Federal Aviation
Administration

2014
National Aviation Research Plan
(NARP)

Final

August 2015

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

2014 NARP – Final
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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.

Table of Contents

List of Tables

Executive Summary

Aviation is a vital resource for the United States (U.S.) because of its strategic, economic, and social importance. 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 U.S. 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 that promote safety and environmental sustainability.

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 aviation 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 features R&D principles and goals that support the strategic visions laid out by the President, the Secretary of Transportation, and the FAA Administrator. 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.

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 applied R&D as defined by the Office of Management and Budget (OMB) Circular A-11[1] and involves activities funded in three appropriation accounts: Research, Engineering and Development (RE&D), Facilities and Equipment (F&E), and Grants-In-Aid for Airports (AIP).

In FY 2015, the FAA plans to invest a total of $246,020,000 in R&D. The R&D investment spans multiple appropriations for the FAA, including $156,750,000 in RE&D; $44,520,000 in F&E; and $44,750,000 in AIP. The funding will be used to achieve the three central FAA R&D Principles of Improve Aviation Safety, Improve Efficiency, and Reduce Environmental Impacts. The NARP aligns with the White House National Science and Technology Council (NSTC)[2] *National Aeronautics Research and Development Plan*, the *U.S. Department of Transportation's Strategic Plan for Fiscal Years 2012-2016*, and the *Federal Aviation Administration Strategic Initiatives 2014-2018*[3].

[1] OMB Circular A-11, *Preparation, Submission and Execution of the Budget*, July 26, 2013, section 84, page 8, *available at* http://www.whitehouse.gov/OMB/circulars.

[2] The National Science and Technology Council (NSTC) was established by Executive Order 12881 on November 23, 1993. This Cabinet-level Council is 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. For more information, see: http://www.whitehouse.gov/ostp/nstc.

[3] FAA Administrator Michael P. Huerta released his *Federal Aviation Administration Strategic Initiatives 2014-2018* on February 19, 2014.

Preface

New this year is a mapping of current NARP principles with FAA Administrator Michael P. Huerta's new strategic vision, *Strategic Initiatives 2014-2018* (released in February 2014). This strategic document urges the FAA to 1) be more proactive about safety and use safety management principles to make smarter, risk-based decisions throughout the agency, with industry, and with global stakeholders, 2) safely integrate new types of user technologies, such as unmanned aircraft systems and commercial space vehicles, into the airspace; and 3) rationalize and rebalance existing services while modernizing existing infrastructure in order to reduce costs and become more efficient in the long run.

Due to extensive changes in the FY 2015 enacted budget amounts across all programs, certain programs have either 1) dropped out of the NARP entirely due to discontinuation of funding (e.g., Networked Facilities - Staffed NextGen Towers) or 2) had their milestones revised or deleted due to funding changes (e.g., Air Traffic Control/Technical Operations Human Factors, Joint Planning and Development Office (JPDO), NextGen - Advanced Systems and Software Validation, Operations Concept Validation Modeling, and Wake Turbulence - Re-categorization).

Finally, another major change from the 2013 NARP is the fact that the Commercial Space Program, whose research used to be funded out of a dedicated Operations (Ops) budget account, is now being funded through a RE&D budget account (A12.b NextGen - Air Ground Integration Human Factors). All references to Ops have been removed from the NARP and, while the Commercial Space milestone and progress item section remains in Chapter 1 (Safety), it is no longer identified by its own BLI number.

Introduction

To maximize the opportunities that the aviation industry provides, the U.S. must not only maintain, but also continue to improve upon, the National Airspace System (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 research and development (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. To support this mission, the FAA's corresponding 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 aeromedical research to the development of new products, services, and procedures.

Vision

The overall vision of the FAA is to strive to reach the next level of safety, efficiency, environmental responsibility, and global leadership. The FAA is accountable to the American public and stakeholders. In 2003, the Secretary of Transportation set forth a specific 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.[4] That proclamation led to the Vision 100 – Century of Aviation Reauthorization Act,[5] which became the foundation of the Next Generation Air Transportation System (NextGen). To support these visions, the FAA strives to conduct world-class, cutting edge R&D.

The FAA has defined five R&D organizational values to enable it to better manage its programs and achieve its 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.

[4] Letter to the President from Secretary of Transportation Norman Y. Mineta, "America at the Forefront of Aviation: Enhancing Economic Growth," November 25, 2003.
[5] Vision 100 – Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003, *available at* http://www.gpo.gov/fdsys/pkg/PLAW-108publ176/pdf/PLAW-108publ176.pdf

- 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 its vision and the national vision of a transformed aviation system.

National Goals and Strategic Plans

The establishment of national goals provides a framework for the FAA to identify and confront the most significant research challenges facing our nation's aviation system. This section explains how the White House Office of Science and Technology Policy, Office of the Secretary of Transportation, and FAA framework of goals and strategic plans are connected and how the FAA R&D portfolio supports the larger effort by providing research to pursue the near-, mid-, and far-term needs of the aviation community.

National Aeronautics Research and Development Plan

The National Aeronautics Research and Development Policy (December 2006) established a series of guiding principles to conduct Federal aeronautics R&D:

- Mobility through the air is vital to economic stability, growth, and security as a Nation.
- Aviation is vital to national security and homeland defense.
- Aviation safety is paramount.
- Security of and within the aeronautics enterprise must be maintained.
- The United States should continue to possess, rely on, and develop its world-class aeronautics workforce.
- Assuring energy availability and efficiency is central to the growth of the aeronautics enterprise.
- The environment must be protected while sustaining growth in air transportation.

To advance these principles, on February 2, 2010, the NSTC published the most recent *National Aeronautics Research and Development Plan*. The plan lays out high-priority national aeronautics R&D challenges, goals, and supporting objectives to guide the conduct of U.S. aeronautics R&D activities through 2020. As the first in a process of biennial updates, the plan

provides focused updates to a number of specific R&D goals and objectives in the *National Plan for Aeronautics Research and Development and Related Infrastructure* published in 2007. This R&D plan:

- Supports the coordinated efforts of the Federal departments and agencies in the pursuit of stable and long-term foundational research
- Ensures U.S. technological leadership in aeronautics for national security and homeland defense capabilities
- Advances aeronautics research to improve aviation safety, air transportation, and reduce the environmental impacts of aviation
- Promotes the advancement of fuel efficiency and energy independence in the aviation sector
- Spurs the development of innovative technologies that enable new products and services

For more information, see: http://www.whitehouse.gov/sites/default/files/microsites/ostp/aero-rdplan-2010.pdf.

U.S. Department of Transportation Strategic Plan

The *U.S. Department of Transportation's Strategic Plan for Fiscal Years 2012-2016: Transportation for a New Generation* was created with input from the U.S. Department of Transportation's (DOT) leadership, employees, and stakeholders. The plan re-imagines America's transportation system as the means by which we connect with one another, grow our economy, and protect the environment. The national objectives of general welfare, economic growth and stability, and the security of the United States, require the development of transportation policies and programs that contribute to providing fast, safe, efficient, and convenient transportation at the lowest cost, consistent with those and other national objectives, including the efficient use and conservation of U.S. resources.[6] The Plan fulfills DOT's mission and sets the direction for DOT to provide safe, efficient, convenient, and sustainable transportation choices through five strategic goals that are supported by a wide-ranging management goal (Organizational Excellence):

- Safety
- State of Good Repair
- Economic Competitiveness
- Livable Communities
- Environmental Sustainability

For more information, see: http://www.dot.gov/dot-strategic-plan.

[6] DOT's mission as stated in Section 101 of Title 49, U.S.C.

FAA Strategic Initiatives

FAA Administrator Michael P. Huerta released his *Federal Aviation Administration Strategic Initiatives 2014-2018* on February 19, 2014 to underscore what will be strategically necessary for the FAA to lay the foundation for the aerospace system of the future. This document stresses the need for transformational change in the face of rapidly changing industry, technological opportunities, an uncertain fiscal environment, an evolving workforce, and the global backdrop. The Administrator's priority initiatives include:

- Risk-Based Decision Making
- National Airspace System (NAS) Initiative
- Global Leadership
- Workforce of the Future

For more information, see: https://ksn2.faa.gov/narp/Home/NARP/Reference%20Documents/faa_strategic_initiatives_plan_v18_final.pdf.

Next Generation Air Transportation System (NextGen)

Enacted in 2003 under the Vision 100 – Century of Aviation Reauthorization Act, 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 (ATC) to a satellite-based system of air traffic management (ATM). This transformation is being enabled by a shift to smarter, satellite-based and digital technologies and new procedures that combine to make air travel more convenient, predictable and environmentally friendly. In conjunction with innovative technologies are new airport infrastructure and new procedures, including the shift of certain decision-making responsibilities from the ground to the cockpit. The *NextGen Implementation Plan* provides a roadmap of the FAA's ongoing transition to NextGen[7].

For more information, see: http://www.faa.gov/nextgen/.

[7] http://www.faa.gov/nextgen/implementation/

FAA's Research and Development Principles and Goals

The FAA uses R&D to support policy and planning, regulation, certification, standards development, and modernization of the NAS. 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 three R&D principles. The R&D principles help the FAA align, plan, and evaluate its R&D portfolio. The R&D principles are:

- **Improve Aviation Safety -** systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will improve aviation and space safety and achieve the lowest possible accident rate.

- **Improve Efficiency -** systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will improve access to and increase capacity and efficiency of the nation's aviation system.

- **Reduce Environmental Impacts -** systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will reduce aviation's environmental and energy impacts to a level that does not constrain growth.

The following table shows the primary relationship among the FAA R&D principles and the goals from other pertinent strategic documents. The following chapters will provide greater detail about the 22 underlying goals that support FAA's accomplishment of these three principles.

Strategic Alignment of FAA R&D Principles

FAA R&D Principles	***DOT Strategic Plan* Goals**	***National Aeronautics Research and Development Plan* Principles**	***FAA Strategic Initiatives 2014-2018***
Improve Aviation Safety	Safety	Aviation Safety	Risk-Based Decision Making
Improve Efficiency	Economic Competitiveness	Mobility	National Airspace System (NAS) Initiative
Reduce Environmental Impacts	Environmental Sustainability	Energy and Environment	National Airspace System (NAS) Initiative

1.0 R&D Principle 1 - Improve Aviation Safety

Systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will improve aviation and space safety and achieve the lowest possible accident rate.

Ten R&D goals support R&D Principle 1 - Improve Aviation Safety with work spread across all three budget appropriations (RE&D, F&E, and AIP):

- Goal 1 - Improved understanding of aerospace vehicle design, structure, and subsystems to reduce the potential for accidents and incidents and support the development of standards and policy and methodologies and tools for certification.

- Goal 2 - Improved knowledge of the human-system interface and a reduction in accidents and incidents through enhanced aerospace vehicle, air traffic, and technical operations that adapt to, compensate for, and augment the performance of the human.

- Goal 3 - Improved understanding of factors that influence human physiology and performance in aerospace environments and guidance and tools that enhance human safety, protection, and survival during civil aerospace operations.

- Goal 4 - Improved system-wide access and sharing of aviation safety data and analysis tools within the aviation community, providing safety resources that are integrated with operations of aviation industry stakeholders.

- Goal 5 - Established requirements and standards for enabling the availability and improving the quality and quantity of meteorological information to safely implement NextGen operational improvements.

- Goal 6 - Improved accuracy and accessibility of observed and forecast weather to reduce the number of accidents and incidents attributed to hazardous weather.

- Goal 7 - Optimized technical and regulatory provisions and processes used to oversee, coordinate, regulate, and promote safe and responsible activities for reliable aerospace operations between space and Earth.

- Goal 8 - Improved vehicle safety and risk management, including knowledge of all safety-critical components and systems of the space vehicles and their operations, to better identify potential hazards and apply and verify hazard controls.

- Goal 9 - Guidance and tools that enhance human safety, protection, and survival during space operations.

- Goal 10 - No fatal accidents on certificated airports as a result of airport design, runway incursions or excursions, or wildlife strikes.

Table 1.0.1 shows how the FAA's Aviation Safety R&D goals and programs align with the NSTC Aviation Safety Goals. In many cases, FAA R&D programs support more than one NSTC goal.

Table 1.0.1: Alignment of FAA R&D Safety Goals and Programs with NSTC Aviation Safety Goals

FAA R&D Principle	FAA R&D Programs	NSTC Goals		NSTC Principle	FAA Strategic Initiative
Improve Aviation Safety	Advanced Materials/Structural Safety	Goal 1 - Develop Technologies to Reduce Accidents and Incidents Through Enhanced Vehicle Design, Structure, and Subsystems		Aviation Safety is Paramount	Risk-Based Decision Making
	Aircraft Catastrophic Failure Prevention Research				
	Propulsion and Fuel Systems				
	Continued Airworthiness		Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air		
	Aircraft Icing/Digital Systems Safety				
	NextGen – Advanced Systems and Software Validation				
	Unmanned Aircraft Systems Research Program				
	Air Traffic Control/Technical Operations Human Factors	Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air			
	Flightdeck/Maintenance/System Integration Human Factors				
	NextGen - Air Ground Integration Human Factors				
	Aeromedical Research	Goal 3 - Demonstrate Enhanced Passenger and Crew Survivability in the Event of an Accident			
	Fire Research and Safety				
	System Safety Management	Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air			
	Systems Safety Management Transformation				
	NextGen - Weather Technology in the Cockpit	Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air			
	Weather Program				
	Commercial Space Transportation Safety	Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air			
	Runway Incursion Reduction Program	Goal 2 - Develop Technologies, for Manned and Unmanned Systems, to Reduce Accidents and Incidents through Enhanced Aerospace Vehicle Operations on the Ground and in the Air			
	Airport Cooperative Research Program - Safety				
	Airport Technology Research Program - Safety				

In FY 2015, 42 percent of total FAA R&D funding is allocated to R&D Principle 1 - Improve Aviation Safety. Program funding levels for the 2014 Enacted and 2015 President's Request are shown in Table 1.0.2. Percent of Program reflects each program's contribution towards R&D Principle 1 in the 2015 President's Request. Table 1.0.2 also lists the section and page number reference for each budget narrative within the FY 2015 Congressional Justification (CJ) for the President's Budget Request. The link to the FY 2015 CJ is: http://www.dot.gov/sites/dot.gov/files/docs/FAA-FY2015-Budget-Estimates.pdf.

Table 1.0.2: Program Funding for R&D Principle 1 - Improve Aviation Safety

2015 BLI	Program	CJ Reference (Section/Page)	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2015 Percent of Program
A11.a	Fire Research and Safety	3C/9	RE&D	8,000	6,929	100%
A11.b	Propulsion and Fuel Systems	3C/14	RE&D	1,800	2,413	100%
A11.c	Advanced Materials/Structural Safety	3C/16	RE&D	2,600	2,909	100%
A11.d	Aircraft Icing/Digital System Safety	3C/20	RE&D	7,500	5,889	100%
A11.e	Continued Airworthiness	3C/25	RE&D	8,000	9,619	100%
A11.f	Aircraft Catastrophic Failure Prevention Research	3C/30	RE&D	1,500	1,567	100%
A11.g	Flightdeck/Maintenance/System Integration Human Factors	3C/33	RE&D	5,000	9,897	100%
A11.h	System Safety Management	3C/36	RE&D	11,000	7,970	100%
A11.i	Air Traffic Control/Technical Operations Human Factors	3C/41	RE&D	5,000	5,898	100%
A11.j	Aeromedical Research	3C/46	RE&D	7,000	8,919	100%
A11.k	Weather Program	3C/50	RE&D	7,100	8,900	50%
A11.l	Unmanned Aircraft Systems Research	3C/57	RE&D	8,644	8,974	100%
A11.n	NextGen - Advanced Systems and Software Validation	N/A	RE&D	1,000	0	100%
A12.b	NextGen - Air Ground Integration Human Factors	3C/71	RE&D	7,930	6,788	70%
A12.c	NextGen - Weather Technology in the Cockpit	3C/75	RE&D	1,800	1,822	45%
A14.a	System Planning and Resource Management	3C/89	RE&D	1,375	1,334	62%
A14.b	William J. Hughes Technical Center Laboratory Facility	3C/91	RE&D	2,783	2,759	81%
1A01A	Runway Incursion Reduction Program	3B/14	F&E	4,776	3,500	100%
3A09B	Systems Safety Management Transformation	3B/258	F&E	7,555	5,700	100%
4A08	Center for Advanced Aviation System Development (CAASD)	3B/294	F&E	2,311	2,311	18%
--	Airport Cooperative Research Program - Safety	3D/36	AIP	5,000	5,000	100%
--	Airport Technology Research Program - Safety	3D/26	AIP	15,393	15,523	100%
	Total ($000)			**123,068**	**124,621**	

**Commercial Space Transportation Safety research is no longer being conducted under a dedicated BLI. Funding for this program's research is now being allocated from the A12.b NextGen - Air Groud Integration Human Factors ($1.0M in FY 2014 and $1.0M in the FY 2015 request).*

1.1 Aviation Safety R&D Goal 1

Improved understanding of aerospace vehicle design, structure, and subsystems to reduce the potential for accidents and incidents and support the development of standards and policy and methodologies and tools for certification.

1.1.1 Advanced Materials/Structural Safety (RE&D - A11.c)

The Advanced Materials/Structural Safety Program supports Aviation Safety R&D Goal 1 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 supports the goal by increasing the ability of passengers to survive aviation accidents by developing advanced methodologies for assessing aircraft crashworthiness. The FAA establishes rules for the certification of aircraft designed and constructed using a variety of materials and design methods. The program conducts research to support FAA regulatory activities, such as rulemaking, guidance, and advisory circulars (ACs), particularly in the area of composite materials.

The research milestones and their statuses are shown in Table 1.1.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.1: Advanced Materials/Structural Safety Program Milestones

Year	Milestone	Status	Notes
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	Completed	2013 NARP Status: On schedule
2014	Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain	On schedule	
2014	Evaluate field bonded repair practices to update related guidance and training for composite aircraft structures	On schedule	New milestone
2014	Evaluate the ability of models to predict off-axis and multiple terrain impacts	On schedule	New milestone
2015	Characterize the effects of blunt impact on composite structures typically used in fuselage applications	On schedule	New milestone
2016	Develop standards and methods to characterize dynamic properties of composite material systems	On schedule	New milestone

Year	Milestone	Status	Notes
2017	Evaluate new material forms (e.g., discontinuous fiber composites) that have found application in primary aircraft structures	On schedule	New milestone
2017	Address specific ARAC inputs and certification needs for certification of composite aircraft	On schedule	New milestone
2018	Develop assessment of typical range of ditching and other water landing scenarios to provide recommendations on certification requirements	On schedule	New milestone
2018	Evaluate composites quality control AC 21-26 for necessary updates and provide background data	On schedule	New milestone
2019	Identify key characteristics of metallic aircraft response to crash conditions to establish a baseline for other structural concepts and materials	On schedule	New milestone
2019	Develop background information and data for creation of a Part 21 AC on composite structures	On schedule	New milestone

Advanced Materials/Structural Safety Program Progress in FY 2013:

- ✓ Made significant progress in understanding damage formation on aircraft through: 1) establishing maintenance practices and educating of the workforce in the new expertise area of composite structure; 2) creating a better understanding of crashworthiness issues for composites and developing simulation capabilities to replace physical tests; and 3) developing a complete understanding of the influences on durability of bonded structure; and 4) concluding work in standardizing laboratory test methods to determine maximum service temperature for composite structural materials.

