Federal Aviation Administration

NARP

2012 National Aviation Research Plan

March 2012

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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.

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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.

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[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.

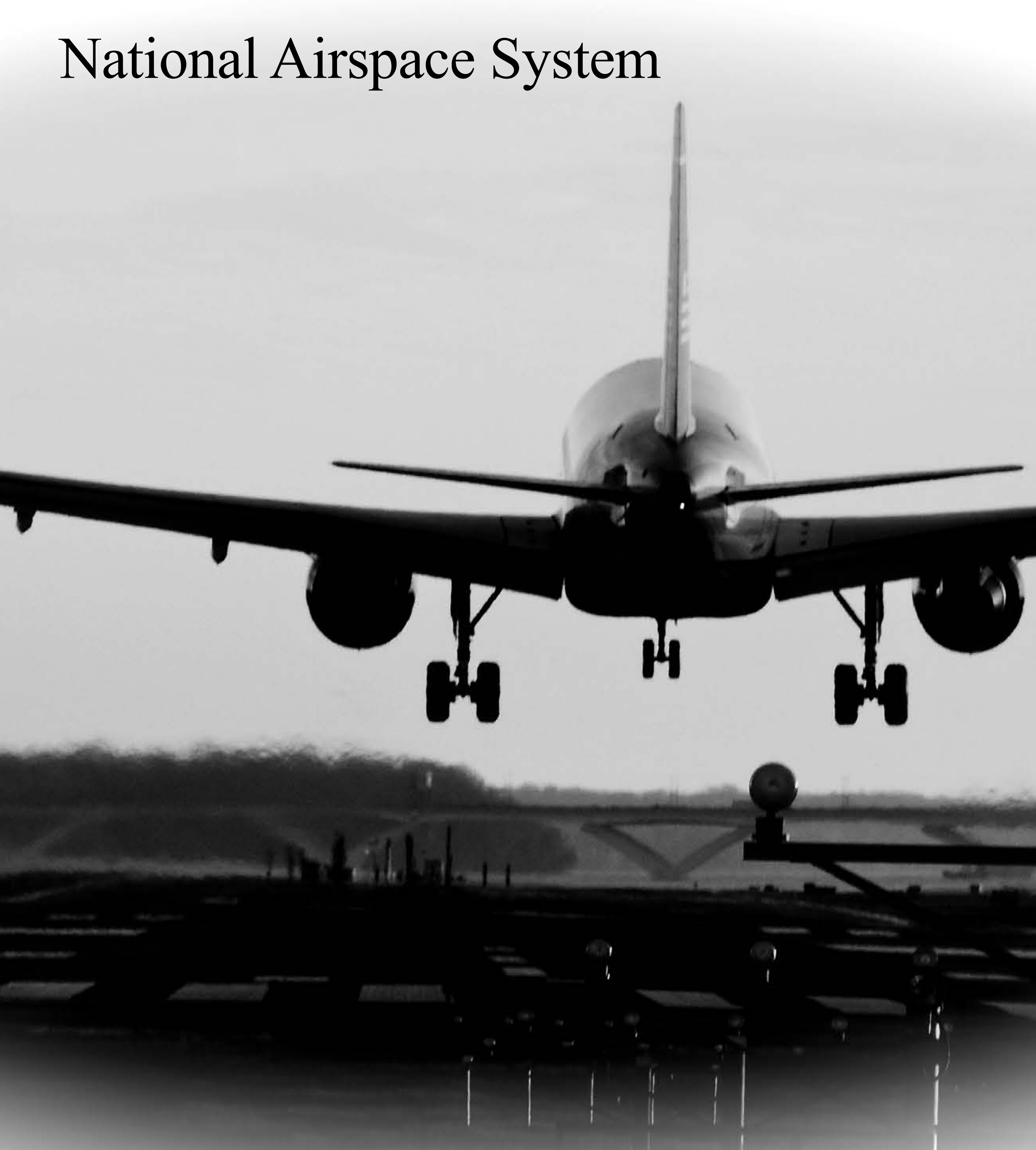
Appendix D reports the status of all milestones in Chapter 2 of the 2012 NARP. To ensure complete transparency and to maintain continuity with previous editions of the NARP, this appendix notes any changes in the milestones aligned with the ten R&D goals.

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]

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[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

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[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.

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[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 Development Goals

