated Pavement Applications at Airports. A new study is needed to identify which U.S. airports and what specific locations at the airport would most benefit from heated pavement installations. The study must incorporate the total cost of a heated pavement installation including system operational and maintenance costs as compared to the total benefits expected from reductions in snow plowing equipment, materials, labor, and plow maintenance. In order to provide a realistic comparison, the actual true savings must also account for airline losses and passenger delay costs. Cost: $358,000
- Advanced Materials for Heated Pavements. Fund research into advanced materials; materials developed through nanotechnology for the purpose of improving the insulating capacity of a pavement layer located directly below heating elements or improving the heat conductance of the pavement heating elements. Cost: $408,000
- Advanced Construction Techniques for Heated Pavement. Study how to best automate construction of large scale heated pavements. Significant problems that must be answered include material selection, joint interfaces, new equipment necessary for installation of heating elements, time factors for installation, and location of ancillary equipment at the airport. Cost: $252,000

<u>New Initiative #2: Design of Pavements for 40-year Life:</u> In FY 2013 we are requesting $1,018,000 (under Pavement Design and Evaluation Methodology) for initiating a new project as a core activity doubling the expected life of runway pavements at large hub airports from the current standard of 20 years to 40 years.

The current 20-year design life for all airport pavements is specified in FAA Advisory Circular 150/5320-6E. Surveys and anecdotal evidence show that designs meeting current standards already provide service life in excess of 20 years. AC 150/5320-6E (Appendix 1) also recommends using an analysis period for life cycle cost analysis (LCCA) of 20 years, while a technical report from the Airfield Asphalt Pavement Technology Program (AAPTP) entitled "Lifecycle Cost Analysis" (Jan. 2011) characterizes this period as "too short" and specifically recommends increasing it to 40 years. Extending the standard pavement life would result in lower life cycle costs overall, due to:

- The relatively small marginal cost increase for initial construction would be more than offset by amortizing the cost over 40 years rather than 20 years.

- Lower present value of construction-related closures and delays.
- Lower present value of environmental costs associated with major construction activities.

In order to accomplish the required extension of pavement life, a 4-year coordinated R&D effort will be needed, including:

- Modify the existing pavement design program "FAARFIELD" to accommodate the new pavement life standard.
- Better modeling of pavement remaining life. Current procedures are best at predicting performance deterioration once significant structural distress is manifest. For a 40-year life, this may not occur for decades after opening, so an improved estimate of used fatigue life is needed.
- Quantify the reliability of design procedures for flexible and rigid pavements based on field survey data, including available FAA pavement management data from FAA PAVEAIR databases.
- Revise standard PCN reporting procedures (COMFAA) to accommodate the expected 40-year life.

Funding in FY 2013 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.
- Continue investigating 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 using the Airport Pavement Test Vehicle 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 firefighting to address double decked aircraft carrying up to 800 passengers.
- Modify the habitats of increasing numbers of wildlife on or near airports.
- Study the emerging technologies for detecting and deterring hazardous wildlife species on or near airport.
- Continue full-scale live fire testing of cargo aircraft to provide better guidance to airport fire fighters on the unique characteristics of cargo aircraft fires.
- Continue to evaluate green technologies in airfield pavements.
- Certification of the Materials Testing Laboratory at the National Airport Pavement Test Facility.
- Integration of FAA suite of software programs into one web application.
- Upgrade of FAA PAVEAIR to include Life Cycle Cost Analysis.

2. What Is The Program?

Safety

The research conducted within the Airport Safety Technology Research Program directly supports FAA's Advisory Circular system, which is the principal means by which FAA communicates with the nation's airport planners, designers, operators, and equipment manufacturers. These Advisory Circulars commonly referred to as an AC, present the standards used in the design, construction, installation, maintenance, and operation of airports and airport equipment. Additionally, the AC provides current advice on airport operational and safety topics. To date, the research conducted within the Airport Safety Technology Research Program has provided the necessary technical data to support hundreds of ACs that have been published on a wide range of technical subjects. These technical subjects include airport design standards, visual guidance aids such as lighting marking, or navigational aids, airport rescue and firefighting equipment and procedures, pavement surface conditions, wildlife mitigation and detection, airport capacity enhancements, pavement friction, and snow and ice mitigation. Some examples of the research include:

- Foreign Object Debris (FOD) Detection research efforts will be conducted to evaluate new detection technologies, conduct a FOD characterization study, and also develop a national FOD database that can be used to track safety issues related to FOD.
- Taxiway Deviation research efforts will be conducted to better understand the behavior of larger design group aircraft on smaller airport design group airports, in support of the projected increase in levels of travel at smaller airports as part of the NextGen program.
- Cargo Aircraft Interior Fire Suppression research program will develop better tactical guidance for ARFF departments responding to interior fire emergencies on cargo aircraft. This will be accomplished through full-scale, live fire testing of various Unit Load Devices (ULDs) types and configurations in aircraft main deck and lower deck holds.
- Advanced Composite Material Cutting is a project to determine the effectiveness of the fire service rescue saw and a variety of available blades on traditional and new commercial aircraft skin materials. With this shift toward advanced material structures over traditional aluminum structures the tools firefighters use must be evaluated to ensure they will continue to be as effective as they are now.
- New Airfield Lighting Infrastructure is an effort focused on identifying an efficient and standardized airfield lighting infrastructure that supports the operation of new light sources including Light Emitting Diodes (LEDs). The new system architecture will provide potential resolutions to issues that have arisen with the implementation of the LED fixtures in the current airfield lighting infrastructure.
- Low Cost Surface Surveillance Framework is a research effort initiated to assess the efficacy of using localized surveillance sensors to provide real-time situational awareness of aircraft and vehicle movements in the non-movement area at airports without the use of Surface Movement Radars (SMR). This effort is focused on how these systems can be employed to enhance operational capability and safety.

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 firefighting 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 (PCN) for any mix of aircraft traffic, which an airport may currently or in the future experience.
- 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 BasicTM source code for BAKFAA and LEAF available for programmers to run LEAF from their own applications.
- FAA PAVEAIR is a web-based airport pavement management system that provides users with historic current information about airport pavement construction, maintenance and management. The program offers users a planning tool capable of modeling airport pavement surface degradation due to external effects such as traffic and the environment. The program can be used with other FAA pavement applications, such as BAKFAA and COMFAA, to give users input to determine repair scheduling and strategies. It has been developed for installation and use on a stand-alone personal computer, a private network, an intranet and the internet. An implementation of the internet version of FAA PAVEAIR is hosted and supported on a server at the William J. Hughes Technical Center and is accessible from the FAA PAVEAIR website.
- High Tire Pressure Testing (HTPT) - NAPTF has completed three cycles of testing the effects of tire pressure on asphalt pavement in conjunction with the Airport Technology group of Boeing Commercial Airplanes. The full scale tests determined that by increasing tire pressure from 210 psi (1.45 MPa) to 245 psi (1.66 MPa) had an insignificant effect on the amount of rutting caused by trafficking at two different wheel loads on two different asphalt mixes but increasing wheel load caused a significant increase in rutting on asphalt pavements. This testing is helping to support a revised tire pressure classification for ICAO standards.

<u>Environmental Sustainability</u>
In FY 2013, FAA will continue 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 2013 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.
- Start full scale testing of “green” paving materials with Accelerated Pavement Test Vehicle (APTV).
- Determine Runway Roughness Index Scale for Pavement Evaluation and Ride quality Evaluation.

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 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 2013. 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 2013 - Commercial Space Transportation Safety

Activity/Component	FY 2011 Enacted	FY 2012 Enacted	FY 2013 Request	Difference from FY 2012 Enacted
Commercial Space Transportation Safety	$165,000	$1,000,000	$1,000,000	$0

In FY 2013, 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 2013.

FY 2013 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. The requested funds are required to continue the following ongoing research projects in FY 2013:

- Wearable Biomedical Monitoring Equipment for Passengers on Suborbital and Orbital Spaceflights
- Space Environment MOD Modeling & Prediction
- Space Situational Awareness Improvements
- Unified 4-Dimensional Trajectory Approach for Integrated Traffic Management
- Develop a Spaceport Operations Framework
- Air and Space Traffic Considerations for Commercial Space Transportation
- Masters Level Commercial Operations Instruction Criteria
- Analysis Environment For Safety Assessment of Launch & Re-Entry Vehicles
- Magneto-Elastic Sensing for Structural Health Monitoring
- High Temperature Pressure Transducers for Hypersonic Vehicles
- Ultra High Temperature Composites for Thermal Protection Systems
- Autonomous Rendezvous and Docking (For Space Debris Mitigation)
- Wearable Biomedical Monitoring Equipment For Human Spaceflight
- Physiological Database Definition and Design
- Human System Risk Management Approach
- Additional NASTAR Centrifuge Testing
- Human Rating of Commercial Spacecraft
- Flight Crew Medical Standards & Participant Acceptance Guidelines

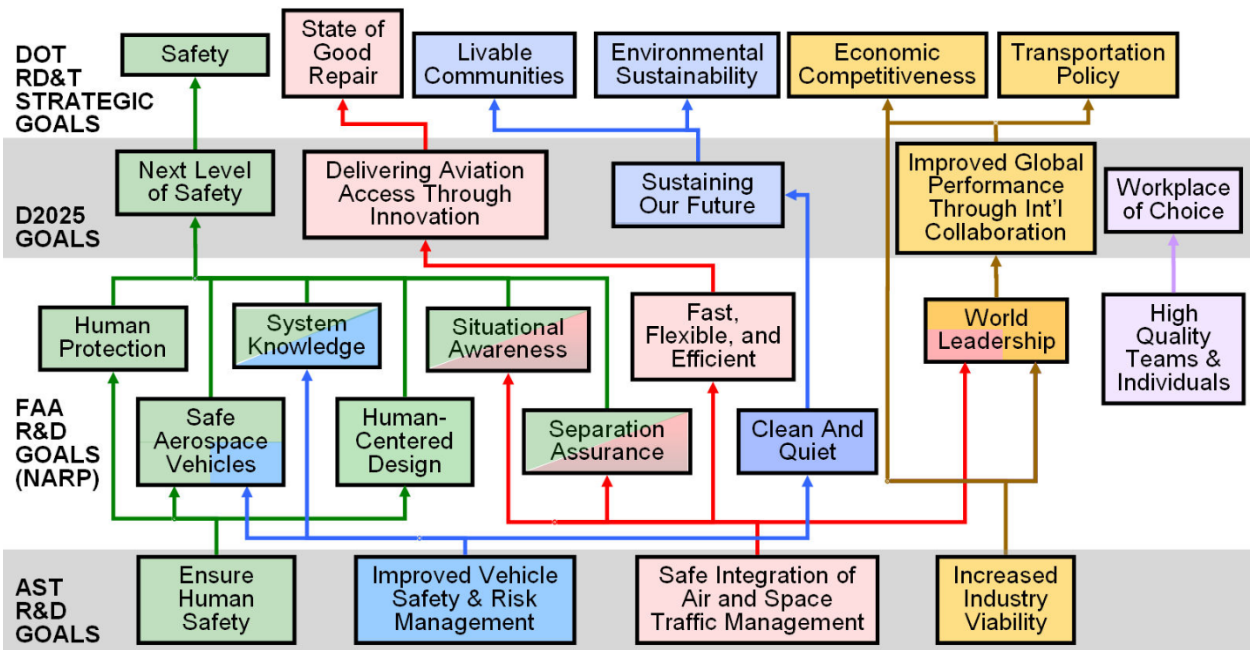
2. What Is The Program?

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 2012 include (1) completion of R&D research project milestones, and (2) publication and presentation of FY 2011 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 directly reduce the amount of R&D that can be performed by AST with the COE CST program.

This Page Is Intentionally Blank

Appendix B: Partnership Activities

Table of Contents

List of Tables

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, promotes the transfer of FAA technologies to the private sector for other civil and commercial applications, and expands the U.S. technology base. The Agency uses a variety of partnership mechanisms.

1.0 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, which are written agreements between the FAA and other agencies in which the FAA agrees to receive or exchange supplies or services with the other agency. International Agreements establish an R&D relationship between the 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. 49 U.S.C. § 106(f)(2)(A) and 106(l) and (m) authorize the 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 2011

Active MOUs in FY 2011						
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Agreement Title**	**Partner**	**Objective**
1/31/2011	Advanced Concepts and Technology Development	Anthony LaSure		Pilot Training, Flight Proficiency, and Developing Training Curriculums for Unmanned Aerial Systems	NASA - DFRC	
9/30/2010	Environment and Energy	Lourdes Maurice	58-0202-0-173N	Develop the Feedstock Readiness Tool	USDA	This MOU sets a framework of cooperation with USDA, facilitating research to assess the dependability of feedstock supplies for the production of advanced biofuels for jet aircraft.
7/8/2010	Advanced Concepts and Technology Development		10-173-RH-01MOU	AFRL NextGen Research Liaison	AFRL - WPAFB	
12/5/2008	Advanced Concepts and Technology Development			Advanced Implementation of NextGen	NETJETS	
6/9/2008	Joint Planning and Development Office			Next Generation Air Transportation System Joint Planning and Development Office	DoD DOC DHS 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).
4/9/2008	Advanced Concepts and Technology Development			Roles and Responsibilities for NextGen	DOT DOC DoD DHS NASA JPDO	
5/15/2006	R&D Integration	Richard May	FNA/11	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. 49 U.S.C. § 106(f)(2)(A) and 106(l) and (m) authorize the 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 2011

Active MOAs in FY 2011						
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Agreement Title**	**Partner**	**Objective**
5/25/2011	NextGen – Staffed NextGen Towers	Michele Triantos		Staffed NextGen Tower Camera Stream and No Cost Use of Land	DFW Airport - International Airport Board	
10/13/2010	Environment and Energy	Lourdes Maurice		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.
9/10/2010	Technology Development and Prototyping	Neal Suchy		Message Downlink Development	Alaska Airlines	
2/04/2010	Continued Airworthiness	John Bakuckas	DTFACT-10-A-00002	Collaborative Technical Interchange and Continued Support of Advanced Damage Tolerant Structural Design Concepts	NASA	This MOA establishes a working relationship with NASA to conduct research on damage containment of unitized stitched composites.

Active MOAs in FY 2011						
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Agreement Title**	**Partner**	**Objective**
9/22/2009	Advanced Operational Concepts	Albert Schwartz, Mike Paglione	DTFACT-09-OTA-00001	Research to Build an FAA Lab Asset for the William J. Hughes Technical Center in Collaboration with Academia that Can Fast Time Simulate the National Airspace System (NAS) Today and the NAS of 2018-2025	Drexel University	
6/30/2009	Technology Development and Prototyping	Tom Prevost	DTFAWA-09-A-80016	Operational Assessment of Advanced Airport Surface Traffic Management	FEDEX	
3/1/2009	Aircraft Icing	Warren Underwood	PA-17	Deicing and Anti-icing Research	Transport Canada	Research aircraft ground deicing and anti-icing
12/18/2008	Traffic Management Advisor	Bill Boyer	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 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.
10/1/2008	Aircraft Icing	James Riley	NAT-I-8417	Aircraft and Propulsion System Icing Research	National Resource Council of Canada	Cooperating in research on the facility simulation of ice crystal environments for the investigation of the effects of such environments on engines
5/29/2008	Technology Development and Prototyping	Jason Coon	LL-4461	Installation of RWSL in Boston	MASSPORT	

Active MOAs in FY 2011						
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Agreement Title**	**Partner**	**Objective**
12/12/2007	Technology Development and Prototyping	Jason Coon	AA_Basic	Data Sharing	American Airlines	
6/23/2005	Environment and Energy	Lourdes Maurice		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.
4/25/2005	Environment and Energy	Lourdes Maurice		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.
6/2/2004	Technology Development and Prototyping	Jason Coon		Evaluation of FAROS	City Of Long Beach	
10/6/2003	Technology Development and Prototyping	Jason Coon		Installation of RWSL in Dallas	DFW Airport	
6/25/2003	Digital System Safety	Charles Kilgore	DTFACT--03-Y-90018	MOA between the FAA and TEES, Aerospace Vehicle Systems Institute (AVSI)	Texas Engineering Experiment Station	
6/15/1999	Flight Safety	John Frye	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 outlines the roles and responsibilities of each agency.
4/29/1999	Aircraft Icing	James Riley	NAT-I-3444	Atmospheric Icing Flight Research	AES - Environment Canada	Research of in-flight icing environments and the instrumentation used to measure the variable employed to describe those environments

1.3 Interagency Agreements

An IA is a written agreement between the FAA and another Federal agency, as defined in 5 U.S.C. § 551(a), where one agency agrees to receive or exchange supplies or services with another agency, and the agreement includes an obligation of funds. The Federal Aviation Act of 1958, 49 U.S.C. § 106(l) and (m), and 31 U.S.C. § 1535 authorize the FAA to establish IAs. 49 U.S.C. § 40121(c)(2) further authorizes the FAA to establish joint activity with DoD. Table B.3 provides details of the active interagency agreements in FY 2011.

Table B.3 - Active Interagency Agreements in FY 2011

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
9/15/2011	Digital System Safety	Charles Kilgore	FAAWA-11-V-00026 Mod 1	DOT - RITA	Aeronautical systems security
5/14/2011	Continued Airworthiness	John Bakuckas	DTFACT-11-X-80000	DoD	Support research into areas of safety and airframe structural integrity, especially verification of the design, analysis, and application of bonded repair technology
3/31/2011	Data Communication	Brent Phillips	DTFAWA-08-X-80021_MOD 05	NASA - Glenn	Modeling, simulation and analysis of VHF Digital Link Mode 2 and airport surface wireless network analysis and assessment
11/14/2010	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 06	NOAA - NSSL	Advanced weather radar technology
9/30/2010	Weather	Warren Fellner	DTFAWA-10-X-80013	MIT - LL	Research and development of improved storm forecasts and the required scientific analyses and support research prototype algorithm development in support of CoSPA; including probabilistic forecasts and weather avoidance fields, development of standards, code documentation, and support of a quality assessment evaluation
9/15/2010	Digital System Safety	Charles Kilgore	DTFACT-10-X-00008	NASA - Langley	Design, verification, and validation of advanced digital airborne systems technology
9/13/2010	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 08	NOAA - NSSL	Creation of air route traffic control centers regional and national mosaics
9/13/2010	Surveillance Systems		DTFAWA-09-A-80018_MOD 07	NASA - Langley	Pacific Organized Track System (PACOTS)
8/5/2010	Weather	Guillermo Sotelo	DTFAWA-09-X-80005_MOD 05	NSF	Advanced weather radar techniques research team, model development and enhancement product team, and turbulence product development team
8/1/2010	Continued Airworthiness	Cu Nguyen	AJP-RN-ACT-10-1-12	DOT - RITA	Develop non-destructive evaluation on the next generation of aircraft engines

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
7/30/2010	ATM/ATC	Steve Bradford	DTFAWA-08-X-80031_MOD 12	NASA - Ames	Trajectory prediction
7/15/2010	ATM/ATC	Cynthia Morris	DTFAWA-08-X-80031_MOD 11	NASA - Ames	Multi sector planner
7/9/2010	ATM/ATC	Anton Koros	DTFAWA-08-X-80031_MOD 09	NASA - Ames	High altitude trajectory
7/9/2010	ATM/ATC	Mike Paglione	DTFAWA-08-X-80031_MOD 10	NASA - Ames	ACES modeling
6/25/2010	Data Communication		DTFAWA-08-X-80021_Basic	NASA - Glenn	Communications Navigation Surveillance Information (CNSI)
6/23/2010	Human Factors	Tom McCloy	DTFAWA-10-A-80033_TD1	AFRL - WPAFB	Aeronautical research and technology development
6/18/2010	Weather	Warren Fellner	DTFAWA-08-Z-80001_MOD 05	NOAA - NCEP	Model development and enhancement, AWRP transition support, and transition of weather algorithms into operations
/10/2010	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 07	NOAA - NSSL	Advanced weather radar technology and model development and enhancement product development team
6/3/2010	Data Communication		DTFAWA-08-X-80021_MOD 04	NASA - Glenn	VDL M2 Data Communications system assessment
6/1/2010	Advanced Operational Concepts	Albert Schwartz	DTFACT-10-X-00003	NASA - KSC	Integrating UAS, modeling, simulation and demonstration into NAS
5/17/2010	Weather		DTFAWA-10-X-80020	NOAA - ESRL	Efforts in support of RUC, WRF/RR infrastructure, data assimilation, 3 km HRRR development, and test and maintenance; numerical modeling forecast efforts in support of CoSPA Op Evaluation and on-going CoSPA numerical model research efforts
5/11/2010	RWSL	Jason Coon		NASA - Ames	Data sharing at DFW
4/30/2010	Continued Airworthiness	Traci Stadtmueller	DTFACT-10-X-00005	ARMY - AED	Joint Rotorcraft Research, Development, and Evaluation (R,D&E) with the Army Aviation Engineering Directorate (AED)
4/27/2010	Human Factors	Midori Tanino	DTFAWA-08-X-80031_MOD 07	NASA - Ames	Weather integration into air traffic management
4/27/2010	ATM/ATC	Charles Buntin	DTFAWA-08-X-80031_MOD 08	NASA - Ames	3D-Path Arrival Management (3D-PAM)

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
3/23/2010	Advanced Materials	Curt Davies	DTFACT-10-X-00009	NASA - Langley	Assessment of safety characteristics and substantiation strategies for aircraft and related systems
3/10/2010	Human Factors		DTFAWA-09-A-80018_MOD 06	NASA - Langley	Develop interval management safety and performance requirements
3/10/2010	Weather	Warren Fellner	DTFAWA-09-X-80005_MOD 03	NSF	Convective weather program, CoSPA, and model development and enhancement testing
2/24/2010	Human Factors		DTFAWA-09-A-80018_MOD 05	NASA - Langley	Synthetic vision systems
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005	NASA	NextGen human factors air traffic control research under MOU (FNA/11): This IA establishes roles and responsibilities for the FAA and NASA to collaboratively 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.
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 01	NASA - Ames	Navigation reference system NextGen HF
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 02	NASA - Ames	Automation roles and responsibilities
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 04	NASA - Ames	Evaluating human-automation interaction
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 05	NASA - Ames	Closely Spaced Parallel Operations
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 06	NASA - Ames	Pilot/ATC/AOC communication and coordination
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 07	NASA - Ames	Closely Spaced Parallel Operations in NextGen
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 08	NASA - Ames	Shared information needs for collaboration and decision making
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 09	NASA - Ames	Decision making capabilities and limitations

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
1/27/2010	Human Factors	Tom McCloy	DTFAWA-10-X-80005_Basic_Annex 10	NASA - Ames	Evaluation of flight crew awareness
1/7/2010	Human Factors		DTFAWA-09-A-80018_MOD 03	NASA - Langley	Collision avoidance and separation assurance systems for merging and spacing operations
11/30/2009	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 04	NOAA - NSSL	Advanced weather radar technology and model development research team
11/17/2009	ATM/ATC	Charles Buntin	DTFAWA-08-X-80031_MOD 05	NASA - Ames	3D-Path Arrival Management (3D-PAM)
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 02	NASA - Ames	Operator effects on decision making
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 03	NASA - Ames	Electronic Flight Bag
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 05	NASA - Ames	Vision model to predict target detection
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 06	NASA - Ames	Very light jet simulator study
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 08	NASA - Ames	FMS data entry errors
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 09	NASA - Ames	Guidance for heads up display (HUD)
10/14/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80023_MOD 01_Task 10	NASA - Ames	Human performance issues

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
9/22/2009	Flight Safety	John Frye	DTFAWA-09-X-80016	NASA	Aviation Safety Reporting System (ASRS) under MOU (FNA/11): 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.
9/15/2009	Human Factors	Dino Piccione	DTFAWA-08-X-80011_MOD 15	NASA - Ames	NextGen evaluation of controller schedule changes
9/15/2009	Human Factors	Dino Piccione	DTFAWA-08-X-80011_MOD 15 (2)	NASA - Ames	NextGen workstation design requirements
9/14/2009	Airport Technology Capacity	Albert Larkin	DTFACT-09-X-00005	ARMY - ERDC	
9/1/2009	Human Factors	Tom McCloy	DTFAWA-08-X-80011_MOD 16	NASA - Ames	NextGen Air Ground Integration
8/17/2009	Weather	Warren Fellner	DTFAWA-09-X-80005	NSF	Conduct applied aviation weather research to improve safety, efficiency, and capacity of the NAS. Detect, diagnose, and forecast weather phenomena using instrumentation, advanced models, and algorithms.
8/17/2009	Weather	Guillermo Sotelo	DTFAWA-09-X-80005_MOD 01	NSF	CoSPA, NextGen network enabled weather transition team, convective weather research team
8/12/2009	CSPO	Jason Coon	IA1-973	NASA - Langley	SAPA tool
8/11/2009	Airport Technology Safety	Joseph Breen	DTFACT-09-X-00006	USAF - 780th TS	Improve airport safety
6/12/2009	Human Factors	William Johnson	DTFAWA-09-A-80018	NASA	Enhancement of aeronautical research and technology development under MOU (FNA/11): This IA provides a framework under which NASA and the FAA can collaborate in aeronautics research and technology.
6/12/2009	Human Factors		DTFAWA-09-A-80018_Basic	NASA - Langley	Enhancement of aeronautical RTD
5/20/2009	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 05	NOAA - NSSL	Advanced weather radar technology and model development research team
5/18/2009	Weather	Midori Tanino	DTFAWA-08-X-80031_MOD 01	NASA - Ames	Analysis of SFO stratus weather information

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
3/20/2009	Surveillance Systems		DTFAWA-09-X-00018_Basic	NASA - Langley	ADS-B merging and spacing
3/12/2009	Weather	Warren Fellner	DTFAWA-08-Z-80001_MOD 03	NOAA - NCEP	RUC, WRF infrastructure support, RR development, ensemble development, and development of dissemination techniques for aviation weather information
2/26/2009	Weather	Warren Fellner	DTFAWA-08-Z-80001_MOD 02	NOAA - NCEP	Ashflow research team, convective weather research team, in-flight research team, model development and enhancement research
1/26/2009	Airport Technology Safety	Ryan King	DTFACT-09-X-00001	USDA	Animal and Plant Health Inspection Service (APHIS)
10/20/2008	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 02	NOAA - NSSL	Model development and enhancement
10/17/2008	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 03	NOAA - NSSL	Advanced weather radar technology and model development research team
10/1/2008	Airport Technology Safety	Satish Agrawal	DTFACT-08-X-00003	DOI - Smithsonian Inst., NMNH	Defines an R&D program in DNA-based bird identification techniques in cooperation with the National Museum of Natural History (NMNH) and the Smithsonian Institution (SI)
9/30/2008	Human Factors	Cynthia Morris	DTFAWA-08-X-80031_Basic	NASA - Ames	Multi Sector Planner (MSP)
9/10/2008	Weather	Warren Fellner	DTFAWA-08-Z-80001_MOD 01	NOAA - NCEP	Model development and enhancement and Weather Tech implementation
8/28/2008	Weather	Warren Fellner	DTFAWA-08-Z-80001	NOAA - NCEP	Conduct collaborative research activities to develop, test, evaluate, and implement results that provide analyses and forecast products, algorithms, and visualization techniques tailored to aviation weather needs. Improve operational forecasting of weather conditions hazardous to aviation.
8/28/2008	Weather	Warren Fellner	DTFAWA-08-Z-80001_MOD 08	NOAA - NCEP	Infrastructure support for running of models (RUC, WRF/RR); develop test and implement improvements to WRF/RR; develop improvements to data assimilation
8/12/2008	Unmanned Aircraft Systems Research	Xiaogong Lee	DTFACT-08-X-00005	NASA	P-STAR Radar Systems under MOU (FNA/11): This IA establishes collaborative research activities on manned and UAS, and in particular, on utilization of ground based radar systems to support the FAA UAS safety studies.
7/15/2008	Weather	Cyndi Flournoy	DTFACT-08-X-00006	USGS	Monitor volcanic seismic networks and continue real-time seismic monitoring on dangerous volcanoes in the Aleutian arc for air traffic safety.