- ✓ Tested several built-up panels representing fuselage sections and applied simulated vehicle impacts. This effort used computer simulation of the impacts to predict the resulting damage condition. Additionally, the test results were reviewed to assess the test fixture's capability to replicate an operational environment. Based on the assessment, changes are being made to the test to more closely replicate actual service conditions. The modeling effort successfully replicated the test results once the test fixture constraints were understood.

- ✓ Performed research to characterize the fracture properties of sandwich structure which was involved in the Air Transat 961 rudder separation incident. The effort has developed test methods that are currently being evaluated by a number of industry and research partners. This has led to work in developing design and substantiation information which will provide for safer sandwich structure.

- ✓ Continued work in the development of out-of-plane characterization of notched laminate composites structures. The work this year continued efforts that examined tension and compression characterization, extending it to the shear force influences.

- ✓ Developed training materials to teach the aviation workforce the differences between metallic and composite structure: 1) completed development and conducted the first Composite Structural Engineering Technology course in the spring of 2013; and 2) completed initial draft of the Composite Manufacturing Technology course.

- ✓ Completed a round-robin evaluation of depot bonded repairs for 48 panels at 4 different depots in the continuing effort to develop bonded repair standards.

- ✓ Conducted an international round-robin test series to evaluate a new test method used to determine composite dynamic tension material properties. The test series also evaluated different measurement technologies and the effectiveness of a methodology to correct for test facility/equipment influences on the test results. The information will be used to help develop a standardized test to determine composite dynamic tension material properties.

- ✓ Made modifications to an analytical model of a full-scale aircraft fuselage section to more accurately reproduce available test data. The model provided insight into strain rate response of the fuselage section as well as developing modeling guide lines and best practices. A model of a full-scale, narrow-body transport aircraft is being developed to improve understanding of aircraft impact response and help develop aircraft certification by supported by test analyses. The analytical model will be used to help identify aircraft fuselage response and resulting occupant loading.

1.1.2 Aircraft Catastrophic Failure Prevention Research (RE&D - A11.f)

The Aircraft Catastrophic Failure Prevention Research Program supports Aviation Safety R&D Goal 1 by developing 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. Together with industry, the program develops material models associated with engine debris impact. These material models may be used for aircraft impact or shielding evaluations, engine containment evaluations, and to assist both aircraft and engine certification.

The research milestones and their statuses are shown in Table 1.1.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.2: Aircraft Catastrophic Failure Prevention Research Program Milestones

Year	Milestone	Status	Notes
2014	Develop and verify an improved predictive capability for aircraft damage associated with engine failure and debris impact	On schedule	
2015	Complete Inconel testing for certification by analysis	On schedule	New milestone
2016	Develop an anisotropic material model for composite impact problems in aviation	On schedule	New milestone
2016	Complete MAT224 anisotropic metal to account for cold working and directional manufacture	On schedule	New milestone
2016	Complete homogeneous composite failure model	On schedule	New milestone
2017	Complete standard composite tests testing for certification by analysis	On schedule	New milestone
2018	Develop new tests needed for composite impact and failure	On schedule	New milestone
2018	Complete verification study for uniaxial composite impact	On schedule	New milestone
2019	Update certification by analysis guidance for metals	On schedule	New milestone

Aircraft Catastrophic Failure Prevention Research Program Progress in FY 2013:

- ✓ Developed predictive metal failure models for impact conditions experienced when engine fragments impact either 1) engine containment or 2) the fuselage structure (in rare cases when fragments are uncontained).

- ✓ Maintained and improved the Uncontained Engine Debris Damage Assessment Model (UEDDAM), which was 1) developed under an interagency agreement with the Naval Air Warfare Center (NAWC) to assess the multiple fragment threat from an uncontained engine failure at the aircraft level and 2) provides a means to assess the merits of different aircraft designs for vulnerability reduction.

- ✓ Per the request of the Transport Airplane Directorate, provided 1) support for the Open Rotor Turbine Engine design and 2) ideas to mitigate the vulnerability created when the fan containment is removed. The program coordinated work with NASA Glenn and the NAWC to use UEDDAM and LS-DYNA to study the impact of adding fuselage protection to mitigate the consequences of a released open rotor fan blade.

1.1.3 Aircraft Icing/Digital System Safety (RE&D - A11.d)

The Aircraft Icing/Digital System Safety Program supports Aviation Safety R&D Goal 1 by developing and testing technologies that 1) detect frozen contamination; 2) predict anti-icing fluid failure; and 3) 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 during the certification of aircraft and engines, and studies the airworthiness requirements of airborne cyber security.

The research milestones and their statuses are shown in Table 1.1.3 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.3: Aircraft Icing/Digital System Safety Program Milestones

Year	Milestone	Status	Notes
2013	Identify safety issues and propose mitigation approaches when software development techniques and tools are used in airborne systems	Completed	
2014	Develop a cyber-security research plan to identify components in airborne networks that pose cyber security threats to aircraft safety	On schedule	New milestone
2014	Complete testing on sloped surface testing of fluid behavior on flaps, slats, and main elements of aircraft and on flat plates at angles simulating angles of aircraft surfaces	On schedule	New milestone
2014	Conduct field campaign on high ice water content atmospheric environments out of Darwin, Australia	On schedule	New milestone
2015	Provide a recommendation for design of a generic system architecture for an airborne network that identifies cyber security vulnerabilities	On schedule	New milestone
2015	Test simulated ice shapes with and without roughness on swept wing model at low to moderate Reynolds number	On schedule	New milestone
2016	Provide recommendations for new criteria and guidance on multi-core processors used in aircraft systems.	On schedule	New milestone
2016	Develop data and methods for guidance material for the airworthiness acceptance criteria and test methods for engines in simulated high ice water content environments	On schedule	2013 NARP Status: Delayed from 2014 to 2016
2017	Conduct aerodynamic test of swept wing with ice shapes in ONERA F1 wind tunnel	On schedule	New milestone
2018	Create a validation database of ice shapes and their aerodynamic effects on swept wings for computational fluid dynamics	On schedule	New milestone
2018	Determine feasibility of dynamic allocation of code blocks in multi-core processors	On schedule	New milestone
2018	Identify airborne electronic hardware development error types that remain undetected by verification techniques	On schedule	New milestone

Year	Milestone	Status	Notes
2019	Develop criteria to ensure integration of complex digital systems	On schedule	New milestone
2019	Develop methodology to accurately calculate WCET (worst case execution time) for multi-core processors	On schedule	New milestone
2019	Report on use of computational fluid dynamics analysis and of test methods and scaling for iced swept wings	On schedule	New milestone

Aircraft Icing/Digital System Safety Program Progress in FY 2013:

- ✓ Developed a Cyber-Security R&D Collaboration Plan that identifies the FAA's Aircraft Certification Service (AIR) priorities related to cyber security, identifies related efforts across the team that could be leveraged in the development of cyber security guidance, and provides recommendations in areas that AIR should move forward with to ensure a comprehensive approach. Through Executive Order # 13636 (Improving Critical Infrastructure Cyber security, dated February 12, 2013), the President has identified the need for federal agencies to collaborate on cyber security threats. This plan lays the groundwork to ensure that future issuance of cyber security guidance, standards, and regulation related to safety is done in a collaborative and efficient manner, according to the need identified in the Presidential Executive Order.

- ✓ Completed the information package needed to update the annual winter notice providing guidance for formulation of ground de-icing plans as required by airlines in CFR 121.629. Each fall, airlines are required by FAR 121.629 to submit updated ground de-icing plans for the coming winter. In preparing these plans, they depend on the information in the annual FAA Notice 8900.xx, "Revised FAA-Approved Deicing Program Updates, Winter 20xx-20xx".

- ✓ Identified candidate minimum icing instrumentation requirements and flight and wind tunnel test points required for verification of ice protection systems on rotorcraft. The first domestic rotorcraft (S-92A) was approved for flight in icing conditions in October 2005. Several other civil rotorcraft are now in the certification process for flight in icing conditions. The FAA corporate knowledge and experience with the certification of rotorcraft for flight in icing conditions is limited, and additional information pertaining to regulations and guidance materials for rotorcraft icing certification is needed by ACO engineers.

- ✓ Collaborated with NASA Glenn to complete tunnel and flight testing and the evaluation of the Isokinetic Evaporative Probe, which is crucial to the ice crystal research flight campaign out of Darwin, Australia (started in mid-January 2014). This is a collaborative undertaking between the North American High Ice Water Content project and the European High Altitude Ice Crystal project.

1.1.4 Continued Airworthiness (RE&D - A11.e)

The Continued Airworthiness Program supports Aviation Safety R&D Goal 1 by promoting 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 long-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.

The research milestones and their statuses are shown in Table 1.1.4 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.4: Continued Airworthiness Program Milestones

Year	Milestone	Status	Notes
2013	Develop technical data on rotorcraft that provide guidance for certification of Health and Usage Monitoring Systems for usage credits	Completed	2013 NARP Status: On schedule
2013	Develop technical data on the performance of advanced nondestructive inspection methods and procedures for improved damage detection in solid composite laminates	Completed	2013 NARP Status: On schedule
2014	Develop technical data to assess the application of advanced aluminum-lithium metallic alloys for primary fuselage structure in transport category airplanes	On schedule	2013 NARP Status: On schedule
2014	Perform the final phase of flight testing with the U.S. Army on the UH-60M which will be used to validate existing Gross Weight/Center of Gravity algorithms related to usage loads monitoring.	On schedule	New milestone
2015	Determine the current state of active flutter suppression in the commercial airplane sector to assess adequacy of existing standards, guidance, and regulations	On schedule	New milestone
2015	Develop test methods and provide data to assess arcing damage for new high voltage aerospace electrical systems	On schedule	New milestone
2015	Develop technical data and demonstrate advanced sensor technology and prototypes capable of real-time monitoring and evaluation of aircraft flight critical systems and composite structure	On schedule	New milestone

Year	Milestone	Status	Notes
2016	Develop technical data to assess the fatigue and environmental durability of bonded repairs to metallic structure	On schedule	2013 NARP Status: On schedule
2017	Develop technical data to assess damage tolerance of aluminum-lithium primary structure - follow on effort to material characterization	On schedule	New milestone
2017	Develop technical data to validate and enhance the Health Usage Monitoring System AC29-2C, MG-15 for a usage credit	On schedule	New milestone
2017	Provide technical data for use by the FAA for approving angle of attach systems installation on General aviation airplanes	On schedule	New milestone
2018	Develop technical data to evaluate non-flammable electrolyte lithium batteries and battery systems for aerospace applications	On schedule	New milestone
2018	Develop technical data to assess bonded repairs of wing structure	On schedule	New milestone
2018	Develop Property Standards for Emerging Process Intensive Materials	On schedule	New milestone
2019	Conduct test on an advanced metallic fuselage structure to access durability and damage tolerance of emerging technologies including unitized welded structure, new metallic alloys, and hybrid bonded construction	On schedule	New milestone
2019	Develop technical data to evaluate the feasibility of using fuel cell systems for aerospace application while retaining or improving the current level of safety in commercial transport aircraft	On schedule	New milestone

Continued Airworthiness Program Progress in FY 2013:

- ✓ Obtained preliminary results from Phase 1 of material characterization testing, which indicated that aluminum-lithium (Al-Li) has different fatigue and crack growth characteristics compared to typical aluminum alloys used in airplanes today. Such differences warrant further investigation into the crack growth behavior to validate the applicability of existing damage tolerance requirements. Additionally, preliminary Phase 1 results indicate that Al-Li materials may require more data to adequately characterize the material than typically published in MMPDS for stock aluminum material.
- ✓ Verified enhancements to the FAA's Full-Scale Aircraft Structural Test Evaluation and Research (FASTER) fixture for mechanical and environmental loading capabilities. This unique feature was added to the fixture as part of the Cooperative Research and Development Agreement (07-CRDA-0236) between the Aviation Safety Division and The Boeing Company, a cost-share arrangement leveraging resources to conduct research into areas of safety and structural integrity of bonded repairs. The new capability is being

used to gain a better understanding of the environmental durability and damage tolerance aspects of bonded repair technology to fuselage structure.

- ✓ Obtained FAA Health Usage Monitoring System (HUMS) data from the U.S. Army and Sikorsky, who successfully completed flight tests on UH-60M helicopter to gather direct load data on several flight-critical components. The data was compared to the indirect method called regime recognition currently used on the HUMS system on the helicopter. The direct data will assist in determining the validity of the regime recognition algorithms. This is a validation of the existing AC which will facilitate a planned FY 2017 revision.

1.1.5 NextGen - Advanced Systems and Software Validation (RE&D - A11.n)

The NextGen - Advanced Systems and Software Validation Program is a new program in FY 2014 that supports Aviation Safety R&D Goal 1 by developing policy, guidance, technology, and training needs for the highly integrated and complex systems expected to operate in a NextGen environment. Such systems will rely on digital systems and be tightly integrated across airborne and ground-based components. The program supports end-to-end safety analysis and performance allocation, identifies safety opportunities, and develops the regulatory framework for integration of NextGen technologies within the aircraft. The program will also identify and mitigate possible issues and shortcomings with the current processes used by the commercial aviation industry for airborne systems requirements definition, validation, and verification..

The research milestones and their statuses are shown in Table 1.1.5 below.

Table 1.1.5: NextGen - Advanced Systems and Software Validation Program Milestones

Year	Milestone	Status	Notes
2015	Define complexity, investigate quantification of complexity beyond the usual metrics, and determine if an aircraft can become too complex to certify	Deleted	Milestone was deleted since it is a task under the milestone below. 2013 NARP Status: Not started
2016	Identify effects of system complexity on aircraft safety margins and investigate highly integrated, complex airborne systems that are difficult to validate and verify and the potential for a reduction in aircraft safety margins with highly integrated, complex airborne systems	On schedule	Milestone is delayed from 2014 to 2016 since new programs cannot be funded under a continuing resolution. 2013 NARP Status: Not started
2016	Identify possible issues with the current process used by the commercial aviation industry regarding requirements' definition, validation, and verification for aircraft digital system requirements to ensure their applicability to NextGen systems	On schedule	Milestone is delayed from 2015 to 2016 since new programs cannot be funded under a continuing resolution. 2013 NARP Status: Not started

Year	Milestone	Status	Notes
2016	Complete the examination of safety issues associated with, and potential approaches to, safely approving independently-verified components when part of a larger non-federated system	Deleted	Milestone was deleted since it is a task under the milestone below. 2013 NARP Status: Not started
2016	Identify what specific tasks are necessary to ensure complex digital systems have been fully integrated	Delayed	Milestone is delayed from 2015 to 2016 and is revised to better reflect the scope of work. Old wording: "Identify specific proposals to address what specific tasks are necessary to ensure complex digital systems have been fully integrated." 2013 NARP Status: Not started

1.1.6 Propulsion and Fuel Systems (RE&D - A11.b)

The Propulsion and Fuel Systems Program supports Aviation Safety R&D Goal 1 by developing 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.

The research milestones and their statuses are shown in Table 1.1.6 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.6: Propulsion and Fuel Systems Program Milestones

Year	Milestone	Status	Notes
2015	Complete a certification tool that will predict the risk of failure of turbine engine rotor disks that may contain undetected material and manufacturing anomalies	On schedule	2013 NARP Status: On schedule
2016	Enhance DARWIN® code to enable optimal autozoning to handle larger 3-D files now more commonly used by engine manufacturers during rotor design	On schedule	New milestone
2017	Develop and release new DARWIN® analysis mode to address new Advisory Circular for attachment slots	On schedule	New milestone
2017	Develop and implement improved fleet risk analysis methods to address corrective actions	On schedule	New milestone
2018	Develop advanced stress intensity factor solutions for new geometries, extending the applicability of DARWIN® to new classes of life-limited engine components	On schedule	New milestone

Year	Milestone	Status	Notes
2019	Develop and implement practical methods and tools to incorporate new/advanced Integrated Computational Materials Engineering manufacturing and design practices into damage tolerance methodologies	On schedule	New milestone

Propulsion and Fuel Systems Program Progress in FY 2013:

- ✓ Updated the Design Assessment of Reliability with INspection software code (DARWIN® 8.1) developed by the Southwest Research Institute with several new capabilities for rotor designers and analysts:
    - Automated inspection assignments for application to autozoning. This capability greatly simplifies the inspection definition process and provides a consistent framework for zones that are created both manually and via autozoning.
    - Created zones on surfaces and edges of three-dimensional (3D) finite element (FE) model geometries. This capability enables the analyst to import and view complex 3D FE blade slot models and to select individual finite element faces or edges for inclusion in zones.
    - Extended the surface treatment residual stress capability for use with 3D FE models. This capability enables the analyst to manually define a univariant residual stress gradient and to superimpose it with service stresses that are extracted along the crack path in 3D FE models.
    - Included a Fleet Assessment module that can be used for Continued Airworthiness assessments associated with FAA AC 39-8. This module enables the analyst to use results from multiple DARWIN® runs to quantify risk factors and risk per flight values addressed in AC 39-8 for a fleet of aircraft.

  These enhancements map directly to future ACs planned by the FAA's Engine and Propeller Directorate. Benefits will accrue in the form of reduced risk of engine failures and fewer accidents, leading to fewer injuries and fatalities.

1.1.7 Unmanned Aircraft Systems Research (RE&D - A11.l)

The Unmanned Aircraft Systems Research Program supports Aviation Safety R&D Goal 1 by conducting research to ensure the safe, efficient, and timely integration of unmanned aircraft systems (UAS) in the NAS. Information is provided 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. The Joint Planning and Development Office (JPDO) facilitated the interagency collaboration for the program by generating and executing the UAS Comprehensive Plan, which has six National Goals and eight National Objectives for UAS

integration. The UAS Comprehensive Plan was signed by the Secretary of Transportation and submitted to Congress in November 2013.