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	■		■

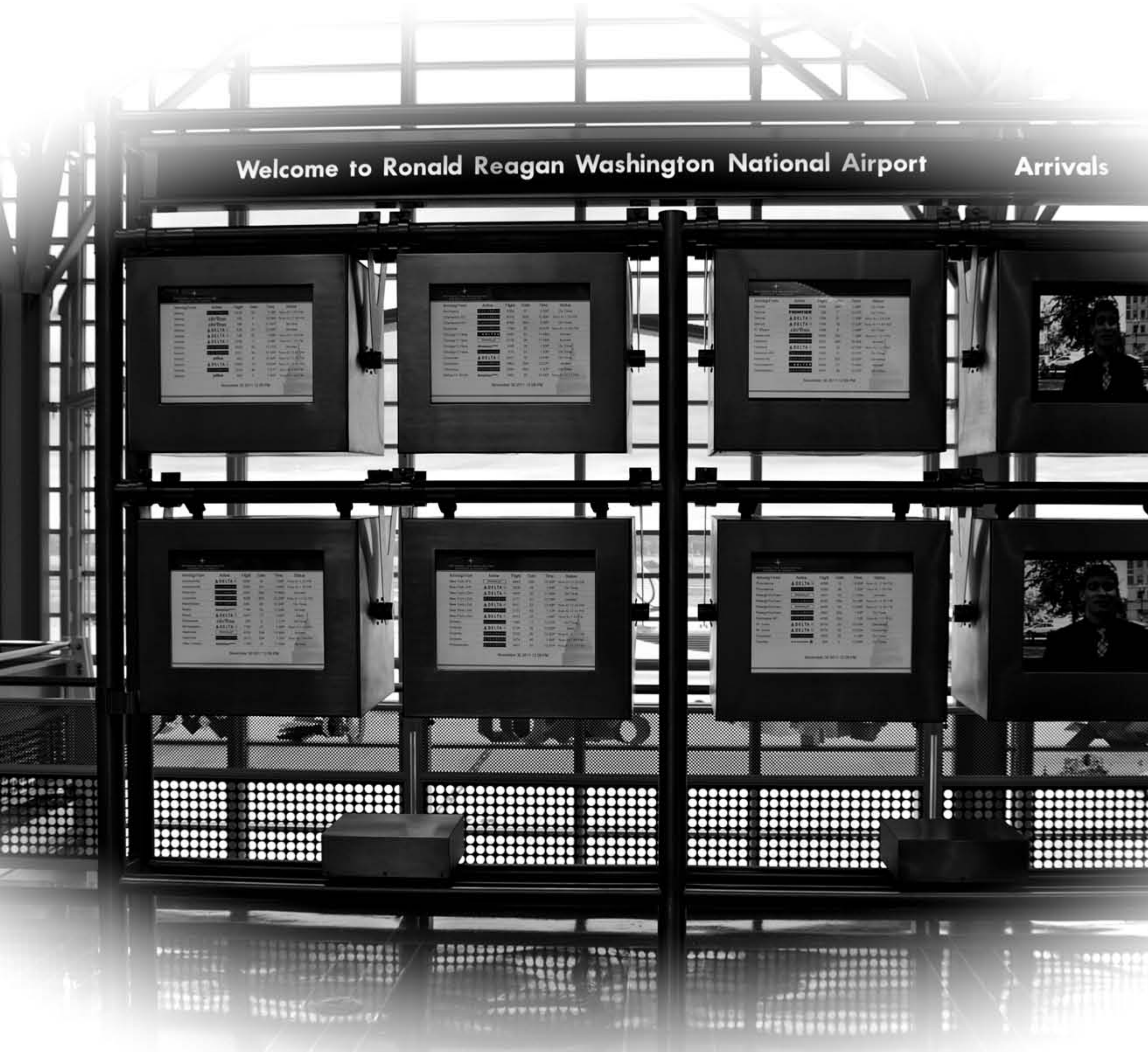
Table 2.1 (continued)

Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goal 9	Goal 10	
Human-Centered Design	**Human Protection**	**Safe Aerospace Vehicles**	**Separation Assurance**	**Situational Awareness**	**System Knowledge**	**World Leadership**	
	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

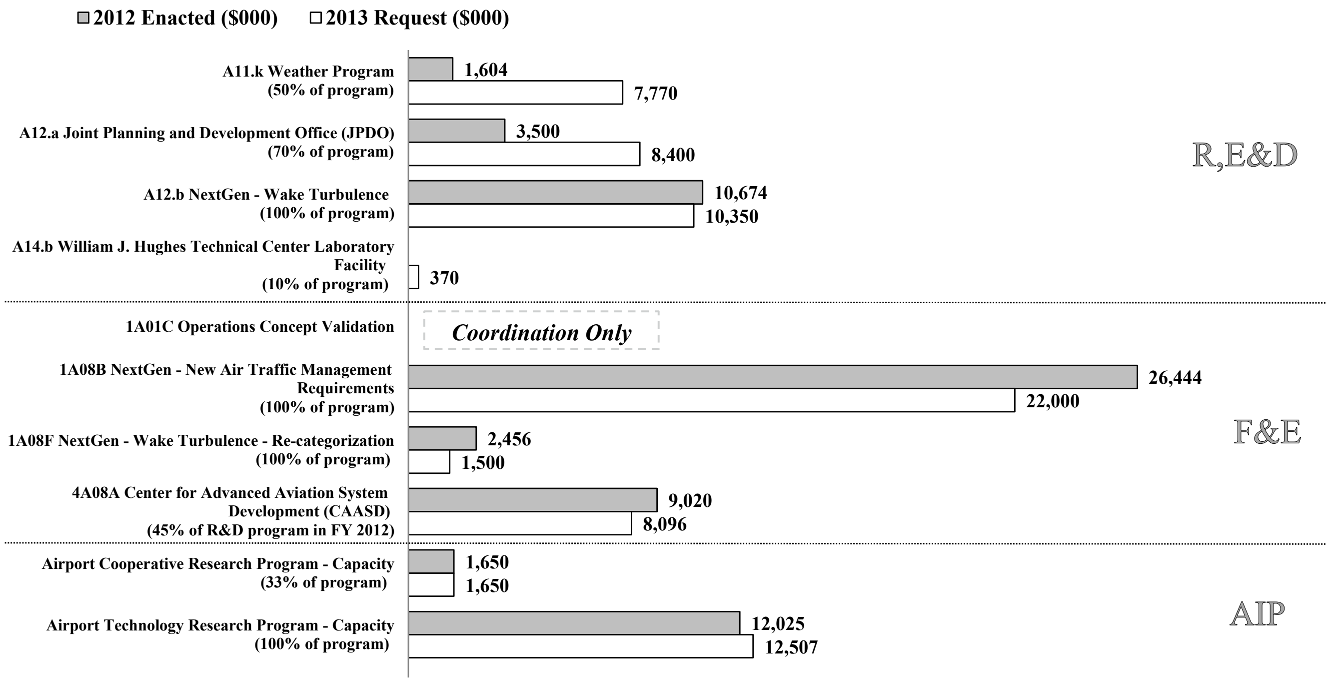
By 2016, demonstrate that the modernized system can handle anticipated growth in traffic demand and reduce gate-to-gate transit time.