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
7/9/2008	Aircraft Icing	James Riley	DTFACT-08-X-00007	NASA	Characterization of High Ice-Water Content Environments under MOU (FNA/11): 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.
7/7/2008	Continued Airworthiness	Felix Abali	DTFACT-08-X-00004	NASA	Software enhancement, standardization and material database generation for damage tolerance analysis under MOU (FNA/11): This IA establishes a cooperative procedure to enhance the NASA crack growth program software and generate material database for damage tolerance analysis.
6/27/2008	Weather	Warren Fellner	DTFAWA-08-Z-80002_MOD 01	NOAA - NSSL	Model Development and Enhancement Research Team (MDERT)
6/4/2008	Data Communication		DTFAWA-08-X-00009_MOD 01	NASA - Langley	Glenn, IETF study
4/14/2008	ATM/ATC	Charles Buntin	DTFAWA-08-X-80011_Basic (2)	NASA - Ames	3D-Path Arrival Management (3D-PAM)
3/24/2008	Weather	Jackie Hill	DTFAWA-08-X-80008	NOAA - ESRL/GSD	NNEW dissemination
9/21/2007	NextGen - Wake Turbulence	Jeff Tittsworth	DTFAWA-07-X-80026	NASA	Wake turbulence and associated reduced separation research under MOU (FNA/11): 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.
9/21/2007	ATM/ATC		DTFAWA-07-X-80026_Basic	NASA - Langley	Wake turbulence
9/21/2007	ATM/ATC		DTFAWA-07-X-80026_MOD 01	NASA - Langley	Transition of wake vortex research to products in support of NGATS
3/13/2007	Weather	Cyndi Flournoy	DTFACT-07-X-00002_MOD 08	NSF	Liquid water equivalent research team
3/13/2007	Weather	Cyndi Flournoy	DTFACT-07-X-00002_MOD 10	NSF	Snow machine research
3/13/2007	Weather	Cyndi Flournoy	DTFACT-07-X-00002_MOD 19	NSF	Terminal Area Icing Weather Information System (TAIWIS) product development team

Active Interagency Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
1/10/2007	Aircraft Icing	James Riley	DTFACT-07-X-00002	NSF	Ground deicing/anti-icing program: This IA fosters technical participation with and financial support for National Center for Atmospheric Research (NCAR) on ground icing research.
8/1/2006	Continued Airworthiness	Traci Stadtmueller	SAA3-872	NASA - Glenn	Maintenance credit evaluation
6/27/2006	Airport Technology Safety	Keith Bagot	DTFACT-06-X-00007	AFRL	Establish a mechanism for the conduct of research and exploratory development efforts in aircraft and firefighting.
6/27/2005	Human Factors	Charles Johnson	DTFACT-05-X-00011	DoD	Flight deck illumination by unauthorized lasers: This IA evaluates laser eye protection during human-in-the-loop simulation studies; develops database models to enhance airmen training; and develops and evaluates procedures for flight crew awareness and recovery action.
	Human Factors	Sabrina Saunders-Hodge	DTFAWA-10-A-80033	AFRL - WPAFB	Aeronautical research and technology development

1.4 Interagency Committees

The FAA creates partnerships with other agencies through a variety of interagency 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 on the needs for future aviation noise abatement and new research efforts. The committee conducts annual public forums in different geographic regions 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 technical assistance or an R&D relationship between the FAA and the foreign entity. 49 U.S.C. § 40113(e) authorizes the FAA to establish International Agreements. Table B.4 presents the active international agreements in FY 2011.

Table B.4 - Active International Agreements in FY 2011

Active International Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
12/9/2011	Aircraft Icing	Jim Riley	NAT-I-8417	National Resources Council of Canada	Aircraft and Propulsion System Icing Research (Annex 1 to MOC): This agreement forms cooperative research on simulation of ice crystal environments for the investigation of effects of such environments on engines.
7/1/2011	System Safety Management	John Lapointe	AIA/CA-52 Annex 8	CAA - Netherlands	Aviation System Safety
10/1/2010	Unmanned Aircraft Systems Research	Xiaogong Lee	AIA/CA-52 Annex 8 Appendix 6 (2)	CAA - Netherlands	Unmanned Aircraft Systems
8/1/2010	System Safety Management	John Lapointe	AIA/CA-52 Annex 8 Appendix 9 (2)	CAA - Netherlands	Unified framework for risk assessment and risk management
9/1/2009	System Safety Management	Stephen Barnes	AIA/CA-52 Annex 8 Appendix 8	CAA - Netherlands	Pilot model development for collision risk modeling studies
6/19/2007	Airport Technology Capacity	Albert Larkin	AIA/CA-5 Annex 16	La Direction Generale de L'Aviation Civile (DGAC)	Coordination of R&D activities and the sharing of information resulting from related studies, tests, and analyses in the field of airfield pavement
9/24/2004	Wake Vortex Research	Paul Fontaine	MOC NAT-I-3454-1	EUROCONTROL	Air Traffic Management Research: Collaborate and share experiences on various ATM research topics that are of interest to both the U.S. and Europe.
9/24/2004	Environmental Modeling for ATM and Safety Management Techniques	Lourdes Maurice	NAT-I-3454-5	EUROCONTROL	Harmonizing Safety and Environmental Factors (Annex to MOC): Collaborate on and share methods for evaluating safety management, ATM security, and ATM environmental factors.
9/1/2004	System Safety Management	Andrew Cheng	AIA/CA-52 Annex 8 Appendix 4 (Amendment 2 approved 08/2009)	CAA - Netherlands	Landing Distance Performance Analysis
8/1/2004	System Safety Management	Cristina Tan	AIA/CA-52 Annex 8 Appendix 5	CAA - Netherlands	Risk Assessments of Potential Unsafe Conditions
4/2/2004	Fire Safety	Gus Sarkos	AIA/CA-41 Annex 3 Appendix 7	CAA – United Kingdom	Establish a method of cooperation in performing research to improve passenger survivability during aircraft emergencies or accidents involving fire.

Active International Agreements in FY 2011					
Effective Date	**FAA R&D Program**	**FAA POC**	**Agreement Number**	**Partner**	**Purpose of Agreement**
7/10/2001	System Safety Management	John Lapointe	MOC AIA/CA-52	CAA - Netherlands	Aviation System Safety: 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.
6/18/1970	Aircraft Icing	Warren Underwood	MOC NAT-I-0831 PA-17	Transport Canada	Deicing and Anti-Icing Research: 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.

2.0 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 2011, the FAA maintained 31 active CRDAs. Table B.5 provides details on the active CRDAs in FY 2011.

Table B.5 - Active Cooperative Research and Development Agreements in FY 2011

Active Cooperative Research and Development Agreements in FY 2011					
Award Date	**FAA R&D Program**	**FAA POC**	**CRDA Number**	**Industry Partner**	**Subject**
5/12/2011	Airport Technology	Albert Larkin	10-CRDA-0271	Northeastern University	Research the feasibility of measuring surface and subsurface runway conditions from a moving vehicle using remote sensing technology.
10/12/2010	Airport Technology		10-CRDA-0270	Norsk Glassgjenvinning AS	

Active Cooperative Research and Development Agreements in FY 2011					
Award Date	**FAA R&D Program**	**FAA POC**	**CRDA Number**	**Industry Partner**	**Subject**
8/10/2010	Airport and Aircraft Safety	Nelson Miller	2010-A-0269	RFID TagSource LLC Camden, NJ	Research that will support the improvement of flight safety operations by storing maintenance history information directly on aircraft parts by using radio frequency identification (RFID) technologies
5/13/2010	Unmanned Aircraft Systems Research	Xiaogong Lee	10-CRDA-0266	Insitu, Inc., The Boeing Company	UAS safety research, modeling, and simulation
7/15/2009	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 UAS
6/26/2009	Unmanned Aircraft Systems Research	Kerin Olson	2009-A-0259	AAI Corporation Hunt Valley, MD	Modeling and simulation to assess the impact of UAS
6/19/2009	Unmanned Aircraft Systems Research	Kerin Olson	2009-A-0260	GE Aviation Systems LLC Grand Rapids, MI	Modeling and simulation to assess the impact of UAS
1/27/2009	Laboratory Future Development	Joseph DiLuzio	2009-A-0257	Diakon Solutions, LLC Cape May Court House, NJ	Aircraft geometric height measurement element
1/6/2009	Human Factors	Ben Williams	2008-A-0252	The Richard Stockton College of New Jersey Pomona, NJ	Index of cognitive activity and characteristics of the air traffic control task
12/10/2008	Laboratory Future Development	Joseph DiLuzio	2008-A-0251	Diakon Solutions LLC Cape May Court House, NJ	Advancement and commercialization of the Sun Keyboard System Translator
10/23/2008	Weather	Thomas Ryan	2008-A-0255	Center for Network Centric Product Support Research LLC East Hartford, CT	Network centric airborne microserver
8/5/2008	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
2/19/2008	Unmanned Aircraft Systems Research	James Sizemore	2008-A-0245	New Mexico State University Las Cruces, NM	UAS research
10/30/2007	Continued Airworthiness	John Bakuckas	2007-A-0236	The Boeing Company Huntington Beach, CA	Composite repair of aircraft structures

Active Cooperative Research and Development Agreements in FY 2011					
Award Date	**FAA R&D Program**	**FAA POC**	**CRDA Number**	**Industry Partner**	**Subject**
9/21/2007	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.
7/18/2007	Surveillance	Michael McNeil	2007-A-0233	CNS Aviation Vienna, VA	Flight testing for ADS-B separation standards
2/20/2007	Human Factors and Aviation Medicine	Ben Williams	2006-A-0219	Drexel University Philadelphia, PA	Air traffic controller cognitive modeling
12/13/2006	Surface Surveillance	Jeffery Livings	2006-A-0223	RVision LLC San Diego, CA	Airport Surface Surveillance
7/25/2006	Air Traffic Models and Evaluation Tools	Mike Pagilone, Ben Williams	2006-A-0216	Rowan University Glassboro, NJ	Development and improvement of a graphical user interface for the display of recorded air traffic data, predictions of this air traffic data from NAS decision support tools, and a visualization framework for radar data integrity
1/17/2006	Air Traffic Models and Evaluation Tools	Graham Elliot	2005-A-0213	Ordinate Corporation Menlo Park, CA	Machine-graded aviation English test for pilots for measuring levels of English language proficiency
7/17/2002	Capacity and Air Traffic Management Technology	Albert Rehmann	2002-A-0171	The Boeing Company McLean, VA	Development of modeling and simulation tools to assist in technology implementation of capacity enhancing capabilities for the NAS
4/5/2002	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
7/29/1996	Airport Technology Research – Capacity	Satish Agrawal	1996-A-0097	The Boeing Company Seattle, WA	Development of the National Airport Pavement Test Machine for the research on pavement design procedures to ensure compatibility between aircraft and airports throughout the world
9/7/1994	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
	Human Factors	Ben Williams	06-CRDA-0219	Drexel University	Data collected during high fidelity human in the loop simulations
	Unmanned Aircraft Systems Research	Karen Buondonno	09-CRDA-0259	AAI Corporation	Support research activities to integrate UAS into NAS

Active Cooperative Research and Development Agreements in FY 2011					
Award Date	**FAA R&D Program**	**FAA POC**	**CRDA Number**	**Industry Partner**	**Subject**
	Surveillance	Mike McNeil	07-CRDA-0233	CNS Aviation Services Corporation	Support the participation in a series of flight scenarios to obtain data supporting the analysis of separation standards, standards and rulemaking, and risk management for the evaluation of NextGen concepts and technologies.
	Unmanned Aircraft Systems Research	Karen Buondonno	09-CRDA-0258	General Atomics Aeronautical Structures	Support research activities to integrate UAS into NAS
	Unmanned Aircraft Systems Research	Karen Buondonno	09-CRDA-0260	General Electric Aviation Systems	Support research activities to integrate UAS into NAS
	Engineering Development Services	Stephen Beamer	10-CRDA-0268	United Parcel Service	Provide data of the SDSS in daily operations at the Louisville International Airport.
	Weather	Thomas Ryan	08-CRDA-0255	Center For Network Centric Product Support Research	Establish a network-centric airborne web server test capability on a WJHTC aircraft for use in NextGen NEO and SWIM tests.

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 per 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 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 Issued	**Patent Number**	**Title**	**Description**
09/22/2009	7,592,816	Localizer Cable Fault Analyzer	An analyzer that memorizes which antenna in a Localizer antenna array caused a fault
11/02/2004	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
10/29/2002	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
10/22/2002	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
10/15/2002	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
09/12/2000	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
11/09/1999	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 businesses 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.

3.0 Working with Academia

The FAA works with academia in three ways: the Joint University Program (JUP), aviation grants, and Air Transportation Centers of Excellence (COEs).

3.1 Joint University Program for Air Transportation Research

The JUP is a research partnership between the FAA and Ohio University, Massachusetts Institute of Technology, and Princeton University. The program aids in the development of a safer and more efficient air transportation system 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 gain valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit of JUP 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 are eligible 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 2011. The FAA awarded $3,657,792 in new research grants in FY 2011.

Table B.7 - FAA Research Grants Started in FY 2011

FAA Research Grants Started in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
9/14/2011	System Wide Information Management (SWIM)	Todd Gardner	2011-G-018	Quality of Service and Service Availability in Mission Critical Service Oriented Architectures - An Analysis of the FAA NextGen Swim Architecture	Curators of the University of Missouri-on behalf of UMKC	$40,000
6/31/2011	Continued Airworthiness	John Bakuckas	2011-G-004	Aluminum 2024 and Aluminum-Lithium 2198 Crack Growth Comparison Study	University of Dayton	$61,505
8/30/2011	Flightdeck Maintenance System Integration Human Factors	Dan Herschler	2011-G-017	Determination of NextGen Human Factor Issues and Recommended R&D Requirements for Single-Pilot Aircraft Operations in the NextGen Environment	Florida Institute of Technology	$98,998
8/29/2011	Joint University Program	Paul Tan	2011-G-016	FAA Joint University Program for Air Transportation Proposal for Activities by the Massachusetts Institute of Technology	Massachusetts Institute of Technology	$150,000
8/18/2011	Aircraft Catastrophic Failure Prevention Research	Don Altobelli	2011-G-015	Non-linear Finite Element Modeling and Material Model Development for Aircraft Engine Failure Analysis	The George Washington University	$353,099
8/17/2011	Airport Technology Research Program	David Brill	2011-G-014	Concrete Airfield Pavement Design Analysis	The Pennsylvania State University	$150,000
8/16/2011	Ground Based Augmentation System (GBAS)	John Warburton	2011-G-012	Personal Privacy Jammer Vehicle Modeling and Testing	Oakland University	$60,000

FAA Research Grants Started in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
8/15/2011	Propulsion and Fuel Systems	Joseph Wilson	2011-G-009	Probabilistic Integrity and Risk Assessment of Turbine Engines	Southwest Research Institute	$1,100,000
8/10/2011	Continued Airworthiness	John Bakuckas	2011-G-013	Development of a Ten Year Emerging Metallic Structures Technology (EMST) R&D Roadmap	Wichita State University	$80,000
8/9/2011	Continued Airworthiness	Michael Walz	2011-G-011	Development of Technologies to Improve the Reliability and Intelligence of Aircraft Electrical Wire and Interconnect Systems	University of Dayton	$100,000
8/8/2011	System Safety Management (Terminal Area Safety)	Andrew Cheng	2011- G-010	Analyses of Aircraft Performance Based on In-Flight Recorded Parameters	University of Louisville Research Foundation, Inc.	$180,273
7/14/2011	Airport Technology Research Program	Gordon Hayhoe	2011-G-008	Performance of Unbound Layers of a Flexible Pavement System During aircraft Loading	Rowan University	$64,545
7/14/2011	Environment and Energy	Dale Livingston	2011-G-007	Analysis, Modeling and Simulation of NextGen Trajectory-Based Operations	Rutgers, The State University of New Jersey	$144,027
7/12/2011	GPS Civil Requirements	Deane Bunce	2011-G-006	Ionospheric Research in Support of Next Generation Satellite Based Augmentation Systems	Trustees of Boston College	$265,000
6/7/2011	Aircraft Catastrophic Failure Prevention Research	Don Altobelli	2011-G-003	Characterization of Aircraft Materials for Dynamic Impact Loading Applications	The Ohio State University	$300,000
6/2/2011	Aeromedical Research	G A McLean	2011-G-005	Development and Validation of Computer Simulations for Aircraft Emergency Evacuation	Rutgers, The State University of New Jersey	$75,362
3/25/2011	Aircraft Catastrophic Failure Prevention Research	Don Altobelli	2011-G-002	Non-Linear Finite Element Modeling Guidelines for Aerospace Impact Applications	Central Connecticut State University	$141,869
3/7/2011	System Safety Management (Terminal Area Safety)	Andrew Cheng	2011-G-001	Study of Aircraft Performance in Slippery Runway Conditions	Embry-Riddle Aeronautical University	$293,114
Total of awards originating in FY 2011:						$3,657,792

3.3 Air Transportation Centers of Excellence

For the past decade, the Air Transportation Centers of Excellence have represented a major commitment by the FAA to support multi-year and multi-million dollar research that ensures coordination and innovation. These investments result in significant advancements in aviation science and technologies and technology transfer. Since the inception of the COE program, the FAA has competitively established nine COEs with more than 60 university partners and over 200 industry and government affiliates. Through long-term cooperative agreements, partnerships are formed that produce research in specific areas of aviation considered critical to the mission of the FAA. COEs also help develop the nation's technology base by supporting the next generation of engineers and scientists.

The agreements require the universities to match FAA grants dollar for dollar, thereby encouraging collaboration 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. This long-term commitment encourages each COE to become a self-sufficient national aviation resource.

The COE for Aviation Operational Research (NEXTOR) currently serves as a self-sufficient resource for the aviation community. The FAA is actively sponsoring six centers with academic institutions throughout the United States:

- 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

COE for Commercial Space Transportation

On August 18, 2010, the Secretary of Transportation announced the selection of the new COE for Commercial Space Transportation. The R&D efforts of the COE 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 serves as the administrative lead with nine other university members, including Florida Institute of Technology, Florida State University, New Mexico Institute of Mining and Technology, Stanford University, University of Central Florida, University of Colorado at Boulder, University of Florida, and University of Texas Medical Branch at Galveston. For additional information, see: http://www.coe-cst.org/.

Table B.8 - Grants Awarded in FY 2011 to the COE for Commercial Space Transportation

COE for Commercial Space Transportation Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
9/9/2011	Commercial Space Transportation Safety	Nick Demidovich	10-C-CST-UFL-005	High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles	University of Florida	$60,000
9/9/2011	Commercial Space Transportation Safety	Nick Demidovich	10-C-CST-FSU-007	Autonomous Rendezvous and Docking for Space Debris Mitigation	Florida State University	$45,000
9/9/2011	Commercial Space Transportation Safety	Ken Davidian	10-C-CST-FSU-008	Technical Oversight and Integration	Florida State University	$50,000
9/6/2011	Commercial Space Transportation Safety	Megan Mitchell	10-C-CST-SU-12	Unified 4D Trajectory Approach for Integrated Management of Commercial Air and Space Traffic	Stanford University	$50,000
9/6/2011	Commercial Space Transportation Safety	Megan Mitchell	10-C-CST-SU-13	Mitigate Threats through Space Environment Modeling/Prediction Including Micrometeoroid and Orbital Debris (MMOD)	Stanford University	$50,000
9/6/2011	Commercial Space Transportation Safety	Nick Demidovich	10-C-CST-SU-14	Autonomous Rendezvous and Docking for Space Debris Mitigation	Stanford University	$40,000
9/6/2011	Commercial Space Transportation Safety	Doug Graham	10-C-CST-UTMB-12	Flight Crew Medical Standards and Passenger Acceptance Criteria	University of Texas Medical Branch at Galveston	$35,000
9/1/2011	Commercial Space Transportation Safety	Nick Demidovich	10-C-CST-FSU-6	High Temperature, Optical Sapphire Pressure Sensors for Hypersonic Vehicles	Florida State University	$30,000
8/31/2011	Commercial Space Transportation Safety	Megan Mitchell	10-C-CST-CU-11	Development of Masters Level Commercial Launch, On-orbit, and Re-entry Operations Instruction Criteria	University of Colorado at Boulder	$50,000
8/31/2011	Commercial Space Transportation Safety	Ken Davidian	10-C-CST-UCF-4	Technical Oversight for UCF	University of Central Florida	$10,000
8/31/2011	Commercial Space Transportation Safety	Julie Price	10-C-CST-CU-10	Space Situational Awareness Improvements to Enable Safe Commercial Space Operations and Traffic Management	University of Colorado at Boulder	$80,000
					Total awarded in FY 2011:	$500,000

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. The core university team includes Auburn University, Boise State University, Harvard University, Kansas State University, Purdue University, and the University of Medicine and Dentistry of New Jersey. RITE generated close to $1.5M in matching contributions in FY 2011. For additional information, see: http://www.acer-coe.org/.

Table B.9 - Grants Awarded in FY 2011 to the COE for Research in the Intermodal Transport Environment

COE for Research in the Intermodal Transport Environment Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
6/16/2011	Aeromedical Research	Jean Watson	10-C-RITE-AU-002	Research in the Intermodal Transport Environment (RITE)-Sensors and Prognostics to Mitigate Bleed Air Contamination Events	Auburn University	$384,683
6/16/2011	Aeromedical Research	Jean Watson	10-C-RITE-PU-001	Developing a Risk Paradigm for Pesticides and VOC's from Ozone Reactions in Aircrafts	Purdue University	$159,995
6/16/2011	Aeromedical Research	Jean Watson	10-C-RITE-BSU-001	Sensors and Prognostics to Mitigate Bleed Air Contamination Events	Boise State University	$135,965
6/16/2011	Aeromedical Research	Jean Watson	10-C-RITE-KSU-002	Sensors and Prognostics to Mitigate Bleed Air Contamination Events	Kansas State University	$105,333
5/27/2011	Aeromedical Research	Jean Watson	10-C-RITE-HU-001	Exposure to Flame Retardants in Commercial Aircraft	Harvard University	$302,071
5/27/2011	Aeromedical Research	Jean Watson	10-C-RITE-KSU-001	Application of Hazard Analysis and Critical Control Points (HACCP) Methods to Disease Transmission on Fomites in Aircraft	Kansas State University	$76,174
5/27/2011	Aeromedical Research	Jean Watson	10-C-RITE-AU-001	Hazard Analysis and Critical Control Points Methods Applied to Disease Transmission	Auburn University	$217,362
10/18/2010	Aeromedical Research	Jean Watson	07-C-RITE-AU-006	Sensors and Prognostics to Mitigate Bleed Air Contamination Events	Auburn University	$100,000
					Total awarded in FY 2011	$1,481,584

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. Wichita State University was designated as a Center of Excellence for Composites and Advanced Materials (CECAM) and the University of Washington was designated as a center for Advanced Materials in Transport Aircraft Structures (AMTAS). JAMS conducts R&D on material standardization and shared databases, bonded joints, structural substantiation, damage tolerance and durability, maintenance practices, advanced material forms and processes, cabin safety, life management of materials, and nanotechnology for composite structures. The FAA expects this COE to become self-sufficient by FY 2013. Members of CECAM include Northwestern University, Purdue University, Tuskegee University, University of California at Los Angeles, and University of Delaware. AMTAS members include Washington State University, Oregon State University, and Edmonds Community College. JAMS generated matching contributions close to $2M in FY 2011. For additional information, see http://www.jams-coe.org/.

Table B.10 - Grants Awarded in FY 2011 to the Joint COE in Advanced Materials

Joint COE in Advanced Materials Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
8/10/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-UU-009	Damage Tolerance Test Method Development for Sandwich Composites	University of Utah	$100,000
8/10/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-UU-008	Durability of Adhesively Bonded Joints for Aircraft Structures	University of Utah	$75,000
8/10/2011	Advanced Materials/ Structural Safety	David Westlund	07-C-AM-FIU-006	Effect of Surface Contamination on Composite Bond Integrity and Durability	Florida International University	$75,000
8/9/2011	Advanced Materials/ Structural Safety	Lynn Pham	08-C-AM-WISU-026	Damage Tolerance Testing and Analysis Protocols for Full-Scale Composite Airframe Structures under Repeated Loading	Wichita State University	$250,000
8/9/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-WISU-024	Development of Dynamic Mechanical Analyzer (DMA) Calibration and Testing Procedures	Wichita State University	$200,000
8/9/2011	Advanced Materials/ Structural Safety	Lynn Pham	08-C-AM-WISU-023	Effect of CACRC Depot Repairs on Composite Airframe Structures	Wichita State University	$125,000
8/9/2011	Advanced Materials/ Structural Safety	Lynn Pham	08-C-AM-UW-019	Certification of Discontinuous Composite Material Forms for Aircraft Structures	University of Washington	$99,999
8/9/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-UW-021	Compliance Methodology with FAA Requirements for Crashworthiness of Composite-Intensive Aircraft Structures	University of Washington	$99,984

Joint COE in Advanced Materials Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
8/9/2011	Advanced Materials/ Structural Safety	Curtis Davies	08-C-AM-WISU-025	Administration of the Center of Excellence for Composites and Advanced Materials (CECAM) at Wichita State University	Wichita State University	$75,000
8/9/2011	Advanced Materials/ Structural Safety	Lynn Pham	08-C-AM-OSU-004	Failure of Notched Laminates Under Out-of-plane Bending	Oregon State University	$75,000
8/9/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-UW-020	Improving Adhesive Bonding of Composite through Surface Characterization	University of Washington	$75,000
8/9/2011	Advanced Materials/ Structural Safety	Curtis Davies	08-C-AM-UW-018	Administration of the FAA Center on Advanced Materials in Transport Aircraft Structures (AMTAS)	University of Washington	$74,835
7/11/2011	Advanced Materials/ Structural Safety	David Westlund	08-C-AM-UU-007	Development and Evaluation of Fracture Mechanics Test Methods for Sandwich Composites	University of Utah	$62,790
6/27/2011	Advanced Materials/ Structural Safety	Allan Abramowitz	08-C-AM-WISU-022	Certification by Analysis-Structural Crashworthiness	Wichita State University	$153,000
6/21/2011	Advanced Materials/ Structural Safety	Curtis Davies	08-C-AM-WISU-021	Composites Materials Handbook	Wichita State University	$125,000
6/9/2011	Advanced Materials/ Structural Safety	Allan Abramowitz	08-C-AM-WISU-027	Development and Safety Management of Composite Certification Guidance	Wichita State University	$127,500
6/9/2011	Advanced Materials/ Structural Safety	Curtis Davies	08-C-AM-WISU-020	Development and Safety Management of Composite Certification Guidance	Wichita State University	$109,300
1/24/2011	Advanced Materials/ Structural Safety	Curtis Davies	08-C-AM-WISU-018	Composite Structural Engineering Safety Awareness	Wichita State University	$87,731
					Total awarded in FY 2011	$1,990,139

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. Universities that collaborate with PARTNER include Boston University, Georgia Institute of Technology, Harvard University, Massachusetts Institute of Technology, Pennsylvania State University, Purdue University, Stanford University, University of Illinois at Urbana - Champaign, Missouri University of Science and Technology, University of North Carolina, University of Pennsylvania, and York University. PARTNER generated matching contributions in excess of $4.5M in FY 2011. For additional information, see http://www.partner.aero/.