The research milestones and their statuses are shown in Table 1.1.7 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.1.7: Unmanned Aircraft Systems Research Program Milestones

Year	Milestone	Status	Notes
2013	Analyze data and identify potential safety implications of system performance impediments of communications latency	Completed	2013 NARP Status: On schedule
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	Completed	2013 NARP Status: On schedule
2014	Develop the capability to evaluate potential sense-and-avoid logic and algorithms; review several available algorithms for methodology development	Delayed	Milestone is delayed from 2013 to 2014 due to changing program priorities. 2013 NARP Status: On schedule
2014	Investigate control latencies during takeoff and landing scenarios in UAS with low levels of automation and determine information requirements for executing sense and avoid maneuvers in UAS	On schedule	New milestone
2014	Recommend data fusion strategies based on review (and validation where necessary) of existing sense-and-avoid research and documentation	On schedule	New milestone
2014	Conduct a human-in-the-loop experiment to assess lost link procedures and impacts of UAS lost link events on the NAS	On schedule	New milestone
2015	Develop a comprehensive list of operational and airworthiness approval issues based on 14CFR 91 compliance	On schedule	New milestone
2015	Define ground control station human interface requirements, UAS pilot training requirements, and ground observer requirements	On schedule	Milestone was revised to clarify the research. Old wording: “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” 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2016	Conduct field evaluations of unmanned aircraft system technologies and procedures (including sense-and-avoid, control and communications, and contingency management) to develop certification and airworthiness standards	On schedule	2013 NARP Status: On schedule
2017	Develop prototype antenna and brassboard electronics, lab-test and flight test antenna final designs for ACAS-X antennas along with hardware/software for test data collection	On schedule	New milestone
2017	Document the most optimal sensor fusion strategy and the sensitivity of each data fusion performance parameter in transitioning from sense-and-avoid function 1 (remain well clear) to function 2 (avoid collisions)	On schedule	New milestone
2018	Collect and analyze UAS Safety Data from congressionally mandated test sites	On schedule	New milestone
2018	Complete manufacturer and operator maintenance data collection and analysis and develop maintenance technician Part 147 practical test standards and UAS repair station operational criteria	On schedule	New milestone
2019	Develop UAS maintenance programs content and related UAS accident/incident data reporting requirements	On schedule	New milestone

Unmanned Aircraft Systems Research Program Progress in FY 2013:

- ✓ Estimated the nominal piloted aircraft response delay to controller clearances to turn, climb, or descend in the NAS. The results showed that communication times are similar across the ATC environment, but that aircraft start their controller commanded maneuvers more quickly in the terminal radar approach control (TRACON) environment (Mean Total Time To Aircraft Response = 19.9 seconds) than they do in the en route environment (Mean Total Time To Aircraft Response = 34.4 seconds). The results of this effort established a benchmark for the UAS response delays.

- ✓ Determined the maximum acceptable communication delays associated with step-on(s) for UAS. The results showed that the maximum acceptable communication (one way) delay is 390 milliseconds.

- ✓ Completed a web-based repository database application to track the continuous airworthiness of life limited components of small UAS. The prototype database provides for statistical analysis and record tracking of maintenance actions performed in accordance with a list of data elements and descriptions for maintenance items for a candidate UAS but adaptable to other platforms. The development team implemented the DOT E-Authentication Team's Siteminder Agent and configured the web server to authenticate FAA users via the Personal Identity Verification (PIV) Card for MyAccess.

This alternate logon system will allow for password and DOT/PIV card access. A login scheme for non-FAA email users is also being implemented.

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

- ✓ Identified existing procedures for lost link events and gathered and reviewed existing data from prior FAA UAS studies, which may be used in developing simulations.

1.1.8 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) supports R&D Aviation Safety R&D Goal by conducting analyses and assessments of UAS operations in the NAS.

CAASD made the following progress in FY 2013 towards Aviation Safety R&D Goal 1:

- ✓ Conducted a preliminary analysis of current UAS operations in En Route Class A airspace, as allowed per Certificate of Waiver or Authorization operations. This analysis included a comparison of flight performance of both unmanned and manned aircraft operating in Class A airspace, a review of recent controller and pilot reported UAS-related events in the NAS, and the analysis of sample scenarios of UAS-related events. The observations resulting from this assessment are intended to help FAA with initial decisions concerning procedures, processes, training, and automation changes to improve the efficiency and safety of UAS operations in Class A.

1.2 Aviation Safety R&D Goal 2

Improved knowledge of the human-system interface and a reduction in accidents and incidents through enhanced aerospace vehicle, air traffic, and technical operations that adapt to, compensate for, and augment the performance of the human.

1.2.1 Air Traffic Control/Technical Operations Human Factors (RE&D - A11.i)

The Air Traffic Control/Technical Operations Human Factors Program supports Aviation Safety R&D Goal 2 by emphasizing 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 addresses the interactions between workstation design, personnel selection and training, and human error and human safety.

The research milestones and their statuses are shown in Table 1.2.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.2.1: Air Traffic Control/Technical Operations Human Factors Program Milestones

Year	Milestone	Status	Notes
2013	Assess the Front Line Manager Quick Reference Guide for effectiveness in aiding air traffic control safety	Completed	2013 NARP Status: On schedule
2015	Provide a draft of a revised Human Factors Design Standard for human factors application to air traffic control system acquisition	On schedule	2013 NARP Status: Delayed from 2014 to 2015
2016	Deliver a method for the development of TRACON air traffic controller training standards	On schedule	New milestone
2017	Validate the TRACON training standards and determine the reliability of the evaluation criteria	On schedule	New milestone
2018	Deliver human factors training information to support the Air Traffic Organization's Top 5 NAS hazards	On schedule	New milestone
2019	Deliver a human performance database to support Safety Risk Management Documents as part of the FAA Acquisition Management System	On schedule	New milestone

Air Traffic Control/Technical Operations Human Factors Program Progress in FY 2013:

- ✓ Developed the Front Line Manager's (FLMs) Quick Reference Guide (QRG) to provide management best practices in a format specific to ATC to assist FLMs. The guide has

been incorporated into training at both the Academy and the Operations Supervisor Workshop for FLM's.

1.2.2 Flightdeck/Maintenance/System Integration Human Factors (RE&D - A11.g)

The Flightdeck/Maintenance/System Integration Human Factors Program supports Aviation Safety R&D Goal 2 by providing the human factors research for guidelines, handbooks, ACs, rules, and regulations that ensure safe and efficient aircraft operations. Research results enable the FAA and industry to: improve task performance and training for aircrew, inspectors, and maintenance technicians; improve training for UAS control station and crew; develop and apply error management strategies to flight and maintenance operations; and ensure certification of new aircraft and design or modification of equipment considers human factors.

The research milestones and their statuses are shown in Table 1.2.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.2.2: Flightdeck/Maintenance/System Integration Human Factors Program Milestones

Year	Milestone	Status	Notes
2014	Document the results of preliminary research on the role of startle, surprise, and distraction in jet upset/loss of control and identify potential mitigations	On schedule	Milestone was revised due to program management and AVS sponsor redirection. Old wording: "Document the results of jet upset/loss of control simulation model development and evaluation" 2013 NARP Status: On schedule
2014	Analyze and provide recommendations on evolving methods of alternative fatigue risk assessment (e.g., voice analysis) that considers time on task fatigue and method validation	On schedule	2013 NARP Status: On schedule
2015	Conduct field test on alternative Aircraft Maintenance Fatigue Risk Management techniques and provide assessment and implementation recommendations	On schedule	New milestone
2016	Provide recommendations for operational credit related to equipage with synthetic vision systems	On schedule	New milestone
2017	Provide recommendations for ADS-B/Cockpit Display of Traffic Information minimum operational performance standards and related FAA guidance	On schedule	New milestone
2018	Define methods for evaluating both traditional and Advanced Qualification Program training programs to support updates to guidance for crew resource management	On schedule	New milestone

Year	Milestone	Status	Notes
2019	Address minimum equipment requirements for new operational concepts using advanced vision systems and Head-Up/Head-Mounted Displays	On schedule	New milestone

Flightdeck/Maintenance/System Integration Human Factors Program Progress in FY 2013:

- ✓ Developed a document for use by FAA flight test pilots, engineers, and human factors specialists who work in the field doing hands-on evaluations of avionics. The document is intended to serve as a single comprehensive source for human factors regulatory and guidance material related to flight deck displays and controls, and to facilitate the identification and resolution of human factors issues with these systems. Chapters address key human factors/pilot interface issues seen across multiple FAA Aircraft Certification projects. Appendices provide a variety of sample checklists, testing scenarios and procedures, key reference lists, and human factors research reports have been useful to both the FAA and industry representatives who evaluate and approve flight deck displays and controls.

1.2.3 NextGen - Air Ground Integration Human Factors (RE&D - A12.c)

The NextGen - Air Ground Integration Human Factors Program supports Aviation Safety R&D Goal 2 by addressing flight deck and ATC integration for NextGen operational capabilities. It focuses on human factors that primarily affect the pilot side of the air-ground integration challenge. It conducts research to ensure pilots receive the right information at the right time for decision-making and collaboration with ATC to operate in the NAS safely. The program also includes research done in the former NextGen - Self-Separation Human Factors (A12.d) program, which addressed human performance and coordination requirements for pilots and Air Navigation Service Providers through development of the initial standards and procedures that lead to operational capabilities for separation assurance. It assessed 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.

The research milestones and their statuses are shown in Table 1.2.3 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.2.3: NextGen - Air Ground Integration Human Factors Program Milestones

Year	Milestone	Status	Notes
2014	Complete research to identify likely human errors with NextGen flight deck avionics and potential means of compliance to new human error regulation 14 CFR 25.1302	On schedule	Milestone was revised due to changing sponsor requirements. Old wording: "Complete research to identify likely human error modes and recommend mitigation strategies in closely spaced arrival/departure routings" 2013 NARP Status: On schedule
2014	Evaluate and recommend minimum display standards and operational procedures for use of Cockpit Display of Traffic Information to support pilot awareness of potential ground conflicts and to support transition between taxi, takeoff, departure and arrival phases of flight	On schedule	2013 NARP Status: On schedule
2014	Complete research to enable enhanced aircraft spacing for surface movements in low visibility conditions guided by enhanced and synthetic vision systems	Accelerated	Milestone was revised due to sponsor requirements and accelerated from 2015 to 2014. Old wording: "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" 2013 NARP Status: On schedule
2015	Complete research and provide human factors guidance for Automatic Dependent Surveillance-Broadcast/ Cockpit Display of Traffic Information equipment used for In-Trail Procedures	On schedule	Milestone was revised to clarify the research. Old wording: "Complete research and provide human factors guidance to reduce arrival and departure spacing including variable separation in a mixed equipage environment" 2013 NARP Status: On schedule
2015	Enable reduced and delegated separation in oceanic airspace and en route corridors	Deleted	Milestone was deleted due to changing sponsor priorities

NextGen - Air Ground Integration Human Factors Program Progress in FY 2013:

- ✓ Conducted research to support the introduction and use of synthetic vision systems (SVS) and enhanced flight vision systems (EFVS) as advanced cockpit vision technologies in NextGen operations. Various scenarios were developed to test the potential for using EFVS to conduct approach, landing, and roll-out operations in visibility as low as 1,000 feet runway visual range. SVS was also tested to evaluate the potential for lowering

decision heights on certain instrument approach procedures below what can be flown today. Research results will be used to develop regulatory standards and design guidance for SVS and EFVS.

1.2.4 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) Program supports Aviation Safety R&D Goal 2 by providing a concept for a reduced cost surface surveillance capability for small and medium airports in the NAS.

CAASD made the following progress in FY 2013 towards Aviation Safety R&D Goal 2.

- ✓ Developed algorithms that can identify when a block of the airport surface is occupied by a vehicle or aircraft, based on output from low-cost magnetic sensors. These algorithms have been shown to reliably process sensor data collected during field tests, use that data to determine that a vehicle or aircraft is present within the block, and depict that information on a graphical user interface. This information may be useful for improving controller situation awareness in the tower cab.

1.3 Aviation Safety R&D Goal 3

Improved understanding of factors that influence human physiology and performance in aerospace environments and guidance and tools that enhance human safety, protection, and survival during civil aerospace operations.

1.3.1 Aeromedical Research (RE&D - A11.j)

The Aeromedical Research Program supports Aviation Safety R&D Goal 3 by identifying 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.

The research milestones and their statuses are shown in Table 1.3.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.3.1: Aeromedical Research Program Milestones

Year	Milestone	Status	Notes
2014	Develop and validate chemical kinetic models for bleed air systems for health and safety effects on passengers and crew	Completed	2013 NARP Status: Delayed from 2012 to 2014
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	On schedule	2013 NARP Status: On schedule
2014	Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants	Completed	2013 NARP Status: On schedule
2014	Apply and validate advanced air sensing technology for volatile organic compounds in the aircraft cabin environment	Deleted	Milestone was deleted due to changing sponsor priorities 2013 NARP Status: On schedule
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	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2015	Develop bleed air contamination models of engine compressors and high temperature air system for effects on the health and safety of passengers and crew	On schedule	2013 NARP Status: On schedule
2015	Incorporate aerospace medical issues in the development of safety strategies concerning pilot impairment, incapacitation, spatial disorientation, and other aeromedical-related factors that contribute to loss of aircraft control	On schedule	2013 NARP Status: On schedule
2015	Develop advanced methods to extract aeromedical information for prognostic identification of human safety risks	On schedule	2013 NARP Status: On schedule
2015	Deploy a system (Aerospace Accident Injury and Autopsy Data System) capable of compiling, classifying, assessing, and determining causal factors of aviation-related injuries. The system will link aviation-related injuries to autopsy findings, medical certification data, aircraft cabin configurations, and biodynamic test results	On schedule	2013 NARP Status: On schedule
2016	Apply and develop advances in gene expression, toxicology, and bioinformatics technology and methods to define human response to aerospace stressors	On schedule	2013 NARP Status: On schedule
2017	Analyze medical certification and accident data to derive methods or tools to enhance aircrew health, education programs, and medical certification decision-making processes	On schedule	New milestone
2018	Develop advanced methodologies to analyze human biological samples for emerging drugs, toxins or factors that may impact pilot performance or assist in determining accident causality	On schedule	New milestone
2019	Develop and assess safety and emergency equipment standards, procedures, and criteria to ensure the protection and survival of all aircraft occupants from all aircraft incidents and accidents	On schedule	New milestone

Aeromedical Research Program Progress in FY 2013:

- ✓ Conducted analysis and assessed the distribution of Zolpidem, a prescription medication used for the short-term treatment of insomnia, in postmortem specimens from aviation accident fatalities. Research involved collaboration with the University of Central Oklahoma.

- ✓ Conducted and updated review of aircraft accidents involving pilot suicide in order to assist medical certification review processes in identifying mental disease.

- ✓ Calculated galactic cosmic radiation dose rates in the atmosphere at altitudes above 60,000 feet, incorporating current recommendations of the International Commission on Radiological Protection. Provided flight-dose estimation software (CARI-7) to organizations involved in high altitude flight.

- ✓ Created a collaborative research program between the FAA-Civil Aeromedical Institute (CAMI) in Oklahoma City, OK and the Air Cruisers in Belmar, NJ to evaluate performance predictions for emergency evacuation slides. Although the Technical Specifications for emergency evacuation slides for many airplanes require operational capability at airport altitudes that range from -1,000 feet to 15,000 feet above sea level, actual deployment data at high altitudes have not been available. Typically, predictions of performance are generated by a combination of ambient tests conducted under factory conditions and by analysis of mass flow and the inflation system's efficiency. The altitude chamber at CAMI was used to determine the actual effects of altitude on inflation performance of normally aspirated inflatable slides.

- ✓ Developed and maintained analytical tools, empirical data and scientific expertise to support regulatory actions, standards development, accident investigations, and enhanced safety of airplane interior arrangements and emergency equipment/operations, as they relate to the ability to evacuate an airplane. The primary outcome was better tools to assess the evacuation safety of different interior arrangements under different scenarios, and the application of those tools to both certification and accident investigation. The research was implemented through updated advisory/policy material and rulemaking as needed.

- ✓ Created Aerospace Standard 6271 ('Halon Replacement Hand-Held Fire Extinguisher') in response to a request by the European Aviation Safety Agency to craft the technical basis for a European Technical Standard Order that addresses International Civil Aviation Organization (ICAO) Assembly Resolution A36-12 regarding the replacement of halon in civil aircraft fire extinguishers. The Standard is intended to identify pertinent hand-held fire extinguisher requirements selected from the broad range of fire extinguisher standards existing across the international community.

- ✓ Developed methods to qualify replacement elements for worn seat cushions used in transport category seats. Advanced occupant and material modeling techniques will be used during development to leverage full-scale and component test results towards developing new policy.

- ✓ Determined human impact tolerance levels and methods for predicting occupant unconsciousness and leg injuries that can occur during a survivable crash. Investigated enhanced means of mitigating injury causing mechanisms for the brain and leg (2011-2015). In response to NTSB Safety Recommendation A-10-78, the row-to-row brace

positions will be investigated as a potential mitigation method for both head and leg injuries.

- ✓ Collaborated with the Functional Genomics Research Team to develop a protocol investigating the feasibility of novel hypoxia biomarkers (e.g., HPH1, S100B) in rapid decompression studies. Awarded the contract to secure volunteer researchers, completed drills to assure safety in research protocol operations, and conducted the first data collection trial in August 2013.

- ✓ Collaborated with the SAE-10 Oxygen Committee to develop a new Aerospace Standard (AS 5722) for the performance of aircrew oxygen regulators installed on commercial aircraft. Addressed 1) raising the operational ceiling to 45,000 feet from 35,000 feet and 2) preemptive oxygen breathing requirements.

- ✓ In collaboration with industry, compared the index of passenger health (i.e., cardiac events) to that of 10 years ago and provided future planning recommendations regarding the incidence of automated external defibrillator use. Based on these findings, provided recommendations to improve passenger safety.

1.3.2 Fire Research and Safety (RE&D - A11.a)

The Fire Research and Safety Program supports Aviation Safety R&D Goal 3 by developing 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.