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)

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[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

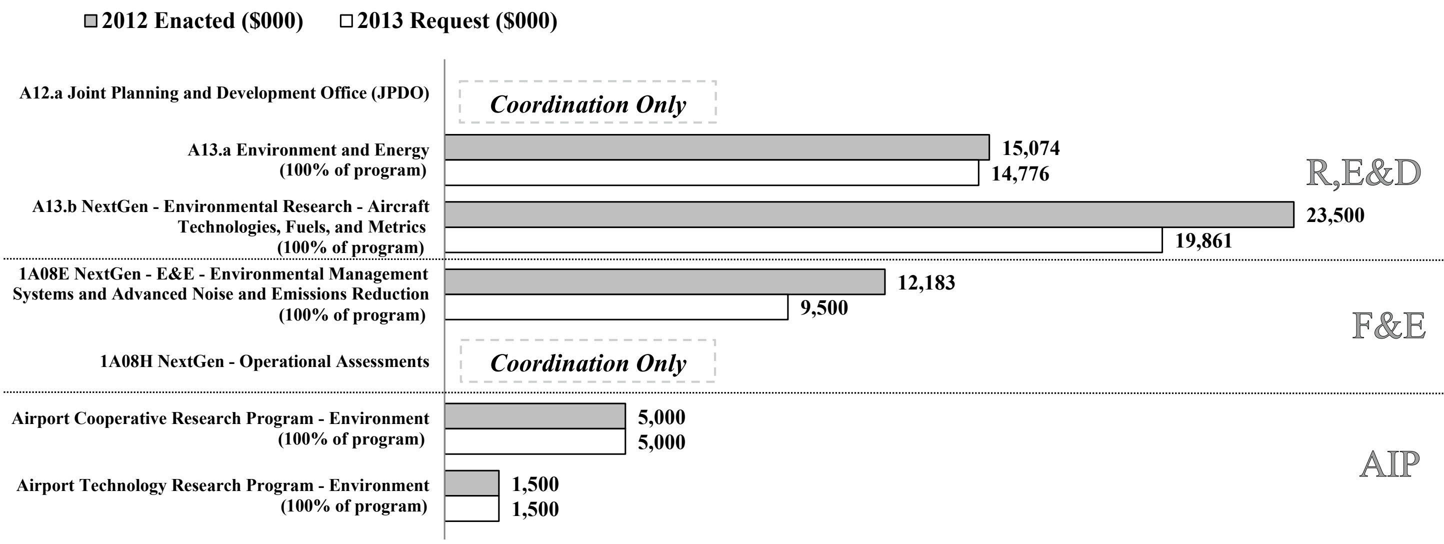
By 2016, demonstrate[11] that significant aviation noise and emissions impacts can be reduced in absolute terms (despite growth) in a cost-beneficial way, make progress toward achieving carbon neutral growth by 2020 from a 2005 baseline, and reduce uncertainties in particulate matter and non-carbon dioxide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

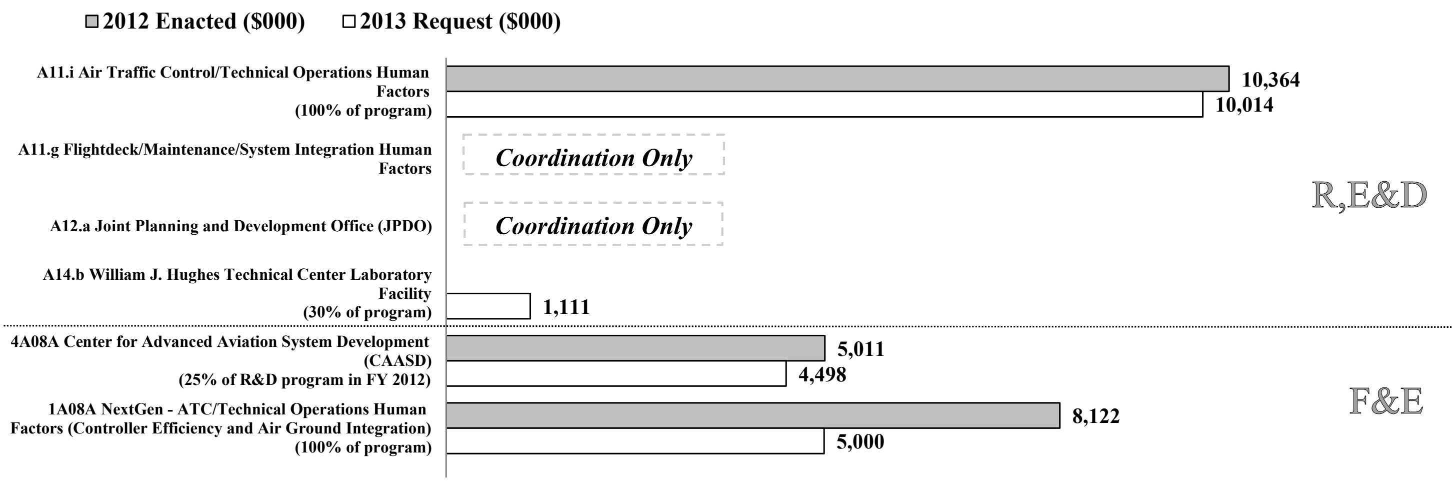
By 2016, demonstrate improvement in Air Navigation Service Provider efficiency (e.g., greater number of aircraft) and effectiveness (e.g., improvement of safety metrics) through automation and standardization of operations, procedures, and information.