Table B.11 - Grants Awarded in FY 2011 to the COE Partnership for AiR Transportation Noise and Emissions Reduction

COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
9/2/2011	Environment and Energy	Laurette Fisher	09-C-NE-UPENN-002	Noise Exposure Response- Sleep Disturbance	Pennsylvania State University	$30,000
9/1/2011	Environment and Energy	Pat Moran	09-C-NE-MIT-014	Low Power/Low Drag Approaches to Mitigate Environmental Impacts of Aviation	Massachusetts Institute of Technology	$40,000
8/31/2011	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	Carl Ma	10-C-NE-MST-005	Aerospace Recommended Practice Measurement Protocol Demonstration	Missouri University of Science and Technology	$250,000
8/17/2011	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	Warren Gillette	09-C-NE-MIT-013	Alternative Jet Fuels DLA Energy Analysis	Massachusetts Institute of Technology	$300,000
8/17/2011	Environment and Energy	Laurette Fisher	09-C-NE-PU-013	Human Response - Sleep Disturbance	Purdue University	$5,000
8/17/2011	COE Management	Mohan Gupta	09-C-NE-MIT-012	Program Management for Aircraft Noise and Aviation Emissions Mitigation COE	Massachusetts Institute of Technology	$271,160
7/22/2011	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction	Warren Gillette	09-C-NE-MIT-009	Environmental Cost-Benefit Analysis of Alternative Jet Fuels	Massachusetts Institute of Technology	$150,000
7/11/2011	Environment and Energy	Rangasayi Halthore	10-C-NE-SU-003	Studying the Effects of Aircraft Exhaust on Global and Regional Climate	Stanford University	$150,000

COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
7/8/2011	Environment and Energy	Rangasayi Halthore	10-C-NE-UI-003	Development and Evaluation of Climate Metrics for Aviation Based on Climate-Chemistry Modeling Analyses	University of Illinois at Urbana - Champaign	$150,000
7/8/2011	Environment and Energy	Natalia Sizov	09-C-NE-HU-004	Health Effects of Aviation-Related Noise in the Elderly	Harvard University	$40,000
7/8/2011	Environment and Energy	Laurette Fisher	09-C-NE-PSU-009	Sonic Boom Metrics	Pennsylvania State University	$70,000
7/8/2011	Environment and Energy	Natalia Sizov	10-C-NE-BU-002	Health Effects of Aviation-Related Noise in the Elderly	Boston University	$50,000
7/8/2011	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	Carl Ma	10-C-NE-MST-004	In-depth Analysis of the E-31 AAFEX II	Missouri University of Science and Technology	$50,000
6/29/2011	Environment and Energy	Christopher Sequira	10-C-NE-BU-001	Health Impacts of Aviation-Related Air Pollutants	Boston University	$120,000
6/28/2011	Environment and Energy	Hua He	09-C-NE-GIT-022	Prediction of Far-Field Source Noise from En-Route Commercial Aircraft	Georgia Institute of Technology	$30,000
6/27/2011	Environment and Energy	Laurette Fisher	09-C-NE-PSU-006	Outreach	Pennsylvania State University	$50,000
6/27/2011	Environment and Energy	Bill Hua	09-C-NE-PU-010	Propagation of noise from en-route aircraft	Purdue University	$20,000
6/27/2011	Environment and Energy	Bill Hua	09-C-NE-PSU-008	Source Emission and Propagation	Pennsylvania State University	$30,324
6/27/2011	Environment and Energy	Christopher Sequeira	09-C-NE-UNC-002	Extension of Subgrid Scale Treatment of Aircraft Emissions in Air Quality Models to Include Organics and Volatile PM	University of North Carolina	$169,996
6/27/2011	Environment and Energy	Laurette Fisher	10-C-NE-UPENN-001	Noise Exposure Response- Sleep Disturbance	University of Pennsylvania	$75,000
6/27/2011	Environment and Energy	Bill Hua	09-C-NE-PSU-007	Evaluation of the Impact of Whole-House Construction on Aircraft Noise Perception	Pennsylvania State University	$20,000

COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
6/27/2011	COE Management	Mohan Gupta	09-C-NE-MIT-008	Program Management for Aircraft Noise and Aviation Emissions	Massachusetts Institute of Technology	$153,840
6/27/2011	Environment and Energy	Mehmet Marsan	09-C-NE-PU-009	Noise Exposure Response - Annoyance	Purdue University	$110,000
6/27/2011	Environment and Energy	Laszlo Windhoffer	09-C-NE-GIT-021	Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring	Georgia Institute of Technology	$250,000
6/27/2011	Environment and Energy	Bill He	09-C-NE-GIT-020	Sound Transmission Indoors Study of Whole Houses	Georgia Institute of Technology	$50,000
6/27/2011	Environment and Energy	Laurette Fisher	09-C-NE-PU-011	Human Response - Sleep Disturbance	Purdue University	$70,000
6/10/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Rhett Jefferies	09-C-NE-GIT-018	EDS Assessment of CLEEN Technology	Georgia Institute of Technology	$450,000
6/10/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Joe DiPardo	09-C-NE-GIT-017	EDS Development and Application	Georgia Institute of Technology	$750,000
6/10/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Thomas Cuddy	09-C-NE-MIT-007	Understanding the Relationship between Aviation Economics and the Broader Economy	Massachusetts Institute of Technology	$50,000
4/27/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Laszlo Windhoffer	09-C-NE-GIT-016	Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring from a NAS Perspective	Georgia Institute of Technology	$163,000

COE Partnership for AiR Transportation Noise and Emissions Reduction Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
4/4/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Laszlo Windhoffer	09-C-NE-GIT-015	Assessment of CO2 Emission Metrics for Commercial Aircraft Certification and Fleet Performance Monitoring from a NAS Perspective	Georgia Institute of Technology	$150,000
4/1/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Pat Moran	09-C-NE-SU-002	System-Level Implications of Changes in Future Aircraft Mission Specifications	Stanford University	$120,261
3/2/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Pat Moran	09-C-NE-MIT-005	System Level Implications of Changes in Future Aircraft Mission Specifications	Massachusetts Institute of Technology	$99,787
2/28/2011	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction	Pat Moran	09-C-NE-GIT-012	System Level Implications of Changes in Future Aircraft Mission Specifications	Georgia Institute of Technology	$100,000
					Total awarded in FY 2011:	$4,588,368

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 CGAR to become self-sufficient by 2013. Members include Wichita State University, University of North Dakota, and the University of Alaska. CGAR generated matching contributions in excess of $375K in FY 2011. For additional information, see http://www.cgar.org/.

Table B.12 - Grants Awarded in FY 2011 to the COE for General Aviation Research

COE for General Aviation Research Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
8/9/2011	COE Management	Pete Sparacino	01-C-ERAU-1P	Year Eleven, Management and Administrative Support - General Aviation Center of Excellence	Embry-Riddle Aeronautical University	$170,994
4/15/2011	NextGen - Weather Technology-in-the-Cockpit	Ian Johnson	07-C-GA-UAA-012	Weather in the Cockpit (WITC)- Concept of Operations	University of Alaska	$10,000
11/29/2010	System Safety Management	Michael Vu	07-C-GA-UND-017	General Aviation System Safety Management Research	University of North Dakota	$54,296
11/29/2010	System Safety Management	Michael Vu	07-C-GA-UAA-011	General Aviation System Safety Management Research	University of Alaska	$8,000
11/29/2010	System Safety Management	Michael Vu	07-C-GA-ERAU-031	General Aviation System Safety Management Research	Embry-Riddle Aeronautical University	$134,542
					Total awarded in FY 2011:	$377,832

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. 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). The FAA expects this COE to become self-sufficient in 2012. Other university members include Embry-Riddle Aeronautical University and North Carolina A&T State University. CEAT generated matching contributions in excess of $2.2M during FY 2011. For further information, see http://www.ceat.uiuc.edu/.

Table B.13 - Grants Awarded in FY 2011 to the COE for Airport Technology

COE for Airport Technology Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
6/13/2011	Airport Technology Research Program	Ryan King	05-C-AT-UIUC-032	Proposal for Wildlife Hazard and Safety Technology Research	UIUC	$280,233
6/13/2011	Airport Technology Research Program	Ryan King	05-C-AT-UIUC-031	Support of Avian Radar Performance Assessments at Various Airports	UIUC	$967,701
6/13/2011	Airport Technology Research Program	Robert Bassey	05-C-AT-UIUC-034	Low Cost Surveillance System Program Support	UIUC	$595,428
6/13/2011	Airport Technology Research Program	James Patterson	05-C-AT-UIUC-033	CEAT FOD Program Support	UIUC	$299,506

COE for Airport Technology Awards in FY 2011						
Award Date	**FAA R&D Program**	**FAA POC**	**Grant Number**	**Grant Title**	**Recipient Institution**	**Award Amount**
4/1/2011	Airport Technology Research Program	David Brill	05-C-AT-UIUC-030	Center of Excellence for Airport Technology (CEAT) Graduate Student Support	UIUC	$157,000
Total awarded in FY 2011:						$2,299,868

Appendix C: Research, Engineering and Development Advisory Committee

Table of Contents

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 2010, the Committee provided guidance for planning the fiscal year (FY) 2013 R&D portfolio. During the spring of 2011, the committee reviewed and provided recommendations on the proposed FY 2013 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 2011, including FAA responses to the following reports:

1. *REDAC Guidance for the FY 2013 R&D Portfolio*, October 14, 2010

2. *REDAC Recommendations on the FY 2013 R&D Portfolio*, June 8, 2011

In FY 2012, FAA expects to receive the Committee's recommendations on FAA's planned research and development investments for FY 2014, including detailed recommendations from the standing subcommittees.

1.0 *REDAC Guidance for the FY 2013 R&D Portfolio* (October 14, 2010)

The Committee Chairman, Dr. John Hansman, submitted the REDAC's guidance for planning the FY 2013 R&D portfolio to the Administrator on October 14, 2010. The FAA provided responses to the recommendations on February 17, 2011.

1.1 General Observations

<u>Complexity of NextGen Research and Development Plans</u>: The REDAC is concerned that there does not appear to be a clear high level Research and Development plan for NextGen that articulates the critical NextGen needs and links them to the R&D portfolio. The REDAC understands the challenge of defining such a plan for a complex system such as NextGen. However, the plans and roadmaps that have been presented to the REDAC do not articulate a high level vision and are so detailed and complex that they are intractable. This makes it difficult to evaluate if the necessary R&D is being accomplished and how R&D results will be used. The REDAC recommends that a high level R&D plan be developed from the existing more detailed plans and enterprise architecture to articulate the R&D vision and identify the critical path of R&D for NextGen.

<u>FAA Response</u>: We agree that improvements are necessary in the way Next Generation Air Transportation System (NextGen)-related research is communicated to the REDAC so that we can convey the critical aspects of the R,E&D portfolio to the REDAC without requiring them to do in depth analysis. To date, the focus of the NextGen Integration and Implementation (I&I) Office has been on mid-term implementation. The Office of Research and Technology Development (AJP-6) and the NextGen I&I Office will work together to identify the best approach to articulate the NextGen research and development activities using the plans and roadmaps that have been developed.

<u>Concern on Level of Technical Expertise in Key Areas</u>: As noted in prior recommendations 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 REDAC is further concerned that the mechanisms identified to address this issue which accompanied your letter of 16 September, 2010 only discuss the process for developing research needs and do not address any plans for attracting talent to the FAA or increasing the level of technical expertise of existing personnel in key technical areas. The REDAC recommends that a strategy be developed and executed to improve the ability of the FAA to compete in the market for highly desirable talent.

<u>FAA Response</u>: 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 and environmental and energy concerns. As noted, our previous response addressed the processes for developing research needs and the core capabilities to address those needs. We regret that we did not fully address your previous recommendation. We will describe our plans for attracting talent to the FAA and plans for increasing the level of technical expertise of existing personnel in key technical areas.

We have made some gains in attracting talent to the FAA. In the past year we have added 17 Federal employees within the Office of Research and Technology Development. Of that number there were five engineers, four operations research analysts, and three human factors specialists. That total also includes five program management analysts who will assist in managing our many research programs, including NextGen programs.

Included in the above figures are several additional staff that have added needed expertise to the human factors area. Two personnel in the area of program management, one Federal employee and one contractor, were added. Three human factors research specialists were also added, one being a senior person with over a decade of experience working human factors issues in certification and a second has a Ph.D. in psychology and is PMI certified, with extensive experience with the Department of Homeland Security.

The Human Factors Research and Engineering Group (AJP-61) has been working with academia to leverage new NextGen research projects in order to expand the number of graduate students being trained and educated in human factors. These students after graduation will have the necessary skills to fill positions at FAA and National Aeronautics and Space Administration (NASA) as well as in industry. AJP-61 is working with academia to expand graduate programs and further develop the human factors workforce.

We have also made substantial gains in the environment and energy area. Over the last year, ten highly qualified individuals have joined the Office of Environment and Energy to support our environment and energy efforts in noise, emissions, technology, operations, and policy research. Of these, three have a Ph.D. in engineering or science and four have engineering degrees. Within the last two years we have recruited as Federal employees two excellent students we sponsored under the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER).

In addition, we will also work with our Human Resources Office to investigate alternate approaches for hiring critical personnel in hard-to-fill areas, such as software and digital systems and environment and energy. We have already started developing a plan for workforce development and will include plans to increase the level of technical expertise of existing personnel in key technical areas. One option to be considered is hiring high potential junior staff and plan for fast track training and increasing responsibilities. Also, we will continue to work with universities that participate in our Centers of Excellence to recruit highly qualified staff.

<u>UAS Research</u>: The REDAC applauds progress in defining a clearer path toward certification and routine operation of UAS in the NAS. In light of the significant community pressure on the FAA to accelerate the safe integration of UAS in the NAS, the REDAC questions if the research is sufficient to address the complexity of the operational, technical and policy changes associated with safe integration of UAS and whether the timeline could be accelerated if additional resources were available. The REDAC also notes significant related R&D efforts at other government agencies such as NASA and the Department of Defense, which could leverage FAA efforts and benefit from stronger FAA involvement.

FAA Response: The FAA plans to review UAS research requirements and the research plan in an attempt to match the integration timeline to the integration needs of the community. The FAA is currently updating the notional UAS-NAS integration roadmap to reflect significant progress made and revised milestones. This update will be available by March 2011. Once finalized, the UAS-NAS integration roadmap will drive a specific, detailed research plan.

Throughout the development of the research plan, which will help us validate current research requirements and drive future requirements, we will continue to coordinate research activities with partner agencies (e.g. NASA, Department of Defense [DoD]). We will then be able to jointly assess opportunities to accelerate UAS research deliverables.

1.2 Subcommittee on Airports

Finding (1): Research activities in the visual guidance / runway incursion reduction program focus on three main areas: marking materials; lighting technologies; and sign technologies. The project on using LED technology in improved runway approach signs is of particular interest to the Subcommittee. They mentioned that any effort to reduce confusion and improve the human factors associated with these airfield signs would be extremely valuable for aircrew at certain problematic airports.

Recommendation: Research into the evaluation of GPS navigation devices for preventing runway incursions is complete, and the FAA indicates that they are now writing the final project report. Results have indicated that the devices are most effective when used as a situational awareness tool and not for providing directions. The Subcommittee is concerned that the combination of this program and a similar effort by the Air Traffic Organization (development of ADS-B technology) would confuse airports, since the different specifications for tracking assets on the ground are not fully interchangeable. The Subcommittee believes that airports would ultimately like to use a system that can provide all users with a shared data set (as this was the initial promise of the ADS-B system). If the ADS-B systems are able to work as initially designed, then the GPS systems in this project would be redundant. The Subcommittee recommends that the Branch carefully considers the context in which this project is taking place, and produce results that can clearly tell airports the effectiveness of equipment.

FAA Response: The FAA agrees. We will discuss this issue at the next Subcommittee meeting on March 29-30, 2011. The FAA's plan for the GPS navigation devices referenced here is to develop a relatively low cost system (similar to a GPS for one's car) that can provide situational awareness to ground vehicles operators to prevent runway incursions. The system provides audio and visual alerts when entering the Runway Safety Area. This system does not in any way replace or compete with ADS-B or any other surveillance systems under development by FAA.

Finding (2): The Technical Center's research into avian radar and wildlife hazard mitigation is progressing steadily. Airports participating in the testing with the Technical Center have been very supportive of the new capabilities that the project offers. Airports have been able to extend their wildlife observations to 24 hours/day coverage.

Recommendation: The Subcommittee is very pleased with the progress of the avian radar assessment project, and noted that the airports that participated in the testing have been highly supportive of the new capabilities the system offers. The Subcommittee notes that those airports were able to benefit by extending wildlife observations to 24 hours a day, identifying movement patterns/trends, educating staff, and taking appropriate action. The Subcommittee recommends that the next step in bird radar research should be to investigate the integration of bird radar into the air traffic control tower environment.

FAA Response: The FAA agrees. We are planning to investigate the integration of bird radar and other technologies into the air traffic control tower environment. While these technologies have shown great promise in aiding the wildlife biologist, the usefulness to provide real-time ability to prevent wildlife strikes needs to be further evaluated.

Finding (3): The Subcommittee was presented with two projects that were deferred by the ACRP: one on through-the-fence security and another on aircraft airport accident data.

Recommendation: The Subcommittee was presented with two research proposals that were deferred to the FAA by the ACRP Oversight Committee. On a project that involved the collection and evaluation of aircraft accident data on airports, the Subcommittee recommends that the FAA integrate the elements of the proposal into the Branch's recently formed project on the same topic. Regarding a project on the investigation of "through the fence" operations that impact airport security, the Subcommittee recommends that no further action is taken, as the subject matter is outside of the scope of the Branch's current research portfolio.

FAA Response: The FAA agrees. We have plans in place for the collection and evaluation of aircraft accident data on airports. This Airport Cooperative Research Program (ACRP) project has been included in the FAA's project in the same topical area. We also do not intend to pursue a research project on "through the fence" operations as it is not appropriate for the Airport Technology Research Program.

Finding (4): Research on runway roughness and real-time aircraft braking are important projects.

Recommendation: The Subcommittee believes that the research project on investigating runway roughness is an excellent idea and can produce results that have many potential applications. As the research progresses on the separate project to investigate aircraft braking performance, the Subcommittee recommends that the FAA investigate any potential correlation of that data with the runway roughness studies. The Subcommittee also strongly recommends that the FAA investigate any application of the roughness data to initial pavement construction standards. Airports are currently dealing with problematic construction issues that involve runway smoothness, and the Subcommittee believes that any revised or supplemental standard on that topic would be a tremendous benefit to the industry.

FAA Response: The FAA agrees with the recommendation and believes there is currently enough roughness data collected and available that a draft roughness specification can be written by the end of Fiscal Year (FY) 2011 for both asphalt and concrete pavements. We also concur that the effect of roughness on aircraft braking should be studied. We will also investigate any potential correlation between the airplane braking performance and runway roughness.

Finding (5): The Subcommittee is concerned that the research effort to investigate sustainable/green technology in airport pavement construction, such as warm mix asphalt, is being delayed until 2012.

Recommendation: Although questions about the performance of such methods exist, the Subcommittee recommends that the Branch accelerate the testing of sustainable/green technologies, using the results from other research programs (ACRP, AAPTP, IPRF, etc.) as a starting point.

FAA Response: The FAA agrees with the subcommittee recommendation that the Airport and Aircraft Safety Branch (AJP-63) accelerates the testing of sustainable/green technologies, and research effort on this critical topic has already commenced.

Two projects were completed by the Airfield Asphalt Pavement Technology Program (AAPTP) and the Innovative Pavement Research Foundation (IPRF) related to the use of sustainable/green technology in airport pavements. Both of these projects recommended using the recycled materials in airport pavement construction. The Center of Excellence for Airport Technology at University of Illinois has completed a literature review documenting the use of warm mix asphalt (WMA) on airport projects. This will provide us with guidance on WMA performance on airport pavements. In FY 2012 the FAA has set aside funding for greener technologies which will include laboratory characterization of resilient modulus, rutting, and fatigue behavior of WMA and comparing it with conventional P-401. Laboratory test results will be verified with full-scale testing to characterize performance of these mixes and would be started once the Accelerated Pavement Testing Vehicle becomes operational.

Finding (6): The Subcommittee held an extensive conversation on the content of the Branch Manager's 10-year R&D "look-ahead" plan.

Recommendation: The Subcommittee recommends that future versions of the plan contain thoughts as to not only how the Branch can support the Headquarters program (including elements from the FAA Flight Plan, ARP Business Plan, NextGen plans) but also contain ideas of what could (or needs to) be done outside of the existing programmatic constraints. High-level goals are: reducing runway incursions; reducing excursion fatalities; pavement improvements (reduced costs, increased life, improved maintenance and construction, etc.); airport/environmental sustainability; ramp safety; and safety during construction, etc.

FAA Response: The FAA agrees with the recommendation and will include the Headquarters program and ideas of what needs to be done outside the existing program. This will include high-level goals as suggested by the Subcommittee.

1.3 Subcommittee on Environment and Energy

Finding (1): The subcommittee discussed research drivers, needs and gaps. Members reaffirmed previous priorities (solutions, with a focus on aircraft technology and alternative fuels, science, particularly climate impacts) but also questioned whether FAA's research efforts are addressing evolving issues with general aviation leaded avgas and water quality, both driven by EPA regulatory activity. While these issues are addressed by the Office of Aviation Safety and the Office of Airports, the subcommittee had two specific requests/recommendations.

Recommendation (1a): In conjunction with EPA, the general aviation industry, and other interested stakeholders, the FAA should develop an integrated aviation gasoline program to research and test new piston engine technology and fuels with reduced or no lead additives in order to find safe alternatives to leaded aviation gasoline. This program is necessary for FAA to provide the required technical support for anticipated EPA rulemaking activities on lead emissions from piston engine aircraft in light of statutory and regulatory requirements to also consider the impacts of safety, noise, costs, and technology in the development and adoption of standards. The subcommittee asked for a briefing on the status of avgas research at its next meeting.

FAA Response: The FAA agrees that it is important to ensure we are well positioned to address issues associated with leaded aviation gasoline (avgas). Our efforts in this area are led by the FAA Office of Aviation Safety (AVS) in close collaboration with the Office of Environment and Energy (AEE). In FY 2011, we expect to stand up a comprehensive research effort to address these issues. The FAA has established an Aviation Rulemaking Committee (ARC) to collaborate with industry to plan the transition to unleaded avgas. We expect that the Unleaded Avgas Transition ARC will provide recommendations for collaborative industry-government initiatives to facilitate the development and deployment of an unleaded avgas and these recommendations will inform our research and development efforts. We will brief the Environment and Energy REDAC subcommittee on our efforts at its next meeting. We encourage interested subcommittee members to attend the Safety REDAC subcommittee meetings, as this is where the avgas research element of our program is reviewed.

Recommendation (1b): In conjunction with Airport Council International-North America (ACI-NA), the FAA should assess the implications of water quality regulations on airports and identify any research needs. The subcommittee asked for a briefing at its next meeting.

FAA Response: The FAA agrees that the implication of water quality requirements on airports is a significant issue. However, it is unclear whether there is a requirement for additional research in this area. We are working with ACI-NA representatives to review regulations and ongoing research efforts such as those being pursued under the auspices of the Transportation Research Board Airport Cooperative Research Program (ACRP) and identify any gaps. We will brief the subcommittee on this effort at its next meeting on March 22-23, 2011.

Finding (2): The subcommittee noted substantial progress in the NextGen Environmental Management System (EMS) work. The concept is extremely complex and development requires input from many stakeholders.

Recommendation: The subcommittee suggested that the Office of Environment and Energy conduct a Focus on NextGen EMS for all relevant stakeholders to educate the community and ensure their views are integrated into the development of NextGen EMS.

FAA Response: We agree that NextGen EMS is a complex process. We are working with a number of stakeholders on NextGen EMS planning, pilot studies, and outreach. We are also planning a NextGen EMS Workshop in 2011 to engage relevant stakeholders and seek their input on our plans. We recommend that Environment and Energy REDAC subcommittee members attend this workshop to help focus our research and development efforts.

Finding (3): The subcommittee noted that FAA's environmental science efforts are maturing and that FAA needs to develop plans for using these results to inform policy. The committee felt that a "science readiness scale" might facilitate this transition

Recommendation: The subcommittee should form a small task force to develop a "science readiness scale" in conjunction with the FAA.

FAA Response: We agree that it is important to develop plans for using evolving research to inform policy. Developing a "science readiness scale" is an excellent idea – the PARTNER Center of Excellence recently agreed to undertake an effort to explore such a scale. We understand that some of the Environment and Energy REDAC subcommittee members, as well as members of the E&E Office, are part of the PARTNER effort. We will keep the subcommittee apprised of this effort as it evolves.

Finding (4): The subcommittee was pleased with progress made by the Office of Airports and the Office of Environment and Energy identifying funds for noise research. This is a critical issue that must be addressed. While the availability of funds is encouraging, the committee was concerned about the ability of keeping oversight of so many funding strings.

Recommendation: The Office of Environment and Energy should continue to work with the Office of Airports through the budgeting process through the Office of Management and Budget (OMB) to ensure funding is available for noise research, in particular to conduct community noise surveys. The subcommittee also recommends that the Office of Environment and Energy work with funding partners to ensure the noise research program is well integrated and is given sufficient priority.

FAA Response: We agree that advancing our noise research to inform policy is critical. FAA's Offices of Airports and Environment and Energy are working closely to coordinate efforts and funding in this critical area. We are pursuing efforts to identify additional resources in FY 2012 through the budgeting process. We are also working closely with other relevant departments and agencies as well as industry and community groups. There are many elements and funding strings associated with noise research and we are coordinating our efforts through a comprehensive National Noise Research Roadmap similar to our very successful Aviation Emissions Characterization Roadmap.

Finding (5): The subcommittee was pleased with progress standing up the Continuous Low Energy Emissions and Noise (CLEEN) program. Excellent projects are underway and appear on track to deliver substantial environment and energy efficiency and diversity gains.

Recommendation: The FAA should continue to provide robust funding for CLEEN and explore ways of increasing investment in the future.

FAA Response: We are very pleased with the CLEEN program - it is an excellent example of how government and industry should collaborate to address critical environmental issues. CLEEN is one of the top priorities of the environment and energy program and, within the context of various priorities, we will continue robust funding of CLEEN; we are exploring various avenues to augment the effort if this initial technology development pilot program proves successful.

Finding (6): The environment and energy program has experienced substantial growth; however staff growth has been slower. The Office of Environment and Energy has added some well qualified staff but still has many vacancies. The subcommittee understands that hiring well qualified staff in aeronautics is a national issue and requires focused attention.

Recommendation: The Office of Environment and Energy should develop a recruitment plan and make use of subcommittee members to help fill vacancies.

FAA Response: Even in these hard economic times, recruiting qualified scientists and engineers is extremely difficult. We are working with the PARTNER Center of Excellence to enhance our recruitment practices. We have hired some exceptional individuals but still have gaps. We are developing a comprehensive staffing plan, including identifying approaches to make the FAA Office of Environment and Energy an employer of choice and we welcome the help of the subcommittee in our recruitment efforts.

Finding (7): The subcommittee noted progress developing the NextGen environmental policy and standing up an effort to assess and quantify goal targets. The subcommittee noted that these efforts require refinement and continued attention.

Recommendation: The subcommittee urged the Office of Environment and Energy to continue advancing the computational capabilities to quantify the contribution of various strategies toward environmental goals. This information should inform refinements of the NextGen environmental policies, but should not hold up release of the policy document. The subcommittee asked for updates at the next meeting.

FAA Response: We understand that thorough analyses of potential growth scenarios and penetration of mitigation solutions are needed to develop interim targets towards meeting NextGen environmental goals and to inform policies. We are advancing our analytical capabilities and we will provide status updates to the subcommittee.

1.4 Subcommittee on Human Factors

Finding (1): FAA mechanisms for guiding NextGen developments across organizations within the FAA require significant workforce time and effort, yet are insufficient or inappropriate for the range of activities required to develop NextGen. Of particular concern are, first, safety assessment activities that drive research units to make estimates of failure mechanisms and error rates to calculate quantitative reliability estimates at an inappropriate level of detail early in the design process, rather than guiding developments that promote safety. This is of particular concern for safety-risk-assessments which are demanding detailed estimates of human error rates given fairly notional concepts of operation while not considering safety-enhancing behaviors, as noted in many prior studies, including RTCA Task Force 4. Second, significant effort is required to maintain and compare 'roadmaps,' yet it is unclear from these roadmaps what major goals or capabilities their entries represent, whether redundancies or gaps exist, and what are the critical decision paths and system dependencies. While the roadmaps may provide some valuable functions, they should only be viewed as one of several representations required to drive design; for example, immediate human factors research requires greater specificity of scenarios (including degraded modes) and of roles and responsibilities.

Recommendation (1a): The Subcommittee recommends the FAA examine methods of examining safety throughout the development of NextGen, including the human contribution to safety and human error, at an appropriate level of detail and in a manner that guides development to improve safety.

FAA Response (1a): The FAA agrees that the human contribution to safety is an important aspect of NextGen development. The Human Factors Research and Engineering Group is working with the ATO's Safety Service Unit (ATO-S) to enhance the human component to safety risk management. We are participating in the development of their safety risk management process and hazard tracking system to ensure that human factors risks are proactively identified, tracked, and managed as NextGen concepts and systems mature. We have been gratified by the positive response by the safety community to our suggestion that human performance is an important aspect of safety. They have responded by embracing the human performance aspects of safety analyses and pledged to continue to strengthen that aspect of the FAA's Safety Management System. The range of activities includes maintenance functions as well as the air traffic control functions in the NextGen environment. One area of increased attention is that of automation used by controllers in both nominal and off-nominal conditions. We are collaborating with research partners at EUROCONTROL in the development and application of human system integration safety tools and methods. Through our human factors working groups we are working with the service units to develop human system integration requirements that include an emphasis on safety to ensure that NextGen changes take a systematic view of the impact of safety on workstation design, training, and personnel selection. Additionally, safety is an area of intense collaboration between the NextGen air traffic human factors program and the NextGen flight deck human factors program within the Human Factors Research and Engineering Group. Many NextGen changes will have a profound impact on flight deck procedures and the relationship between the ground and air elements of the National Airspace System (NAS). Our flight deck human factors program maintains a close relationship with the Aviation Safety offices in the FAA to address potential safety issues that arise.