The research milestones and their statuses are shown in Table 1.3.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.3.2: Fire Research and Safety Program Milestones

Year	Milestone	Status	Notes
2013	Recommend a lab-scale flammability test method for magnesium seat structure	Completed	2013 NARP Status: On schedule
2014	Evaluate the effectiveness of a water spray system in a freighter main deck cargo compartment	On schedule	2013 NARP Status: On schedule
2015	Develop a performance standard for small lithium batteries transported in passenger carrying aircraft	On schedule	New milestone

Year	Milestone	Status	Notes
2015	Evaluate aircraft improvements to protect against lithium battery cargo fires	On schedule	New milestone
2015	Analyze the large number of in-flight smoke, odor and detector activation incidents	On schedule	New milestone
2015	Develop and finalize a small-scale flammability test method for the in-flight fire resistance of composite fuselage structure	On schedule	New milestone
2016	Develop hidden fire detection and extinguishment improvements	On schedule	2013 NARP Status: On schedule
2016	Develop a computational fluid dynamics model for hidden fire growth	On schedule	New milestone
2017	Evaluate detector technology that discriminates between aircraft fire and non-fire smoke/odor sources	On schedule	New milestone
2017	Determine the efficacy of current emergency smoke ventilation procedures and certification criteria	On schedule	New milestone
2018	Test and evaluate an integrated aircraft fire detection and extinguishment system	On schedule	New milestone
2018	Examine state-of-the-art technology for protection of compressed hydrogen in aircraft fuel cell applications	On schedule	New milestone
2019	Conduct a cost-benefit analysis of an integrated fire detection and extinguishment system	On schedule	New milestone
2019	Develop fire protection measures for aircraft fuel cell applications	On schedule	New milestone

Fire Research and Safety Program Progress in FY 2013:

- ✓ Developed a flammability test method for seat structure incorporating potentially combustible materials such as magnesium alloys. A laboratory-scale flammability test was developed for magnesium alloys used in the construction of aircraft seats. The test utilizes an oil burner as the fire threat, and exposes a 20-inch-long horizontally-oriented bar sample for a period of four minutes. In order to pass the test, the sample must not ignite prior to two minutes, and must self-extinguish within three minutes of the burner flames being removed. When exposed to the burner flames, the magnesium alloy samples typically melt and fall into a catch pan situated beneath the sample, and the molten residue will continue to burn. Therefore, an allowable weight loss of 10 percent was an additional criterion added to place a limit on the quantity of sample burned. The pass/fail criterion is based on the performance of a fire resistant magnesium alloy that was shown not to impact survivability during full-scale post-crash fire tests.

- ✓ Configured the aft section of the DC-10 test article to represent a main deck freighter cargo compartment and fire hardened to protect against damage from repeated fire tests. A drain system was installed to prevent water leakage into the lower cargo compartments. Extensive instrumentation was installed, including a large number of thermocouples as well as gas analyzing sampling lines, smoke meters, and different types of power sources.

The main deck was then affixed with a ducting system and configured to simulate the ventilation conditions in a freighter airplane. The water mist system supply lines were plumbed to each zone, which have a separate solenoid valve, and to the water supply tank. The water supply system was tested manually for functionality. A computer code was written to control the functioning of the zoned water mist system. Nozzles and tubing were purchased to complete the zoned water mist system. Upon completion of the water mist system installation, tests will be conducted with small fires to optimize nozzle configurations and water pressures. Upon completion of these system functionality tests, the full scale fire tests will commence on cargo loaded on both palettes and cargo container containers for various types of representative cargo, including lithium batteries.

1.4 Aviation Safety R&D Goal 4

Improved system-wide access and sharing of aviation safety data and analysis tools within the aviation community, providing safety resources that are integrated with operations of aviation industry stakeholders.

1.4.1 Systems Safety Management Transformation (F&E - 3A09B - NextGen – System Safety Management Portfolio)

The Systems Safety Management Transformation Program supports Aviation Safety R&D Goal 4 by developing a comprehensive and proactive approach to aviation safety, especially as it relates to the implementation of NextGen. The research enables safety assessments of proposed NextGen concepts, algorithms, and technologies and provides system knowledge to understand economic, implementation, operational and performance impacts (with respect to safety) of NextGen system alternatives. The program supports the development and implementation of integrated safety management systems across the air transportation system to ensure that the safety risk throughout the system is managed to an acceptable level.

The research milestones and their statuses are shown in Table 1.4.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.4.1: Systems Safety Management Transformation Program Milestones

Year	Milestone	Status	Notes
2013	Complete the Aviation Safety Information Analysis and Sharing system pre-implementation activities, including concept definition, with other Joint Planning and Development Office member agencies, participants, and stakeholders	Completed	2013 NARP Status: On schedule
2014	Develop standard platform software incorporating previously deployed surface and terminal area risk analysis capabilities	On schedule	2013 NARP Status: On schedule
2014	Produce an annual comparison of predicted versus actual events and precursor rates for severe accident scenarios	On schedule	2013 NARP Status: On schedule
2014	Provide a safety report on surface movement for facilities with Airport Surface Detection Equipment, Model X and other surveillance data	On schedule	2013 NARP Status: On schedule
2014	Deliver advisory group recommended analyses of operational safety assessments for NextGen concepts	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Conduct an annual FAA-wide safety risk management coordination workshop including all Systems Safety Management Transformation stakeholders to discuss and critique methodologies, topics and results of recent activities	On schedule	2013 NARP Status: On schedule
2014	Conduct local surface and terminal area risk impact analyses for potential NextGen improvements with local risk forecast modeling assumptions adjusted to reflect the impact of NextGen improvements on throughput, delay and potential safety impacts	On schedule	2013 NARP Status: On schedule
2014	Deliver stakeholder-required analyses and reports for the advisory group using the integrated safety modeling capabilities. User requirements and feedback will be incorporated into changes in airport surface and terminal area risk baselines	On schedule	2013 NARP Status: On schedule
2014	Develop baseline event sequence diagrams and probabilistic risk-based calculations for 30 accident scenarios relevant to aviation safety, calibrated to U.S. historical data, and accompanying fault tree analysis	On schedule	2013 NARP Status: On schedule
2014	Establish an Aviation Safety Information Analysis and Sharing data interchange protocol and produce a report that provides a model-based risk assessment of an airport surface safety risk	On schedule	2013 NARP Status: On schedule
2014	Deliver a preliminary peer-review report featuring FAA and European Organisation for the Safety of Air Navigation data exchange on Integrated Safety Assessment Model and Single European Sky Air Traffic Management Research Accident Incident Model for system risk baselines	On schedule	2013 NARP Status: On schedule
2014	Deploy model-based risk calculation software in a secure web-based environment and produce a precursor data tracking requirements document	On schedule	2013 NARP Status: On schedule
2014	Deliver an annual NAS-wide risk impact assessment for NextGen implementation segments	On schedule	2013 NARP Status: On schedule
2014	Develop and conduct human-in-the-loop protocol for expert-judgment assessment of NextGen safety impacts and capture data into the Integrated Safety Assessment Model	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Establish software access to the NextGen program office and other FAA safety and operational organizations so that they can provide integrated data collected via FAA-wide hazard tracking systems into the system risk baseline analysis	On schedule	2013 NARP Status: On schedule
2015	Develop prototype system baseline risk software for airports and terminal areas without sophisticated surveillance (ASDE-X sites	On schedule	New milestone
2015	Develop prototype system risk forecast software for airports and terminal areas without sophisticated surveillance (ASDE-X sites)	On schedule	New milestone
2015	Test the prototype baseline and forecast software at the top 100 US airports with and without sophisticated surveillance	On schedule	New milestone
2015	Test the prototype forecast software at the top 100 US airports with and without sophisticated surveillance	On schedule	New milestone
2015	Deliver trend analysis software for risk estimates for top 100 US airports with data requirements for trend validation	On schedule	New milestone
2015	Develop baseline event sequence diagrams and probabilistic risk-based calculations for 30 accident scenarios relevant to aviation safety calibrated to US historical data as well as additional accident scenarios relevant to Unmanned Aerial Vehicle (UAV) activity	On schedule	New milestone
2015	Implement fault-trees associated with primary failure modes relevant to the 30 accident scenarios in a web-based environment	On schedule	New milestone
2015	Customize risk-based reports for scenarios relevant to the FAA Lines of Business	On schedule	New milestone
2015	Develop ASIAS data interchange protocol and report that provides a model-based risk assessment of an airport surface safety risk	On schedule	New milestone
2015	Integrate international risk baselines (and a comparison report) through cooperative research activity with SESAR	On schedule	New milestone
2015	Deliver a preliminary peer-review report on FAA/Eurocontrol data exchange on ISAM and SESAR Accident Incident Model for system risk baselines	On schedule	New milestone
2015	Deliver model-based risk calculation software deployed in web-based environment extended to include new vehicles (UAV)	On schedule	New milestone

Year	Milestone	Status	Notes
2015	Produce precursor data tracking requirements document, including data requirements for UAV modeling	On schedule	New milestone
2015	Conduct annual NAS-wide risk impact assessment for implementation of NextGen using ISAM model and expert assessments	On schedule	New milestone
2015	Provide results of expert-judgment assessment of NextGen safety impacts on operational scenarios	On schedule	New milestone
2015	Deliver a peer review coordination report: ISAM results of NextGen and SESAR impacts (FAA/Eurocontrol cooperative effort)	On schedule	New milestone
2015	Conduct test of Standardized Hazard Taxonomy and associated Event Sequence Diagram and Fault Tree associations	On schedule	New milestone

1.4.2 System Safety Management (RE&D - A11.h)

The System Safety Management Program supports Aviation Safety R&D Goal 4 by developing 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.

The research milestones and their statuses are shown in Table 1.4.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.4.2: System Safety Management Program Milestones

Year	Milestone	Status	Notes
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	On schedule	2013 NARP Status: On schedule
2015	Complete the study on best practices for training and using AOA Equipment in general aviation operations	On schedule	New milestone
2015	Expand the Aviation Safety Information Analysis and Sharing system safety analysis to other domains (e.g., general aviation, rotorcraft, corporate, military)	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2016	Establish safety metrics to align with NextGen system changes	Deleted	Milestone was deleted due to area of focus being shifted to the System Safety Management Transformation program. 2013 NARP Status: On schedule
2016	Complete an evaluation of an identified airplane-based measuring method concerning real-time runway slipperiness reporting of all potential runway surface conditions and airplane configurations	On schedule	Milestone was revised for clarity Old wording: "Complete an evaluation of the reported runway slipperiness condition from all potential runway surface conditions and airplane configurations" 2013 NARP Status: On schedule
2016	Develop test criteria by varying motion characteristics to span the domain of the criteria and compare variations against subjective opinions of motion quality	On schedule	2013 NARP Status: On schedule
2016	Develop analytical capabilities for Air Traffic Safety Oversight Service to target its oversight resources toward facilities posing the highest risk to air traffic safety	On schedule	New milestone
2016	Develop a process to create representative stall models that could be applied for most transport category airplanes for upset recovery training in flight simulators	On schedule	New milestone
2017	Develop concept of operations and a model to establish safety oversight profiles for ATO facilities, systems, procedures, and safety standards	On schedule	New milestone
2017	Expand the Integrated Domain Assessment from eight selected NAS systems to all major NAS systems	On schedule	New milestone
2017	Complete an initial feasibility assessment of air traffic controllers calling for go-arounds according to the to-be-defined stabilized approach criteria	On schedule	New milestone
2018	Conduct exploratory simulation study of appropriate angle-of-attack sensor and display combinations for mitigating low airspeed and upset events	On schedule	New milestone
2018	Develop methodology to identify and optimize Air Traffic Safety Oversight Service (AOV) oversight activities, surveillance targets, and data collection parameters based on risk trends and AOV resources	On schedule	New milestone
2018	Develop additional capability for the Integrated Domain Assessment tool functions to support the evaluation of NAS procedure changes related to separation minima	On schedule	New milestone

Year	Milestone	Status	Notes
2019	Develop and demonstrate Safety Oversight Management System prototype tool and case studies for Air Traffic Safety Oversight Service	On schedule	New milestone
2019	Demonstrate applications of the Integrated Domain Assessment tool functions	On schedule	New milestone

System Safety Management Program Progress in FY 2013:

- ✓ Developed a data-driven estimate of flight crew error rates for situations when certain aircraft failures, warnings, or other abnormal conditions occur. The cockpit en-route inspection data, which resides in The National Program Tracking and Reporting System database, were used in this study. Due to the small sample size of the cockpit en-route inspection data, alternate data sources are being considered to determine a more reliable and practical estimate for the flight crew error rates. Final estimates will be used in the transport airplane Continued Operational Safety process.

- ✓ Conducted a computational simulation study to evaluate methods to estimate runway slipperiness conditions by using information from airplane's on-board sensor systems. An algorithm was developed based on detailed knowledge of the aerodynamic and engine performance for a particular regional jet, and was then applied to a high fidelity simulation program. The evaluation of the algorithm included an assessment of the impact of realistic noise and biases on the on-board measurements and the impact of modeling errors associated with proprietary engine and aerodynamic data. The simulation study showed promising feasibility of using aircraft on-broad data to provide useful runway condition estimates for improving runway safety. Additional approaches will be tested and evaluated in follow-up studies.

- ✓ Initiated exploratory development for a simulation study that aims to minimize the danger of inappropriate simulator training caused by unsatisfactory motion cueing. The preparation included the development of an experimental plan for simulator tests, review of modeling modifications and motion algorithms, and installation and evaluation of software and hardware changes on the NASA Ames Vertical Motion Simulator. These simulation modifications are essential to support the subjective evaluation tests and data collection on the Vertical Motion Simulator for the requirements associated with objective motion cueing criteria.

1.5 Aviation Safety R&D Goals 5 and 6

Established requirements and standards for enabling the availability and improving the quality and quantity of meteorological information to safely implement NextGen operational improvements.

Improved accuracy and accessibility of observed and forecast weather to reduce the number of accidents and incidents attributed to hazardous weather.

1.5.1 NextGen - Weather Technology in the Cockpit (RE&D - A12.d)

The NextGen - Weather Technology in the Cockpit Program supports Aviation Safety R&D Goals 5 and 6 by developing, verifying, and validating requirements to support airworthiness standards for enabling availability and improving the quality and quantity of meteorological information to the aircraft to support safe current and NextGen operations. The program will result in the development of standards and requirements that define the weather information in the cockpit needed to support operations, the presentations and interfaces to enable proper information consumption and safe operations by pilots, and capabilities that enable efficient dissemination of the weather information to and from the cockpit at the right place and right time.

The research milestones and their statuses are shown in Table 1.5.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 1.5.1: NextGen - Weather Technology in the Cockpit Program Milestones

Year	Milestone	Status	Notes
2013	Identify specific and recurring weather-related causes in reported safety incidents/accidents that identify weather as a primary cause	Completed	2013 NARP Status: Delayed from 2012 to 2013
2013	Develop preliminary recommendations for a minimum weather service for mobile devices, and a preliminary associated concept of operations for mobile MET applications	Completed	Milestone was revised to better align the research and its deliverables with the overall program Old wording: “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” 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Quantify the impacts to the NAS of uplinking Graphical Turbulence Guidance and Eddy Dissipation Rate to the cockpit	On schedule	Milestone was revised due to changing NextGen - Weather Technology in the Cockpit program priorities Old wording: "Assess and quantify the safety benefits to the NAS of providing Graphical Turbulence Guidance, Eddy Dissipation Rate, and icing to the cockpit" 2013 NARP Status: Delayed from 2013 to 2014
2014	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	On schedule	2013 NARP Status: Delayed from 2013 to 2014
2014	Develop recommendations for standards on time stamping of cockpit composite weather presentations	On schedule	Milestone was revised to clarify the research Old wording: "Develop standards for time stamping of cockpit composite weather presentations" 2013 NARP Status: On schedule
2015	Propose standards and develop recommendations to address meteorological information shortfalls that were identified as causal factors in selected weather-related safety incidents/accidents	Delayed	Milestone was revised to clarify the research and delayed from 2014 to 2015 due to a need for gap analysis Old wording: "Develop and implement resolutions to prevent recurrence of previously researched weather-related safety incidents/accidents" 2013 NARP Status: Delayed from 2013 to 2014
2016	Develop recommendations for providing meteorological-uncertainty information to the cockpit to increase pilot confidence in weather forecasts	Delayed	Milestone was revised and delayed from 2015 to 2016 due to changing NextGen - Weather Technology in the Cockpit program priorities Old wording: "Simulate, test, and evaluate cockpit use of weather decision support tools, including probabilistic forecasts" 2013 NARP Status: Delayed from 2014 to 2015

Year	Milestone	Status	Notes
2016	Safety reporting systems indicate success of corrective actions and enhanced meteorological information (turbulence and icing) to reduce weather-related accidents/incidents	Deleted	Milestone was deleted since it is no longer in scope. 2013 NARP Status: Delayed from 2015 to 2016
2016	Implement cockpit alerting to enhance pilot awareness of adverse weather (e.g., turbulence, icing)	Deleted	Milestone was deleted as it is duplicative of other NextGen - Weather Technology in the Cockpit milestones. 2013 NARP Status: On schedule
2016	Provide recommendations on optimal presentation of general aviation weather information	On schedule	2013 NARP Status: On schedule
2017	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	Delayed	Milestone is delayed from 2016 to 2017 due to delays in supporting milestones. 2013 NARP Status: Delayed from 2015 to 2016
2019	Complete development of recommendations for Part 91 Minimum Weather Service information content, training enhancements, and presentation (human-machine interface) attributes that will resolve or reduce identified General Aviation (GA) safety risks associated with gaps of MET information in the cockpit	On schedule	New milestone

NextGen - Weather Technology in the Cockpit Program Progress in FY 2013:

- ✓ Completed research using NASA's Aviation Safety Reporting System database and NTSB accident reports to identify trends of weather-related causes in reported incident/accident reports. The Weather Technology in the Cockpit program is now able to focus future research on the resolutions of the identified trends to enhance safety.

- ✓ Complied a prioritized list of information and capabilities for a mobile MET application and developed a preliminary Concept of Operations. These products will be used to develop guidance for a mobile MET application minimum weather service (information content, quality, latency, presentation, etc.) to enhance general aviation (GA) safety by resolving current gaps and shortfalls in mobile MET applications currently in use by GA pilots.

1.5.2 Weather Program (RE&D - A11.k)

The Weather Program supports Aviation Safety R&D Goals 5 and 6 by conducting applied research focused on improving weather information required for integration into decision-support tools to reduce the impact of adverse weather on the NAS. The improved weather information increases safety by supporting better operational planning and decision-making by ATM, dispatchers, and pilots.

The research milestones and their statuses are shown in Table 1.5.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 1.5.2: Weather Program Milestones

Year	Milestone	Status	Notes
2014	Complete initial evaluation of high-resolution in-flight icing analysis and forecast capability	On schedule	New milestone
2015	Transition in-flight icing Alaska forecast and analysis capability for implementation (as detailed in NextGen Plans)	Delayed	Milestone is delayed from 2014 to 2015 due to a new research approach resulting from collaboration with the National Weather Service; it has also been revised to include a reference to NextGen Plans Old wording: “Transition in-flight icing Alaska forecast and analysis capability for implementation” 2013 NARP Status: On schedule
2015	Demonstrate integrated FAA/National Weather Service ceiling and visibility forecast capability	On schedule	2013 NARP Status: On schedule
2016	Transition ceiling and visibility Alaska analysis capability for implementation (as detailed in NextGen Plans)	On schedule	New milestone
2016	Complete initial demonstration/ validation of 0-36 hour probabilistic forecast of oceanic convection	On schedule	Milestone was revised to clarify the research. Old wording: “Demonstrate and validate prototype oceanic convection forecast capability” 2013 NARP Status: On schedule
2018	Transition CONUS in-flight icing forecast and analysis capability, that includes liquid water content, drop-size distribution, and temperature, for implementation (as detailed in NextGen Plans)	On schedule	New milestone

Weather Program Progress in FY 2013:

- ✓ Upgraded the Current Icing Product (CIP) and Forecast Icing Product (FIP) algorithms to meet NextGen plan requirements of high resolution diagnoses and forecasts of atmospheric conditions conducive to aircraft icing. These upgraded algorithms, also known as CIP/FIP High Resolution (HiRes), improve the horizontal and vertical resolution and extend the forecast from 12 hours out to 18 hours. After completion of an operational evaluation at the Aviation Weather Center, CIP/FIP HiRes are anticipated to become operational on Aviation Digital Data Service (ADDS) by the 4th quarter of FY 2014.