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))

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[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

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

R&D Target

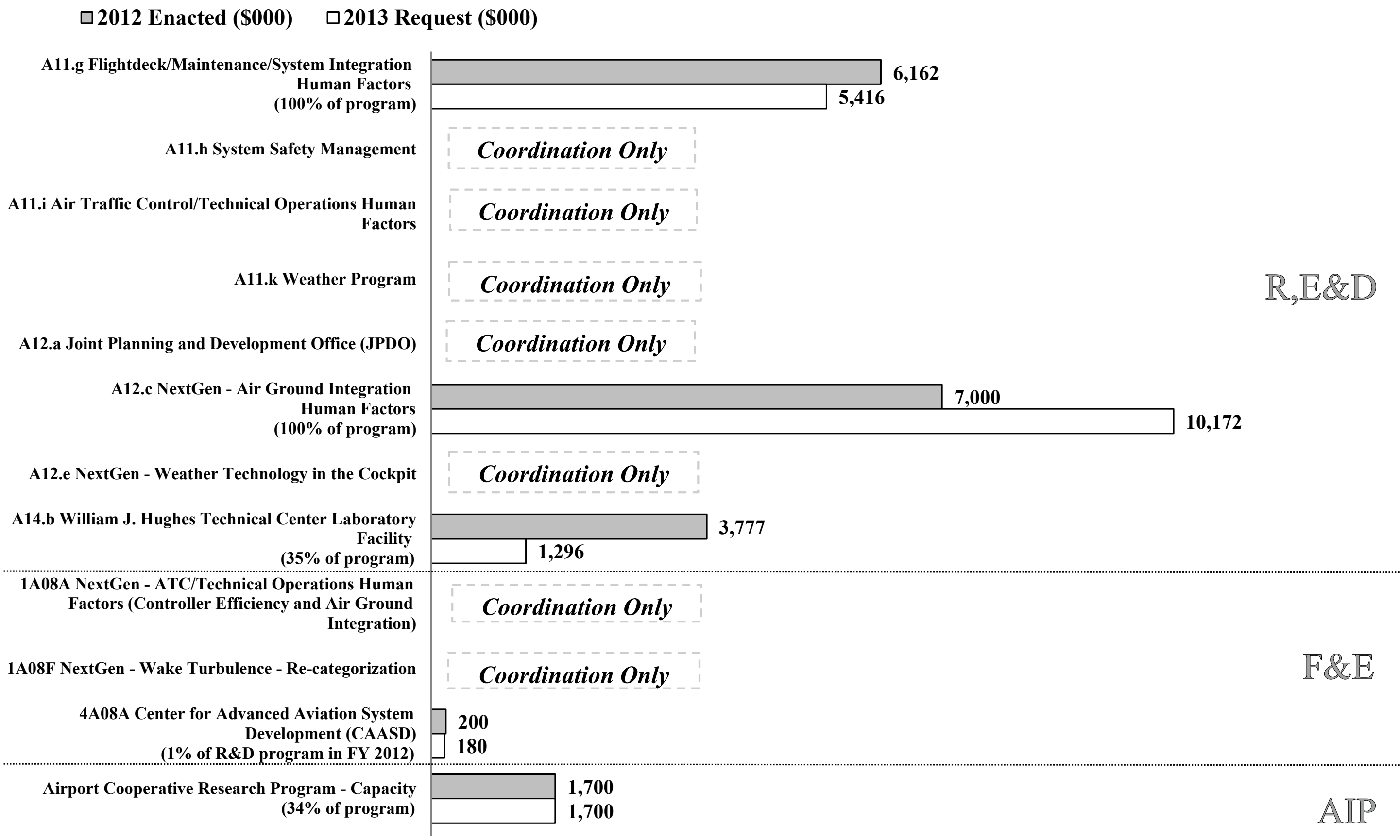
By 2016, demonstrate that operations (e.g., day and night, all weather), procedures, and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft.

Method of Validation

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

Funding Requirements - R&D Goal 4

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)

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

Automatic Dependent Surveillance - Broadcast: 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)

Relationship between Human Pilots and Controllers with Associated Automated Systems: 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)

Cockpit Presentation of Meteorological Information: 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)

Standardized Meteorological Symbology and Support to SAE G-10: 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)

General Aviation Meteorological Information User Needs: 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