Recommendation (1b): Likewise, the Subcommittee recommends the FAA examine the roadmaps for their ability to clearly articulate the critical paths, system dependencies and critical decision points; the standard by which they should be examined is not just whether these effects are captured in theory, but also whether they are clearly documented in a manner sufficient for the range of domains and stakeholders involved in NextGen development. These roadmaps should be able to address the other immediate research needs to achieve NextGen; for example, greater definition is needed for scenarios and role definitions to enable effective research on critical human factors concerns. Where the roadmaps are not a sufficient representation, the FAA should clarify other mechanisms to guide NextGen development. Likewise, the FAA should evaluate the appropriate resources for maintaining these NextGen development mechanisms to ensure that they are used only where there is a clear need without requiring excessive personnel time.

FAA Response (1b): The NAS Enterprise Architecture (EA) roadmaps represent a complete collection of all existing and planned investments needed to support the evolution towards NextGen. The research depicted in the supporting activities of each NAS EA roadmap represents active R&D efforts, both internal and external to the FAA, that have the potential to influence decision points and reduce risk for the implementation of major NextGen investments.

Finding (2): We agree with the conclusions of the GAO report that much has been done to coordinate FAA and NASA Human Factors NextGen Research, but that these activities could be enhanced through "a cross-agency plan developed [by the FAA] in cooperation with NASA to identify, prioritize, and coordinate NextGen human factors issues." Such a plan should additionally include other entities as appropriate, and should recognize the disparate approaches taken by each entity, such as the orientation of FAA NextGen research towards the Enterprise Architecture and FAA NextGen Concepts of Operation whereas the orientation of NASA NextGen research is towards the JPDO visions of NextGen and Concepts of Operation.

Recommendation: We recommend to the Director of Research and Technology Development that a small high-level 'human factors coordinating committee,' comprised of individuals with appropriate authority for the development of agency NextGen plan development at both the FAA and NASA, meet and come to an agreement on a vision for the 'initial focus areas' as recommended by the GAO report. Within the FAA, this coordinating committee must extend beyond the Human Factors Research and Engineering Group (HFREG) to other research groups that are conducting human factors research or whose activities require human factors research. For this activity to have the greatest utility, this committee should also include other NextGen stakeholders, such as the Department of Defense, the Department of Homeland Security, and the JPDO, as well as Federally Funded Research and Development Centers supporting research such as MITRE/CAASD.

FAA Response: The FAA's use of the NAS Enterprise Architecture and the Mid-term Concept do not in any way indicate a difference in orientation between the FAA and NASA with respect to human factors and NextGen. The FAA's enterprise architecture and concept are fully consistent with the JPDO Concept and reflect the requirements of an implementing organization to flesh out its portion of the concept as part of its implementation. The FAA has as part of its due diligence reached out to the other agency partners with respect to the mid-term and is now taking the lead for the JPDO in establishing a combined research plan in support of JPDO's role as sponsor of cross-agency activities. The FAA also has a liaison with the Air Force Research Lab to better coordinate activities of mutual interest with DoD. Internally, the FAA has established the role of Human Factors' Integrator within the System Engineering and Integration group to ensure better cross-program Human Factors coordination as well as sponsoring semi-annual meeting of FAA human factors practitioners to improve coordination and cooperation.

Finding (3): The Subcommittee was heartened to hear that two senior leadership positions – the head of the Human Factors Research and Engineering Group and the Integration Lead for Human Factors in NextGen – have been either filled or are actively being solicited. However, the committee was concerned to see that these positions have been effectively downgraded from their original conception; in particular, the head of the HFREG was created as a Senior Executive Service (SES)-rank job. This suggests a de-emphasis of human factors and a diminished visibility and priority to ensure that human performance considerations are factored agency-wide into programmatic decisions across the system life cycle. Likewise, it remains unclear what resources and authority the Integration Lead will have, and, thus, whether it will be situated to identify and resolve particularly cross-cutting human factors concerns that may require, for example, changes in technology, operational procedures, and concepts of operation on both air and ground sides. Finally, the HFREG remains short-staffed with research program management staff.

Recommendation: We recommend that the FAA senior leadership responsible for defining these positions and for allocating SES and research program management staff positions review the positions currently being hired and clarify their roles, ensure that the HFREG has sufficient research program management staff, without establishing excessive supervisory chain and management overhead, clarify the mechanisms by which the Human Factors Integration Lead can identify human factors issues in NextGen and guide effective cross-cutting resolutions, and ensure that the position has the appropriate resources and staff to do so.

FAA Response: For the first position mentioned, the Manager of the Human Factors Research and Engineering Group (HFREG), the FAA feels that the HFREG position is appropriately defined and that the correct staffing resources have been allocated for the Group. Since the last quarter of FY 2010, four additional employees (three Federal and one contractor) have been added to the Group. Two of the positions were filled with research project management staff.

The other position mentioned (Integration Lead for Human Factors in NextGen) is in the newly created Systems Engineering Integration Group in the Office of Systems Engineering and Safety. The Group was specifically created to identify and resolve cross-cutting issues that may hinder or impede NextGen integration. Being in this Group, the Integration Lead for Human Factors in NextGen is uniquely situated to identify and resolve cross-cutting human factors concerns that could require changes in technology, operational procedures, and concepts of operation.

Finding (4): The Subcommittee was pleased to see the extent to which the high-level plan to validate NextGen Con Ops accounts for human factors concerns, to the degree that they were covered in the high level briefing provided. The committee also appreciates the mechanisms at both the researcher and management level to coordinate human factors research where possible between this effort and the HFREG.

Recommendation: The subcommittee recommends to the Manager of the ATS Concept Development and Validation Group to continue coordination between this effort and the HFREG. The subcommittee requests some deep-dives into the human factors component of validating NextGen con ops. This should include the strategy for identifying relevant human factors issues and examining them in tests of fidelity relevant to the concept maturity level, from early-on methods such as cognitive walk through to detailed human-in-the-loop simulations, through the data analysis and conclusions based on these research activities. The Subcommittee also notes the need to carefully consider off-nominal and degraded operations and recommends further development (or elaboration) of the strategy for addressing this.

FAA Response: The Air Traffic Systems Concept Development and Validation Group (CD&V) will continue to coordinate with the Human Factors Research and Engineering Group (HFREG). From the very first steps in concept validation, development of the Enterprise Architecture Operational Scenarios (OV-6c), we are looking at the humans in NextGen mid-term operations in terms of tasking and information flows. We will begin to develop off-nominal and degraded condition scenarios in FY 2011, and the HFREG is getting involved in scenario development as well. We will collaborate with the HFREG on this effort. The CD&V manager would be happy to brief the subcommittee on the process for identifying and assessing human factors issues as part of NextGen concept development and validation. Staffed NextGen Towers might be a good example to walk through.

Finding (5): The Human Factors Subcommittee has not been briefed on the Weather Technology in the Cockpit (WTIC) program and understands that it is in the process of re-planning in response to earlier recommendations made by other sub-committees. However, the presentation and repeated questions did not present a clear, consistent vision for this project, and identified several proposed objectives of this research where government research does not appear to be justified. It is unclear what the research will provide beyond developments already taking place in industry, and how specifically it will support NextGen and/or AVS activities. Human factors efforts appeared to be vague and disparate, without clear, technically sound approaches; the presentation and use of weather information in the flightdeck should be better coordinated with, or actually conducted by, specialists in this area associated with the FAA Human Factors Research and Engineering Group (HFREG).

Recommendation: As in earlier recommendations, the Human Factors Subcommittee strongly recommends to the Director of Research and Technology Development that the vision, intended deliverables and anticipated customers of the WTIC program be clearly articulated. The role of government research in this area needs to be carefully examined, as should whether an isolated project in weather in the cockpit is more appropriate than broader inclusion of weather concerns in other NextGen programs and by the HFREG. An expert review of the project is warranted. Following that, the project should be resourced and staffed appropriately to its goals and intended impact relative to other NextGen research areas.

<u>FAA Response</u>: The FAA appreciates the support of the REDAC in our efforts to present a clear, consistent vision for the WTIC project. FAA has conducted an industry survey of current weather cockpit technologies and technologies that are planned to be implemented within the next three years. The results of the survey identified WTIC research activities to support aviation safety and efficiency during adverse weather. In addition, FAA has conducted a NextGen documentation survey to identify NextGen Operational Improvements that the WTIC Program Research may support. The FAA is willing to articulate the research vision for the WTIC program and to provide the Human Factors Subcommittee a briefing of the results of the surveys and accomplishments to date.

<u>Finding (6)</u>: The Subcommittee applauds the FAA for attempting to develop a Human Systems Integration (HSI) Roadmap that encompasses all human system integration aspects of NextGen and is developed in accordance with Operational Improvements (OIs) as they are represented in the NAS Enterprise Architecture (EA). While the Subcommittee recognizes the limitations of roadmaps as an agency mechanism for guiding NextGen development, the committee applauds their use by the HFREG. The Subcommittee also respects the careful consideration given to balancing the workload of maintaining the HSI roadmap with the benefits it provides for within-agency coordination. However, the Subcommittee also recognizes the limits of the roadmaps and the need for human factors research to also use other representations of NextGen as input to their research activities, such as scenarios (including degraded modes) and storyboards.

<u>Recommendation</u>: The Subcommittee recommends to the Director of Research and Technology Development a coordinated approach across FAA R & D efforts where the HFREG and, as appropriate, the new HF NextGen Integration Lead and other programs examining human factors concerns use the insights of the road map to create other representations that serve other important purposes. This would include fleshing out the job requirements of all important personnel sufficiently to identify key research needs, to ‘storyboard’ their future positions sufficiently to provide a common vision within HF research and to highlight concerns with assumptions about human roles in a sensible way to the community, and to identify programmatic and technical risks, redundancies, and gaps that require near-term action. To the maximum extent possible this effort should build on any NextGen descriptions developed elsewhere within the FAA, both for efficiency and to foster coordination with, and transition of human factors results to, other NextGen research and development efforts.

<u>FAA Response</u>: The NAS EA roadmaps, including the Human Systems Integration (HIS) Roadmap, represent a complete collection of all existing and planned investments needed to support the evolution towards NextGen. The research depicted in the supporting activities of each NAS EA roadmap represents active R&D efforts, both internal and external to the FAA, that have the potential to influence decision points and reduce risk for the implementation of major NextGen investments.

The FAA will continue to evolve in how it communicates the R&D activities. For example, to supplement the roadmaps, views of the NAS (As Is, Mid-Term, and To Be) that capture various perspectives of the NAS including system context, interfaces and interoperability, operational scenarios and activities, functions, communications, data, and standards were developed. These views are being used to inform the operational scenarios, define roles and responsibilities, and address key human factors issues. To supplement the mid-term scenario work already completed, the FAA is working to complete the scenarios with representation of off-nominal conditions and to address the full implications of new automation/technologies on the operator's (e.g., controller, pilot, dispatcher, etc.) performance.

1.5 Subcommittee on Aircraft Safety

Finding (1): Aeromedical Research program (CAMI) is conducting research on the subject of human fatigue both from the human factors and aero-medical perspectives. The expertise at CAMI and the output from their research is an essential technical resource available to the FAA in support of recent and future rulemaking activities on pilot fatigue. The SAS understands that the Human Factors expertise at CAMI has been well integrated into this rule making activity. However there may be a gap in the coordination and integration with aero-medical expertise at CAMI with regard to their input to new rulemaking activities on fatigue. While this may be a unique case, it was not clear to the SAS that a sufficient process is in place to ensure that the in-house FAA science community is integrated into the rulemaking process, in particular for future rulemaking to address human fatigue.

Recommendation: The Subcommittee should receive a review on how FAA integrates its in-house technical expertise into the rule making process to ensure new rules are based upon and influenced by publicly available scientific findings.

FAA Response: The FAA agrees with the Subcommittee recommendation and will review how FAA research is integrated with the rule making process at a future SAS meeting as determined by the SAS Chairman. The remainder of this response seeks to provide clarity regarding the relationship of both the Aerospace Human Factors Division (AAM-500) and Aerospace Medical Research Division (AAM-600) fatigue research to fatigue rulemaking.

The FAA agrees with the finding that AAM-500 expertise has been well integrated into rule making activity associated with fatigue countermeasures. The Associate Administrator for Aviation Safety has effectively delegated responsibility for coordination of research expertise into rulemaking to the Air Transportation Division of the Flight Standards Organization (AFS-200). Accordingly, AFS-200 has effectively engaged in defining requirements, serving as research sponsors, and reviewing research findings as research projects led to development of recommendations. As research knowledge and Executive and Legislative direction have led towards regulation, AFS-200 has effectively engaged AAM-500 researchers in advising regulatory progress, and more broadly has engaged agency and outside expertise in a scientific steering committee to support both the recent "Flightcrew Member Duty and Rest Requirements" Notice of Proposed Rule Making (NPRM) and efforts on establishing requirements for ultra-long range flight operations. Likewise, the Air Traffic Organization has actively sought AAM-500 research support for revisions to Air Traffic Control Specialist scheduling through the Article 55 Working Group, called for in the recent working agreement with the National Air Traffic Controllers Association.

Regarding aerospace medicine, AAM-600 continues to communicate with AAM-500 human factors scientists regarding functional genomics research and other aeromedical concerns relative to the subject of fatigue. However, functional genomics research is in the early stages of development; further studies and validation of research findings are required for these efforts to reach the stage of maturity that would warrant their transition to the rule making process. The aviation applications of genomics research are at the forefront of scientific exploration having the greatest potential for making leaps in human safety and performance. AAM-600 aeromedical research personnel do participate in the rule making process addressing laser eye-protection guidelines, biodynamics certification requirements, cabin safety procedures, radiological protection measures, fire safety standards, and other aeromedical safety issues. This collaboration is accomplished by providing expertise and advisory language for the formulation of FAA advisory circulars (AC), regulatory documents, and international safety standards.

Examples of publicly available scientific findings and recommendations proceeding from CAMI are found at http://www.aafs.org/, http://www.asma.org/journal/index.php, http://www.asma.org/Organization/ashfa/, http://www.faa.gov/library/online_libraries/aerospace_medicine/, and http://www.hfes.org/web/Default.aspx.

Finding (2): AFS recently issued the first significant revision to pilot flight and duty time regulations in over 30 years. This regulation is science based and will require carriers to manage risk using SMS principles. It also permits compliance using a Fatigue Risk Management System (FRMS) for all or part of a carrier's operation. There are gaps in some of the scientific knowledge that must be filled in order to improve the effectiveness of the regulation. CAMI is currently providing oversight on industry funded research and data collection. CAMI, in conjunction with FAA, industry and labor has the expertise to either conduct this scientific research or provide oversight to fill the necessary scientific gaps. It is clear to the SAS that this new regulation will require research and data collection and that, to date there has been none requested by FAA to support this regulation for FY 10 and beyond.

Recommendation: AFS and CAMI meet with AVS as soon as possible to sponsor needed research to support the new pilot flight and duty time regulation.

FAA Response: AFS is in the NPRM phase with this rule. The NPRM is based on existing science and Aviation Rulemaking Committee (ARC) recommendations. At this phase AFS does not believe additional research is warranted.

Finding (3): The Weather Research Program continues to deliver useful products. The subcommittee is impressed with the quality and relevance of the work and found the program to be tightly integrated with the research efforts of NCAR, NOAA (various laboratories) and MIT/LL. The program is also connected to the real world through partnerships with UAL, Delta and SWA. The Subcommittee supports the weather research program's focus on improving general aviation safety through enhancing forecast accuracy. However, the subcommittee notes the importance of balancing enhanced weather forecast information with developing tools and resources for improved pilot decision making to address the root-causes of GA weather accidents.

The Subcommittee noted the absence of a volcanic ash research effort. Following the meeting the Subcommittee received a copy of the FAA letter responding to a previous Subcommittee recommendation on this subject. The letter states in part ("…….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.").

Recommendation: Due to the significant disruption caused by the recent Icelandic volcanic eruption and the resulting activities led by ICAO to establish international guidance for operations in the vicinity of volcanic ash, the Subcommittee recommends that FAA identify and aggressively pursue any research needed to support these international discussions. This research may include the prediction or modeling of the movement and intensity of volcanic ash following an eruption, the provision of tactical information to flight planners and crews so they can effectively avoid hazardous areas with minimum impact on flight schedules, and identification of ash tolerance levels for aircraft, engines, and passengers.

FAA Response: The FAA concurs with the recommendation to establish a volcanic ash research effort. The Agency has taken several steps in response to recent volcanic eruptions and the need to establish a research approach that will lead to a defined path to operations for the aviation community. The FAA hosted a public meeting November 5, 2010, inviting the public to assist the FAA in better defining the operational requirements for the reporting and forecasting of volcanic eruptions. Information from this meeting will be also used to help direct R&D efforts for improved services in support of NextGen and global harmonization with the international community in terms of guidance and operational performance for volcanic ash.

Finding (4): The Subcommittee received an excellent briefing on the emerging details of a UAS Research Plan intended to support the milestones of the current FAA notional roadmap for UAS NAS integration and noted significant progress has been made in defining a clearer path towards certification and routine operation of UAS in the NAS. In light of the significant community pressure on the FAA to accelerate the safe integration of UAS into the NAS, the SAS questions whether the envisioned timeline would be acceptable. The SAS questions whether the resources currently devoted to research, engineering, and development is sufficient to address the complexity of the operational, technical, and policy challenges associated with the safe integration of UAS and whether the timeline could be accelerated if additional resources were available.

Recommendation: The Subcommittee recommends the following:

1) The FAA should review UAS research requirements and the research plan in an attempt to match the integration timeline to the integration needs of the community.
2) The FAA should reassess staffing and funding requirements for research, engineering, and development.

FAA Response: The FAA agrees that we should review UAS research requirements and the research plan in an attempt to match the integration timeline to the integration needs of the community. The FAA is currently updating the notional UAS-NAS integration roadmap to reflect significant progress made and revised milestones. This update will be available by March 2011. Once finalized, the UAS-NAS integration roadmap will drive a specific, detailed research plan.

Throughout the development of the research plan, which will help us validate current research requirements and drive future requirements, we will continue to coordinate research activities with partner agencies (e.g. NASA, DoD). We will then be able to jointly assess opportunities to accelerate UAS research deliverables.

Background: The Subcommittee noted in March 2009 that Software/Digital/ Systems R&D be given additional emphasis, increased staffing and funding. In August 2009 the Subcommittee noted the lack of a comprehensive and integrated Software/Digital Systems Project Plan and also noted that little progress had been made in acquiring the specialized expertise required to support this critical research program. In March 2010 the Subcommittee was pleased to note the development of an SDS comprehensive research plan which would provide a solid context against which research initiatives could be assessed.

Finding (5): Although the Subcommittee was pleased to see that the SDS Research projects were organized to address four significant research requirements, time did not allow for a comprehensive assessment to be accomplished. The SAS again noted that the level of specialized expertise to support this critical program is not yet in place.

Recommendation: The Subcommittee would like to do a “Deep Dive” review of the FAA integrated SDS R&D portfolio and recommends that this be accomplished in a one day workshop. The Subcommittee recommends that the one day workshop be convened prior to the next SAS meeting.

FAA Response: We agree that it would be beneficial to provide the REDAC SAS with a comprehensive review of software and digital systems (SDS) research. Thus, we will conduct a comprehensive deep dive review of the SDS research program at the regularly scheduled March 2011 REDAC SAS meeting. This review will provide details on the research being conducted, clearly linked to the aircraft certification requirements being addressed. Additionally, any new research efforts that have been started prior to the SAS meeting will also be briefed along with the associated gaps in aircraft certification each research effort will address. Recent accomplishments and the requirements they addressed will also be covered.

Finding (6): The descriptions and discussions under the four areas – Performance Based Navigation (PBN), Aircraft Performance in Terminal Area Operations, Simulation Model for Advanced Maneuvers, and Laser Safety – were relatively general. The briefing on PBN indicated that a primary focus of this research is to understand issues associated with operations in a mixed equipage environment. It was unclear exactly what information was needed from this research to allow it to move forward with the implementation of PBN in terminal airspace. What may be valid and focused needs were difficult to ascertain from the generalized briefings.

Recommendation: The Subcommittee would find it helpful if at the next review, the research efforts could be described specifically in a way that reflects actual needs of system implementers or regulation developers.

FAA Response: We agree that the descriptions were relatively general. In the next review, the research efforts will be described in a way that reflects the actual needs of system implementers or regulation developers.

Finding (7): A stated objective of the Aircraft Performance in Terminal Area Operations research is to determine "what can be done to prevent unsafe landings and runway excursions." The Subcommittee noted that work to date has been focused on analysis of operational landings and modeling aircraft performance. The Subcommittee also noted that most of the focus of this research dealt with runway excursions due to contaminants (ice, snow, etc.). Since many runway excursions result from unstable approaches (high, fast, long, etc.) on dry as well as contaminated surfaces, the Subcommittee believes that the research needs to cover all causes, not just slippery runways. While program funding runs out in FY 10, deliverables that would result in solutions for reducing runway excursions are not at hand.

Recommendation: The Subcommittee recommends this project be refocused and funded to identify solutions to improve the safety of landing operations and reduce runway excursions from all causes.

FAA Response: We agree that the project should be refocused and funded to identify solutions to improve the safety of landing operations and reduce runway excursions from all causes. To accomplish that, an additional request to restart the examinations of runway excursions from unstable approaches, regardless of runway surface condition, will be made for the 2011-2012 timeframe.

Finding (8): The Subcommittee again emphasizes the need to support funding for FAA research facilities which serve not only FAA but are also resources for the world. It is important to ensure adequate funding and support not only for the modernization 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. The subcommittee recognizes the difficulties in providing needed significant funding out of a limited Aircraft Safety R&D budget. The massive building program that transformed NAFEC into the FAA Technical Center in the mid-1970s is an example of what can be accomplished when all elements of the FAA pull together and think "out of the box". The Pavement Test Facility is another example on a lesser scale of what can be accomplished with good planning and a commitment.

Recommendation: The Subcommittee recommends that FAA undertake a R&D Facilities Needs Review to answer the following questions:

1) What facilities need to be upgraded?
2) What facilities need to be replaced?
3) What facilities are no longer required?

4) What capabilities are required to address future requirements and when will they be required?
5) Where should they be located?
6) Costs and schedules
7) Capital Investment funding Options
8) Operation and maintenance options, private versus public

FAA Response: We agree with the Subcommittee that an assessment of the FAA R&D facilities would be beneficial. This will be a complex undertaking, involving multiple lines of business, and some of the information the Subcommittee suggested be included will not be easy to define or obtain. However, we do believe that all those elements do need to be addressed by the FAA.

We will develop a plan for conducting the assessment. The plan will identify pertinent stakeholders and their responsibilities and include a timeline for completing the assessment. We will present the plan to the Subcommittee at the March 2011 meeting for your feedback.

Finding (9): The Subcommittee remains concerned that several research programs lack a sufficient level of technical expertise to ensure success. Within the Aircraft Safety Program, the Software/Digital Systems Program, the Icing Program and Unmanned Aircraft Systems are examples of where there are needs for increased core competency.

Recommendation: The Subcommittee recommends that developing an R&D core competency and high quality R&D technical workforce continue to be a high FAA priority.

FAA Response: To address your concern related to developing the core competency and technical workforce in 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 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 this month.

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. 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. In addition, the Airport and Aircraft Safety Group has realigned its organizational structure to better meet future demands in aviation research.

Finding (10): The Subcommittee believes it would be helpful for FAA and the industry to draw a clear distinction between two areas of R,E&D activity under its purview. Both are vitally important. The first areas are those in which FAA or its partners do the lead work in developing new knowledge – such as in icing, fire safety research, wake vortex issues, fatigue measurements, - and many others.

The other areas, equally important, are work efforts in which the basic work may have been done, or is being done in industry, but where FAA’s efforts are needed to synthesize research of others to inform FAA of needed regulatory and processes, and where, this FAA expertise is essential. Some of this work may point to specific needed efforts of research.

Recommendation: The SAS believes it would be worthwhile for FAA to draw a clear distinction between the two areas of work so that both can be better understood and supported by the responsible and interested parties.

FAA Response: The FAA agrees that it is important to clearly identify the purpose of each requirement within the Aviation Safety Research Program, ensuring that it is clearly understood and supported by responsible and interested parties. All aviation safety research and development addresses needs identified by the FAA. For example, each AVS research requirement identifies the basic problem that needs to be solved and the steps the FAA will use to implement the research results to successfully address the problem. Requirements also define the responsible performers and sponsors to ensure that all parties understand and support the research requirements. Thus, we do not feel that there is additional benefit in segregating our research as suggested by the Subcommittee.

1.6 NAS Operations Subcommittee

Finding (1): Reviewing the FAA’s NextGen research portfolio continues to be very difficult, particularly with regard to demonstrable connections between the research elements being briefed and the development of required NextGen attributes while eliminating existing gaps in technology and policy. First, the linkages of the research to a needed NextGen requirement, the basis for that requirement, and the costs, anticipated benefits and priority of the research activity, are rarely evident in the briefings. New concepts for NextGen should be linked to the needs of the key customers and stakeholders outside of the FAA, and explicitly incorporate the interests and capabilities of each; this linkage is also rarely evident in the briefings. Several of the specific findings and recommendations from this briefing stem from the difficulty of finding these linkages.

Recommendation: The Solution Set taxonomy the FAA has adopted may be a useful construct in which to define the NextGen R&D program and to brief its research activities, and NASOPS recommends trying this approach. The R&D program should articulate clearly the intended roles and responsibilities of the customers and stakeholders as a basis for performing needs assessments, defining resulting NextGen system design requirements, and conducting operational demonstrations to achieve system performance metrics. The costs and anticipated benefits of projects or research elements that make up the program should be explained, and their prioritization to develop the system should be defined. NASOPS recommends that the I&I Coordinator should be included in briefings to REDAC, and address the issues of (1) stakeholder/customer involvement across the portfolio, (2) connection of the ongoing research to specific NextGen needs, and (3), the extent to which research concepts will be validated in operational demonstrations to demonstrate system performance improvements. The individuals performing the work should, in the briefings, link the individual research activities that comprise the solution set back to these considerations. This connectivity will assure the REDAC of the strategic alignment needed and ensures the same internally within the FAA.

FAA Response: The FAA agrees that the targets for research activities (i.e., goals, timelines, etc.), the anticipated value, and anticipated transition into the F&E development portfolio should be more clearly articulated. NextGen related components of the R,E&D portfolio target longer term needs and are intended to explore concepts. Consequently, by its very nature, research work does not lend itself well to the development of detailed assessments, such as capability cost and benefits. The requested details expand beyond the maturity level of most research activities. However, the FAA recognizes the need to more carefully construct briefings of NextGen related research contained in the R,E&D portfolio.

Finding (2): The subcommittee was appreciative of the presentations discussing CAASD’s work in Collaborative ATM, which included IDRP, Probabilistic TFM, Flow Contingency Management, and High Density Area Departure/Arrival Management. While all of the work presented had demonstrable value, it was clearly limited to an internal ANSP focus. The subcommittee was not presented with any research on advanced collaboration capabilities to enable increased user/operator roles in addressing capacity constraints and limitations.

Recommendation: It is essential that user engagement in true collaboration be emphasized fully in the research. The subcommittee recommends that the FAA research focus, including the work program at CAASD, have a more balanced approach that gives greater weight to the participation and leverage of the NAS operator’s role in collaborative ATM. Specific example emphases might include:

1) Greater emphasis on enabling the operators to provide a first response to the adjustment, clarification, and balancing of demand to meet and alleviate constraints and limitations.
2) Greater emphasis on negotiations of constraints, slots, trajectories and throughput between ANSP and operators to allow fleet-wide optimization, with less focus on reactive and/or unilateral actions by the ANSP.