1.6 Aviation Safety R&D Goals 7 - 9

Optimized technical and regulatory provisions and processes used to oversee, coordinate, regulate, and promote safe and responsible activities for reliable aerospace operations between space and Earth.

Improved vehicle safety and risk management, including knowledge of all safety-critical components and systems of the space vehicles and their operations, to better identify potential hazards and apply and verify hazard controls.

Guidance and tools that enhance human safety, protection, and survival during space operations.

1.6.1 Commercial Space Transportation Safety (RE&D)

The Commercial Space Transportation Safety Program supports Aviation Safety R&D Goals 7, 8, and 9 by examining 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. In previous NARP versions, milestones for this research were funded through the FAA's Operations budget appropriation. Starting in 2014, R&D for the Commercial Space Transportation Program is conducted through its Center of Excellence and is funded through the NextGen – Air Ground Integration Human Factors (A12.c) budget line item (BLI).

The research milestones and their statuses are shown in Table 1.6.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 1.6.1: Commercial Space Transportation Safety Program Milestones

Year	Milestone	Status	Notes
2014	Develop FACET model to calculate probabilistic four-dimensional rocket trajectory envelopes to minimize impact on NAS	On schedule	2013 NARP Status: On schedule
2014	Develop and deliver "anytime" version of Space Based Model Predictive Optimization to optimize power consumption and minimum energy trajectory calculations	On schedule	2013 NARP Status: On schedule
2014	Report results of thermal ablation testing and analysis of ultra-high temperature composites for thermal protection systems in liquid rocket engine plume	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2015	Conduct a study to identify means of preventing hazards (such as fires and explosions) involving nontraditional monopropellants and oxidizers (specifically hydrogen peroxide and nitrous oxide) used in propulsion systems in commercial space applications	Delayed	Milestone is delayed from 2014 to 2015 due to changing organizational priorities 2013 NARP Status: Delayed from 2012 to 2014 due to changing laboratory facility sites.
2015	Complete Whole Atmosphere Model implementation coupling ionosphere and magnetospheric forcing and assimilate high-resolution data	On schedule	2013 NARP Status: On schedule
2015	Report centrifuge test results evaluating biomedical monitoring equipment	On schedule	2013 NARP Status: On schedule

1.7 Aviation Safety R&D Goal 10

No fatal accidents on certificated airports as a result of airport design, runway incursions or excursions, or wildlife strikes.

1.7.1 Airport Cooperative Research Program – Safety (AIP)

The Airport Cooperative Research Program – Safety supports Aviation Safety R&D Goal 10 by preventing or mitigating potential injuries and accidents within the airport operational environment. A fundamental element of the program is to produce results that provide protection of aircraft passengers and airport personnel through improved safety training, airport design, and advanced technology implementation.

The research milestones and their statuses are shown in Table 1.7.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.7.1: Airport Cooperative Research Program – Safety Milestones

Year	Milestone	Status	Notes
2013	Develop a tool to help define the roles of airports and airlines in the transmission and spread of insect-borne human diseases	Completed	2013 NARP Status: On schedule
2013	Determine high-risk areas and activities conducive to human disease at airports and on aircraft and identify mitigation measures to address those risks	Completed	2013 NARP Status: On schedule
2013	Develop guidance for airport operators to help them understand the capabilities, benefits, and challenges of integrating geographical information systems into emergency management	Completed	2013 NARP Status: On schedule
2013	Develop guidance to evaluate and implement web-based collaboration tools that provide a common operating picture for both day-to-day operations and full emergency response management	Completed	2013 NARP Status: On schedule
2013	Develop a model Community Emergency Response Team program for the airport community	Completed	2013 NARP Status: On schedule
2013	Provide guidance to all size airports in integrating National Incident Management System in response to incidents/accidents and events regardless of the size, cause, or complexity of such events	Completed	2013 NARP Status: On schedule
2014	Develop a runway veer-off location distribution risk assessment model with guidelines for reporting and collecting runway veer-off incident/accident data	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Develop a scalable tool to create and maintain integrated incident response plans for hazards in and around airport terminals	On schedule	2013 NARP Status: On schedule

1.7.2 Airport Technology Research Program – Safety (AIP)

The Airport Technology Research Program – Safety supports Aviation Safety R&D Goal 10 by increasing airport safety through research that improves airport lighting and marking, reduces wildlife hazards near airport runways, improves airport fire and rescue capability, and reduces surface accidents.

The research milestones and their statuses are shown in Table 1.7.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.7.2: Airport Technology Research Program – Safety Milestones

Year	Milestone	Status	Notes
2013	Complete assessment of the safety implications of using long-range acoustic devices on civil airports to deter hazardous bird species	Completed	2013 NARP Status: On schedule
2013	Complete characterization of foreign object debris at Chicago O'Hare International Airport (ORD)	Completed	2013 NARP Status: On schedule
2013	Develop visual aid enhancements for Engineered Materials Arresting System beds	Completed	2013 NARP Status: On schedule
2013	Update the Airport Safety Database and conduct analysis to identify the top airport risk areas, mitigation strategies and implementation methods	Completed	Milestone was revised to clarify the research and to reflect research results Old wording: “Develop a safety database to identify the top five airport risk areas, mitigation strategies and implementation” 2013 NARP Status: On schedule
2013	Develop aircraft rescue and firefighting procedures and equipment for improved freighter aircraft fire fighting	Completed	2013 NARP Status: On schedule
2013	Develop improved tactics and strategies for freighter aircraft fire fighting	Completed	2013 NARP Status: On schedule
2013	Complete evaluation of operational and technical performance requirements of an alternative airfield lighting infrastructure (Electrical Infrastructure Research)	Completed	2013 NARP Status: On schedule
2014	Complete human factor laboratory/ simulation tests on use of linear light sources on airports	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Complete in-service testing of new light emitting diode lighting circuits at a large and small airport	On schedule	2013 NARP Status: On schedule
2014	Update the Airport Safety Database and publish updated analysis report	On schedule	2013 NARP Status: On schedule
2014	Complete evaluation to determine feasibility of implementing bird radar displays in air traffic control towers	On schedule	2013 NARP Status: On schedule
2014	Complete the first phase of a study to establish a test protocol and collect baseline data for large aviation fuel fires at the New Large Aircraft Full-Scale Mockup	On schedule	2013 NARP Status: On schedule
2014	Complete Taxiway Centerline Deviation data collection for Airplane Design Group - III	On schedule	New milestone
2014	Conduct an evaluation of Approach Hold/Runway Safety Area signage and markings	On schedule	New milestone
2014	Complete a review of problematic taxiway locations leading to runway incursions	On schedule	New milestone
2014	Complete evaluation of prototype construction signs to determine the effectiveness of the construction signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield and in mitigating adverse operational incidents at airports during construction	On schedule	New milestone
2014	Publish report on characterization of foreign object debris collected at Chicago O'Hare International Airport (ORD)	On schedule	New milestone
2014	Complete construction of the High Temperature Pavement Test Facility	On schedule	2013 NARP Status: On schedule
2014	Complete upgrade of all FAA Pavement Software to Windows Presentation Foundation to create a common platform to integrate the programs	On schedule	Milestone was revised to clarify the research. Old wording: "Complete upgrade of all FAA Pavement Software to Windows Presentation Foundation" 2013 NARP Status: On schedule
2014	Complete definition of airport pavement failure for 40 Year Pavement Life project	On schedule	2013 NARP Status: On schedule
2015	Complete rehabilitation of the Airport Technology Research Taxiway	Delayed	Milestone is delayed from 2014 to 2015 due to refining the specifications of the project. 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2015	Complete Mu-Slip testing with nose gear brake testing and main gear brake testing, both on contaminated runway surfaces	Delayed	Milestone is delayed from 2014 to 2015 and the wording revised due to the expansion of the testing program. Old wording: "Complete mu-slip testing with aircraft landing gear brakes on contaminated runway surfaces" 2013 NARP Status: On schedule
2015	Complete draft concept of operations for bird radar in air traffic control	On schedule	New milestone
2015	Complete first round of small-scale fire testing of aviation biofuels	On schedule	New milestone
2016	Survey airport communities to update dose response curves for aircraft noise annoyance and sleep disturbance	Delayed	Milestone is delayed from 2013 to 2016 due to a change in scope. 2013 NARP Status: On schedule
2016	Publish Guidebook on dynamic test performance requirements for frangible connections/structures utilized in runway and terminal safety areas	On schedule	New milestone

Airport Technology Research Program – Safety Progress in FY 2013:

- ✓ Completed an assessment of the safety implications of using long-range acoustic devices on civil airports. A draft final report titled *Safe Operation of Acoustic Hailing Devices as Wildlife Deterrents on Airports* has been written and should be published by the end of 2014.

- ✓ Completed a two-year data collection period, accumulating 78 weekly samples, to identify and characterize the number and type of foreign object debris found on a single runway at Chicago O'Hare International (ORD). A final report covering the analysis of the data will be published by the end of 2014.

- ✓ Identifed additional visual aids for Engineered Materials Arresting Systems. This task involved the development of prototype signs and retro-reflective markers for field testing at the FAA Technical Center and Baton Rouge Metropolitan Airport as well as simulation testing at the Airways Facilities Tower Integration Lab. A report was completed that detailed the research and provides recommendations for new visual aids standards.

- ✓ Updated the Airport Safety Database to include an additional five years of data and additional airports. The updated analysis report was completed on June 30, 2013. The top airport risks areas were identified as: Runway Excursions, Runway Incursions, and Wildlife Strikes. A mitigation team was created for each top risk and identified tasks for implementation that could mitigate/reduce the risks. The Mitigation Plans were completed on August 28, 2013.

- ✓ Developed new, improved tactics and strategies for freighter aircraft fire fighting through the execution of full-scale live fire tests using an Airbus A310 cargo aircraft. At the conclusion of the research, a report was published, entitled DOT/FAA/TC-13/30, *Full-Scale Evaluation of ARFF Tactics and Strategies* and DOT/FAA/TC- TN13/11, *Prototype Aircraft Skin Penetrating Nozzles*.

1.7.3 Runway Incursion Reduction Program (F&E - 1A01A – Advanced Technology Development and Prototyping)

The Runway Incursion Reduction Program supports Aviation Safety R&D Goal 10 by conducting research, development, and operational evaluation of technologies to increase runway safety. Emphasis is on technologies that provide for direct safety indications and alerts to pilots at large airports as well as those that can be applied cost effectively at small and medium-size airports. The program tests alternative airport surface detection technologies and the application of these technologies for pilot, controller, and vehicle operator situational awareness tools. Program initiatives include removal of Low Cost Ground Surveillance (LCGS) pilot sites, Runway Safety Assessment studies, and Enhanced Final Approach Runway Occupancy Signal (eFAROS) for high density airports.

The research milestones and their statuses are shown in Table 1.7.3 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 1.7.3: Runway Incursion Reduction Program Milestones

Year	Milestone	Status	Notes
2013	Complete the development of the interface required for the activation of direct-to-pilot indications using a low-cost Surface Movement Radar as the surveillance sensor	Completed	2013 NARP Status: On schedule
2013	Complete human-in-the-loop simulation scenario coordination meeting with the William J. Hughes Technical Center Surface Lighting Team	Completed	2013 NARP Status: On schedule
2013	Complete final luminosity and operational evaluation report on San Diego International Airport's (SAN) light emitting diode Runway Status Lights system	Completed	2013 NARP Status: On schedule
2013	Develop an annual technical and operational evaluation report of the existing Enhanced Final Approach Runway Occupancy Signal prototype system	Completed	2013 NARP Status: On schedule
2013	Publish an initial cost-benefit analysis for Enhanced Final Approach Runway Occupancy Signal	Completed	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2013	Develop an annual technical and operational evaluation report of the existing Runway Status Lights prototype systems	Completed	Milestone was revised to clarify the research Old wording: "Develop an annual technical and operational evaluation report of the existing prototype systems" 2013 NARP Status: On schedule
2014	Develop annual technical and operational evaluation report of four Low Cost Ground Surveillance pilot systems	Deleted	Milestone was deleted due to the FAA's Joint Resources Council's June 19, 2013 decision to discontinue further Low Cost Ground Surveillance evaluation 2013 NARP Status: On schedule
2014	Develop annual technical and operational evaluation report of existing Runway Status Lights prototype systems	Deleted	Milestone was deleted due to the FAA's Joint Resources Council's June 19, 2013 decision to discontinue further Low Cost Ground Surveillance evaluation 2013 NARP Status: On schedule
2014	Develop annual technical and operational evaluation report for Runway Intersection Lights at Boston Logan International Airport (BOS)	Deleted	Milestone was deleted due to the transition of Runway Status Lights sites to the FAA Program Management Office 2013 NARP Status: On schedule
2014	Complete the installation and produce operational evaluation report of a runway safety system for direct-to-pilot indications, using a low cost Surface Movement Radar as the surveillance sensor	Deleted	Milestone was deleted due to the FAA's Joint Resources Council's June 19, 2013 decision to discontinue further Low Cost Ground Surveillance evaluation 2013 NARP Status: On schedule
2014	Remove Low Cost Ground Surveillance pilot sites	On schedule	New milestone
2014	Complete installation and implementation of Enhanced Final Approach Runway Occupancy Signal units at Boston Logan International Airport (BOS) and commence operational evaluation	On schedule	Milestone was revised to clarify the research Old wording: "Complete installation and implementation of Enhanced Final Approach Runway Occupancy Signal units at second prototype location and commence operational evaluation." 2013 NARP Status: On schedule
2014	Develop annual technical and operational evaluation report of Enhanced Final Approach Runway Occupancy Signal units at all prototype locations	On schedule	2013 NARP Status: On schedule
2014	Complete report on cockpit simulations at MITRE Center for Advanced Aviation System Development testing Human Factors, safety logic, aircraft performance, or any uncertainty or deficiency pertaining to surface based runway incursion indications	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Complete report on testing of safety logic enhancements to runway incursion detection and prevention products	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule
2014	Publish initial report on field evaluation of alternative direct-to-pilot testing system at the FAA William J. Hughes Technical Center	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule
2014	Develop Preliminary Requirements Document for Enhanced Final Approach Runway Occupancy Signal	On schedule	Milestone was revised to clarify the research Old wording: "Complete initial requirements document for Enhanced Final Approach Runway Occupancy Signal" 2013 NARP Status: On schedule
2014	Publish the initial project plan and resource management plan for the utilization of fiber optics as a sensor to drive the activation of direct-to-pilot alerting safety logic	Deleted	Milestone was deleted due to a prerequisite need for the outcome of 2014 analysis and reports on new runway incursion reduction technologies 2013 NARP Status: On schedule
2014	Develop Runway Incursion Prevention Shortfall Analysis report	On schedule	New milestone
2014	Develop report on proposed solution set for new runway incursion reduction technologies based on market survey assessment and shortfall analysis report	On schedule	New milestone
2015	Develop readiness report based on coordination of preliminary requirements document and cost benefit analysis documents required for Enhanced Final Approach Runway Occupancy Signal Investment Analysis Readiness Decision	Delayed	Milestone is delayed from 2014 to 2015 due to the shift of the creation of the preliminary requirements document to FY 2014 2013 NARP Status: On schedule
2015	Develop documentation such as the Business Case Analysis Report required for an Enhanced Final Approach Runway Occupancy Signal Investment Analysis Readiness Decision in support of terminal PMO	On schedule	New milestone
2015	Develop annual technical and operational evaluation report of Enhanced Final Approach Runway Occupancy Signal units at all prototype locations	On schedule	New milestone
2015	Complete report on testing of safety logic enhancements to runway incursion detection and prevention products	On schedule	New milestone
2015	Publish initial Project Plan for evaluation of new initiative identified for runway incursion detection and prevention	On schedule	New milestone

Runway Incursion Reduction Program Progress in FY 2013:

- ✓ Completed development of the interface required for LCGS to operate as a sensor to drive the activation of direct-to-pilot alerting safety logic. Data recordings from the LCGS system at Spokane International Airport (GEG) were post-processed and tested with the interface to successfully prove the viability of using LCGS as a sensor to drive eFAROS safety logic.

- ✓ Began installation of the eFAROS prototype system at Boston Logan International Airport (BOS). A Safety Risk Management Panel was conducted at BOS for the eFAROS system, and Flashing Precision Approach Path Indicator (PAPI) modification kits were installed at three PAPI facilities at BOS. Engineering Development and Shadow Operations Tests were also carried out to successfully test the eFAROS safety logic for BOS.

- ✓ Completed development of an initial cost-benefit analysis for eFAROS.

2.0 R&D Principle 2 - Improve Efficiency

Systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will improve access to and increase capacity and efficiency of the nation's aviation system.

Seven R&D goals support R&D Principle 2 - Improve Efficiency with work spread across three budget appropriations (RE&D, F&E, and AIP):

- Goal 1 - Necessary NextGen related research priorities are identified, defined, and coordinated with partner agencies for improvements in efficiency and capacity.

- Goal 2 - Improved aircraft separation processes associated with current generalized and static air navigation service provider wake turbulence mitigation separation standards.

- Goal 3 - Improved human-system integration and an increase in ATC efficiency through enhanced controllers-pilots coordination in cooperatively managing traffic loads as cockpit technology and air traffic workstations are more closely connected.

- Goal 4 – Established feasible procedures, operational methods, and technologically-advanced systems that can decrease workload and increase efficiency of the NAS.

- Goal 5 - Established requirements and standards for enabling availability and improving the quality and quantity of meteorological information to reduce impacts of adverse weather on rerouting, NAS capacity, and NextGen operational procedures.

- Goal 6 - Improved accuracy and accessibility of observed and forecast weather information to improve NAS efficiency (e.g., reduced delays and cancellations, increased capacity in high traffic areas).

- Goal 7 - Availability of existing airport facilities protected and used as efficiently as possible, while making strategic investments in new facilities consistent with evolving aviation needs.