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

R&D Target

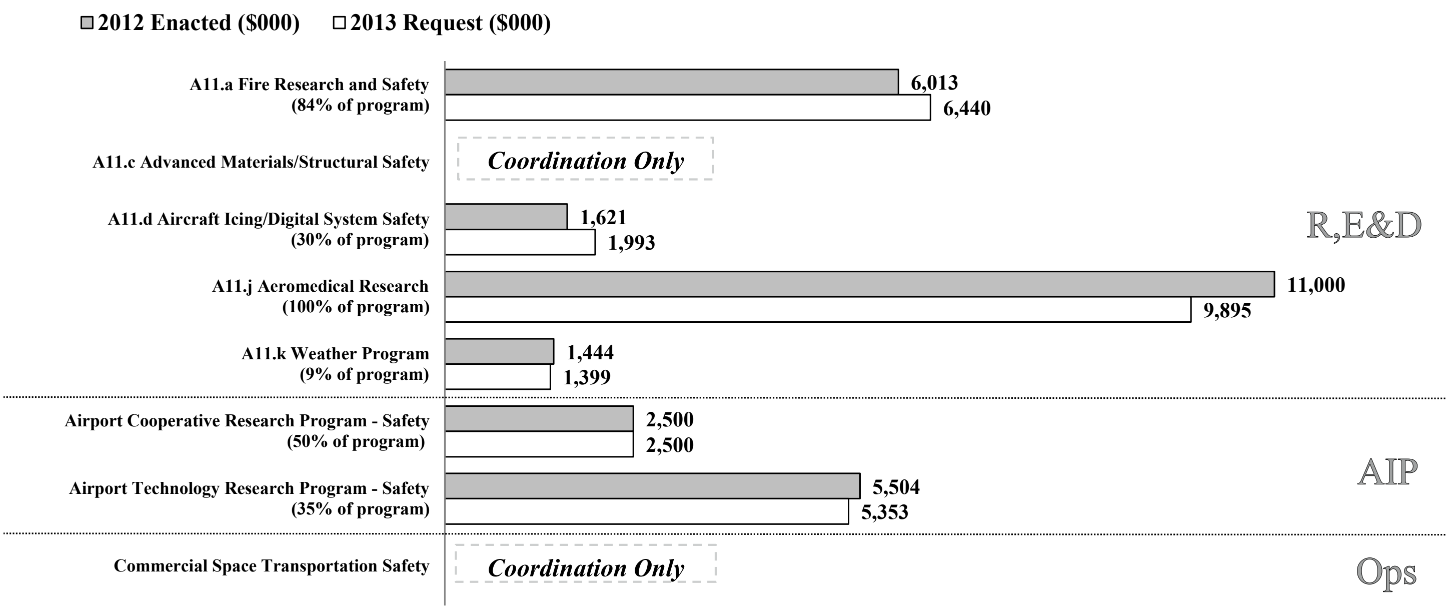
By 2016, demonstrate a significant reduction in the rate of aerospace-related fatalities and significant injuries.

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

Assessing the Role of Airports and Airlines in the Spread of Vector-Borne Diseases: 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)

Developing Improved Civil Aircraft Arresting Systems: 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)

Selection of Appropriate Child Anthropomorphic Test Dummies for Aviation Testing: 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)

Enhanced Emergency Evacuation of Passengers Using Modeling and Simulation: 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)

Biomarkers of Moderate Alcohol Ingestion: 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)

Radiation Exposure In-Flight: 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)

Medical Certification Process Review: 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)

Ischemic Heart Disease in Airline Transport Pilots: 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)

<u>Evaluation of New Airport Runway Pavement Groove Shape</u>: 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)

<u>Composite Aircraft Fire Safety</u>: 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)


ATTACH
JACK PAD
MOORING FITTING
HERE
DANGER

R&D Goal 6

Safe Aerospace Vehicles

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

R&D Target

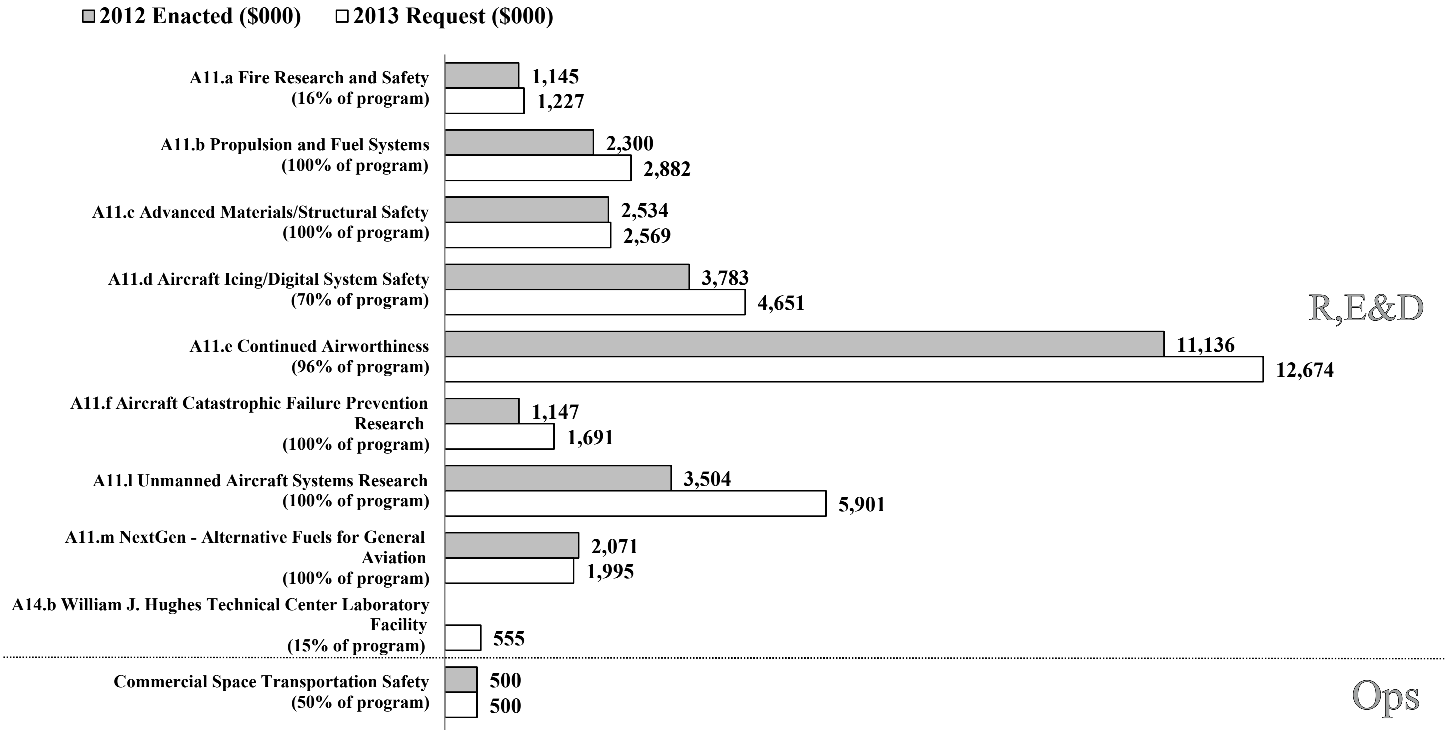
By 2016, demonstrate damage and fault tolerant vehicles and systems.