3) Mapping specific linkages between the NextGen CATM solution set and the research, including that in the CAASD work program

FAA Response: The FAA appreciates the comments of the committee and assures the committee that these elements are part of the considerations in the FAA's interactions with the community on TFM development. This work is funded either directly as part of the programs developmental baseline or as part of the pre-implementation development work supported in the solutions sets. The CAASD work was presented to the committee as information taking advantage of the opportunity afforded by the meeting being held at MITRE facilities. The CAASD efforts do not represent the totality of the FAA's developmental work in Collaborative ATM nor does it indicate the level of engagement with the CDM community. The FAA continues to plan and coordinate all changes to traffic flow management with the community through the CDM working group.

Finding (3): The briefing on incremental, probabilistic, congestion resolution was well received by the subcommittee. The work provides a very useful framework for conceptualizing next generation traffic flow management during severe weather conditions. The subcommittee is aware that the FAA has agreed to develop CATM capabilities in their response to the RTCA TF5 report, but has not been briefed on the progress or the scope of this effort. The subcommittee did express an interest in moving the concepts forward more rapidly with an aim towards prototyping, high fidelity simulation and, eventually, operational evaluation.

Recommendation: The FAA should:

1) Develop a detailed research and implementation roadmap within the NextGen CATM program and solidify necessary multiyear funding resources. Broaden the research team to include outside expertise in areas such as ensemble weather forecasting, airline operations decision making and terminal and en route capacity impact modeling.
2) Refine and validate methods for probabilistic weather forecasting as applied to this concept. The aviation weather forecasting community is currently experimenting with various ensemble techniques for characterizing forecast uncertainty. The efficacy of these methods relative to this concept of use should be rigorously assessed.
3) Refine and validate methods for "weather impact translation" as applied to capacity forecasting for en route sectors (e.g. dynamic MAP values), individual flows, terminal airspace and airports. This is a big job and will require participation from multiple research organizations as well as the operational community, working in an integrated, cross-research manner, from fundamental research in weather, to means of translation to ATM tactical and strategic decision aids.
4) Articulate and validate the concepts for Traffic Management Initiatives (TMI) that would be used to incrementally adjust demand relative to constrained resources. It is not clear that today's TMIs (e.g. ground delay or ground stops, airspace flow programs, miles or minutes in trail) would support this incremental congestion resolution concept effectively.

Incorporate, as a key element of the concept, the impact of airline operators in modulating demand in response to forecasts of reduced capacity. As with several of the briefings, the subcommittee felt that the work did not adequately consider the essential role of the operator in developing solutions to the capacity-demand imbalance. Operational demonstration with airline operators will be key to entrain users in concept validation.

FAA Response: The FAA appreciates the recommendations from the subcommittee and will take those related to additional research requirements into consideration as it formulates its RE&D weather portfolio. The Reduced Weather Impact Solution Set has initiated work to incorporate existing weather translation research products into services for FAA Decision Support Tools. The implementation of weather products into the NAS is included in the NextGen Segment Implementation Plan which provides a detailed view of the allocation of ATM functions including weather products to NAS systems.

Finding (4): As examples of areas in which the user/operator community is supportive of expediting the implementation of FAA research, the subcommittee heard two briefings of specific interest. Although not covered in the weather briefing, operators are currently using their own wind estimates for TOD computations, which could lead to a variety of "optimal" descent profiles. In a different area, the subcommittee was pleased with the presentations of the research on Relative Position Indicator (RPI) and Automation for Monitoring RNP/RNAV Operations (AMRO) tools. These tools will assist Air Traffic Control in utilizing these procedures and delivering the benefits of the RNP/RNAV procedures. Since RNP/RNAV procedures are currently being developed, expediting these automation tools would accelerate benefits in environment and fuel consumption to appropriately equipped users.

Recommendation: FAA, in conjunction with the NWS who generates the core wind data, should work with the user/operator community to ensure that consistent, certified wind information is provided to equipped operators for use in developing descent profiles. FAA and CAASD should expedite the development and implementation of the Relative Position Indicator (RPI) and the Automation for Monitoring RNP/RNAV Operations (AMRO) tools to enable full use of these procedures.

FAA Response: The FAA has within its FY 2011 budget request funding to move forward with RPI and other controller aids to support more extensive development and use of RNAV and RNP procedures. The FAA has ongoing research on trajectory prediction and performance especially sensitivity to wind information as well as on the availability of information in-flight to the flight deck for improved planning including Top of Descent. These activities are being funded through the CLEEN initiatives and the New ATM Requirements research. The FAA is collaborating with the National Weather Service (NWS) on improved winds aloft predictions with NWS responsible for the core wind data and requirements being developed by the FAA.

Finding (5): TCAS has been a significant safety element in the National Airspace System since first deployed in 1993. Its design was carefully coordinated with existing ATM procedures to minimize false alarms while reducing the risk of midair collisions. As NextGen introduces new procedures, it is appropriate to consider whether TCAS will continue to operate effectively while maintaining an acceptably low false alarm rate. The NASOPS Subcommittee was briefed on a new IRAD CAASD program to explore changes to TCAS surveillance, communications and threat logic to achieve compatibility with proposed NextGen flight procedures while preserving its collision avoidance capability. For example, a 2008 CAASD study concluded that of twelve proposed NextGen procedures in Oceanic/Non-Radar, Enroute and Terminal airspace, six would probably not increase the chances of unwanted TCAS Resolution Advisories, four might increase them and two would likely increase them.

Recommendation: The subcommittee applauds the CAASD NextCAS IRAD effort, but modifying TCAS or creating a new collision avoidance system to achieve compatibility with NextGen would be a particularly complex problem, and that work would need to be based on a clear understanding of changed requirements and be a mainstream activity within CAASD's FAA-funded work program, to be done in concert with existing TCAS experts at FAA, MIT/LL and other organizations.

FAA Response: The FAA agrees that any potential changes to TCAS need to be coordinated with all of the current TCAS experts. Through ASIAS, the FAA has identified several areas where the current NAS operations are already incompatible with TCAS algorithms; the number of such areas may increase with NextGen operations. As such, the FAA requested that RTCA convene a committee to develop recommendations on future collision-avoidance system(s) that would be compatible with TCAS II, be more compatible with operations in congested airspace, and integrate ADS-B data effectively. This work is underway in Special Committee 147 and is supported by FAA, MITRE, Massachusetts Institute of Technology Lincoln Labs and other organizations.

Finding (6): The CAASD analysis to determine how many sectors might lend themselves to generic airspace operations did not consider a mix of aircraft that is different from today's mix and did not consider the possible introduction of trajectory based operation (TBO). The Subcommittee believes that in the timeframe when generic airspace might be implemented, there will be a greater diversity of aircraft flying at high altitudes (RJs for example). This mix of aircraft might well change the eligibility of a sector for generic airspace operation. The analysis assumed the current sector layout, but it is likely that the current sector layout could well change because of TBO.

Recommendation: To get a more realistic assessment of how many sectors lend themselves to generic airspace operation, the analysis should be repeated, taking into account the fleet mix that might be expected at high altitude and possible changes, such as new sector boundaries, resulting from TBO.

FAA Response: We concur with the Subcommittee and anticipate a much greater diversity in traffic mix in the midterm timeframe than is evident in today's NAS. This dynamic variable most certainly holds important implications in the modeling and implementation of NextGen. One objective of the initial MITRE evaluation was to investigate opportunities for early rollout of some aspects of the NextGen generic airspace concept. As such, the traffic modeled did reflect current NAS characteristics. Future activities will consider the transition in NAS traffic diversity, volume, and other important characteristics. The FAA has additional analyses planned along the lines recommended by the NAS Ops Subcommittee. We will continue to evaluate these and other research considerations through mini-human-in-the-loop (HITL) simulations, cognitive walk-throughs, fast-time modeling, and other techniques. The specific conditions and traffic models used in this and other research efforts will be determined based on products of the NextGen Project office, ongoing research efforts, and other relevant activities. When the NextGen high altitude concept is finalized, the FAA will conduct a high-fidelity, fully-integrated HITL simulation to validate its viability. This evaluation will take into consideration the impact of aircraft mix, TBO, NextGen tools, and other factors on air traffic controller performance in generic and non-generic sectors.

Finding (7): As briefed, it appeared that CAASD's System-Wide Model is perhaps two generations beyond the NASPAC tool currently in use by the FAA. The subcommittee would like to understand the FAA plans for adopting the System-Wide Model as a NASPAC update, if doing so is, in fact, the case.

Related Finding: In existing modeling and simulation tools (*e.g.,* NASPAC, System-Wide Model, ACES), there is a gap in the ability to account for the effects of dynamically changing 4D trajectories on NAS performance. Such ability is required to assess the impacts of weather avoidance field dynamics, traffic flow dynamics, and airspace dynamics, for example, on NAS capacity and safety. Additionally, the modeling of NAS demand and operations with tools such as FATE, NASPAC, System-Wide Model, ACES, and others focuses on IFR traffic between a limited number of U.S. airports. Specifically, the modeling has limited accounting for the effects of VFR and VFR-Flight-Following operations predominantly by Part 135/91 operations, on total system capacity, workloads, and safety. The ability to model these effects and operations is important to the future implementation of trajectory-based operations of the NAS.

Recommendation: The subcommittee requests the FAA to provide it with a strategic view of the modeling and simulation needs for NextGen, contrasted with the tools currently available. The FAA should begin to develop modeling and simulation capabilities and related requirements for analyzing the effects of dynamically changing 4D trajectories on NAS performance, in accounting for the VFR operations and UAS operations, and in accounting for operations at airports not currently included in NAS modeling tools.

FAA Response: The FAA agrees that a sophisticated fast-time modeling capability is critical for making the right decisions regarding NextGen investments. CAASD's System-Wide Modeler is a state-of-the-art fast-time NAS model, and is used by CAASD to support the FAA in various activities. However, System-Wide Modeler is a proprietary tool of the MITRE Corporation. It is the FAA's policy to use public domain, open source models for decision-making whenever possible. This policy is aligned with President Obama's goal of a more transparent Government. For this reason the FAA has been investing considerable resources over the last few years to modernize its NASPAC model. In 2009 the FAA's NAS Modeling Group briefed the NAS Operations Subcommittee on their strategy for upgrading this model. Every component of the legacy NASPAC model has now been replaced. The FAA is therefore unveiling the new System-Wide Analysis Capability (SWAC). SWAC is open source software, developed with modern languages and design principles, that runs extremely fast on a single personal computer. SWAC incorporates several features not available in CAASD's System-Wide Modeler. While SWAC is now operational, additional development is planned in order to add a number of features not found in other system-wide models, such as Monte Carlo capability. The FAA looks forward to the opportunity to brief the NAS Operations Subcommittee on the status of and plans for this model.

The NAS Operations Subcommittee is concerned about the extent of IFR, VFR, and UAS traffic modeled by the FAA. The FAA modeling process accounts for *all* IFR traffic that departs, arrives, or transits U.S. airspace, including oceanic airspace. Additionally, the FAA model includes all VFR traffic at the “capacitated” airports. The SWAC model currently represents 110 airports with finite capacities, though it can accommodate an unlimited number of capacitated airports. Based on the REDAC recommendation, the FAA will make plans to increase the number of such airports. VFR flight following could easily be represented in the model, but no data is available indicating the quantity and disposition of this traffic. Similarly, UASs can be accommodated within the SWAC model. However, there is tremendous uncertainty on how these vehicles will operate in the NAS, in what numbers, and when. As soon as a reliable forecast of UAS operations is produced, these vehicles will be represented in the FAA’s model.

The FAA agrees with the REDAC observation that 4D trajectory management is a limitation of all current system-wide models, making it difficult to analyze the impact of this fundamental aspect of the NextGen concept of operations. The FAA will investigate means to account for 4D trajectory management in its model, and use other models if necessary.

Finding (8): The subcommittee is encouraged that the FAA has developed an initial Weather-ATM integration plan. To initiate the implementation of integrated weather-ATM capabilities, however, the FAA needs to develop a detailed implementation plan that ensures needed activities are in place to support investment decisions. The subcommittee was pleased to see that FAA and NWS have made substantial progress in defining clear roles and responsibilities, as illustrated in the FAA briefing figure which identifies the four key functions: 1) developing and maintaining the NWS 4D weather cube, 2) determining potential weather constraints on NAS resources, 3) assessing ATM impacts, and 4), developing proposed mitigations. This framework is a positive step forward in defining roles and responsibilities between the NWS and FAA meteorological communities, and ATM stakeholders. The committee notes, however, that weather research in the FAA and NWS should not be firewalled from Wx-ATM integration research, which would be directly counter to the integrated research processes emphasized in the Weather – Air Traffic Management (ATM) Integration Working Group (WAIWG) Report of the National Airspace System (NAS) Operations Subcommittee of the FAA’s Research, Engineering and Development Advisory Committee (REDAC).

Recommendation: The FAA should develop a detailed weather-ATM integration implementation plan, consistent with the JPDO strategy for NextGen weather improvements, that ensures requirements are established, develops needed operational concepts, and establishes a clear business case for weather-ATM integration investments. This detailed plan should address needed activities across FAA lines of business and identify needed external stakeholder actions. Specific suggestions include:

1) Improve coordination between NWS, AJP, AJW and NextGen I&I office in developing foundational NextGen weather capabilities (forecasts, processing, distribution)
2) Improve the process for coordinating weather-ATM concept development and demonstration projects across AJP and AJR. RAPT/IDRP is a successful example. Analogous projects dealing with weather impacts on strategic traffic flow management, time-based metering, en route conflict-probe and high-density arrival management are needed
3) Empower traffic flow management researchers to exploit experimental strategic forecast products like Consolidated Storm Prediction for Aviation (CoSPA) for the development and demonstration of advanced concepts, in conjunction with weather researchers
4) Articulate commitments to all of the user community by demonstrations for near and mid-term advances in operational weather capability

FAA Response: The FAA has moved to improve its integration of weather into decisions making by more carefully defining roles, responsibilities, and leadership for each of the four functions. The assignment of leadership is not intended to be a barrier to cooperation and participation of either NWS or any part of the FAA's weather and decision support community. In fact the FAA welcomes and expects participation in the three phases for which it has primary responsibility and welcomes the opportunity to participate with NWS on the function that they lead. The FAA is using this construct to better allocate functionality to its systems and improve the efficiency of implementation as well as the long term maintenance.

The FAA continues to use well defined demonstrations with respect to performance and duration to evaluate advanced capabilities. We conducted two this summer including CoSPA and are currently evaluating the results. Any demonstration tool can have both an F&E and operational cost if the experiment is not well defined and the criteria for performance clearly set. The basis for the demonstration, the parties to the demonstration, and the goals for the demonstration need to be well understood by all participants before commencing.

Finding (9): The Subcommittee received an interesting briefing on the development of Metroplex study teams in preparation for NextGen. While the studies are, appropriately, focused on areas recommended by the RTCA, some early work on these complex airspaces has been accomplished by NASA, and the FAA has not utilized that work. Doing so might permit a more aggressive approach to addressing some of the more complex situations than those currently under consideration. Additionally, the committee was struck by the FAA's desire to examine situations in which they would not need to comply with NEPA requirements to perform an Environmental Assessment (EA) or Environmental Impact Statement (EIS) for new airspace usage because of the time associated with such a requirement. As the committee has noted before, the FAA needs to find a way to streamline compliance with NEPA requirements for new routings, as well as to give credit for offsetting savings. Similarly, in the Metroplex environment, it is clear that separation standards will need to be addressed from the same perspective of developing approaches to tackle complex challenges.

Recommendation: The FAA should not shy away from addressing these long-pole issues in the Metroplex studies, as solving them now will enable much faster implementation of possible NextGen improvements and savings.

FAA Response: Part of the Metroplex Study Team process involves surveying each Metroplex area to determine ongoing research and planned improvements. As an example, the Prototype North Texas Metroplex Team has been coordinating with the NextGen demonstration efforts at the NASA Texas Test Bed to identify opportunities to leverage new technologies and align enhancement opportunities and proposals. Any other specifically applicable research will be considered in a similar vein. In addition, the Metroplex Airspace and Procedures Optimization effort is focused on first identifying problems, and then examining a range of solutions for addressing those issues. A full range of problems and solutions are evaluated by the Study Teams, including options that may require more comprehensive environmental reviews such as an EIS. Nevertheless, the focus of the Metroplex Airspace and Procedures Optimization work is on near-term improvements that can be implemented in two to three years, a focus of the RTCA recommendations. FAA intends to focus on quality over quantity, but also wants to implement PBN solutions in a timely manner. As a result, the Metroplex Optimization Design and Implementation Teams will be focusing on solutions that can be implemented with an Environmental Assessment (i.e., no significant environmental impacts), and FAA expects that streamlined environmental reviews of these proposals could be completed within 12-18 months. Solutions that may require longer environmental reviews or that may require longer time for evaluation, testing, and certification are still being considered; they are just not included as part of the near-term design and implementation effort. Solutions that require an EIS will likely be considered within a separate large-scale, clean-sheet redesign effort. Moreover, it is anticipated that each Metroplex will be examined on a recurring basis, so as solution options mature (including new separation standards), they can be incorporated into the next round of Metroplex Optimization improvements.

2.0 *REDAC Recommendations on the FY 2013 R&D Portfolio* (June 8, 2011)

The Committee Chairman, Dr. John Hansman, submitted REDAC's recommendations on the FY 2013 R&D portfolio to the Administrator on June, 8, 2011. The agency provided the following response to the recommendations on September 21, 2011.

2.1 General Observations

Prioritization Within the Research & Development Portfolio: It is anticipated that the difficult federal budget environment will create pressure to reduce the funding of research and development within the agency. In this environment it will be important to take a strategic approach to evaluating research and development activities in order to prioritize those activities which are most critical to the agencies mission or to the staged implementation of NextGen. The RED AC offers its assistance if it can be helpful in this process.

FAA Response: The FAA agrees with the RED AC that we need to use a strategic approach to define our R&D portfolio, particularly in the current environment of shrinking budgets. The FAA Research and Development Executive Board (REB) provides strategic oversight to the formulation of the FAA's R&D portfolio.

The R&D portfolio includes research funded by four appropriation accounts: Research, Engineering and Development R,E&D; Facilities and Equipment (F&E); Grants-In-Aid for Airports (AIP); and Operations (Ops). The REB members represent the senior executives of each line of business that sponsors research in each of the four appropriations. The REB ensures that the various iterations of the portfolio are reviewed and approved by FAA senior leaders in each sponsoring line of business, as well as by the Next Generation Air Transportation System (NextGen) Integration and Implementation Office, Air Traffic Organization (ATO) Executive Council, NextGen Review and Management Boards, and the FAA Joint Resources Council (JRC). This ensures a strategic, well-balanced portfolio that addresses the agency's needs. However, there is always room for improvement and under our "Foundation for Success" initiative, the FAA is reviewing the processes we use to make strategic budget decisions. Lastly, following the FAA internal review, each of the RED AC Subcommittees also reviews the portfolio within their subject area. That provides an opportunity for their input on criticality to the agency mission and implementation of NextGen.

Complexity of NextGen Research and Development Plans: The need to identify the high priority (critical path) research and development activities within NextGen highlights the need for a clear high level Research and Development plan that articulates the critical NextGen needs and links them to the R&D portfolio. The RED AC understands the challenge of defining such a plan for a complex system such as NextGen but has previously noted that the FAA plans and roadmaps do not articulate a high level vision and are so detailed and complex that they are intractable. This makes it difficult to evaluate if the necessary R&D is being accomplished, how R&D results will be used and which elements could be deferred to accommodate budget constraints. The RED AC reiterates its recommendation that a high level R&D plan be developed from the existing more detailed plans and enterprise architecture to articulate the R&D vision and identify the critical path of R&D for NextGen.

FAA Response: In response to the previous RED AC recommendation on this topic (RED AC Letter Fall 2010), the Office of Research and Technology Development (AJP-6) and the NextGen Integration and Implementation (I&I) Office developed a presentation to convey the critical aspects of the R&D portfolio to the RED AC without requiring an in-depth analysis. We described the NextGen research and development activities using existing plans and roadmaps linked to the FAA acquisition management system. This was combined with a presentation from the I&I Office on their portfolio management approach. This was presented to the NAS Operations (Ops) Subcommittee at their Spring 2011 meeting. Based on the feedback from the NAS Ops Subcommittee, additional presentations are being planned for future meetings to address this recommendation.

Concern on Level of Technical Expertise in Key Areas: As noted in prior recommendations 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 and it has been difficult to build and maintain the technical capabilities of the agency in these and other critical areas. The RED AC notes some limited progress (e.g. the reported hiring a chief scientific and technical advisor for software after a 5-year search) but *reiterates its now standing concern* that there has been inadequate progress in developing the core competency and technical workforce in this and other key areas. The RED AC recommends that a strategy be developed and executed to improve the ability of the FAA to compete in the market for highly desirable talent.

FAA Response: The FAA agrees that we have an important need for expertise in key areas such as critical software and digital systems and human factors both for certification and acquisition. Although we have made gains in some areas, as you noted, there are still remaining gaps. Unfortunately, it is unlikely that we will be able to hire any new employees in the near future with the current and foreseeable budget outlook and staffing ceilings. We will continue with our efforts in workforce development that will include plans to increase the level of technical expertise of existing personnel in key technical areas. In the interim, and as resources permit, we will continue to supplement our in-house expertise with contractor support in targeted technical areas. In this way, the salaries would be competitive with industry so that we could attract the right level of expertise. This would also allow us to maintain contractor staff with state-of-the-art knowledge in fields with rapid technological advancements, such as software and digital systems.

2.2 Subcommittee on Airports

Finding (1): The Subcommittee is very concerned over potential actions to move the Airport Technology Research Program and the Airport Cooperative Research Program from the AIP appropriation into the R, E and D appropriation. Both programs have grown and matured with the resources and attention provided by the Office of Airports (ARP) and the AIP appropriation. It would be a setback to put these programs back into annual competition for R, E and D funding with the other Lines of Business.

Recommendation: The Subcommittee believes it is critical to maintain this successful management and funding approach and recommends that FAA continue to support these programs in the AIP appropriation. Should, however, that prove unsuccessful, the committee recommends that FAA take administrative action to assure that the Office of Airports is designated to provide primary management control of these two important airport research programs.

FAA Response: We fully concur with the RED AC recommendation that funding support for the Airport Technology Research Program and the Airport Cooperative Research Program should continue to come from the AIP appropriation. If these programs are moved from the AIP to Research, Engineering and Development (RE&D) appropriation as proposed by the House FAA reauthorization bill, it will not be possible to fully fund the current ARP requirements because there are equally high priorities for research from the other lines of business already being funded in the RE&D appropriation. The ARP research requirements would have to compete for a share of total RE&D research dollars. With the RE&D funding facing reductions, it will be impossible to maintain the current level of the ARP research programs if they are moved to the RE&D appropriation. Once a total amount is determined for the AIP research, the Associate Administrator for Airports would retain management responsibility for oversight of the ARP research programs.

Finding (2): The Subcommittee would like to see more detailed milestone charts for projects instead of the standard "quad" funding charts.

Recommendation: The FAA should develop an example of an improved project tracking approach with milestones that will enable the Subcommittee to better understand the deliverables and project schedules. This should be briefed at the next Subcommittee meeting.

FAA Response: We concur with the RED AC recommendation. A project tracking schedule with deliverable milestones was presented to the Subcommittee at the August 10-11 meeting.

2.3 Subcommittee on Environment and Energy

Finding (1): One of the most promising areas of environmental research continues to be in the area of the development and certification of alternative aviation fuels. Such research will lead to reductions in emissions of C02 and air quality pollutants, and will promote energy security by reducing dependence on sources of foreign oil.

Recommendation: The ongoing CAAFI support and alternative fuels research effort must continue to be funded. At the present time, much of the alternative fuels research funding is included in the Agency's NextGen Research Engineering and Development (RE&D) account, an account that is in jeopardy under current budget scenarios. Faced with this situation, the Subcommittee recommends continuing CAAFI support through the "Core Research and Development" fund category to ensure at least a measure of funding in this area in the event of any future budget cuts.

FAA Response: The FAA agrees that alternative fuels research is a critical activity to meet environmental and energy sustainability goals. It is one of the highest priorities for the Environment and Energy portfolio. Commercial Aviation Alternative Fuels Initiative (CAAFI) has made significant progress toward deploying alternative jet fuels for commercial aviation, and the FAA will make every effort to continue supporting this effort.

Finding (2): Continued Operational Research is necessary to support the implementation of NextGen initiatives.

Recommendation: In order to be able to implement NextGen initiatives, continued funding must be available for continued Operational Research. Such research leads to both increased efficiency and improvements in environmental performance. A recent example of the importance of this research is the so-called "N Control" surface movement research at Boston's Logan Airport in which aircraft were selectively held at the gates to reduce time idling on taxiways as well as reduction in fuel burn and emissions. This initiative was hailed by everyone from airlines to air traffic controllers and may be ready for more general use in the near future. The Subcommittee recommends that such research activities, which lead to early implementation possibilities, be given a high priority in any necessary budget reductions.

FAA Response: The FAA agrees that advances in operational procedure research have potential for near-term implementation for efficiency and environmental benefits. This has been demonstrated through our Continuous Descent Approach (CDA) research program and now through N-Control surface movement research. In fact, due to its simplicity and the demonstrated significant environmental benefits of the N-Control concept at Boston Logan International Airport, a research paper on this concept was recognized as the 'best of the best' paper and presented with the Kevin Corker Award at the recently held joint FAA-Eurocontrol ATM-2011 seminar. The Office of Environment and Energy is working actively with the NextGen Implementation and Integration Office on the next phase of this project to develop the transition plan for its implementation. Given its strong potential for environmental benefits, estimated to be similar to benefits from CDA operational procedures, the FAA will give it a high priority in prioritizing our work program under reduced budget situations.

Finding (3): In the area of technology research, the ongoing CLEEN program to develop new aircraft and engine types with better environmental profiles shows great promise. However, since this program is dependent on funding appropriated after 2008, the entire program would be in jeopardy if Congress cuts funding to 2008 levels.

Recommendation: The Subcommittee recognizes the funding threat to the CLEEN program, but recommends, even in a worst case scenario, that the CLEEN office within the Office of Environment and Energy be maintained to work with NASA on possible continuing projects and to be available should future increased funding return. While the implementation of CLEEN projects is relatively far off, completely abandoning the program will push technology-based environmental initiatives too far into the future.

FAA Response: Traditionally technological improvements have led to reduction in aircraft noise, emissions and fuel burn. Continuous Lower Energy Emissions and Noise (CLEEN) program is following the same direction and has a greater near-term potential to deliver environmental benefits because of its focus on accelerated maturation of system and subsystem level technologies. The FAA will continue assessing the budget situation and prioritize the

CLEEN work program accordingly to maximize the return on our investment. Under the extreme budget reduction situation, we will strive to maintain the base CLEEN office so that we can maintain our communication and links with the National Aeronautics and Space Administration (NASA) aircraft technology programs, and revitalize the CLEEN program as funding opportunities improve.

Finding (4): United States leadership in the international community continues to be an important environmental priority, especially as the International Civil Aviation Organization (ICAO) debates the setting of a worldwide aircraft C02 emissions standard.

Recommendation: The Subcommittee strongly recommends that funding necessary to support ICAO activities continue. More specifically, the Agency's modeling activity (AEDT and APMT) should be supported to enable informed judgments to be made on all possible ICAO scenarios.

FAA Response: The FAA agrees with the subcommittee recommendation. Development and release of the Aviation Environmental Design Tool (AEDT) is certainly one of our top priorities. It enables more efficient and accurate modeling of all aviation environmental effects in an integrated manner. Besides supporting International Civil Aviation Organization (ICAO) activities, AEDT helps to streamline processes to meet domestic aviation environmental regulatory requirements. Likewise, the Aviation environmental Portfolio Management Tool (APMT) provides us the ability to perform cost-benefit analyses to inform domestic and international decision-making. The FAA will continue to closely monitor the budget situation and support development and application of both AEDT and APMT on a priority basis.

Finding (5): A few ongoing Environment and Energy projects should be given a relatively low priority and scaled back to permit continued activity in higher priority areas.

Recommendation: The Subcommittee recommends that work in the Aviation Climate Change Research Initiative (ACCRI), which concentrates on non-C02 climate effects, be deferred until a more robust funding stream becomes available. Similarly, research initiatives related to leaded AvGas should be scaled back and noise research should focus on policy issues, with field surveys to determine annoyance levels deferred until more funding becomes available.