Table 2.0.1 shows how the FAA's Efficiency R&D goals and programs align with the NSTC Mobility Goals. In many cases, FAA R&D programs support more than one NSTC goal.

Table 2.0.1: Alignment of FAA R&D Efficiency Goals and Programs with NSTC Mobility Goals

<table>
<tr><th>FAA R&D Principle</th><th>FAA R&D Programs</th><th colspan="2">NSTC Goals</th><th>NSTC Principle</th><th>FAA Strategic Initiative</th></tr>
<tr><td rowspan="14">Improve Efficiency</td><td>NextGen - Wake Turbulence</td><td colspan="2" rowspan="2">Goal 1 - Develop Reduced Aircraft Separation in Trajectory- and Performance-Based Operations

Goal 4 - Maximize Arrivals and Departures at Airports and in Metroplex Areas</td><td rowspan="14">Mobility Through the Air is Vital to Economic Stability, Growth, and Security as a Nation</td><td rowspan="14">National Airspace System (NAS)</td></tr>
<tr><td>Wake Turbulence - Re-categorization</td></tr>
<tr><td>NextGen - Air Ground Integration Human Factors</td><td colspan="2" rowspan="2">Goal 1 - Develop Reduced Aircraft Separation in Trajectory- and Performance-Based Operations

Goal 4 - Maximize Arrivals and Departures at</td></tr>
<tr><td>Air Traffic Control/Technical Operations Human Factors</td></tr>
<tr><td>New Air Traffic Management Requirements</td><td rowspan="3">Goal 2 - Develop Increased NAS Capacity by Managing NAS Resources and Air Traffic Flow Contingencies</td><td rowspan="2">Goal 1 - Develop Reduced Aircraft Separation in Trajectory- and Performance-Based Operations

Goal 4 - Maximize Arrivals and Departures at Airports and in Metroplex Areas</td></tr>
<tr><td>Major Airspace Redesign</td></tr>
<tr><td>System Capacity, Planning and Improvements</td><td></td></tr>
<tr><td>Operations Concept Validation Modeling</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>Networked Facilities - Staffed NextGen Towers</td></tr>
<tr><td>Operations Concept Validation and Infrastructure Evolution</td></tr>
<tr><td>NextGen - Weather Technology in the Cockpit</td><td rowspan="2">Goal 3 - Reduce the Adverse Impacts of Weather on Air Traffic Management Decisions</td><td>Goal 2 - Develop Increased NAS Capacity by Managing NAS Resources and Air Traffic Flow Contingencies</td></tr>
<tr><td>Weather Program</td><td></td></tr>
<tr><td>Airport Cooperative Research Program - Capacity</td><td colspan="2" rowspan="2">Goal 2 - Develop Increased NAS Capacity by Managing NAS Resources and Air Traffic Flow Contingencies</td></tr>
<tr><td>Airport Technology Research Program - Capacity</td></tr>
</table>

In FY 2015, 33 percent of total FAA R&D funding is allocated to R&D Principle 2 - Improve Efficiency. Program funding levels for the 2014 Enacted and 2015 President's Request are shown in Table 2.0.2. Percent of Program reflects each program's contribution to R&D Principle 2 in the 2015 President's Request. Table 2.0.2 also lists the section and page number reference for each budget narrative within the FY 2015 CJ for the President's Budget Request. The link to the FY 2015 CJ is: http://www.dot.gov/sites/dot.gov/files/docs/FAA-FY2015-Budget-Estimates.pdf.

Table 2.0.2: Program Funding for R&D Principle 2 - Improve Efficiency

2015 BLI	Program	CJ Reference (Section/Page)	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2015 Percent of Program
A11.k	Weather Program	3C/50	RE&D	7,100	8,900	50%
A12.a	NextGen - Wake Turbulence	3C/66	RE&D	9,000	8,541	100%
A12.b	NextGen - Air Ground Integration Human Factors	3C/71	RE&D	3,399	2,909	30%
A12.c	NextGen - Weather Technology in the Cockpit	3C/75	RE&D	1,800	1,822	45%
A14.a	System Planning and Resource Management	3C/89	RE&D	324	315	15%
A14.b	William J. Hughes Technical Center Laboratory Facility	3C/91	RE&D	657	651	19%
1A01B	System Capacity, Planning and Improvements	3B/14	F&E	5,349	6,000	100%
1A01C	Operations Concept Validation and Infrastructure Evolution	3B/14	F&E	3,821	4,000	100%
1A01D	Major Airspace Redesign	3B/14	F&E	4,776	5,000	100%
1A10E	New Air Traffic Management Requirements	3B/53	F&E	20,775	4,980	100%
4A08	Center for Advanced Aviation System Development (CAASD)	3B/294	F&E	9,502	9,502	74%
--	Air Traffic Control/Technical Operations Human Factors	N/A	F&E	4,721	0	100%
--	Networked Facilities - Staffed NextGen Towers	N/A	F&E	1,889	0	100%
--	Operations Concept Validation Modeling	N/A	F&E	4,722	0	100%
--	Wake Turbulence - Re-categorization	N/A	F&E	1,416	0	100%
--	Airport Cooperative Research Program - Capacity	3D/36	AIP	5,000	5,000	100%
--	Airport Technology Research Program - Capacity	3D/26	AIP	12,607	12,714	100%
	Total ($000)			**96,857**	**70,333**	

2.1 Efficiency R&D Goal 1

Necessary NextGen related research priorities are identified, defined, and coordinated with partner agencies for improvements in efficiency and capacity.

2.1.1 Joint Planning and Development Office (RE&D)

The JPDO supports Efficiency R&D Goal 1 by ensuring efficient coordination and collaboration among NextGen partner agencies and reinforcing agency accountability for NextGen through agency plans and reports that complement the long-term strategic plan. The program addresses key interagency priorities identified by the Cabinet-level Senior Policy Committee for NextGen.

Beginning in FY 2014, JPDO activities have been assumed by various offices in the NextGen organization; as such, this BLI will no longer appear in future volumes of the NARP.

The research milestones and their statuses are shown in Table 2.1.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.1.1: Joint Planning and Development Office Milestones

Year	Milestone	Status	Notes
2013	Formulate the strategic national program plan for unmanned aircraft system integration	Completed	2013 NARP Status: On schedule
2013	Participate in a bi-agency capability evaluation between the FAA and the National Weather Service by June 30, 2013	Completed	2013 NARP Status: On schedule

Joint Planning and Development Office Program Progress in FY 2013:

- ✓ Collaborated with the NextGen partner agencies to develop the UAS Comprehensive Plan, which includes six national goals and eight objectives that set the overarching approach to integrating UAS into the NAS. The Plan also highlights other important topics for safe integration, such as UAS R&D, UAS Test Ranges, and the Small UAS Rule. The UAS Comprehensive Plan, which was prepared by the JPDO and approved by the JPDO Board, was signed by the Secretary of Transportation and submitted to Congress on November 6, 2013.

- ✓ Facilitated a bi-agency capability evaluation that was conducted in June and successfully demonstrated the NextGen concept of providing a common weather picture for all aviation system users and decision makers. The capability evaluation included end-to-end (source to pilot) use cases with prototyped applications. The capability evaluation was a collaborative effort between our National Oceanic and Atmospheric Administration /National Weather Service partner in NextGen Weather and three FAA programs:

Common Support Services-Weather, Aircraft Access to System Wide Information Management (SWIM), and Weather Technology in the Cockpit.

2.2 Efficiency R&D Goal 2

Improved aircraft separation processes associated with current generalized and static air navigation service provider wake turbulence mitigation separation standards.

2.2.1 NextGen - Wake Turbulence (RE&D - A12.b)

The NextGen - Wake Turbulence Program supports Efficiency R&D Goal 2 by conducting research to increase airport runway capacity safely by reducing aircraft wake separation minima under certain conditions and addressing wake turbulence restrictions in today's terminal, en route airspace, and future NextGen airspace designs.

The research milestones and their statuses are shown in Table 2.2.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.2.1: NextGen - Wake Turbulence Program Milestones

Year	Milestone	Status	Notes
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)	Completed	2013 NARP Status: On schedule
2014	Provide wake separation recommendations for Airbus 350 series aircraft	On schedule	2013 NARP Status: On schedule
2014	Add Phoenix (PHX) and Las Vegas (LAS) airports to those approved to use 7110.308 procedures for their closely spaced parallel runways	On schedule	New milestone
2015	Evaluate air traffic control procedures for providing wake mitigation separations between unmanned aeronautical systems and piloted aircraft	On schedule	New milestone
2015	Deliver statistics based wake encounter risk evaluation tool for use in evaluating NextGen Trajectory Based Operations flight routing procedures	On schedule	New milestone
2016	Develop algorithms that will be used in the Air Navigation Service Provider (and flight deck as needed) automation systems for setting dynamic wake separation minimum for each pair of aircraft	On schedule	2013 NARP Status: On schedule
2017	Develop prototype information display for the controller decision support tool used to allow reduced wake separations for instrument approaches to a single runway	On schedule	New milestone

Year	Milestone	Status	Notes
2018	Produce the initial draft of a safety risk management document for the Wake Turbulence Mitigation for Arrivals - system	On schedule	New milestone
2019	Submit a draft of the safety risk management document for Wake Turbulence Mitigation for Arrivals - system	On schedule	New milestone

NextGen - Wake Turbulence Program Progress in FY 2013:

- ✓ Added San Francisco International Airport (SFO) runway and Newark International Airport (EWR) runway criteria modifications to Order 7110.308 (Change 3) for use of the runway throughput capacity increasing instrument approach procedure. FAA ATC Order 7110.308 documents the procedures and the closely spaced parallel runways (CSPR) that are approved for reduced diagonal wake separation spacing between pairs of aircraft conducting instrument approaches to an airport's runways. On September 30, 2013, SFO began use of the 7110.308 procedure. Also, completed the documentation (mainly an update of the Order's Safety Risk Management Document to include the analyses for additional airport runways and criteria for use of the procedure at the additional airports) for Change 4 to 7110.308 that will, when approved, allow the use of the 7110.308 ATC instrument approach procedure at the Phoenix (PHX) and Las Vegas (LAS) airports.

- ✓ Deployed the LIDAR wind profiler (which is man portable and less than three feet in height, thus is easy to place for acquiring wind profile measurements on or near an airport) under the BOS and JFK approach corridors. The wind profile data from these field trials was processed to extract information concerning aircraft wakes. The information provided measured values of a wake characterization parameter that in prior data collections had to be estimated from aircraft types and other measured parameters. The measured parameter will provide greater accuracy in models used to estimate the strength and duration of wakes generated by specific aircraft types. Further field evaluations of the Next Generation LIDAR wind profiler are planned in FY 2014.

- ✓ MIT Lincoln Laboratory upgraded the Wind Forecast Algorithm (WFA) design (developed for use in the currently deployed Wake Turbulence Mitigation for Departures controller decision support tool) to accept wind data from additional information sources. Work in FY 2014 and FY 2015 will focus on using these new NextGen era information sources to enhance the accuracy of the WFA tactical and strategic crosswind forecasts for airport arrival and departure corridors. WFA will provide controllers information on when and which runways will allow for reduced wake separation between aircraft pairs.

- ✓ Completed validation testing of an aircraft flight data recorder screening tool that that is able to detect for further study likely wake encounters (minor or less) that occurred during an aircraft's flight. Tool was validated using flight data recordings from over 86,000 Boeing 737-800 flight hours and over 9600 Airbus A330-200 flight hours. In FY 2014, the tool will be adapted for use with Boeing 777 and Airbus 320 aircraft flight data

recorders. The screening tool will be used by the FAA to help establish the statistical frequency of wake encounters occurring in today's operating environment. Additionally in FY 2013, the FAA Flight Standards Service Flight Simulation Branch continued research to determine metrics for quantifying the definition for minor and major wake encounter events. Using its flight simulators, Flight Standards collected data from a series of simulator runs using "line" commercial pilots with various simulated wake encounter events. The data analysis from these simulator runs shows a strong correlation between pilot perceived severity of encounter and several parameters of the simulated encounter.

- ✓ Developed several procedures for potential use by controllers in NextGen era congested airspace when an aircraft needs to climb or descend and other aircraft are either in front of or behind the aircraft. A National Center of Excellence for Aviation Operations Research (NEXTOR) II-developed statistics model using NASA-developed fast time wake transport models was used to evaluate the likelihood of a wake encounter if the en route ATC procedure was used. The evaluation allowed the most promising procedure to be selected for more detailed development and validation.

2.2.2 Wake Turbulence - Re-Categorization (F&E - 1A06B – NextGen – Separation Management Portfolio)

The Wake Turbulence - Re-Categorization Program supports Efficiency R&D Goal 2 by developing enhanced ATC procedures and separation standards that will safely allow reduced wake separations between aircraft, resulting in safe increased capacity for the nation's airports and airspace. As part of the program, wake encounter severity models are developed and used in combination with aircraft wake turbulence data collected by the NextGen – Wake Turbulence Program, NASA, and other global research partners. The models, in conjunction with measured data, are used in benefit and safety analyses of the project's developed proposed changes to ATC wake mitigation procedures and separation standards.

The research milestones and their statuses are shown in Table 2.2.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.2.2: Wake Turbulence - Re-Categorization Program Milestones

Year	Milestone	Status	Notes
2013	Develop the initial concept of operations document for leader/follower pair-wise static operations	Completed	2013 NARP Status: On schedule
2013	Develop a benefits assessment based on the initial concept of operations document data collected for 6 Category wake standards	Completed	2013 NARP Status: On schedule
2014	Implement Chicago Airspace Project final phase	On schedule	New milestone
2014	Support infrastructure changes resulting from Las Vegas optimization	On schedule	New milestone

Year	Milestone	Status	Notes
2014	Conduct engineering for airspace redesign implementation	On schedule	New milestone

Wake Turbulence - Re-Categorization Program Progress in FY 2013:

- ✓ Held a working meeting the first week of February at the EUROCONTROL facility in Bretigny, France to discuss Leader/Follower Pair Wise Static standards alternatives and to select a concept for their application. On-going meetings are being held with EUROCONTROL to further define the matrix of aircraft separation distances.

- ✓ Implemented the R,E,&D concept of safe but greater capacity ATC wake separation standards (6 Category Standards) at the Memphis International Airport (MEM) on November 1, 2012, providing the major air carrier at MEM, FedEx, up to a 20 percent increase in runway departure capacity at MEM during their Thanksgiving and Christmas holiday rush. Use of the new standards by the MEM ATC has reduced to near zero the departure delays incurred by FedEx prior to the introduction of the new wake separation standards. Additionally, FedEx is seeing a 16 percent reduction in the time its aircraft spend in the MEM terminal airspace, providing a significant fuel savings to its operations. The 6 Category standards were next implemented at Louisville International Airport (SDF) in September 2013. The major SDF air carrier, UPS, is also seeing significant reductions in departure delays and time spent in terminal airspace.

2.2.3 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) supports Efficiency R&D Goal 2 by performing benefit analyses of operational impacts of new separation standards under Re-Categorization of Wake Turbulence Categories (RECAT).

CAASD made the following progress in FY 2013 towards Efficiency R&D Goal 2:

- ✓ The Re-Categorization of Wake Turbulence Categories (RECAT) is an ongoing international effort to safely reduce and standardize minimum wake turbulence separation distances. RECAT is a three-phase approach that will incrementally progress toward the availability of dynamic, pairwise wake separation standards for any combination of leader/follower aircraft types. The implementation of RECAT Phase I at the first key site, MEM, occurred on November 1, 2012. The FAA Wake Program Office asked CAASD to perform an initial benefits analysis of arrival and departure operations at MEM to depict the operational impact of new separation standards under RECAT Phase I. CAASD conducted a first look analysis comparing pre- and post-RECAT operations shortly after RECAT implementation, provided monthly analysis updates, and delivered a final report that examined the twelve months before and the nine months after RECAT implementation. Quantitative results of the analysis demonstrated significant departure benefits from the outset of RECAT Phase I implementation in terms of decreased separation, increased throughput, increased capacity, and decreased taxi times during MEM's busiest departure hours. More modest arrival benefits were observed, but were

expected because the scheduling of aircraft to MEM was not changed during busy periods. CAASD's analyses provided key quantitative evidence to support FAA and industry claims of improved operational performance due to RECAT implementation at MEM.

2.3 Efficiency R&D Goal 3

Improved human-system integration and an increase in ATC efficiency through enhanced controllers-pilots coordination in cooperatively managing traffic loads as cockpit technology and air traffic workstations are more closely connected.

2.3.1 NextGen - Air Ground Integration Human Factors (RE&D - A12.c)

The NextGen - Air Ground Integration Human Factors Program supports Efficiency R&D Goal 3 by addressing flight deck and ATC integration for NextGen operational capabilities. It focuses on human factors that primarily affect the pilot side of the air-ground integration challenge. It conducts research to ensure pilots receive the right information at the right time for decision-making and collaboration with ATC to operate in the NAS efficiently.

The research milestones and their statuses are shown in Table 2.3.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.3.1: NextGen - Air Ground Integration Human Factors Program Milestones

Year	Milestone	Status	Notes
2013	Complete research to identify human factors issues and potential mitigation strategies for display of 4-D trajectory routings in the flight deck Navigation Display	Completed	Milestone was revised due to changing sponsor priorities Old wording: "Complete research to identify human factors issues and potential mitigation strategies for the use of legacy avionics in NextGen procedures" 2013 NARP Status: On schedule
2014	Develop initial guidance (evaluation methods and techniques) for Aircraft Certification personnel responsible for evaluating NextGen Avionics for potential human errors and error mitigation	On schedule	Milestone was revised due to changing sponsor priorities Old wording: "Develop initial guidance on training methods to support detection and correction of human errors in near- to mid-term NextGen procedures" 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2016	Complete research and recommendations for developing, evaluating, and/or approving standard operating procedures in NextGen	On schedule	Milestone was revised due to changing sponsor priorities Old wording: "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" 2013 NARP Status: On schedule
2016	Complete initial research to enable safe and effective changes to controller roles and responsibilities for NextGen procedures	Deleted	Milestone was deleted due to changing sponsor priorities 2013 NARP Status: On schedule
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	Deleted	Milestone was deleted due to changing sponsor priorities 2013 NARP Status: On schedule
2017	Complete a functional simulation – simulate integrated pilot and controller functional capabilities	Deleted	Milestone was deleted due to changing sponsor priorities 2013 NARP Status: On schedule
2017	Create a report presenting human factors considerations for the evaluation and integration of electronic flight bag/portable electronic device/tablet technologies with NextGen applications/operations	On schedule	New milestone
2018	Create a report with human factors recommendations and considerations for the design and evaluation of electronic chart software related to NextGen capabilities	On schedule	New milestone
2019	Create a report describing the research and experimental findings related to knowledge and skill loss on the flight deck in the NextGen operating environment, where greater reliance on automation is anticipated; report will include enhanced training considerations and mitigations for skill loss	On schedule	New milestone

NextGen - Air Ground Integration Human Factors Program Progress in FY 2013:

- ✓ Evaluated concepts for alternative flight deck displays with graphics, hybrid text and graphics, and other formats that could be integrated with existing navigation displays and with new data communications displays. Twenty-seven specific recommended guidelines for use of graphic and text flight deck displays of complex flight paths will support FAA efforts to update relevant regulatory guidance involving data communications and complex trajectories.