Method of Validation

The approach includes preventing accidents due to engine failures, structural failures, and system failures; developing a fireproof cabin; integrating unmanned aircraft and commercial space vehicles into the NAS; and addressing safety problems specific to 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.

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[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)


U.S. COAST GUARD
SAVANNAH

R&D Goal 7

Separation Assurance

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

R&D Target

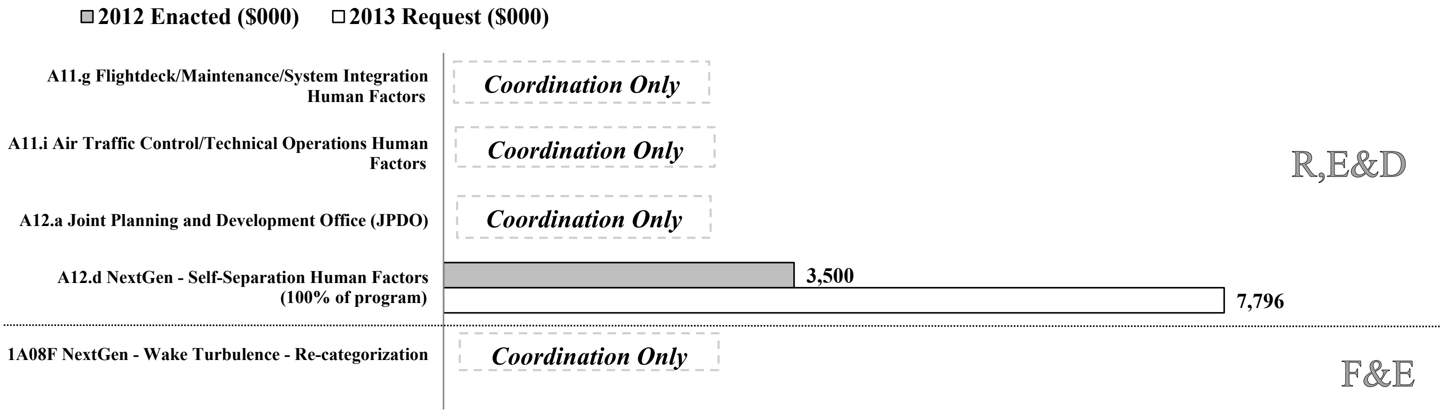
By 2016, develop initial standards and procedures for self-separation.

Method of Validation

The approach includes conducting 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

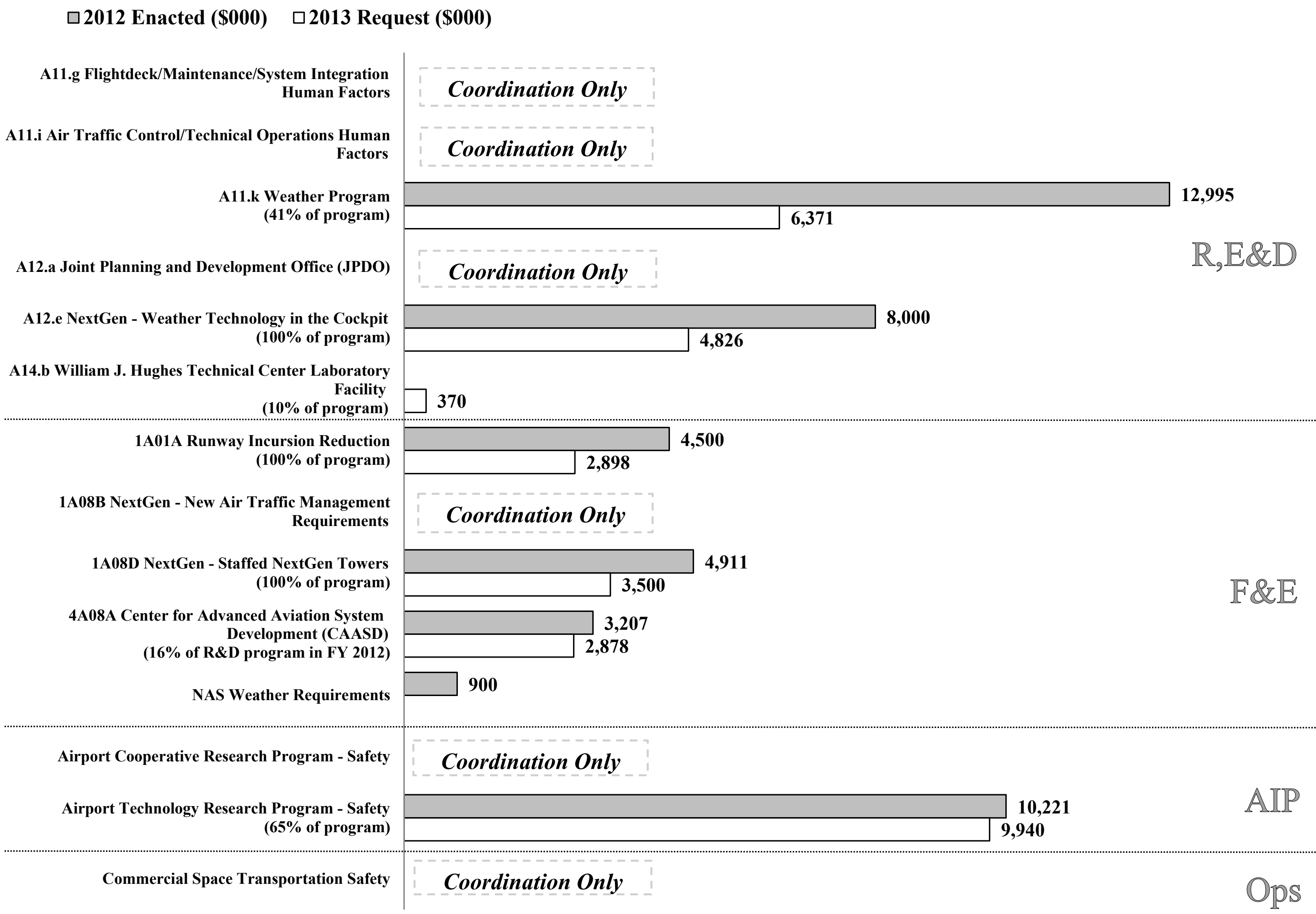
By 2016, demonstrate common, real-time awareness of ongoing air operations, events, crises, and weather in all phases of flight and at all types of airports by pilots and controllers.