FAA Response: The FAA appreciates the subcommittee's efforts to help us prioritize our environment and energy research. The projects you identify as high priority will be protected as much as possible. The FAA agrees that if funding resources are significantly reduced, climate research under ACCRI can be deferred. Although the FAA did reduce funding for leaded AvGas research in Fiscal Year 2011, the FAA remains committed to support this important work, which is under the purview of the Subcommittee on Aircraft Safety. The FAA also agrees that given the costs associated with noise research field surveys, this work will need to be deferred.

Finding (6): Current versions of the FAA Reauthorization Act provide that projects in the Airport Cooperative Research Project (ACRP) cannot be funded using AIP funds. If enacted, these provisions would require ACRP projects to be funded out of the core R&D pool of funds, thereby competing for funding with other, higher priority, items.

Recommendation: The Subcommittee recognized the problem of having ACRP projects compete with other funding priorities in the core RE&D pool. There was, however, no unanimity on what action could be taken to address the issue. The Subcommittee did agree, however, that it is important for the FAA to be aware of this problem.

FAA Response: The FAA concurs with the RED AC recognition that the Airport Cooperative Research Program will have a problem competing for funding if it is moved to the RE&D appropriation. With the RE&D funding facing reductions, it will be impossible to maintain the current level of the ACRP research programs. Once a total amount is determined for the ACRP research, the Associate Administrator for Airports would retain management responsibility for its oversight.

2.4 Subcommittee on Human Factors

Finding (1): The Human Factors Subcommittee was briefed on the Flight Deck and ATO Core and NextGen Human Factors programs. We found that their FY 2013 research portfolios and their underlying structure were appropriate to FAA's mission and covered the area of need as understood by the subcommittee, with the exception listed in the subsequent Finding. In particular, the Subcommittee was impressed that other entities within the FAA are actively coordinating with, or seeking human factors input from, specialists in human factors including the FAA Human Factors Research and Engineering Group (HFREG, AJP-61), especially related to NextGen activities. We were also pleased that technically-knowledgeable personnel have been recruited to support these efforts.

Recommendation: We recommend that the human factors community within FAA continue their work in the areas presented, and that the funding continue at (at least) current levels in both programs.

FAA Response: AJP-61 will continue to coordinate actively with other entities across the FAA to facilitate the integration of human factors in support of its mission to generate and apply new knowledge about human capabilities for effective performance. We will continue in hiring high caliber professionals and leverage the best expertise and resources in the human factors community for executing the Flight Deck and ATO Core and NextGen programs to best apply the funding available.

Finding (2): The Human Factors Subcommittee recently received a briefing on the AVS prioritization of research, and we applaud the efforts of AVS to provide a consistent method to prioritize critical R&D dollars. However, we were severely dismayed that the process results in a 90% reduction of FAA human factor core RE&D funding for contracts in FY13 relative to recent levels, far greater, for example, than the -1.5% reduction of overall AVS funds from FY12 to FY13, and does not allow for the continuation of on-going research areas. This level of funding will effectively end research in critical areas that cannot leverage NextGen funding and research (e.g., research into human factors in maintenance, including fatigue risk management), and may have long-term effects on the maintenance of facilities such as those at the Civil Aerospace Medical Institute (CAMI).

We are extremely concerned with the results of this prioritization effort and the negative trend of human factor R&D funding. Human factors remain a significant factor in the majority of aircraft accidents and incidents and is a priority in the FAA Flight Plan. In addition, external reviews of FAA Programs consistently support increased funding for human factors. Thus, this reduction is inconsistent with FAA's documented research priorities.

Recommendation (2a): This subcommittee strongly recommends the FAA Associate Administrator for Aviation Safety (AVS-1) conduct a thorough review of the recent prioritization results relative to pressing safety concerns and strategic goals. The subcommittee also strongly recommends that the FAA reverse the negative trend in contract funding of core human factors R&D to instead establish a funding level that is appropriately balanced with the core funding needs for human factors R&D, particularly in areas that cannot leverage off NextGen research. To not do this, we believe, will jeopardize the safety of both current operations and future operations involving new technologies and operations with foreseeable human factors concerns.

FAA Response (2a): AVS thanks the Human Factors (HF) Subcommittee for the opportunity to brief the AVS R&D Prioritization Process at your March 2011 meeting. As briefed to the HF Subcommittee, the portfolio is subjected to a series of iterative reviews, concluding with a review by the AVS Senior Management Team. AVS believes the current process correctly prioritized research funding relative to the requirements submitted for prioritization. Nonetheless, AVS is concerned with the current trend in HF research. In support of the FY 2014 R&D portfolio development, AVS has committed additional resources to identifying and developing HF requirements. We believe this additional attention will ensure that potential safety critical HF topics will be appropriately represented in the final AVS portfolio. AVS is committed to conducting research focused upon and responsive to the highest priority aviation safety needs. We are confident that the AVS R&D Prioritization Process will continue to effectively support this goal.

Recommendation (2b): Two changes should be made within the administration of the AVS prioritization process. (1) Increased transparency is recommended for how the research requirements initially established by all the TCRGs are evaluated and selected, so that the final prioritization of the requirements, and the metrics assigned to each research requirement, are clear and not perceived as arbitrary. Specifically, at a minimum the initial and final AVP ratings used to select amongst the research requirements recommended by the TCRGs should be provided, with additional feedback as to the basis for the ratings. This information should be provided for funded and unfunded requirements. (2) There have been wide swings in the prioritization of requirements compared to allocations of contract funding to some of the BLIs. Of note here, the funding level for flight deck human factors varies dramatically across Fiscal Years 2011, 2012 and 2013. The AVS prioritization process needs to ensure the stability in funding between fiscal years required to foster quality research, to prevent the unnecessary application of short-term research methods where longer-term evaluations are required, and to prevent unnecessarily complication of research planning and execution, and to examine the effect of between-year changes in upcoming research funding in terms of the impact on planned human factors research.

FAA Response (2b): Regarding recommended change (1), the evaluation scores for each FY 2013 requirement have been posted to the AVS R&D Requirements Portfolio Web site, which is accessible by the HF research sponsors and performers. Evaluation feedback has been provided to the sponsor and the Technical Community Representative Group (TCRG) at their request. Line-by-line feedback on two of the HF requirements was provided to the HF TCRG, feedback that is generally applicable to the wider set of HF requirements.

Regarding recommended change (2), the funding levels in each fiscal year are in line with the relative shift in priorities of AVS R&D requirements. Funding levels in FY 2014 will be established using the AVS prioritization process. We agree that stable funding is helpful and as briefed to the HF subcommittee at the March 2011 meeting, the AVS process contains provisions for multi-year programming of funds for research requirements that meet defined prerequisites. In fact, a third of the requirements in the FY 2013 AVS portfolio were funded for multiple years.

Finding (3): The Human Factors subcommittee was first briefed on the NextGen Weather Technology in the Cockpit in August 2010 at which point it was is in the process of re-planning in response to earlier recommendations made by other subcommittees. Since the August briefing, significant changes have additionally been made in senior personnel. Although the briefing provided in this cycle (March 2011) provided more detail about specific human factors research activities and interaction with the community, the overall recommendation made in Fall 2010 was not fully addressed: i.e., the vision, intended deliverables and anticipated customers are not consistently and clearly articulated, including the appropriate role of government in this area, and the project should be evaluated as to whether it has the appropriate level of resources and staffing.

Recommendation: The previous recommendation provided Fall 2010 remains open. *As in earlier recommendations, the Human Factors Subcommittee continues to strongly recommend to the Director of Research and Technology Development that the vision, intended deliverables and anticipated customers be clearly articulated. The role of government research in this area needs to be carefully examined, as should whether an isolated program called Weather Technology in the Cockpit is more appropriate than broader inclusion of weather concerns in other NextGen programs including the HFREG flight deck program. An expert review of the project is warranted. Following that, the project should be resourced and staffed appropriately to its goals and intended impact, as judged relative to budget cuts in other NextGen research areas.*

FAA Response: The FAA agrees with the Human Factors subcommittee recommendation that the vision, intended deliverables, and anticipated customers for the Weather Technology in the Cockpit (WTIC) program be more clearly articulated, and that the role of Government research in the WTIC areas be closely examined. In response to these recommendations, the FAA has begun to review the WTIC program and has engaged key NextGen program stakeholders and sponsors to ensure program initiatives support specific Operational Improvements (OIs) and their implementation roadmaps. To identify specific customers for WTIC research, the program has engaged roadmap architects and program management from various NextGen solution sets to ensure that WTIC research supports their initiatives. To more clearly articulate the vision of the program, detailed reviews of WTIC projects have commenced to ensure that each project is focused on a specific goal with tangible success criteria. Detailed project plans and schedules are being developed as part of this review and process improvement to address the subcommittee's recommendations. In response to the recommendation that the program more clearly define its deliverables, this documentation identifies the intended deliverables and delivery schedule for each WTIC project and will be available for a review by the RED AC committee at the next committee meeting.

Finding (4): We were very pleased and impressed with the presentation given by Kathy Abbott regarding the recent multi-year study completed by the Performance Based Operation Advisory Rulemaking Committee/Commercial Aviation Safety Team (PARC/CAST) Flight Deck Automation Working Group. Many of the study findings discussed appear to have great importance and significant implications for several activities, including the design and functioning of flight deck automation and its use, pilot training, air carrier policies and operations, and system certification. Thus, we are concerned that this long promised report and its findings have not yet been distributed or made available to the larger aviation community.

Recommendation: We strongly recommend that the FAA compel the completion of the review process for the final report of this work and its findings, and disseminate the report to the international aviation community as quickly as possible to allow for timely response to its safety implications.

FAA Response: The FAA concurs with the recommendation to complete the PARC/CAST Flight Deck Automation Working Group (WG) report as quickly as possible. The PARC/CAST WG members have completed an initial draft of the report and are working with the FAA and industry team to finalize the report. WG members reviewed an updated draft on August 31.

2.5 Subcommittee on Aircraft Safety

Finding (1): The Aircraft Safety Subcommittee recognizes that as the nation's air transportation system moves to NextGen, the demands for digital systems will continue to grow. The comprehensive deep dive presentation in Software and Digital Systems Safety (SDSS) found FAA to be responsive to previous subcommittee recommendations. While it is evident that FAA is pursuing and executing the needed R&D in this rapidly evolving area, the subcommittee remains concerned that FAA in-house capability lags behind the needs. Further, it remains unclear to SAS how the knowledge gained from this work will be applied to improve FAA's ability to support policy, regulation, and certification of new digital system designs.

Recommendation: The subcommittee recommends that at the next meeting (August 23-25) the FAA present its plan to further build and maintain a capability to manage the breadth of SDSS R&D activities, beginning with the investments in R&D and moving the various R&D products into support of certification. This plan should include a review of the technical and project management skills resident in FAA research personnel, the approach to leveraging outside capability to obtain missing skills, and FAA management's plan to maintain those skills. Second, it should include an overview of past and current SDSS research efforts, their requirements, relevant milestones, level of performance, results, and an outline of how the results will be used to support policy and certification. Third, the plan should lay out a roadmap for the management of potential R&D to support future needs in complex, digital systems.

FAA Response: The FAA presented its plan to manage the Software and Digital Systems (SDS) program at the August 2011 meeting of the Subcommittee on Aircraft Safety (SAS). The plan includes a review of FAA's current technical and program management skills, recent efforts to improve in-house expertise, and research partnerships that bridge current skill gaps. Past and current SDS requirements, research results, and current activities will be mapped to regulatory policy and certification actions. Lastly, the presentation addressed the management challenges and FAA plans to support SDS needs in complex digital systems.

Finding (2): The Aircraft Safety Subcommittee supports the research being performed in the area of Terminal Area Safety and finds it is well structured and relevant. The stall recovery training research is progressing well with clear recognition of the degree of difficulty in accurately simulating this little explored and data lean flight regime. The subcommittee would like to see action taken to assure very close coordination between this research and that of the Flight Control Mechanical Systems area as synergy opportunities exist. The runway friction research aimed at reducing runway excursions needs to be complemented with continued research into how to prevent other causes of excursions such as unstable approaches. Performance Based Navigation (PBN) research is progressing well in a critical area with more to be done.

Recommendation: The subcommittee recommends that future PBN research include analysis of the performance improvements of NextGen satellite-based navigation solutions (e.g., RNP, SBAS, GBAS) over classic navigation sensors (e.g., ILS). This analysis, which should include RNP to GBAS approach and landing operations, should result in data that can be applied to regulatory criteria that establish operational advantages (e.g., lower landing minima) for these NextGen capabilities.

FAA Response: The FAA agrees that the future PBN research should include analysis of the performance improvements of NextGen satellite-based navigation solutions over classic navigation sensors. Current PBN evaluation of radius-to-fix terminator during RNP departure will be completed in FY 2012. The PBN analyses of satellite-based navigation solutions will be addressed outside of the TAS RE&D program after FY 2012.

Finding (3): The Aircraft Safety Subcommittee is pleased to note that FAA has taken steps to establish a Volcanic Ash research approach to better define the operational requirements for the reporting and forecasting of volcanic eruptions which in turn would support the establishment of international guidance for operations in the vicinity of volcanic ash.

Recommendation: The subcommittee again recommends that the Volcanic Ash Research Program be expanded to include the identification of ash tolerance levels for aircraft, engines, and passengers.

FAA Response: The FAA remains vigilant over potential aviation safety hazards from volcanic ash. As recent events have demonstrated, volcanic activity can be highly disruptive to air travel. Current policies that rely on the avoidance of volcanic ash exposure have resulted in safe and accident free air travel. The international community continues to carefully study this issue through groups such as the ICAO Volcanic Ash Task Force (IVATF), in which the FAA participates. It is expected that the activities and discussions will lead to a consolidated definition of the issue(s) and perhaps potential steps to establish ash tolerance thresholds. The FAA will continue to work with the international community and will appropriately support research that is determined necessary to support agreed upon safety objectives. Meanwhile, the FAA will continue our policy of avoidance.

Finding (4): The Subcommittee agrees that the two tasks proposed to address Loss of Control (LoC) accidents are of high priority and should be pursued. The Subcommittee is also aware that requirements are still being defined outside of the FAA within joint government/industry activities such as the Low Speed Alerting Advisory Rulemaking Committee. Consequently, the Subcommittee is concerned that the current proposed funding may not be at levels to effectively address requirements forthcoming from the government/industry subject matter experts who are currently studying the issue of LoC. In addition the Subcommittee feels that better collaboration with the aircraft manufactures will be needed as the FAA studies methods to address stall departure identification, recognition, and recovery technologies.

Recommendation: The FAA AVS sponsors for the Flight Control Mechanical Systems should work to ensure close coordination with other ongoing activities such as the Low Speed Alerting ARC to ensure their findings and recommendations are factored into the next fiscal year funding cycle.

FAA Response: The FAA concurs with the recommendation. Currently we are coordinating directly with the Aviation Rulemaking Advisory Committee (ARAC) on the subject of low speed alerting through linking members from the Flight Control Mechanical Systems (FCMS) Technical Community Representative Group (TCRG) who serve on the ARAC Avionics Systems Harmonization Working Group, which is responsible for supporting the FAA tasking on low speed alerting. Through linking members from the FCMS TCRG, we are coordinating with work currently underway by the Commercial Aviation Safety Team (CAST) on airplane state awareness and with advanced simulation initiatives such as the International Committee for Aviation Training in Extended Envelopes (ICATEE) and Simulation of Upset Recovery in Aviation (SUPRA).

Through our partnership with NASA, we will access their advanced simulation model and participate in validation research already underway in the NASA Aviation Safety Program. We believe such coordination will reduce the direct cost of the research to both the FAA and NASA. We will also actively coordinate industry partners to share their expertise and resources in developing this technology.

2.6 NAS Operations Subcommittee

Finding (1): After the September meeting, the RED AC observed that there does not appear to be a clear high-level R&D plan for NextGen, and NASOPS specifically recommended the FAA clarify research priorities for the REDAC briefings using a framework based on the FAA's Solution Set taxonomy. The FAA's response letter indicated that "the Office of Research and Technology Development (AJP-6) and the NextGen I&I Office will work together to identify the best approach to articulate the NextGen research and development activities using the plans and roadmaps that have been developed." This NASOPS meeting was a good first step in this direction. The subcommittee received a briefing from Paul Fontaine on the Acquisition Management System (AMS) and the role of RE&D in the Concept and Requirements Definition stage. We were pleased, also, to receive a briefing from Michele Merkle stating that the updated mid-term NextGen ConOps was to be issued this spring, and that concept development and validation guidelines have been developed for AMS that will be used to assess each service as to its maturity and readiness to move toward a final investment decision within AMS. Since the FAA will be using these guidelines to perform its own assessment as part of AMS, presenting the results to the subcommittee should impose a minimal burden.

<u>Recommendation</u>: The Subcommittee recommends that the FAA continue to emphasize and effect internal coordination between AJP-6 and I&I in order to provide an information exchange with NASOPS of all R&D in selected focus areas up to at least the Initial Investment Decision in the AMS. Additionally, NASOPS will review the updated NextGen ConOps when it becomes available, and recommends that the FAA present its assessment of the status of NextGen RE&D in the selected focus areas relative to the concept development and validation guidelines that it has developed for the AMS. This will enable the subcommittee to assist the FAA with advancing its RE&D portfolio by making specific recommendations.

<u>FAA Response</u>: AJP-6 will continue to work with the I&I office and the Concept Steering Group (CSG) to assess Concept Maturity. As a starting point, new research being proposed has been going to the CSG to validate the need. The plan is that ultimately all NextGen efforts will be assessed for maturity and readiness for technical transfer. Moreover, as part of the FAA's Foundation For Success Initiative, the overall FAA governance model is being revamped, and it is likely to impact lower level committees such as the CSG. A NextGen Functional Design Consideration Team (FDCT) is establishing a new paradigm for NAS-wide management that will begin with a NAS ConOps that includes all services (both sustainment and NextGen), and provides a single point of entry and common set of criteria for inclusion in the NAS ConOps. The FDCT is taking a broad perspective of the concept through implementation lifecycle as it considers improvements to current processes. Areas of confusion and procedural gaps in the process are being considered from the time a capability enters the lifecycle through to its implementation in the field. At the beginning of the process, the team has recognized the need to establish a comprehensive ConOps whereby all capabilities that make their way into the NAS pass through a ConOps filter. The team is building on the work of AJP-66 with the CSG and the Concept Development and Validation Guidelines. Operational Improvements (OIs) as well as Operational Sustainments, or changes to current capabilities and programs, need to be considered together so that we operate from a comprehensive perspective in evolving the NAS. A similar mechanism is being considered to address allocation of capabilities to portfolios. Once this new process is defined, the FAA would be happy to brief it to the NASOPS Subcommittee.

<u>Finding (2)</u>: Michele Merkle again provided excellent presentations on NextGen Solution Set Ops Concept Development and Validation. The members once again found the presentations and the work itself to be exemplary of the research and development so essential to the success of the FAA NextGen effort. Michele's Separation Management presentation for High Altitude included the following critical attributes: a clear focus on the potential benefits of the research, a

willingness to face the difficult but necessary effect of the research on both pilot and controller roles, and avoidance of overinvestment in a full SRMD for a concept when a preliminary safety analysis was all that was required at an early stage.

Recommendation: The Subcommittee continues to see the Ops Concept research as exemplary in nature and the work itself as critically important, and quite possibly underfunded. We recommend that the FAA continue to ensure funding for these activities.

FAA Response**:** Developing operational concepts is an Office of Management and Budget (OMB) recommended first step in developing an Enterprise Architecture. The two Operational Concept Program budget lines (NextGen and Core) develop and validate operational concepts that are key to Air Traffic Organization's (ATO) modernization programs and NextGen. Many of the Solution Set budget lines fund concept development and validation work as part of pre-implementation risk reduction. If the FAA budget is reduced, all budget lines will be assessed for the impact and it will be important for the FAA to focus their research towards those concepts that are critical to the technical transfer of key NextGen capabilities. Additionally the breadth of research will be reduced to focus on those capabilities most likely to be successfully implemented in the near-midterm.

Finding (3)**:** The Subcommittee has recommended in the past that the FAA work to define the role of public-private partnerships (PPPs) in accelerating NextGen deployment. The history of successful PPPs in accelerating the maturation and deployment of innovations in the marketplace is rich with examples of relevance to the challenge the nation faces in NextGen. The FAA has made sporadic use of one-on-one government-industry partnerships, for example, the JetBlue, US AIR, and related projects. However, these projects do not represent the opportunity for industry-wide acceleration of NextGen capabilities through PPPs. The SE2020 contracts may offer a first opportunity in this regard.

Recommendation**:** The Subcommittee strongly encourages the FAA to conduct a rigorous evaluation of the opportunity for NextGen acceleration through PPPs. The Subcommittee volunteers to form a working group in support of the FAA's exploration of these opportunities and to provide the FAA with lessons learned in the design and operation of PPPs.

FAA Response**:** The FAA thanks you for your recommendation and we are aware of successful uses of public-private partnerships. And, as you noted, we have been extensively using partnerships with private industry, not-for-profit organizations, and academia for many of our efforts. We appreciate your offer to form a working group to help us further explore PPPs, but we do not feel that is it necessary to establish a new working group.

Finding (4): Programs in the FAA NextGen implementation portfolio that are reviewed by NASOPS frequently contain transformational goals that may face resistance or opposition from FAA employees, including but not limited to controllers. A specific example from this meeting is the Staffed NextGen Tower - Small and Medium Airport (SNT-SMA) phase. It appears to the committee that the inhibited dialogue between the controller workforce and the NextGen program leaders significantly limits the valid exploration of such advanced concepts for improvements in operational efficiencies, safety, and cost.

Recommendation: In situations where the research goals have confronted employee organizations' concerns, these concerns should be included in the Subcommittee review process. Recommendations to the Administrator and the Congress on NextGen implementation by RED AC should account for such concerns.

FAA Response: The FAA agrees that such concerns should be highlighted to the Subcommittee who might help influence the research. We will continue to address such issues at Subcommittee meetings. Moreover, as the FAA continues to strengthen its collaboration with the labor unions, research issues once seen as contentious may be more readily accepted in the spirit of research which is to prove or disprove the benefits (including operational and workforce) of various new operational concepts.

Finding (5): NextGen capabilities, and the benefits associated with them, will not be realizable if strategies to implement them do not address transition and mixed equipage considerations. Few capabilities requiring flight operator equipage or other investment can provide a solid economic justification for the creation of exclusionary airspace. Transition and adoption periods span multiple years, resulting in a mixed equipage environment that must be dealt with both from the ANSP and the flight operator perspective. Flight operators are not willing to serve as "early adopters" of capabilities requiring avionics or other investments if there is a significant delay in achieving benefits until achieving a high-level of equipage. FAA concept exploration has begun to address this issue through the re-examination of assumptions for equipage in validating operational suitability and through the consideration of "best-equipped, best served" policies for some NextGen capabilities.

Recommendation (5a): FAA should evaluate current NextGen concept and procedure definition and validation efforts to ensure that extended, multi-year mixed equipage scenarios are both operationally feasible as well as attractive to flight operators that make investments in advanced NextGen capabilities. In particular, concepts need to ensure that benefits to operators with higher levels of equipage are proportionally higher than those accrued to operators with less capability. Concepts and procedures should not unintentionally disadvantage equipped flights or operators due to greater difficulty in managing lesser-equipped traffic.

FAA Response (5a): The FAA agrees with your recommendation and we have been including such evaluations in our current work.

Recommendation (5b): As part of the concept validation of capabilities requiring avionics not currently available, FAA should work with its customers to better reflect customer perspectives on the business case, quantify the differential benefits of equipage, and assess whether these benefits are sufficient to justify operator investments.

FAA Response 5(b): The FAA will continue to work with industry as appropriate to reflect their perspectives on the business case and assess the benefits.

Finding (6): The briefing by Joe Post on the FAA's System-Wide Airspace Concepts (SWAC) model was very good. The progress by the FAA in implementing the modeling capability needed to evaluate mid-term NextGen capabilities appears quite good. However, it is not clear that FAA decision-makers use SWAC broadly in an *a priori* fashion to inform their investment decisions by performing relatively rapid cost-benefit tradeoff analyses of new technologies or capabilities, as opposed to *a posteriori* studies to justify assumptions, and could be scaled up to make better use of this important quantitative tool.

Recommendation: The FAA should embrace the use of SWAC and its continuing improvements for informing prioritization of investments within NextGen implementation plans. The FAA should increase its use of SWAC as part of the suite of tools that it uses to generate a quantitative underpinning for the NextGen benefits story.

FAA Response: Thank you for your positive comments on the System-Wide Airspace Concepts (SWAC) model. We plan to make use of this model as appropriate to support the quantification of NextGen benefits.

Finding (7): The NextGen Weather Operations briefing was the best aviation weather briefing the committee has received. The connection between source weather data associated with the National Weather Service 4 Dimensional Cube, and FAA systems NWP, NNEW, and the provision of source data for CoSPA from the Cube were evidence of the excellent connection between research and the NextGen operations concept. The primary graphic showing connections from base forecasting and observational data, through the cube, to FAA distribution systems, and to FAA and AOC operators was also excellent. Finally, the committee found that the part of the briefing associated with CoSPA (the new NextGen Storm Forecasting Product) was excellent. Member John McCarthy felt that this product was the best produced by FAA research-to-applications effort since the days of the microburst warning system.

Recommendation: The Subcommittee recommends carrying on the excellent progress of this program as currently constituted. The FAA should ensure that the NOAA and NWS observation and forecast community remain fully involved in FAA atmospheric forecast and modeling efforts and that where appropriate, these be operationally implemented at the National Weather Service, and have the results provided on the NWS 4 D-Cube.

FAA Response: FAA concurs with the recommendation. FAA and NWS are actively and continuously working together to define weather products and data sets that will be exchanged through the 4-D Weather Data Cube. FAA-sponsored research activities will follow a well-defined research-to-operations process involving, as appropriate, National Oceanic and Atmospheric Administration (NOAA) and National Weather Service (NWS) partners to reduce the risk of implementation in the NAS.

Finding (8): The briefing on the Weather-Technology-in-the-Cockpit (WTIC) activity was the third in two years to NASOPS. Earlier briefings of WTIC did not articulate a clear set of objectives or a connection to NextGen requirements and the Subcommittee recommended that the FAA correct this shortfall. A critical part of NextGen is the establishment of a Common Operating Picture (COP), which is shared by pilots, controllers, AT managers, and AOC dispatchers. Weather information is clearly part of this COP and the FAA has the objective to ensure that pilots have access to weather information in the cockpit to achieve NextGen safety and efficiency objectives. The most recent presentation demonstrated a greater understanding of issues that need to be addressed with respect to WTIC and a Common Operating Picture (COP) among controllers, TFM personnel, dispatchers, and pilots.

Recommendation (8a): For WTIC to evolve in a credible manner, the project needs to clarify just what the NextGen objectives are that it is attempting to meet. Specifically, if the objective of WTIC is to establish the essential cockpit weather information required to achieve NextGen Operational Improvements, the Subcommittee recommends that the FAA show that a cost-effective methodology is being undertaken to identify them. On this basis, the developing WTIC effort should be evaluated to see whether it is cost effective to continue with this program relative to other key needs for NextGen research.

FAA Response (8a): The FAA agrees with the NASOPS recommendation that the WTIC program needs to clarify the NextGen objectives that it is attempting to meet. In response to this recommendation, the WTIC program has engaged key NextGen program stakeholders and sponsors to ensure program initiatives support specific Operational Improvements (OIs) and their implementation roadmaps. Specifically, the program has engaged roadmap architects and program management from various NextGen solution sets to ensure that WTIC research supports their initiatives and specific OIs. In addition, an independent review of all WTIC proposals will be done to ensure that WTIC objectives align with NextGen objectives and are not redundant to other NextGen research efforts.

Recommendation (8b): As part of the evaluation process, the Subcommittee recommends that the FAA consider any specific cockpit weather information requirements to support NextGen Trajectory Based Operations. Additionally, the Subcommittee recommends that the WTIC consider the impact of weather in the cockpit on pilot training requirements, particularly in the General Aviation environment.