- ✓ Conducted a series of human-in-the-loop (HITL) experiments to evaluate human performance using text clearances and hybrid graphic and text clearances for uplink messages to the flight deck and downlink messages from the flight deck to ATC (research performed by Wright State University). Wright State also developed a highly-portable scenario-based tool, the Data Communications Message Assessment Tool, used for obtaining pilot performance and subjective assessments of various concepts under consideration. A portable, dynamic, low fidelity simulator was also developed for evaluation of pilot performance using graphic clearances including and subjective pilot responses to alternative graphic approaches for creating concatenated downlink messages.

2.3.2 Air Traffic Control/Technical Operations Human Factors (NextGen – System Development and Support Portfolio)

The Air Traffic Control/Technical Operations Human Factors Program supports Efficiency R&D Goal 3 by evaluating the effect of NextGen on the human performance of NAS actors in the larger context of the integration of NextGen improvements with existing tools. The program provides requirements and recommendations for achieving human performance for inclusion in the development of NextGen systems and procedures. Examples of the areas of human performance of this program may include:

1. Improve controller decision making.
2. Proactively identify human performance hazards and their mitigation measures.
3. Improve automation integration and consistency.
4. Provide guidance to ensure training is targeted for NextGen human performance.

This program is structured according to a subset of the HSI domains: human performance in safety, engineering, and training. These HSI efforts are orchestrated by overarching activities which guide how the work is performed, communicated, and structured. These activities include the tools, processes, and lessons learned in HSI, FAA NAS enterprise architecture, and NextGen system implementation support.

This program did not receive funding in FY 2015 and per OMB, will no longer exist as a stand-alone BLI beginning in FY 2016. As such, activities for this program will not appear in the NARP after 2014.

The research milestones and their statuses are shown in Table 2.3.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.3.2: Air Traffic Control/Technical Operations Human Factors Program Milestones

Year	Milestone	Status	Notes
2013	Conduct a conceptual high-level job analysis for NextGen midterm air traffic controllers' activities, tools, and equipment	Completed	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Develop a human error/safety database for NextGen capabilities	On schedule	2013 NARP Status: On schedule
2014	Publish the Human System Integration Roadmap	On schedule	2013 NARP Status: On schedule
2014	Conduct EnRoute/TRACON functional commonality assessment	On schedule	Milestone was revised due to changing program priorities. Old wording: "Develop traffic management coordinator dispatcher, controller, and pilot information requirements document" 2013 NARP Status: On schedule
2015	Conduct NextGen strategic job and training analyses for technical operations	Delayed	Milestone is delayed from 2014 to 2015 and was revised due to changing program priorities. Old wording: "Develop NextGen human-automation interaction functional requirements and resolution guidance documents" 2013 NARP Status: On schedule
2015	Prepare a report identifying causes and potential fixes to reduce non-conformance to Performance Based Navigation Required Area Navigation/Required Performance Navigation standards	Delayed	Milestone is delayed from 2014 to 2015 due to changing program priorities. 2013 NARP Status: On schedule
2016	Update NextGen controller strategic job analysis and training needs documents	Delayed	Milestone is delayed from 2014 to 2016 due to changing program priorities. 2013 NARP Status: On schedule

Air Traffic Control/Technical Operations Human Factors Program Progress in FY 2013:

- ✓ Conducted strategic analyses to determine the impact of NextGen operations on air traffic controllers in 2018 to support pre-employment and selection processes. The study included an analysis of the job tasks, required skills, and equipment used in current day operations as compared to 2018. Results suggested that NextGen will not substantively change what air traffic controllers do in 2018, but will change how they do it. As a result, no substantive changes were recommended to the FAA's controller pre-employment selection test battery. However, due to the extensive impact of NextGen on the required knowledge and skill, the FAA's training program will likely be affected. Continuation of this research in 2013 provided estimates of the impact of the 2018 changes on training development, resources, and time.

2.3.3 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) supports Efficiency R&D Goal 3 by leveraging key NextGen capabilities such as ADS-B In and ADS-B Out into a collaborative ATC and flight crew procedure that enables airports with closely spaced parallel runways to recover most of the capacity they lose when weather conditions deteriorate. Closely spaced parallel runways are runways that are closer than 4,300 feet. Such runways lose half their arrival capacity when weather conditions deteriorate below good visual conditions.

CAASD made the following progress in FY 2013 towards Efficiency R&D Goal 3:

- ✓ Developed a Paired Approach procedure that enables airports and users to recoup 75 percent of the capacity when weather conditions deteriorate. CAASD showed that the procedure is technically feasible and could be supported by the current ADS-B Out rule as well as by the navigation systems currently available in the NAS. CAASD also conducted HITL simulations with pilots and controllers. These real-time simulations showed that the pilots as well as the controllers were comfortable conducting this procedure. As a result, the FAA is now planning to deploy this capability in the pre-2020 time frame.

2.4 Efficiency R&D Goal 4

Established feasible procedures, operational methods, and technologically-advanced systems that can decrease workload and increase efficiency of the NAS.

2.4.1 Major Airspace Redesign (F&E - 1A01D - Advanced Technology Development and Prototyping)

The Major Airspace Redesign Program supports Efficiency R&D Goal 4 by funding changes in facilities necessary to accommodate airspace redesign. Implementation of an airspace redesign frequently results in changes to the number and span of control of operational positions or sectors, including changes to sector, area, or facility boundaries. Transition to a new configuration resulting from airspace redesign requires changes in the supporting infrastructure. These infrastructure changes can include: radio frequencies, connecting a radio site to a control facility, position to position connectivity, surveillance infrastructure modifications to ensure proper radar coverage; automation modifications to facility data and flight data processing; interfacility communication modifications; additional consoles and communication backup needs; and modifications to facility power and cabling. The program also supports the use of risk management and collaborative evaluation capabilities to identify requirements, opportunities and threats in the early stages of the design process.

The research milestones and their statuses are shown in Table 2.4.1 below.

Table 2.4.1: Major Airspace Redesign Program Milestones

Year	Milestone	Status	Notes
2014	Implement Chicago Airspace Project final phase	On schedule	2013 NARP Status: On schedule
2014	Support infrastructure changes resulting from Las Vegas optimization	On schedule	2013 NARP Status: On schedule
2014	Conduct engineering for airspace redesign implementation	On schedule	2013 NARP Status: On schedule
2015	Conduct post- implementation evaluations	On schedule	New milestone
2015	Conduct engineering for airspace redesign implementation	On schedule	New milestone
2015	Support infrastructure changes resulting from airspace redesign	On schedule	New milestone

2.4.2 New Air Traffic Management Requirements (F&E - 1A10E – NextGen – NAS Infrastructure Portfolio)

The New Air Traffic Management Requirements Program supports Efficiency R&D Goal 4 by identifying new opportunities to improve the efficiency and effectiveness of ATM and expanding capacity by developing decision support tools that improve the strategic management of

operations in the NAS. The New Air Traffic Management Requirements Program explores opportunities in the following areas: Traffic Alert and Collision Avoidance System, new radar requirements (surveillance and weather), trajectory modeling, airborne SWIM, weather transition, cloud computing, automation convergence, synchronization of air/ground procedures, and advanced air ground communications.

The research milestones and their statuses are shown in Table 2.4.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.4.2: New Air Traffic Management Requirements Program Milestones

Year	Milestone	Status	Notes
2013	Complete phase one of the Airborne Access to System Wide Information Management concept of operations service level review for bi-directional	Completed	Milestone was revised to clarify the research phase actually completed in FY 2013 Old wording: "Complete the Airborne Access to System Wide Information Management concept of operations service level review for bi-directional" 2013 NARP Status: On schedule
2013	Develop trajectory schema air-ground and ground-ground exchange	Completed	2013 NARP Status: On schedule
2013	Develop evaluation model to assess common trajectory	Completed	2013 NARP Status: On schedule
2013	Develop initial Airborne Access to System Wide Information Management bi-directional shortfall analysis	Completed	2013 NARP Status: On schedule
2013	Conduct validation activities for Airborne Access to System Wide Information Management	Completed	2013 NARP Status: On schedule
2014	Develop Traffic Alert and Collision Avoidance System and Automatic Dependent Surveillance-Broadcast compatibility and future requirements document	On schedule	2013 NARP Status: On schedule
2014	Develop future Collision Avoidance System logic development and future surveillance requirements document	On schedule	2013 NARP Status: On schedule
2014	Develop Collision Avoidance System logic assessment, avionics model future surveillance assessment, and Traffic Alert and Collision Avoidance System - Automatic Dependent Surveillance-Broadcast compatibility engineering study	On schedule	2013 NARP Status: On schedule
2014	Develop Acquisition Management System artifacts for the investment analysis readiness decision for the NextGen surveillance and weather radar capability	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Update the multi-function phased array radar concept of operations for New Radar Requirements (Surveillance and Weather)	On schedule	2013 NARP Status: On schedule
2014	Develop multi-function phased array radar demonstration strategy for New Radar Requirements (Surveillance and Weather)	On schedule	2013 NARP Status: On schedule
2014	Finalize documentation of data elements needed to support Trajectory Modeling	On schedule	2013 NARP Status: On schedule
2014	Develop standard of use document for different classes of trajectories for Trajectory Modeling	On schedule	2013 NARP Status: On schedule
2014	Conduct validation of the information requirements for Airborne Access to System Wide Information Management, which will study the feasibility and benefit of providing operational, weather, and regulatory data to pilots in flight, using Class I and II Electronic Flight Bags receiving data via a commercial data provider	On schedule	2013 NARP Status: On schedule
2014	Develop a requirements allocation and validation document with the National Weather Service for Weather Transition	On schedule	2013 NARP Status: On schedule
2014	Conduct a weather concept demonstration and prepare report of evaluation of demonstration for Weather Transition	On schedule	2013 NARP Status: On schedule
2014	Conduct an assessment of mature research for transition to the National Weather Service for Weather Transition	On schedule	2013 NARP Status: On schedule
2014	Develop an engineering study Cloud Computing evaluating NAS systems for potential assignment to cloud environment and data center rather than the local environment	On schedule	2013 NARP Status: On schedule
2014	Update technical assumptions documentation for Cloud Computing based on safety and mission criticality and the ability of current architecture to provide service in a point-to-point environment	On schedule	2013 NARP Status: On schedule
2014	Develop an engineering study identifying potential systems/displays for convergence including plug and play displays requirements, common Human Machine Interface implementation requirements	On schedule	2013 NARP Status: On schedule
2014	Develop an engineering study which analyzes gaps in common display coordinates among current and future automation systems	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2015	Develop operational requirements for Airborne Access to System Wide Information Management (2-way)	Delayed	Milestone delayed from 2014 to 2015 due to required additional maturation activities 2013 NARP Status: On schedule
2015	Conduct functional analysis and allocation for Airborne Access to System Wide Information Management (2-way)	Delayed	Milestone delayed from 2014 to 2015 due to the need for additional maturation activities 2013 NARP Status: On schedule
2015	Develop high level requirements document for the Multifunction Phased Array Radar (MPAR)	On schedule	New milestone
2015	Complete update to Multifunction Phased Array Radar (MPAR) Cost Model	On schedule	New milestone
2015	Identify the shortfalls in moving from data sharing to a network environment including information protocol and exchange standards and evaluation techniques, criteria for managing standards, and conformance monitoring techniques and policies to ensure compliance	On schedule	New milestone
2015	Develop and implement required capabilities and governance	On schedule	New milestone
2015	Develop strategy to ensure NAS systems maintain compliance with developed standards and protocols	On schedule	New milestone
2016	Develop cost estimates for Airborne Access to System Wide Information Management (2-way)	Delayed	Milestone delayed from 2014 to 2016 due to the need for additional maturation activities 2013 NARP Status: On schedule

New Air Traffic Management Requirements Program Progress in FY 2013:

- ✓ Developed a document that defined five basic trajectory information areas under which activities are classified:
    1. Trajectory Concept Options/Trajectory Alternatives Analysis;
    2. Trajectory Information Analysis;
    3. Trajectory Applications Analysis;
    4. Integrated Solutions; and
    5. Global Harmonization and Outreach.
- ✓ Developed an AAtS Concept of Use document focusing on the uplink of tailored, on-demand, digital NAS information to flight crews through authorized service providers using an interface to a common infrastructure. The research outlined in this document primarily satisfies operational improvements in the mid-term (2015-2020) and is expected to be implemented during that timeframe.

- ✓ Developed a document providing a progress status in the area of trajectory prediction and exchange stand across projects in the USA and Europe. A review of past activities in trajectory prediction, with particular emphasis on the FAA/EUROCONTROL Action Plan 16 on Common Trajectory Prediction Capabilities, was undertaken and summary conclusions were drawn from the past research.

- ✓ Identified existing and future gaps in the provision of data to flight crews and flight data to the FAA that Airborne Access to SWIM (AAtS) will be able to fill.

- ✓ Conducted an AAtS HITL simulation at the NextGen Integration and Evaluation Capability (NIEC) at the William J. Hughes Technical Center. The HITL: 1) evaluated the effect of additional weather and flight information presented on an electronic flight bag (EFB) on pilot workload and pilot-controller communications under arrival and departure scenarios, and 2) assessed what information sources most contribute to pilot situational awareness, which is critical for successful strategic planning. Results revealed pilot acceptance of the AAtS concept, and supporting evidence for specific information sources and elements pilots want for maintaining situational awareness.

2.4.3 Operations Concept Validation Modeling (F&E - NextGen – System Development and Support Portfolio)

The Operations Concept Validation Modeling Program supports Efficiency R&D Goal 4 by developing and validating future gate-to-gate (flight planning through arrival) operational concepts that will increase capacity and improve efficiency and throughput. Special emphasis is placed on researching changes in roles and responsibilities between the FAA and airspace users (e.g., pilots and airlines), as well as the human interaction with automation systems. The program identifies procedures to decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS. The program works toward developing operational methods to expand capacity by addressing future growth in demand and reducing transit times. Products developed by the program include concepts of operations, reports documenting findings of fast-time and real-time concept validation studies, operational requirements associated with validated concepts, shortfall and benefits analysis, and safety assessments.

This program did not receive funding in FY 2015 and, per OMB, will no longer exist as a stand-alone BLI beginning in FY 2016. As such, activities for this program will not appear in the NARP after 2014.

The research milestones and their statuses are shown in Table 2.4.3 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.4.3: Operations Concept Validation Modeling Program Milestones

Year	Milestone	Status	Notes
2013	Complete a report on Three-Dimensional Path Arrival Management research for nominal and off-nominal events for Efficient Descent Advisor evolution analysis to support interval management	Completed	2013 NARP Status: On schedule
2013	Deliver the initial concept of operations for optimized route coordination for optimized route coordinator concept exploration	Completed	2013 NARP Status: On schedule
2014	Conduct concept validation studies and document findings in a concept validation report for end-to-end and lower level operational concepts for implementation in 2020 and beyond	On schedule	2013 NARP Status: On schedule
2014	Develop operational requirements and other documents required for technical transfer for validated concepts for implementation in 2017-2019 and beyond	On schedule	2013 NARP Status: On schedule
2014	Develop research papers on reducing risk and uncertainties of NextGen midterm operational concepts	On schedule	2013 NARP Status: On schedule
2014	Document procedures to decrease workload and increase reliance on automation for routine tasking to increase efficiency of the NAS	On schedule	2013 NARP Status: On schedule
2014	Develop an operational methods document to address future growth in demand and reduce transit time	On schedule	2013 NARP Status: On schedule

Operations Concept Validation Modeling Program Progress in FY 2013

- ✓ Developed an initial functional analysis and operational requirements for the integration of UAS into the NAS. This effort supports the planning work needed to integrate UAS Operations into the NAS while minimizing the impact to other NAS users.

- ✓ Developed a functional analysis for an Optimized Route Capability being developed to assist controllers with trajectory and flow management functions in a metroplex environment by optimizing airspace and route configurations based on demand and capacity.

- ✓ Completed an analysis that assessed the potential benefit of improved departure time predictions from various data sources on overall traffic management delays.

- ✓ Conducted a shortfall analysis for the impact of increased commercial space vehicle operations on the NAS.

2.4.4 Operations Concept Validation and Infrastructure Evolution (F&E - 1A01C - Advanced Technology Development and Prototyping)

The Operations Concept Validation and Infrastructure Evolution Program supports Efficiency R&D Goal 4 by developing and validating NAS level operational concepts that are key to the FAA's modernization programs and NextGen. The program conducts the overall analysis and planning for NAS evolution by determining the required annual updates to the following NAS Enterprise Architecture products: Operational Improvements, Operational Sustainment, and Operational Requirements. It executes research, engineering analysis, and evaluation in support of mission and investment analysis. The program conducts shortfall analyses as part of service analysis and ensures the linkage of proposed solutions back to validated operational needs to support budget planning and investment decisions. The program develops and maintains detailed second level concepts that support validation and requirements development. This work ensures that the NAS level operational concept and sustainment activities are integrated and consistent with the overall NAS Enterprise Architecture. In addition, the program supports the development and sustainment of analytical and computer models used to assess and validate operational changes to the NAS. The program contributes to the FAA's support for the RTCA, a non-profit association that develops standards based on manufacturers, government, and aviation operator inputs. RTCA also recommends operational improvements to increase the efficiency of air transportation.