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.

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

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)

Ceiling and Visibility Analysis: 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)

Forecast Icing Product with Severity: 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

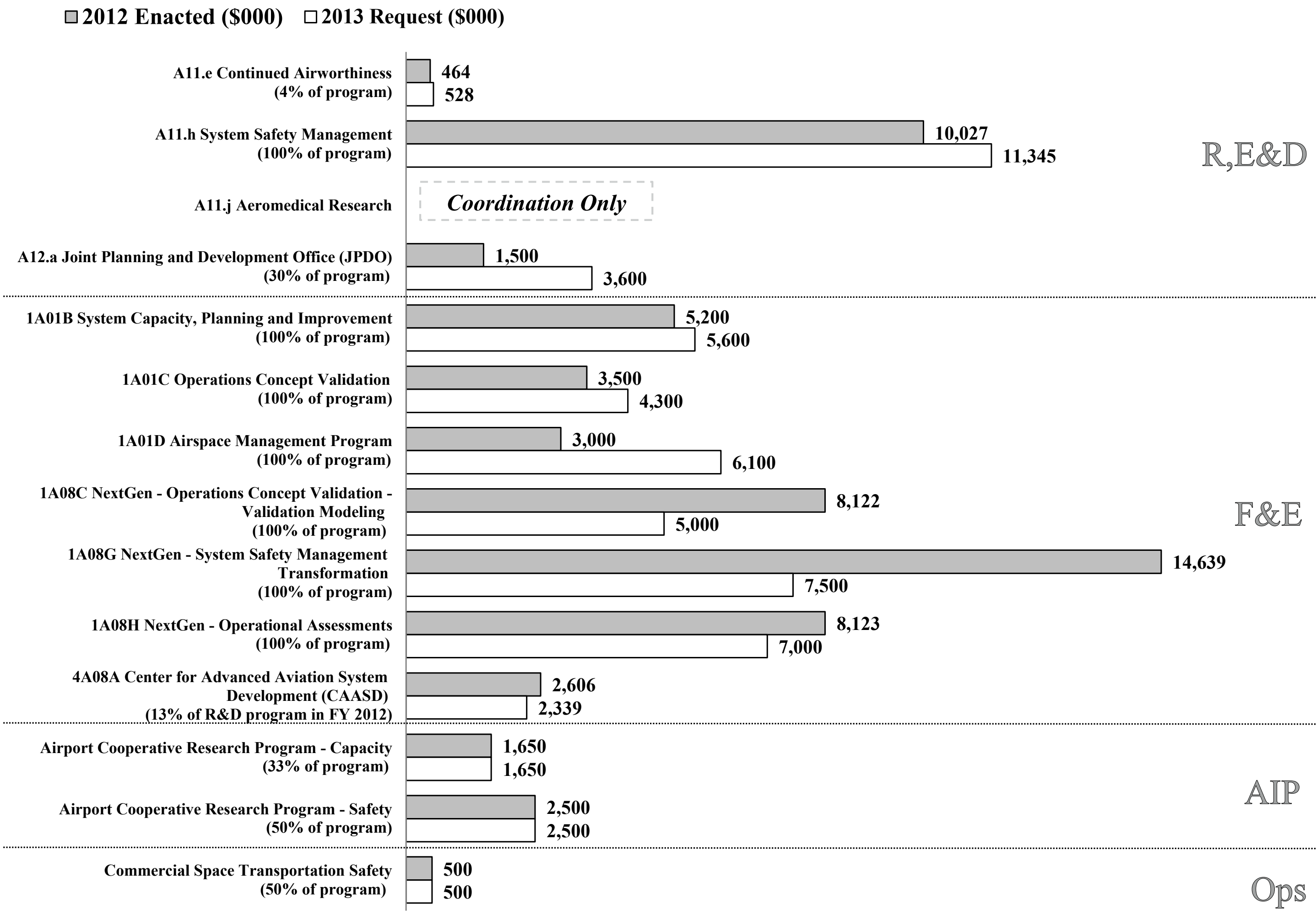
By 2016, understand economic (including implementation) and operational impact of system alternatives.