FAA Response (8b): The FAA agrees with both recommendations. The WTIC program has engaged with roadmap architects from the Aircraft Roadmap with the goal of identifying weather information requirements to support TBO. This collaboration is intended to identify specific TBO OIs that can be assigned to the WTIC program as the source of the required research and deliverables. In response to the recommendation that WTIC program consider the impact of weather in the cockpit on pilot training requirements, particularly in the General Aviation environment, the WTIC program is engaged in research to identify the proper training requirements and will develop recommendations for a training module or template to support NextGen concepts. Based on results of this research, which was due by the end of July 2011, follow-on efforts may be initiated. The results of this research and the plans for follow-on efforts, including stakeholder engagement strategies, will be available for review at the next RED AC subcommittee meeting in the spring of 2012.

Findings (9): FAA and NOAA are evaluating MPAR as a possible future replacement for primary surveillance and weather radars. FAA's interest is relative to airport surveillance radars (ASR-8, 9 and 11) and Terminal Doppler Weather Radar (TDWR), while NOAA is evaluating MPAR as a potential replacement for the WSR-88D (NEXRAD). MPAR offers the possibility of reduced cost-of-ownership for future US national primary radar networks. In addition MPAR may result in enhanced mission performance capabilities for multiple US Government agencies. Capability enhancements include non-cooperative aircraft height measurement, wind turbine clutter mitigation and more rapid volumetric scanning of severe weather. To fully realize these benefits, FAA, NOAA, DoD and DHS must coordinate the development of MPAR technical requirements and must develop joint concepts of operation and synchronized investment decisions. There appears to be good coordination between FAA and NOAA. DoD and DHS, however, have not been effectively engaged in MPAR research.

Recommendation (9a): The FAA should establish a coordinated MPAR research program with other agencies including NOAA, DoD and DHS. This activity should develop integrated technical requirements, complementary research investments and a synchronized schedule for investment decisions. The Joint Planning and Development Office (JPDO) would appear to be an appropriate entity to lead this coordination process, but other governances are possible.

FAA Response (9a): FAA concurs with this recommendation. FAA, NOAA, DoD, and DHS all participate in regular MPAR Working Group meetings under the auspices of the Office of the Federal Coordinator for Meteorology (OFCM) to coordinate research efforts, identify opportunities to leverage research in related fields, and to recommend a unified research and development plan.

Recommendation (9b): The FAA should continue its MPAR research in order to clearly substantiate technical viability and a positive cost-benefit prior to its 2016 Initial Investment Decision milestone. The objectives and expected outcomes of the FAA's MPAR research program should be clearly articulated and the agency should identify key issues that are not being addressed owing to resource limitations. In particular, the FAA should show how its research plan meshes with that of partner agencies (currently NOAA) to address the full spectrum of MPAR implementation issues including technology, concept of operations and system level architecture.

FAA Response (9b): FAA concurs with this recommendation. FAA has initiated several concept maturity and technology development activities to further determine technology viability and affordability. Under the auspices of OFCM, FAA is coordinating program objectives and outcomes and identifying key issues and resource limitations. FAA is currently leading several bilateral coordination efforts with NOAA to address technology issues, concept of operations, and system level architecture.

Finding (10): The NAS Operations Subcommittee was pleased to see the extent to which FAA is funding research into Human Factors, as evidenced by the FAA's thorough overview of Human Factors work sponsored through the RE&D budget line item. This work appears to cover a wide range of activities. The NAS Ops subcommittee was not able to determine from the briefings the relative importance of the tasks presented, nor how these specific tasks were tied to key NextGen needs.

Recommendation: FAA should integrate human factors research with overall concept validation efforts, rather than planning these as separate activities. In addition, FAA should better articulate and provide relative criticality information regarding the underlying shortfalls or risks associated with specific human factors research tasks.

FAA Response: The Operational Concept Development and Validation Group, AJP-66, participates in the FAA Human Factors Coordinating Committee, and briefs the human factors community on on-going and planned concept development work. AJP-66 and AJP-61 work together to further integrate tasks when appropriate, such as with aligning resources for NextGen human in the loop simulations.

Relative criticality information regarding underlying risks and shortfalls is developed as part of the requirements generation process used by AJP-61. This requirements process relies on Technical Community Requirements Groups comprised of stakeholders in the Air Traffic Organization. The process is specified in the "Air Traffic Control / Technical Operations Human Factors Research Program Process" document available on our Web site at https://www2.hf.faa.gov/ATAF. We will add the shortfall information to the project descriptions on that Web site for greater transparency.

Finding (11): The briefing on the Joint Planning and Development Office (JPDO) status left the Subcommittee concerned about its current role and future contribution to NextGen. Because of the new alignment of the office, it appears that an assessment of scope, strategic approach, and connection to the FAA should be conducted.

Recommendation: NASOPS requests a briefing from the JPDO Director and/or Deputy Director at the next meeting addressing JPDO future objectives, plans and priorities, and how the office connects to the FAA, other government agencies such as NASA and industry stakeholders, especially in the research arena.

FAA Response: Dr. Karlin Toner will be presenting this briefing at the REDAC meeting on September 21, 2011.

This Page Is Intentionally Blank

Appendix D: NARP Milestone Status

The 2012 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. This appendix enhances the visibility of this continuity.

Appendix D summarizes the status of the milestones in Chapter 2. Any changes from the 2011 NARP are highlighted in bold, and the Notes column provides an explanation for these changes. The tables below list the milestones under each R&D Goal in chronological order by scheduled year of completion. Only milestones from 2008 and later appear in the 2012 NARP.

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
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 modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.

BLI	Program Name	Year	Milestone	Status	Notes
1A07A	NextGen Demonstrations and Infrastructure Development	2008	Demonstrate improved trajectory-based operations in mixed-equipage, oceanic airspace with actual aircraft and procedures	Completed	This program transitioned out of R&D in FY 2010; Budget Line Item number added for completeness
A12.b	NextGen - Wake Turbulence	2008	Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions	Completed	
AIP	Airport Cooperative Research Program - Capacity	2008	Increase airport capacity	Completed	
1A07A	NextGen Demonstrations and Infrastructure Development	2009	Develop and simulate separation procedures that vary according to aircraft capability and pilot training	Completed	This program transitioned out of R&D in FY 2010; Budget Line Item number added for completeness
1A07A	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	This program transitioned out of R&D in FY 2010; Budget Line Item number added for completeness

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 modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A07A	NextGen Demonstrations and Infrastructure Development	2009	Demonstrate via simulation standard separation in a full-equipage, fully automated environment with no voice communication	Completed	This program transitioned out of R&D in FY 2010; Budget Line Item number added for completeness
A11.k	Weather Program	2010	Develop 0-8 hour advanced storm prediction algorithm	Completed	
A11.k	Weather Program	2010	Transition Rapid Refresh Weather Forecast Model for implementation at National Oceanic and Atmospheric Administration National Centers for Environmental Prediction	Completed	
A12.b	NextGen - Wake Turbulence	2010	Determine Air Navigation Service Provider (and pilot as needed) situational aircraft separation display concepts required for implementation of the NextGen Trajectory-Based Operation and High Density concepts	Completed	
1A08F	NextGen - Wake Turbulence - Re-categorization	2011	Determine initial set of optimal aircraft flight characteristics and weather parameters for use in setting wake separation minimums	**Completed**	A set of parameters have been defined as part of the RTCA workgroup activities. 2011 NARP Status: On schedule

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 modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08F	NextGen - Wake Turbulence - Re-categorization	2011	Refine the boundaries of the current six weight categories for the NAS fleet mix and define automation requirements to support those modifications	**Completed**	A Joint FAA/EUROCONTROL RECAT proposal for 6 new categories was submitted to the International Civil Aviation Organization. The Automated Terminal Proximity Alert Phase I Air Traffic Control decision support tool will aid FAA controllers in using the new separation standards. 2011 NARP Status: On schedule
A11.k	Weather Program	2011	Demonstrate 0-8 hour advanced storm prediction algorithm	**Completed**	2011 NARP Status: On schedule
AIP	Airport Cooperative Research Program - Capacity	2011	Develop guidebook to assist airport planners with airfield and airspace capacity evaluation	**Completed**	2011 NARP Status: On schedule
A12.b	NextGen - Wake Turbulence	2012	Determine the NAS infrastructure requirements (ground and aircraft) for implementing the NextGen Trajectory-Based Operation and High Density concepts within the constraints of aircraft-generated wake vortices and aircraft collision risk	On schedule	NEXTOR II will build upon the work done in NEXTOR I in the exploration of Trajectory-Based Operations and High Density NextGen concepts for issues associated with wake vortex hazards.
A12.e	**NextGen - Weather Technology in the Cockpit**	**2012**	**Establish and justify quantitative requirements for terminal-area wind diagnosis and forecast capabilities to improve benefits from four-dimensional Trajectory Based Operations**	**On schedule**	New milestone

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 modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
AIP	Airport Technology Research Program - Capacity	2012	Develop new standards and guidelines for runway pavement design	On schedule	
1A08F	NextGen - Wake Turbulence - Re-categorization	2013	Determine how best to incorporate the leader/follower based wake separation standards into the en route and terminal automation platforms	On schedule	
A11.k	Weather Program	2013	Transition 0-8 hour advanced storm prediction algorithm for implementation	**Completed**	2011 NARP Status: On schedule
A12.b	NextGen - Wake Turbulence	2013	Modify procedures as requested to allow use of closely spaced parallel runways for arrival operations during non-visual conditions (two to three airports per year per Task Force 5 recommendations and for requests from airports)	On schedule	This project is currently working with San Francisco International Airport and Newark Liberty International Airport in adapting their operations to better use their closely spaced parallel runways during use of instrument operations.
A12.e	**NextGen - Weather Technology in the Cockpit**	**2013**	**Expand wind studies to more comprehensive environments and procedures, and more comprehensive assessment of benefits versus wind modeling error and evaluate weather prediction technology relative to wind modeling accuracy**	**On schedule**	New milestone
A11.k	Weather Program	2014	Transition in-flight icing Alaska forecast and analysis capability for implementation	**On schedule**	2011 NARP Status: Delayed from 2013 to 2014
A12.e	**NextGen - Weather Technology in the Cockpit**	**2015**	**Provide accurate and timely wind information to the Flight Management System and Air Traffic Control systems, and demonstrate Trajectory-Based Operation benefits**	**On schedule**	New milestone

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 modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08F	**NextGen - Wake Turbulence - Re-categorization**	**2015**	**Together with the European Organisation for the Safety of Air Navigation, deliver a more capacity-efficient set of wake separation standards to the International Civil Aviation Organization (Leader-Follower Pair-Wise Static)**	**On schedule**	New milestone
1A08F	NextGen - Wake Turbulence - Re-categorization	2016	Develop the algorithms that will be used in the Air Navigation Service Provider (and flight deck as needed) automation systems for setting dynamic wake separation minimum for each pair of aircraft	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
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	
A13.a	Environment and Energy	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	Completed	
	Environment and Energy Airport Cooperative Research Program – Environment	2009	Develop methodologies to quantify and assess the impact of Particulate Matter and Hazardous Air Pollutants	Completed	
1A08E	**NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction**	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	Completed	The program name for this milestone was changed to correctly align with Chapter 2.
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	
A13.a	Environment and Energy	2010	Develop a preliminary planning version of an Aviation Environmental Design Tool that will allow integrated assessment of noise and emissions impact at the local and global levels	Completed	

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	Environment and Energy Airport Cooperative Research Program – Environment	2010	Develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions	Completed	
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	
1A08H	NextGen - Operational Assessments	2011	Enhance regional analysis capability in aviation environmental analysis tools	**Completed**	2011 NARP Status: On schedule
A13.a	Environment and Energy	2011	Develop a new metric to quantify the environmental impacts of new aircraft types	**Completed**	2011 NARP Status: On schedule
A13.a	Environment and Energy	2011	**Investigate feasibility of metrics for new aircraft standards for CO_2 emissions**	**Completed**	The milestone wording was revised to reflect proper context. Old Wording: Investigate feasibility of new standards for aircraft noise and emissions certification 2011 NARP Status: On schedule
A13.a	Environment and Energy	2011	Assess the level of certainty of aviation's impact on climate change, with special emphasis on the effects of contrails	**Completed**	2011 NARP Status: On schedule
A13.a	Environment and Energy	2011	Complete development of first-generation ground plume model for aircraft engine exhaust	**Completed**	2011 NARP Status: On schedule

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	Environment and Energy NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics Airport Cooperative Research Program – Environment	2011	Determine how aviation-generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate	**Completed**	2011 NARP Status: On schedule
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2011	Complete tests and data collection to determine if the right metrics are being used to assess the impact of aircraft noise	**Completed**	2011 NARP Status: On schedule
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2011	Establish the relationship between aviation engine exhaust and the gases and particulate matter that are deposited in the atmosphere	**Completed**	2011 NARP Status: On schedule
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2011	Complete detailed feasibility study, including economic and environmental impacts and an assessment of the potential of renewable alternative fuels for gas turbine engines	**Completed**	2011 NARP Status: On schedule
A13.a	Environment and Energy	2012	Expand noise data collection to very light jets and supersonic aircraft	On schedule	
AIP	Airport Technology Research Program – Environment	2012	Initiate a project to study aircraft noise annoyance data and sleep disturbance around airports	On schedule	

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction Airport Cooperative Research Program – 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	
1A08E	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction	2013	Evaluate, refine, and apply Environmental Management System decision support tools to the aviation system	On schedule	
1A08E	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction	2013	Identify and pursue the development of a Flight Management System and other system technologies that will be the most effective at producing environmental benefits	On schedule	
A13.a	**Environment and Energy**	**2013**	**Examine the suitability of aircraft noise and emissions metrics to establish environmental standards**	**On schedule**	New milestone

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	Environment and Energy **NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics**	**2013**	**Refine the estimates of aircraft contribution to climate change**	**On schedule**	New milestone
	Environment and Energy **NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics**	**2013**	**Refine estimates of aircraft emitted particulate matter on climate, air quality and human health**	**On schedule**	New milestone
A13.a	Environment and Energy	2013	Obtain direct measurements of hazardous air pollutants and particulate matter data to update modeling tools	On schedule	
A13.a	Environment and Energy	2013	Update environmental assessment models to incorporate new noise metrics	On schedule	
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2013	Complete significant demonstration of “drop-in” alternative turbine engine fuels	On schedule	
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2013	Demonstrate airframe and engine technologies to reduce noise and emissions	On schedule	

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A13.b	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	On schedule	
1A08E	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction	2014	Assess NAS-wide benefits of environmental mitigation solutions comprised of new technologies, alternative fuels, advanced operational procedures, market measures, and options for policy and noise/emissions standards	On schedule	
1A08E	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction	2014	Demonstrate optimized en route operations that enhance fuel efficiency and reduce emissions	**Deleted**	This milestone was deleted because initial analyses indicated relatively lower benefits than previously thought. The project has been discontinued in consultation with the NextGen Integration & Implementation Office. 2011 NARP Status: On schedule
	Environment and Energy Airport Cooperative Research Program – Environment	2014	Complete development and field a fully validated suite of tools, including the Aviation Environmental Design Tool and the Aviation Environmental Portfolio Management Tool	On schedule	
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2014	Complete assessment of renewable alternative turbine engine fuels	On schedule	

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 (CO_2) climate impacts to levels that enable appropriate action.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08E	NextGen – Environment and Energy – Environmental Management System and Advanced Noise and Emission Reduction	2015	Refine and update approaches for Environmental Management System performance tracking	On schedule	
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2015	Assess the environmental benefits of the first round of Continuous Lower Energy, Emissions and Noise airframe and engine technologies through integrated flight demonstration	On schedule	
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	2015	Complete transition plans for renewable alternative fuels	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.i	Air Traffic Control/ Technical Operations Human Factors	2008	Conduct initial simulation to determine what weather information is required by en route and tower controllers to improve efficiency	Completed	
A11.i	Air Traffic Control/ Technical Operations Human Factors	2008	Demonstrate efficiency improvements when controllers receive information on aircraft equipage, performance capabilities, and applicable procedures in a mixed equipage environment	Completed	
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	
1A08A	NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2010	Define initial requirements and anticipated efficiency benefits for merging and spacing decision support tools to support continuous descent approach in the terminal area	Completed	
1A08A	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	On schedule	
A11.i	Air Traffic Control/ Technical Operations Human Factors	2012	Improve computer-human interface design to reduce information overload and resulting errors	**On schedule**	2011 NARP Status: New milestone

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08A	NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2013	Analyze controller roles in a strategic air traffic environment for the impact on personnel selection and training	On schedule	
1A08A	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 Air Navigation Service Providers	On schedule	
1A08A	NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	2013	Demonstrate increased Air Navigation Service Provider (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	
A11.i	Air Traffic Control/ Technical Operations Human Factors	2013	Assess the Front Line Manager Quick Reference Guide for effectiveness in aiding Air Traffic Control safety	**On schedule**	2011 NARP Status: New milestone
A11.i	Air Traffic Control/ Technical Operations Human Factors	2014	Provide a draft of a revised Human Factors Design Standard for human factors application to Air Traffic Control system acquisition	**On schedule**	2011 NARP Status: New milestone
1A08A	NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	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	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08A	NextGen - Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)	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 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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
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	
	NextGen - Air Ground Integration Human Factors **NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	2011	Develop initial mid-term analysis describing the relationship between human pilots and controllers with associated automated systems	**Completed**	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2. 2011 NARP Status: On schedule
AIP	Airport Cooperative Research Program - Capacity	2011	Document ramp operational and safety techniques and how airport operators implement pavement maintenance programs	**Completed**	2011 NARP Status: On schedule
A11.g	Flightdeck/ Maintenance/ System Integration Human Factors	2012	Develop human factors guidance for Automatic Dependent Surveillance – Broadcast enabled Cockpit Display of Traffic Information certification and operational approval	On schedule	
A11.g	Flightdeck/ Maintenance/ System Integration Human Factors	2012	Provide human factors guidance for the design of instrument procedures	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	NextGen - Air Ground Integration Human Factors **NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	2012	Complete initial research to evaluate and recommend procedures for negotiations and shared decision-making between pilots and controllers	On schedule	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.
	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	On schedule	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.
A12.c	NextGen - Air Ground Integration Human Factors	2012	Initiate research to assess pilot performance in normal and non-normal NextGen procedures, including single pilot operations	On schedule	
A12.c	NextGen - Air Ground Integration Human Factors	2013	Complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	NextGen - Air Ground Integration Human Factors **NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	2014	Develop initial guidance on training methods to support detection and correction of human errors in near- to mid-term NextGen procedures	On schedule	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.
A12.e	**NextGen - Weather Technology in the Cockpit**	**2015**	**Demonstrations completed and data available to support the development of human factors standards, guidance, and procedures for the presentation and use of meteorological information in the cockpit. Specific measurable performance objectives verified for human factors design elements.**	**On schedule**	New milestone
A12.c	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	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	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	On schedule	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.
	NextGen - Air Ground Integration Human Factors **NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	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	On schedule	1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	NextGen - Air Ground Integration Human Factors **NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration)**	2017	**Functional simulation – simulate integrated pilot and controller functional capabilities**	On schedule	This milestone wording was revised to accurately reflect the objective of the program. Old Wording: Functional demonstration – demonstrate integrated pilot and controller functional capabilities A14.b William J. Hughes Technical Center Laboratory Facility was removed from having any responsibility for this milestone. This program provides laboratory support for multiple R&D Goals but has no responsibility for the completion of any milestones. 1A08A NextGen Air Traffic Control/ Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) was added to this milestone to correctly align with Chapter 2.

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 significant reduction in the rate of aerospace-related fatalities and significant injuries.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
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.j	Aeromedical Research	2010	Validate computational models of chemical air contaminants, such as volatile organic compounds, to evaluate health and safety impacts on passengers and crew	Completed	
AIP	Airport Technology Research Program - Safety	2011	Complete evaluation of new airport runway pavement groove shape to reduce risk of overrun due to hydroplaning	**Completed**	The results of the evaluation will be published in an FAA Technical Note scheduled for publication in early 2012. 2011 NARP Status: On schedule
A11.a	Fire Research and Safety	2012	Define composite fuselage fire safety design criteria	On schedule	
A11.j	Aeromedical Research	2012	Develop and validate chemical kinetic models for bleed air systems for health and safety effects on passengers and crew	On schedule	
A12.e	**NextGen - Weather Technology in the Cockpit**	**2012**	**Identify specific and recurring weather-related causes in reported safety incidents/accidents that identify weather as a primary cause.**	**On schedule**	New milestone
AIP	Airport Cooperative Research Program - Safety	2012	Assess role of airports and airlines in the spread of vector-borne diseases	**Completed**	2011 NARP Status: Delayed from 2011 to 2012
AIP	Airport Technology Research Program - Safety	2012	Develop aircraft rescue and fire-fighting procedures and equipment standards to address double-decked large aircraft	On schedule	

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 significant reduction in the rate of aerospace-related fatalities and significant injuries.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.k	Weather Program	**2013**	Transition mountain-wave turbulence forecast capability for implementation	**Delayed**	This milestone is delayed from 2012 to 2013 due to changing Weather Program priorities. 2011 NARP Status: On schedule
A12.e	**NextGen - Weather Technology in the Cockpit**	**2013**	**Develop and implement resolutions to prevent recurrence of reported weather-related safety incidents/accidents that were researched in FY 2012.**	**On schedule**	New milestone
A12.e	**NextGen - Weather Technology in the Cockpit**	**2013**	**Assess and quantify the safety benefits to the NAS of providing Graphical Turbulence Guidance, Eddy Dissipation Rate, and icing to the cockpit.**	**On schedule**	New milestone
A11.d	**Aircraft Icing/ Digital System Safety**	2014	Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content environments	On schedule	The program name was changed from “Aircraft Icing-Atmospheric Hazards/Digital System Safety” to Aircraft Icing/ Digital System Safety”.
A11.j	Aeromedical Research	**2014**	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	**Delayed**	This milestone is delayed from 2012 to 2014 due to a change in sponsor priorities.
A11.j	Aeromedical Research	2014	Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants	**On schedule**	2011 NARP Status: Delayed from 2010 to 2014
A11.j	Aeromedical Research	2014	Apply and validate advanced air sensing technology for volatile organic compounds in the aircraft cabin environment	**On schedule**	2011 NARP Status: Delayed from 2011 to 2014

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 significant reduction in the rate of aerospace-related fatalities and significant injuries.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	Aeromedical Research **Advanced Materials/ Structural Safety**	2014	Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain	**On schedule**	A11.c Advanced Materials/Structural Safety was added to this milestone to correctly align with Chapter 2. 2011 NARP Status: Delayed from 2010 to 2014
A11.j	Aeromedical Research	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	**On schedule**	2011 NARP Status: Delayed from 2011 to 2014
			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	**On schedule**	2011 NARP Status: Delayed from 2012 to 2015
A11.j	Aeromedical Research	2015	Develop a system (Aerospace Accident Injury and Autopsy Data System) capable of compiling, classifying, assessing, and determining causal factors of aviation-related injuries. The system will link aviation-related injuries to autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic test results	On schedule	
A11.j	Aeromedical Research	2015	Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks	On schedule	

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 significant reduction in the rate of aerospace-related fatalities and significant injuries.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.j	Aeromedical Research	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	On schedule	
A11.k	Weather Program	2015	Transition turbulence forecast capability for all flight levels for implementation	**On schedule**	2011 NARP Status: Delayed from 2012 to 2015
A12.e	**NextGen - Weather Technology in the Cockpit**	**2015**	**Safety reporting systems indicate success of corrective actions and enhanced meteorological information (turbulence and icing) to reduce weather-related accidents/incidents.**	**On schedule**	New milestone
A11.j	Aeromedical Research	2016	Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors	**On schedule**	2011 NARP Status: Reverted to the original completion date of 2016
A11.k	Weather Program	2016	Transition global turbulence forecast capability for implementation	On schedule	
A11.k	Weather Program	2017	Transition convectively-induced turbulence forecast capability for implementation	**On schedule**	2011 NARP Status: Delayed from 2013 to 2017

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.c	Advanced Materials/ Structural Safety	2010	Develop certification methods for damage tolerance and fatigue of composite airframes	Completed	
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)	Completed	
A11.a	Fire Research and Safety	2011	Provide comprehensive guidance on lithium battery fire safety	**Completed**	2011 NARP Status: On schedule
A11.e	Continued Airworthiness	2011	Apply damage-detection technologies for inspecting remote and inaccessible areas of in-service aircraft with metal structures	**Completed**	2011 NARP Status: On schedule
A11.e	Continued Airworthiness	2011	Complete the study in usage, design, and training issues for rudder control systems in transport aircraft	**Completed**	2011 NARP Status: On schedule
Ops	Commercial Space Transportation Safety	2011	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 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	**Completed**	2011 NARP Status: Delayed from 2010 to 2011

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.l	Unmanned Aircraft Systems Research	2012	Determine a set of performance characteristics and operational requirements for sense and avoid technologies	On schedule	
Ops	Commercial Space Transportation Safety	**2012**	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**	This milestone is delayed from 2011 to 2012 due to changing Commercial Space Transportation Safety research program priorities. 2011 NARP Status: Delayed from 2010 to 2011
Ops	Commercial Space Transportation Safety	**2012**	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	**Delayed**	This milestone is delayed from 2011 to 2012 due to unforeseen complexities in the acquisition process. 2011 NARP Status: Delayed from 2010 to 2011
A11.1	**Unmanned Aircraft Systems Research**	**2013**	**Identify the current technologies for small unmanned aircraft systems to establish a central repository of historical data used to track continuous airworthiness of life limited components.**	**On schedule**	New milestone
A11.c	Advanced Materials/ Structural Safety	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	**On schedule**	2011 NARP Status: New milestone

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.d	**Aircraft Icing/ Digital System Safety**	2013	Identify safety issues and propose mitigation approaches when software development techniques and tools are used in airborne systems	On schedule	The program name was changed from "Aircraft Icing-Atmospheric Hazards/Digital System Safety" to Aircraft Icing/ Digital System Safety".
A11.e	Continued Airworthiness	2013	Develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems for usage credits	On schedule	
A11.l	Unmanned Aircraft Systems Research	2013	Analyze data and identify potential safety implications of system performance impediments of communications latency	**On schedule**	2011 NARP Status: Delayed from 2012 to 2013
A11.d	Aircraft Icing/ Digital System Safety	2014	Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content environments	**Deleted**	This milestone was deleted here because it is duplicated in R&D Goal 5 – Human Protection, where it still appears. 2011 NARP Status: Delayed from 2013 to 2014
A11.e	**Continued Airworthiness**	**2014**	**Develop technical data to assess the application of advanced aluminum-lithium metallic alloys for primary fuselage structure in transport category airplanes**	**On schedule**	**New milestone**
A11.f	Aircraft Catastrophic Failure Prevention Research	**2014**	Develop and verify a generalized damage and failure model with regularization for aluminum and titanium materials impacted during engine failure events	**Delayed**	This milestone is delayed from 2013 to 2014 due to initial test results indicating that additional tests at varying thicknesses are required to properly populate the material model. 2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.1	**Unmanned Aircraft Systems Research**	**2015**	**Identify recommended strategies for unmanned aircraft systems to compensate for missing sensory information at the control station and a method to assess performance requirements and methods of compliance for control stations**	**On schedule**	New milestone
A11.b	Propulsion and Fuel Systems	**2015**	Complete a certification tool that will predict the risk of failure of turbine engine rotor disks that may contain undetected material and manufacturing anomalies	**Delayed**	This milestone is delayed from 2014 to 2015 because of delays receiving a contractor proposal for supplemental research. 2011 NARP Status: Delayed from 2012 to 2014
A11.e	**Continued Airworthiness**	**2016**	**Develop technical data to assess the fatigue and environmental durability of bonded repairs to metallic structure**	**On schedule**	**New milestone**
A11.l	Unmanned Aircraft Systems Research	2016	Conduct field evaluations of unmanned aircraft system technologies in an operational environment, including sense and avoid, control and communications, and contingency management technologies. The documented results will be used to develop certification and airworthiness standards	**On schedule**	2011 NARP Status: Delayed from 2015 to 2016
A11.m	NextGen – Alternative Fuels for General Aviation	2016	Develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded aviation gasoline	**On schedule**	2011 NARP Status: Delayed from 2015 to 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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A12.d	NextGen - Self-Separation Human Factors	**2012**	Complete initial research to evaluate and recommend procedures, equipage, and training to safely conduct oceanic and en route pair-wise delegated separation	**Delayed**	This milestone is delayed from 2011 to 2012 due to changing research program priorities. 2011 NARP Status: On schedule
A12.d	NextGen - Self-Separation Human Factors	**2012**	Complete initial research to evaluate the impact and potential risks associated with use of the Traffic Alert and Collision Avoidance System in NextGen procedures	**Delayed**	This milestone is delayed from 2011 to 2012 due to simulator technical issues at the Georgia Institute of Technology. 2011 NARP Status: On schedule
A12.d	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	On schedule	
A12.d	NextGen - Self-Separation Human Factors	2014	Complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings	On schedule	
A12.d	NextGen - Self-Separation Human Factors	2014	Evaluate and recommend minimum display standards and operational procedures for use of Cockpit Display of Traffic Information to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff, departure and arrival phases of flight	On schedule	
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	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A12.d	NextGen - Self-Separation Human Factors	2015	Enable reduced and delegated separation in oceanic airspace and en route corridors	On schedule	
A12.d	NextGen - Self-Separation Human Factors	**2015**	Complete research to enable enhanced aircraft spacing for surface movements in low-visibility conditions guided by enhanced and synthetic vision systems, as well as cockpit displays of aircraft and ground vehicles and associated procedures	**Accelerated**	This milestone is accelerated from 2016 to 2015 due to changing sponsor priorities. 2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
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	
Ops	Commercial Space Transportation Safety	2009	Conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of radar wind profiler to obtain winds to greater altitudes than currently available	Completed	
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	
1A01A	Runway Incursion Reduction Program	2010	Develop system enhancements for runway status lights	Completed	
A11.k	Weather Program	2010	Develop Continental U.S. ceiling, visibility, and flight category forecast capability	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	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
AIP	Airport Technology Research Program - Safety	2010	Develop advisory material to install new visual guidance systems	Completed	
1A01A	**Runway Incursion Reduction Program**	**2011**	**Continue development of Runway Status Lights System enhancements, install additional Low Cost Ground Surveillance pilot sites, and assess Runway Incursion mitigation programs via simulation**	**Completed**	New milestone This milestone was added for completeness to show its contribution towards meeting the Situational Awareness R&D Goal
A12.e	NextGen - Weather Technology in the Cockpit	2011	Identify, validate, and document datalink system attributes that may affect use of weather in the cockpit	**Completed**	2011 NARP Status: On schedule
AIP	Airport Technology Research Program - Safety	2011	Develop performance standards for avian radar use on airports	**Completed**	2011 NARP Status: On schedule
A11.k	Weather Program	2012	Demonstrate 1-3 hour Continental U.S. ceiling, visibility, and flight category forecast capability	**Deleted**	This milestone was deleted after collaboration with the National Weather Service on ceiling and visibility forecast capability resulted in a new research approach. 2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.k	**Weather Program**	**2012**	**Develop Continental U.S. ceiling and visibility forecast to merge with National Weather Service capability**	**On schedule**	This is a new milestone added after collaboration with the National Weather Service on ceiling and visibility (C&V) forecast capability resulted in a new research approach. The FAA will integrate the results of its C&V forecast research with their forecast capability to provide a gridded forecast product. These grids will be part of the data contained in the NextGen 4D Data Cube.
A12.e	NextGen - Weather Technology in the Cockpit	2012	**Simulate and evaluate the benefits and impacts of presenting impact-oriented meteorological information in the cockpit in a collaborative decision environment**	On schedule	The wording of this milestone was revised for clarification and to better match research efforts. Old Wording: Simulate and evaluate available cockpit weather technologies
AIP	Airport Technology Research Program - Safety	2012	Develop guidance material for airport planning to ensure consistency from the operator's perspective from airport to airport	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A12.e	NextGen - Weather Technology in the Cockpit	**2013**	Develop NextGen Part 121, 135, and Part 91 concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit	**Delayed**	This milestone is delayed from 2011 to 2013 due to changing program priorities. The wording of this milestone was revised to better align with other program documentation. Old Wording: Develop NextGen mid-term concepts of operation and user requirements for the provision, integration, and use of weather information in the cockpit 2011 NARP Status: Delayed from 2010 to 2011
A12.e	**NextGen - Weather Technology in the Cockpit**	**2013**	**Assess the impacts and benefits of mobile/portable devices for use in providing increased common meteorological situational awareness between the cockpit crew and ground based traffic managers.**	**On schedule**	New milestone
A12.e	**NextGen - Weather Technology in the Cockpit**	**2013**	**Develop prototype weather modules for flight deck**	**Deleted**	This milestone was deleted due to changing program priorities.
A11.k	Weather Program	2014	Transition in-flight icing Alaska forecast for implementation	**On schedule**	2011 NARP Status: Delayed from 2013 to 2014

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.k	Weather Program	2014	Demonstrate 1-12 hour Continental U.S. ceiling, visibility, and flight category forecast capability	**Deleted**	This milestone was deleted after collaboration with the National Weather Service on ceiling and visibility (C&V) forecast capability resulted in a new research approach. The FAA will integrate the results of its C&V forecast research with their forecast capability to provide a gridded forecast product. These grids will be part of the data contained in the NextGen 4D Data Cube. 2011 NARP Status: On schedule
A12.e	NextGen - Weather Technology in the Cockpit	2014	Simulate, test, and evaluate cockpit use of weather decision support tools, including probabilistic forecasts	On schedule	
A12.e	NextGen - Weather Technology in the Cockpit	2014	Simulate, test, and evaluate fully-integrated cockpit use of NextGen operational concepts, including Weather Technology in the Cockpit	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.k	**Weather Program**	**2015**	**Demonstrate integrated FAA/National Weather Service ceiling and visibility forecast capability**	**On schedule**	This is a new milestone added after collaboration with the National Weather Service on ceiling and visibility (C&V) forecast capability resulted in a new research approach. The FAA will integrate the results of its C&V forecast research with their forecast capability to provide a gridded forecast product. These grids will be part of the data contained in the NextGen 4D Data Cube. This milestone replaces the deleted "Demonstrate 1-12 hour CONUS ceiling, visibility, and flight category forecast capability" milestone that had a completion date of 2014. There will not be any impact from deletion of the original milestone as the new approach will meet the same need (at a lower cost) - to provide a ceiling and visibility forecast capability over the CONUS.
A12.e	NextGen - Weather Technology in the Cockpit	2015	Demonstrate the integration of navigation information and flight information, including weather information, into cockpit decision-making and shared situational awareness among pilots, dispatchers, and air traffic controllers supported by NextGen air and ground capabilities	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.k	Weather Program	2016	Transition 1-12 hour CONUS ceiling, visibility, and flight category forecast capability for implementation	**Deleted**	This milestone was deleted after collaboration with the National Weather Service on ceiling and visibility (C&V) forecast capability resulted in a new research approach. The FAA will integrate the results of its C&V forecast research with their forecast capability to provide a gridded forecast product. These grids will be part of the data contained in the NextGen 4D Data Cube. 2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
	NextGen - Operations Concept Validation - Validation Modeling Operations Concept Validation System Capacity, Planning and Improvement	2008	Demonstrate capacity increase to 130% of baseline levels	Completed	The NextGen – Operations Concept Validation – Validation Modeling program was added to this milestone to correctly align with Chapter 2.
1A08H	NextGen - Operational Assessments	2009	Develop and implement NAS -wide regional environmental analysis capability within the Aviation Environmental Design Tool	Completed	
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	
1A08H	NextGen - Operational Assessments	2010	Implement weather effects in Aviation Environmental Design Tool environmental analyses	Completed	
A11.h	System Safety Management	2010	Demonstrate a one-third reduction in the rate of fatalities and injuries	Completed	
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 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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A01C 1A08C 1A01B	Operations Concept Validation NextGen - Operations Concept Validation - Validation Modeling System Capacity, Planning and Improvement	2011	Demonstrate an increase in capacity and efficiency at 2018 forecasted traffic levels	**Completed**	2011 NARP Status: No status provided
1A08G	NextGen - System Safety Management Transformation	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	**Completed**	2011 NARP Status: On schedule
A11.e	Continued Airworthiness	2011	Complete study of risk-based fleet management for small-airplane continued operational safety	**Completed**	2011 NARP Status: On schedule
A11.h	System Safety Management	2011	Develop automated tools to monitor databases for potential safety issues	**Completed**	2011 NARP Status: On schedule
AIP	Airport Cooperative Research Program - 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	**Completed**	2011 NARP Status: On schedule
AIP	Airport Cooperative Research Program - Safety	2011	Develop and validate a software tool to quantify risk and support engineering decision-making related to runway safety area requirements	**Completed**	2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
Ops	Commercial Space Transportation Safety	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	**Deleted**	This milestone has been deleted due to changing Commercial Space Transportation Safety Program priorities. 2011 NARP Status: Delayed from 2010 to 2011
Ops	Commercial Space Transportation Safety	2011	Release Commercial Space Transportation Research Road Map document, v1.0	**Completed**	2011 NARP Status: On schedule
1A08G	NextGen - System Safety Management Transformation	2012	**Using the existing Aviation Safety Information Analysis and Sharing system architecture, develop a proof-of-concept and prototype for the sharing of aviation safety information among Joint Planning and Development Office member agencies, participants, and stakeholders**	**Completed**	The wording of this milestone was revised because the "Net Enabled Architecture" is still in development and is an activity outside of scope of Aviation Safety's authority. Old Wording: Validate the Net Enabled Operations proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders 2011 NARP Status: On schedule
A11.h	System Safety Management	2012	Demonstrate a working prototype of network-based integration of information extracted from diverse, distributed sources	On schedule	

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A11.h	System Safety Management	2012	Demonstrate a one-half reduction in the rate of fatalities and injuries	**Deleted**	This milestone was deleted because it is no longer appropriate for this R&D Goal. The milestone was developed when the number of air traffic operations was projected to double by 2012. In addition, the accident reduction goal verbiage has significantly changed in *Destination 2025* from metrics previously used. 2011 NARP Status: On schedule
A11.h	**System Safety Management**	**2012**	**Develop a quantitative and objective approach to prioritize new and evolving safety risks identified through analysis of multiple databases**	**On schedule**	New milestone
A11.h	**System Safety Management**	**2012**	**Develop a user interface and trend analysis capability that monitors NAS performance with respect to failures, risks, impact on Air Traffic Control and other off-nominal occurrences**	**On schedule**	New milestone
A11.h	**System Safety Management**	**2012**	**Complete a pilot-in-the-loop evaluation of radius-to-fix turns during departure procedures**	**On schedule**	New milestone
A11.h	**System Safety Management**	**2012**	**Complete representative stall model for upset recovery training**	**On schedule**	New milestone

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A01C 1A08C 1A01B	Operations Concept Validation NextGen - Operations Concept Validation - Validation Modeling System Capacity, Planning and Improvement	2013	Demonstrate an increase in capacity and efficiency at 2021 forecasted traffic levels	**On schedule**	2011 NARP Status: No status provided
1A08H	NextGen - Operational Assessments	**2013**	**Develop and implement NAS-wide demand forecasting, economic and environmental analysis capability with Aviation Environmental Portfolio Management Tool**	**Delayed**	This milestone is delayed from 2012 to 2013 and wording revised to reflect an increased scope of work. Old Wording: Develop and implement NAS-wide cost-benefit environmental analysis capability with the Aviation Environmental Portfolio Management Tool 2011 NARP Status: On schedule
1A08H	NextGen - Operational Assessments	2013	Explore options to integrate environmental assessment capability with NextGen NAS models	On schedule	2011 NARP Status: On schedule
1A08G	NextGen - System Safety Management Transformation	2013	Complete the Aviation Safety Information Analysis and Sharing system pre-implementation activities, including concept definition, with other Joint Planning and Development Office member agencies, participants, and stakeholders	Completed	2011 NARP Status: On schedule

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08G	NextGen - System Safety Management Transformation	2014	Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across NextGen	On schedule	2011 NARP Status: On schedule
A11.h	System Safety Management	**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**	**Delayed**	This milestone was delayed from 2012 to 2014 and wording revised because the sponsor (Transport Airplane Directorate - TAD) expanded the scope of the initial requirement and mapped it back to SMS and continued operational safety. Old Wording: Develop risk management concepts, models, and tools for transport category airplanes 2011 NARP Status: On schedule
A11.h	**System Safety Management**	**2015**	**Expand the Aviation Safety Information Analysis and Sharing system safety analysis to other domains (e.g., general aviation, rotorcraft, corporate, military)**	**On schedule**	New milestone
1A01C 1A08C 1A01B	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	**On schedule**	2011 NARP Status: No status provided

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
1A08H	NextGen - Operational Assessments	2016	Employ the Aviation Environmental Design Tool and the Aviation Environmental Portfolio Management Tool for NAS-wide environmental analyses	On schedule	
A11.h	**System Safety Management**	**2016**	**Complete an evaluation of the reported runway slipperiness condition from all potential runway surface conditions and airplane configurations**	**On schedule**	New milestone
A11.h	**System Safety Management**	**2016**	**Develop test criteria by varying motion characteristics to span the domain of the criteria and compare variations against subjective opinions of motion quality**	**Not started**	New milestone
A11.h	System Safety Management	2016	Demonstrate a two-thirds reduction in the rate of fatalities and injuries	**Deleted**	This milestone was deleted because it is no longer appropriate for this R&D Goal. The milestone was developed when the number of air traffic operations was projected to triple by 2016. In addition, the accident reduction goal verbiage has significantly changed in *Destination 2025* from metrics previously used. 2011 NARP Status: Delayed from 2015 to 2016
A11.h	**System Safety Management**	**2016**	**Establish safety metrics to align with NextGen system changes**	**On schedule**	New milestone

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
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	
A14.a	System Planning and Resource Management	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	
A14.a	System Planning and Resource Management	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	
A14.a	System Planning and Resource Management	2010	Determine criteria for assessing the benefits of the international research collaboration	Completed	
A14.a	System Planning and Resource Management	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	**Completed**	2011 NARP Status: On schedule
A14.a	System Planning and Resource Management	2011	Develop a strategic mapping for international research collaboration	**Completed**	2011 NARP Status: On schedule
A14.a	System Planning and Resource Management	2011	Identify a process to measure quality, timeliness, and value of international research collaboration	**Completed**	2011 NARP Status: On schedule
A14.a	**System Planning and Resource Management**	**2012**	**Publish the NARP, which documents the annual R&D budget portfolio, describes the activities of the RE&D Advisory Committee, and contains the FY 2012-2017 FAA R&D plan**	**On schedule**	New milestone

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.					
BLI	**Program Name**	**Year**	**Milestone**	**Status**	**Notes**
A14.a	**System Planning and Resource Management**	**2012**	**Measure quality, timeliness, and value of international research collaboration**	**On schedule**	New milestone
A14.a	**System Planning and Resource Management**	**2012**	**Conclude final value of international research collaboration**	**On schedule**	New milestone
A14.a	System Planning and Resource Management	2016	Determine final value of international research collaboration	On schedule	

Appendix E: Appendices Acronyms and Abbreviations

Acronym	Definition
0-9	
100LL	100Low Lead
3D-PAM	3D-Path Arrival Management
4DT	Four-Dimensional Trajectory
A	
AAI	FAA Accident Investigation Division
AAIADS	Aerospace Accident Injury and Autopsy Data System
AAPTP	Airfield Asphalt Pavement Technology Program
AC	Advisory Circular
ACCRI	Aviation Climate Change Research Initiative
ACER	Airliner Cabin Environment Research
ACES	Airspace Conflict Evaluation System
ACI-NA	Airport Council International-North America
ACRP	Airport Cooperative Research Program
ADDS	Aviation Digital Data Service
ADS-B	Automatic Dependent Surveillance-Broadcast
AED	Army Aviation Engineering Directorate
AEDT	Aviation Environmental Design Tool
AEE	FAA Office of Environment and Energy
AEH	Airborne Electronic Hardware
AGC	FAA Legal Counsel
AIA	Aerospace Industries Association
AIDL	Aircraft Intent Description
AIM	Aeronautical Information
AIP	Airport Improvement Program Appropriation
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
ALPA	Airline Pilots Association
AMP	Airspace Management Program
AMRO	Automation for Monitoring RNP/RNAV Operations
AMS	Acquisition Management System
AMTAS	Advanced Materials in Transport Aircraft Structures
ANE	Engine and Propeller Directorate
ANSP	Air Navigation Service Provider
AOC	Airline/Aviation/Aircraft Operations Center
APHIS	Animal and Plant Health Inspection Service
APMT	Aviation Environmental Portfolio Management Tool
APT	Accelerated Pavement Test
APTV	Airport Pavement Test Vehicle

Acronym	Definition
ARAC	Aviation Rulemaking Advisory Committee
ARC	Aviation Rulemaking Committee
ARFF	Aircraft Rescue Fire Fighting
ARP	FAA Office of Airports
ASBS	Auto Brake Systems with Antiskid
ASDE-X	Airport Surface Detection Equipment
ASE	Aviation Safety Engineers
ASIAS	Aviation Safety Information Analysis and Sharing
ASOS	Automated Surface Observing System
ASR	Alkali-Silica Reactive
ASR	Airport Surveillance Radars
ASRS	Aviation Safety Reporting System
ASTM	ASTM International (formerly the American Society for Testing and Materials)
ATC	Air Traffic Control
ATCS	Air Traffic Control Specialists
ATCSCC	Air Traffic Control Systems Command Center
ATCT	Air Traffic Control Tower
ATC/TO	Air Traffic Control/Technical Operations
ATCOV	Air Traffic Color Vision
ATD	Anthropometric Test Dummy
ATD&P	Advanced Technology Development and Prototyping
ATM	Air Traffic Management
ATO	FAA Air Traffic Organization
ATO-S	ATO’s Safety Service Unit
ATR	Airport Technology Research
Avgas	Aviation Gasoline
AVS	FAA Office of Aviation Safety
AVSI	Aerospace Vehicle Systems Institute
AWOS	Automated Weather Observing System
B	
BLI	Budget Line Item
C	
C2	Control and Communications
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 Aviation Safety Team
CATM	Collaborative Air Traffic Management
CD&V	Concept Development and Validation Group
CDA	Continuous Descent Approach

Acronym	Definition
CDTI	Cockpit Display of Traffic Information
CEAT	COE for Airport Technology
CECAM	Center of Excellence for Composites and Advanced Materials
CEQ	Council on Environmental Quality
CGAR	COE for General Aviation Research
CLEEN	Continuous Lower Energy, Emissions, and Noise
CMTD	Concept Maturity and Technology Development
CNS	Communications, Navigation and Surveillance
CNSI	Communications Navigation Surveillance Information
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
ConOps	Concept of Operations
CONUS	Continental United States
ConUse	Concepts of Use
COP	Common Operating Picture
COS	Continued Operational Safety
CoSPA	Consolidated Storm Prediction for Aviation
COTS	Commercial-Off-The-Shelf
CRC	Coordinating Research Council
CRD	Concepts and Requirements Definition
CRDA	Cooperative Research and Development Agreement
CRM	Crew Resource Management
CSG	Concept Steering Group
CSPO	Closely Spaced Parallel Operations
CSPR	Closely Spaced Parallel Runways
CST	Commercial Space Transportation
CU	University of Colorado at Boulder
C&V	Ceiling and Visibility
D	
DAH	Design Approval Holder
DARWIN™	Design Assessment of Reliability With INspection
DFW	Dallas-Fort Worth International Airport
DGAC	La Direction Generale de L'Aviation Civile
DHS	U.S. Department of Homeland Security
DMA	Dynamic Mechanical Analyzer
DNL	Day Night Level
DOC	Department of Commerce
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
E	
E&E	Environment and Energy
EA	Enterprise Architecture

Acronym	Definition
EA	Environmental Assessment
EDR	Eddy Dissipation Rates
EDS	Environmental Design Space
EFB	Electronic Flight Bag
EFVS	Enhanced Flight Vision/Visibility Systems
EIS	Environmental Impact Statement
EMS	Environmental Management System
EMST	Emerging Metallic Structures Technology
EPA	U.S. Environmental Protection Agency
ES	Electrical Systems
EUROCONTROL	European Organization for the Safety of Air Navigation
EWG	Environmental Working Group (formerly the Environmental Integrated Product Team, or E-IPT)
EWIS	Electrical Wiring Interconnect Systems
F	
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FAROS	Final Approach Runway Occupancy Signal
FCMS	Flight Controls and Mechanical Systems
FDCT	Functional Design Consideration Team
FEB	FFRDC Executive Board
FFRDC	Federally Funded Research and Development Center
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Federal Interagency Commission on Noise
FIT	Florida Institute of Technology
FMS	Flight Management System
FOD	Foreign Object Debris
FOS	Fleet and Operations Sequence
FRAT	Facility Risk Assessment Tool
FRMS	Fatigue Risk Management System
FSU	Florida State University
FTE	Full-Time Equivalent
FWD	Falling Weight Deflectometer
FY	Fiscal Year
G	
GA	General Aviation
GAMA	General Aviation Manufacturers Association
GAO	General Accounting Office
GBAS	GPS Local Area Augmentation System
GDP	Ground Delay Program
GHG	Greenhouse Gas
GPS	Global Positioning Satellites/System
GTG2	Graphical Turbulence Guidance 2

Acronym	Definition
GTR	Global Technical Regulations
H	
HACCP	Hazard Analysis and Critical Control Points
HAPs	Hazardous Air Pollutants
HEMS	Helicopter Emergency Medical Services
HF	Human Factors
HFREG	FAA Human Factors Research and Engineering Group
HITL	Human-In-The-Loop
HIWC	High Ice-Water Content
HM	Health Monitoring
HMA	Hot-Mix Asphalt
HSI	Human System Integration
HTPT	High Tire Pressure Testing
HUD	Head-Up Display
HUMS	Health and Usage Monitoring System
I	
I&I	Integration and Implementation
IA	Interagency Agreement
IARD	Investment Analysis Readiness Decision
ICAO	International Civil Aviation Organization
ICATEE	International Committee for Aviation Training in Extended Envelopes
IFR	Instrument Flight Rule
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IPRF	Innovative Pavement Research Foundation
ISS	Information System Security
IT	Information Technology
IVATF	ICAO Volcanic Ash Task Force
IWP	Integrated Work Plan
J	
JAMS	Joint Center of Excellence for Advanced Materials
JPDO	Joint Planning and Development Office
JRC	FAA Joint Resources Council
JUP	Joint University Program
L	
LAAS	Local Area Augmentation System
LCCA	Life Cycle Cost Analysis
LCGS	Low Cost Ground Surveillance
LEAF	Layered Elastic Analysis - FAA
LED	Light Emitting Diode
LoC	Loss of Control
M	
MASPS	Minimum Aviation System Performance Standards
MDERT	Model Development and Enhancement Research Team

Acronym	Definition
MET	Meteorological
M&I	Maintenance and Inspections
MMOD	Micrometeoroid and Orbital Debris
MMPDS	Metallic Materials Properties Development and Standardization
MOA	Memorandum of Agreement
MOC	Memorandum of Cooperation
MOIE	Mission Oriented Investigation and Experimentation
MOPS	Minimum Operational Performance Standards
MOU	Memorandum of Understanding
MPAR	Multi-Function Phased Array Radar
MRMS	Multiple Radar Multiple Sensor
MSAD	Monitor Safety/Analyze Data
MSP	Multi Sector Planner
N	
NAAQS	National Ambient Air Quality Standard
NAPTF	National Airport Pavement Test Facility
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASPAC	NAS Performance Analysis Capability
NAWC	Naval Air Warfare Center
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NDE	Nondestructive Evaluation
NDI	Nondestructive Inspection
NEPA	National Environmental Policy Act
NETE	Net Enabled Test Environment
NextGen	Next Generation Air Transportation System
NEXTOR	National Center of Excellence for Aviation Operations Research
NIEC	NextGen Integration & Evaluation Capability
NIST	National Institute of Standards and Technology
NLA	New Large Aircraft
NMNH	National Museum of Natural History
NMSU	New Mexico State University
NMT	New Mexico Institute of Mining and Technology
NNEW	NextGen Network Enabled Weather
NOAA	U.S. National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxide
NPRM	Notice of Proposed Rule Making
NRS	Navigation Reference System
NTSB	National Transportation Safety Board
NWS	National Weather Service
O	
OFCM	Office of the Federal Coordinator for Meteorology

Acronym	Definition
OI	Operational Improvement
OMB	Office of Management and Budget
OMT	Outcome Management Team
OOOI	Out, Off, On, and In time
Ops	Operations Appropriation
ORD	Chicago O’Hare International Airport
OST	Office of the Secretary of Transportation
OTW	Out-the-Window
P	
PACOTS	Pacific Organized Track System
PARC	Performance Based Operations Advisory Rulemaking Committee
PARTNER	Partnership for Air Transportation Noise and Emissions Reduction
PBN	Performance Based Navigation
PBWP	Product Based Work Plan
PCN	Pavement Classification Number
PDARS	Performance Data Analysis and Reporting System
PDRI	Probabilistic Design for Rotor Integrity
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Particulate Matter
PMB	Polymer Modified Bitumen
PPPs	Public-Private Partnerships
PRA	Probabilistic Risk Analysis
PS	Propulsion Systems
R	
R&D	Research and Development
RAP	Recycled Asphalt Pavement
R,D&E	Research, Development, and Evaluation
R,E&D	Research, Engineering and Development Appropriation
REDAC	Research, Engineering, and Development Advisory Committee
RFG	Requirements Focus Group
RFID	Radio Frequency Identification
RIL	Runway Intersection Lights
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
RPI	Relative Position Indicator
RR	Rapid Refresh
RS	Rotorcraft Systems
RTA	Required Time of Arrival
RTCA	Radio Technical Commission for Aeronautics

Acronym	Definition
RVR	Runway Visual Range
RWI	Reduce Weather Impact
RWSL	Runway Status Light
S	
SAA	Sense and Avoid
SAE	Society of Automotive Engineers
SAS	Subcommittee on Aircraft Safety
SATCOM	Satellite Communications
SBAS	Satellite-Based Augmentation System
SC	Special Committee
SDS	Software and Digital Systems
SDSS	Software and Digital Systems Safety
SES	Senior Executive Service
SESAR	Single European Sky Air Traffic Management Research
SG	Strategic Guidance
SI	Smithsonian Institution
SIM	Structural Integrity Metallic
SLD	Supercooled Large Droplet
SMA	Small and Medium Airport
SMA	Stone Matrix Asphalt
SMR	Surface Movement Radars
SMS	Safety Management System
SNT	Staffed NextGen Towers
SRM	Safety Risk Management
SU	Stanford University
SUPRA	Simulation of Upset Recovery in Aviation
SVS	Synthetic Vision System
SWA	Southwest Airlines
SWAC	System Wide Analysis Capability
SWIM	System-Wide Information Management
T	
TAD RAM	Transport Airplane Directorate Risk Assessment Methodology
TAF	Terminal Area Forecast
TAIWIS	Terminal Area Icing Weather Information System
TAS	Terminal Area Safety
TBFM	Time Based Flow Management
TBO	Trajectory-Based Operations
TCAS	Traffic Alert and Collision Avoidance System
TCRG	Technical Community Representative Group
TDWR	Terminal Doppler Weather Radar
TERPS	Terminal Instrumentation Procedures
TF	Task Force
TFM	Traffic Flow Management
TGF	Target Generator Facility

Acronym	Definition
THERMAKIN	FAA Thermal-Kinetic Burning Model
TMA	Traffic Management Advisor
TMI	Traffic Management Initiatives
TO	Technical Operations
TOps	Trajectory Operations
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TSO	Technical Standard Order
U	
UAS	Unmanned Aerial Systems
UAS	Unmanned Aircraft System
UAT-ARC	Unleaded Aviation Gasoline Transition Aviation Rulemaking Committee
UCF	University of Central Florida
UEDDAM	Uncontained Engine Debris Damage Assessment Model
UF	University of Florida
ULDs	Unit Load Devices
U.S.	United States
USAF	U.S. Air Force
USDA	United States Department of Agriculture
UTMB	University of Texas Medical Branch at Galveston
V	
VFR	Visual Flight Rules
VLJ	Very Light Jet
VOC	Volatile Organic Compound
W	
WAAS	Wide Area Augmentation System
WAIWG	Weather – Air Traffic Management Integration Working Group
WG	Working Group
WJHTC	William J. Hughes Technical Center
WMA	Warm Mix Asphalt
WRF	Weather Research and Forecasting
WTIC	Weather Technology in the Cockpit