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)

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[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)

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[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

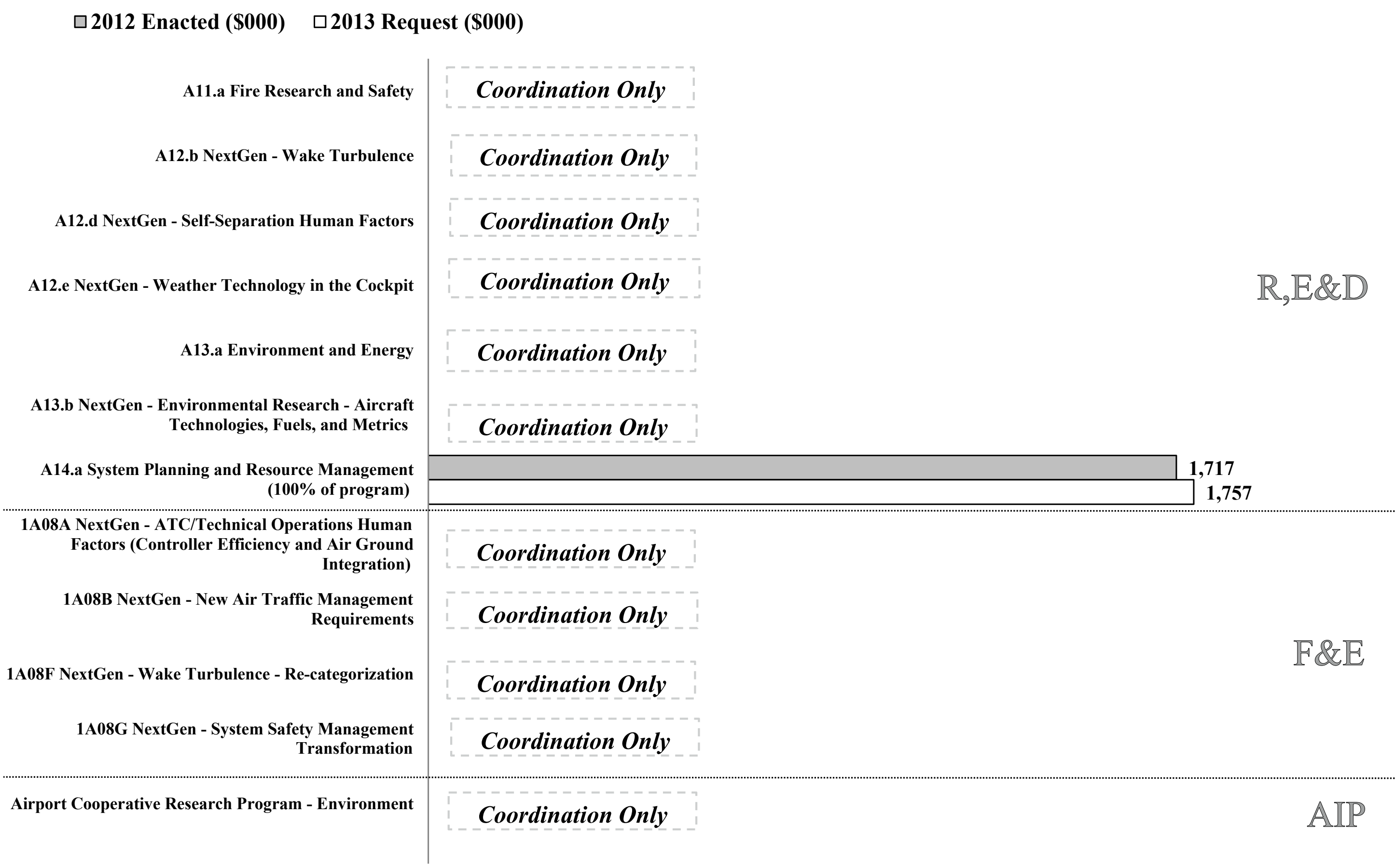
By 2016, demonstrate the value of working with international partners to leverage research programs and studies in order to improve safety and promote seamless operations worldwide.

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.

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

Increase Safety, Security, and Environment: 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.

Transform Facilities: The Transform Facilities (FAC) solution set focuses on capabilities that enable a network of integrated facilities designed to support the delivery of safer and more efficient 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 (A11.m)	NextGen - Wake Turbulence (A12.b)	NextGen - Air Ground Integration Human Factors (A12.c)	NextGen - Self-Separation Human Factors (A12.d)	NextGen - Weather Technology in the Cockpit (A12.e)	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b)	NextGen - Air Traffic Control/Technical Operations Human Factors (Controller Efficiency and Air Ground Integration) (1A08A)	NextGen - New Air Traffic Management Requirements (1A08B)	NextGen - Operational Concept Validation - Validation Modeling (1A08C)	NextGen - Staffed NextGen Towers (1A08D)	NextGen - Environment and Energy - Environmental Management System and Advanced Noise and Emissions Reduction (1A08E)	NextGen - Wake Turbulence - Re-categorization (1A08F)	NextGen - System Safety Management Transformation (1A08G)	NextGen - Operational Assessments (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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Chapter Four

Research Business Management

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.

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[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

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