The research milestones and their statuses are shown in Table 2.4.5 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.4.4: Operations Concept Validation and Infrastructure Evolution Program Milestones

Year	Milestone	Status	Notes
2013	Provide an updated concept gap analysis that identifies concept shortfalls, including a revised concept hierarchy identifying relationships, dependencies, and duplicative efforts for traceability and greater alignment across NextGen mid-term concepts	Completed	2013 NARP Status: On schedule
2013	Evaluate aircraft fuel consumption modeling by comparing model results to actual data from recorded flight operations	Completed	2013 NARP Status: On schedule
2014	Conduct analyses to support assessments of new air traffic control operational concepts	On schedule	2013 NARP Status: On schedule
2014	Develop common concept development, validation, and measurement methodologies to support the Single European Sky Air Traffic Management Research joint undertaking	On schedule	2013 NARP Status: On schedule
2014	Develop concepts of use to describe the operational use of new communication, navigation, automation, surveillance, and flight deck capabilities	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Produce reports on concept development and validation findings, including second-level concepts, fast-time analyses, and human-in-the-loop real time studies	On schedule	2013 NARP Status: On schedule
2014	Develop operational, information, and performance requirements	On schedule	2013 NARP Status: On schedule
2014	Develop and provide annual updates to the NAS Enterprise Level Operational Requirements to reflect the results of research and development conducted in 2013	On schedule	2013 NARP Status: On schedule
2014	Develop and provide annual updates to the NAS Enterprise Architecture for NAS level Operational Improvements and operational sustainment activities based on completed research and acquisition decisions made in 2013	On schedule	2013 NARP Status: On schedule
2015	Develop and provide annual updates to the NAS Enterprise Level Operational Requirements to reflect the results of research and development conducted in 2014	On schedule	New milestone
2015	Develop and provide annual updates to the NAS Enterprise Architecture for NAS level Operational Improvements and operational sustainment activities based on completed research and acquisition decisions made in 2014	On schedule	New milestone

Operations Concept Validation and Infrastructure Evolution Program Progress in FY 2013

- ✓ Aligned the concepts within the NextGen Repository to the near/mid-term operational improvements in the NAS enterprise architecture and identified the gaps in documentation for the bundles of services defined on the Concept Hierarchy.

- ✓ Delivered a report evaluating the FAA Advanced Operational Concept Division's modeling effort and documenting a comparison of modeled data to fuel consumption results from recorded flight operations.

- ✓ Conducted an independent validation of the aircraft performance and controller task modeling in the prototype simulation tool AGENTFLY. Results showed the simulated flights are comparable to operational flight data, and the simulation controller behaves similarly to real controllers. Study methodology and results are documented in a validation report.

2.4.5 System Capacity, Planning and Improvements (F&E - 1A01B - Advanced Technology Development and Prototyping)

The System Capacity, Planning and Improvements Program supports Efficiency R&D Goal 4 by providing data and analyses on NAS operations to identify deficiencies and develop proposals to improve NAS performance. The program conducts airport modeling and analysis using actual data collected from ATC systems in the field to determine the value of potential improvements in airspace or airfield modifications. In addition, the program performs enhancements of the Performance Data Analysis and Reporting System, a fully integrated performance measurement tool designed to improve the NAS by tracking the daily operations of the ATC system and its environmental impacts. The program also develops new Agency-level metrics to enhance management awareness of, and response to, system performance.

The research milestones and their statuses are shown in Table 2.4.5 below.

Table 2.4.5: System Capacity, Planning and Improvements Program Milestones

Year	Milestone	Status	Notes
2013	Program the Performance Data and Analysis Reporting System (PDARS) to calculate surface metrics at one airport	Completed	2013 NARP Status: On schedule
2013	Complete the build-out of the gate-to-gate performance measurement system	Completed	2013 NARP Status: On schedule
2013	Complete PDARS conversion to the FAA Telecommunications Infrastructure network	Completed	2013 NARP Status: On schedule
2013	Define a flight predictability metric and develop a conceptual approach	Completed	2013 NARP Status: On schedule
2013	Define a weather efficiency metric and develop a conceptual prototype	Completed	2013 NARP Status: On schedule
2014	Complete PDARS connectivity with Airport Surface Detection Equipment, Model X at up to 30 core airports	On schedule	2013 NARP Status: On schedule
2014	Initiate PDARS connectivity to En Route Automation Modernization (10 sites)	On schedule	2013 NARP Status: On schedule
2014	Develop a plan to complete connectivity to Automatic Dependent Surveillance-Broadcast	On schedule	2013 NARP Status: On schedule
2014	Complete an implementation plan to integrate Ocean 21 data into a full automated gate-to-gate analysis capability	On schedule	2013 NARP Status: On schedule
2014	Complete a plan to expand Performance Data and Analysis Reporting System analysis capabilities to evaluate NextGen technology demonstrations	On schedule	2013 NARP Status: On schedule
2014	Incorporate noise profiling technology via the Aviation Environmental Design Tool module	On schedule	2013 NARP Status: On schedule
2014	Complete an operations research report to support the Science, Technology, Engineering and Math strategic initiative	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Prepare a bi-annual joint performance benchmark report with the European Organisation for the Safety of Air Navigation	On schedule	2013 NARP Status: On schedule
2014	Complete PDARS analysis to evaluate and improve the flight predictability metric	On schedule	2013 NARP Status: On schedule
2014	Complete PDARS analysis to evaluate and improve the weather metric	On schedule	2013 NARP Status: On schedule
2014	Complete the PDARS capability improvement evaluation	On schedule	2013 NARP Status: On schedule
2015	Develop concept of operations to convert PDARS into a net centric system	On schedule	New milestone
2015	Support PDARS enhancement as needed to support NextGen Programs and Technologies	On schedule	New milestone
2015	Support NextGen reporting capabilities to improve NextGen Program and Technology analysis	On schedule	New milestone
2015	Complete connectivity to En Route Automation Modernization to include remaining available sites	On schedule	New milestone
2015	Provide PDARS baseline data for before/after analysis of NextGen programs	On schedule	New milestone
2015	Incorporate noise profiling technology via the Aviation Environmental Design Tool module	On schedule	New milestone
2015	Complete PDARS analysis to evaluate and improve the weather metric	On schedule	New milestone
2015	Produce Joint Performance Benchmark Report with EUROCONTROL	On schedule	New milestone
2015	Complete PDARS modernization plan	On schedule	New milestone
2015	Provide performance modeling and economic analysis information to support the development of a business case with International Civil Aviation Organization member states for space base ADS-B Out over the North Atlantic	On schedule	New milestone

2.4.6 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) Program supports Efficiency R&D Goal 4 by the identification and evaluation of airport arrival and departure metrics, their measurement methodologies, and controller guidance to increase efficiencies.

CAASD made the following progress in FY 2013 towards Efficiency R&D Goal 4.

- ✓ Developed next-day metrics for the FAA to measure airport departure efficiency so that performance issues can be identified and efficiency can be increased. A methodology

was developed to detect taxi-backs, departing flights that return to the gate after having started the taxi-out phase, for five selected airports on a next-day basis. The taxi-back information is reviewed at the FAA Air Traffic Control System Command Center (ATCSCC) and published in the ATCSCC AERO report used in the ATCSCC's daily operations telcon and transferred daily to the FAA Aviation System Performance Metrics (ASPM) data base. The five airports selected by the FAA are Hartsfield-Jackson Atlanta International (ATL), Newark Liberty International (EWR), John F. Kennedy International Airport (JFK), La Guardia Airport (LGA), and Chicago O'Hare International (ORD).

- ✓ Enhanced a previously developed working prototype, "Arrival-Departure Runway Integration Scheduler," and conducted a second HITL simulation of a terminal automation capability, which increases runway throughput at airports where there is a dependency between arrival and departure operations. The concept is to provide approach controllers with spacing guidance cues that are tailored in real time to the departure demand. Results indicated that controllers achieved a high level of conformance to guidance, workload levels were within a safe range, and both arrival and departure throughput could potentially be increased by using automated spacing guidance.

2.5 Efficiency R&D Goals 5 and 6

Established requirements and standards for enabling availability and improving the quality and quantity of meteorological information to reduce impacts of adverse weather on rerouting, NAS capacity, and NextGen operational procedures.

Improved accuracy and accessibility of observed and forecast weather information to improve NAS efficiency (e.g., reduced delays and cancellations, increased capacity in high traffic areas).

2.5.1 NextGen - Weather Technology in the Cockpit (RE&D - A12.d)

The NextGen - Weather Technology in the Cockpit Program supports Efficiency R&D Goals 5 and 6 by developing, verifying, and validating requirements to support airworthiness standards for enabling availability and improving the quality and quantity of meteorological information to the aircraft to support efficient current and NextGen operations. The program will result in the development of standards and requirements that define the weather information in the cockpit needed to support operations, the presentations and interfaces to enable proper information consumption and safe operations by pilots, and capabilities that enable efficient dissemination of the weather information to and from the cockpit at the right place and right time.

The research milestones and their statuses are shown in Table 2.5.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 2.5.1: NextGen - Weather Technology in the Cockpit Program Milestones

Year	Milestone	Status	Notes
2013	Evaluate and compare pilot performance using three prototype Weather Avoidance Fields cockpit presentations based on the Convective Weather Avoidance Model	Completed	2013 NARP Status: On schedule
2014	Produce plots of wind forecast and diagnosis errors versus performance of selected NextGen operations using realistic scenarios and sufficient fidelity to enable standards development	Delayed	Milestone is delayed from 2013 to 2014 due to a change in scope. 2013 NARP Status: On schedule
2015	Complete demonstrations and provide data to support the development of human factors standards, guidance, and procedures for the presentation and use of meteorological information in the cockpit. Specific measurable performance objectives verified for human factors design elements	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2016	Initial verification demonstrations of recommended implementations of adverse weather alerting functions for the flight deck	On schedule	Milestone was revised due to changing NextGen - Weather Technology in the Cockpit program priorities Old wording: "Complete demonstrations of alerting functions to improve pilot awareness of changing runway conditions resulting from adverse weather" 2013 NARP Status: On schedule
2016	Develop models to run simulations to quantify NAS benefits from uplinking/crosslink of enhanced meteorological information to the cockpit	On schedule	Milestone was revised due to a change in scope Old wording: "Complete an assessment on the benefits to NAS efficiency of providing Eddy Dissipation Rate and Graphical Turbulence Guidance to cockpits to reduce turbulence-induced airspace avoidance (reduced capacity)" 2013 NARP Status: On schedule
2017	Provide accurate and timely wind information to the Flight Management System and Air Traffic Control systems, and demonstrate realization of predicted benefits of associated NextGen application programs	Delayed	Milestone is delayed from 2015 to 2017 due to delays in prerequisite research efforts 2013 NARP Status: On schedule
2018	Propose standards for improving weather information to the flight deck in oceanic and non-controlled airspace	On schedule	New milestone
2019	Complete development of recommendations for Part 121/135 Minimum Weather Service attributes that resolve gaps associated with pilot roles in NAS efficiency	On schedule	New milestone

NextGen - Weather Technology in the Cockpit Program Progress in FY 2013:

- ✓ Produced a final report detailing the prototypes that were used, the demonstration procedures results, and recommendations pursuant to the evaluation of pilot performance using three Weather Avoidance Fields cockpit presentations.

2.5.2 Weather Program (RE&D - A11.k)

The Weather Program supports Efficiency R&D Goals 5 and 6 by conducting applied research focused on improving weather information required for integration into decision-support tools to reduce the impact of adverse weather on the NAS. The improved weather information enhances NAS efficiency and capacity by supporting better operational planning and decision-making by ATM, dispatchers, and pilots.

The research milestones and their statuses are shown in Table 2.5.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 2.5.2: Weather Program Milestones

Year	Milestone	Status	Notes
2013	Transition 0-8 hour advanced storm prediction algorithm for implementation	Completed	2013 NARP Status: Completed
2013	Transition mountain-wave turbulence forecast capability for implementation	Completed	2013 NARP Status: Completed
2015	Transition turbulence forecast capability for all flight levels for implementation (as detailed in NextGen Plans)	On schedule	Milestone was revised to include a reference to NextGen Plans Old wording: "Transition turbulence forecast capability for all flight levels for implementation" 2013 NARP Status: On schedule
2016	Demonstrate and evaluate lightning prediction prototype capability	On schedule	New milestone
2016	Transition global turbulence forecast capability for implementation	On schedule	2013 NARP Status: On schedule
2016	Transition High Resolution Rapid Refresh weather forecast model to the National Weather Service for operational implementation	On schedule	2013 NARP Status: On schedule
2017	Transition convectively-induced turbulence forecast capability for implementation (as detailed in NextGen Plans)	On schedule	Milestone was revised to include a reference to NextGen Plans Old wording: "Transition convectively-induced turbulence forecast capability for implementation" 2013 NARP Status: On schedule
2018	Transition Alaska turbulence forecast capability for implementation (as detailed in NextGen Plans)	On schedule	New milestone
2019	Transition global-scale probabilistic convection guidance capability for implementation	On schedule	New milestone

Weather Program Progress in FY 2013:

- ✓ Modified the current Graphical Turbulence Guidance algorithm capability to also provide mountain-wave turbulence forecasts. After conduct of a quality assessment of scientific validity, evaluation and demonstration of operational relevancy and suitability, and safety risk management, this capability will become operational on Aviation Digital Data Service (ADDS) in FY 2014.

2.5.3 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development (CAASD) supports R&D Goal 5 by the development of a simulation model for the impacts of forecasted weather on NAS traffic.

CAASD made the following progress in FY 2013 towards Efficiency R&D Goal 5.

- ✓ Developed a prototype capability for strategic traffic flow management planning that simulates the impact of forecasted weather, or other NAS constraints, on predicted traffic. The capability, intended for stakeholder use 2-24 hours prior to a weather event, enables decision makers to determine the likelihood of a given event occurring, the severity, timing and location of the impact, as well as the benefit and costs of potential mitigation strategies. The mitigation strategies are defined by a set of Traffic Management Initiatives, whose parameters can be set manually by the decision maker or via automation. Through the prototype's graphic user interface, multiple mitigation strategies can be compared against a variety of potential weather scenarios, enabling quantitative evaluation and situational awareness for all stakeholders involved.

2.6 Efficiency R&D Goal 7

Availability of existing airport facilities protected and used as efficiently as possible, while making strategic investments in new facilities consistent with evolving aviation needs.

2.6.1 Airport Cooperative Research Program – Capacity (AIP)

The Airport Cooperative Research Program – Capacity supports Efficiency R&D Goal 7 by providing 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. The program is preparing for those future needs while simultaneously solving current and near-term airport capacity issues.

The research milestones and their statuses are shown in Table 2.6.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.6.1: Airport Cooperative Research Program – Capacity Milestones

Year	Milestone	Status	Notes
2013	Prepare guidance for airports that provides strategies for developing and maintaining stakeholder support when undertaking new airport capacity initiatives	Completed	2013 NARP Status: On schedule
2013	Produce global best practices for improving terminal design to increase revenue generation and customer satisfaction	Completed	2013 NARP Status: On schedule
2013	Develop best practices for planning, designing, and marking apron areas for all sizes of airports in the U.S.	Completed	2013 NARP Status: On schedule
2013	Develop guidance for airports to create a collaborative environment between operations and maintenance departments	Completed	2013 NARP Status: On schedule
2013	Develop guidance for operational and business continuity planning for prolonged airport disruptions	Completed	2013 NARP Status: On schedule
2013	Identify and quantify the cumulative effects of regulatory compliance requirements at small and non-hub airports	Completed	2013 NARP Status: On schedule
2014	Identify best practices and develop tools, techniques, and training aids for working in or near airport movement areas	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Develop guidance for defining and measuring aircraft delay and airport capacity thresholds	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Assess the factors that drive airline service decisions and passenger choice in multi-airport regions	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Estimate the economic impact of air cargo at airports	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Prepare guidance to assist airports in using benefit-cost analysis and other analytical techniques to make airport capital investment decisions	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Develop methods and tools necessary to improve integration of rail services with airports	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Develop guidelines for air cargo facility planning and development at airports	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Identify, test, and evaluate methods for obtaining aircraft operations counts at non-towered airports	On schedule	2013 NARP Status: On schedule
2014	Quantify the national aggregate value of airports to communities and to aviation stakeholders	On schedule	2013 NARP Status: On schedule
2014	Develop a guidebook to plan general aviation facilities	On schedule	2013 NARP Status: On schedule
2014	Produce guidance to evaluate cost-saving and energy reduction technologies for escalators and moving walks at airports	On schedule	2013 NARP Status: On schedule
2014	Develop guidance to determine the location, number, size, and configuration of airport terminal restroom facilities to best meet customer needs	On schedule	2013 NARP Status: On schedule
2014	Provide guidance to help airports identify optimal lighting solutions for parking garage facilities	On schedule	2013 NARP Status: On schedule
2014	Develop a primer on the benefits of a whole-building systems lifecycle approach to airport operations and maintenance optimization and recommissioning	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Create guidance on successful Computer Maintenance Management Systems selection and practices	On schedule	2013 NARP Status: On schedule
2014	Develop a guidebook that will help airports prepare for, operate during, and recover from disruptive winter events as well as manage airport user expectations	On schedule	2013 NARP Status: On schedule

2.6.2 Airport Technology Research Program – Capacity (AIP)

The Airport Technology Research Program – Capacity supports Efficiency R&D Goal 7 by providing 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.

The research milestones and their statuses are shown in Table 2.6.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 2.6.2: Airport Technology Research Program – Capacity Milestones

Year	Milestone	Status	Notes
2013	Update the Airport and Airspace Simulation Model to Engine Version 4.0 and 4.1	Completed	Milestone was revised to correct a typo in the stated version numbers Old wording: "Update the Airport and Airspace Simulation Model to Engine Version 3.5.10 and 3.11" 2013 NARP Status: On schedule
2013	Complete the North Atlantic Fuel Burn Study	Completed	2013 NARP Status: On schedule
2014	Complete the Accelerated Airport Pavement Test Vehicle	Delayed	Milestone is delayed from 2013 to 2014 due to a manufacturing redesign 2013 NARP Status: On schedule
2014	Complete construction of High Temperature Pavement Test Facility	On schedule	2013 NARP Status: On schedule
2014	Complete upgrade of all pavement software to Windows Presentation Foundation	On schedule	2013 NARP Status: On schedule
2014	Complete definition of airport pavement failure for the 40-Year Pavement Life project	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Complete scheduled software engine version 4.2 and 4.3 for the Airport and Airspace simulation model	On schedule	Milestone was revised to clarify the research Old wording: "Complete scheduled software revisions for the Airport and Airspace Simulation Model" 2013 NARP Status: On schedule
2014	Complete development of display playback animation software for the Airport and Airspace Simulation Model	On schedule	2013 NARP Status: On schedule
2014	Complete the update of the Airfield Modeling Database with all new runway, taxiway, and gate data	On schedule	2013 NARP Status: On schedule
2014	Complete beta version of FAARFIELD 1.4	On schedule	New milestone
2014	Complete construction and performance data for 8 large and medium hub runways to the 40-year life PAVEAIR data warehouse	On schedule	New milestone
2014	Complete tests on subgrade, and aggregate samples collected from 3 airport construction projects	On schedule	New milestone
2014	Finalize the work underway to determine values of in-service airport pavement roughness using the Mike Monroney Aeronautical Center Boeing B-737 simulator	On schedule	New milestone
2014	Perform Reflective Cracking Pavement Tests	On schedule	New milestone
2015	Perform Economic Analysis of Heated Pavements at Selected Airports	On schedule	New milestone

Airport Technology Research Program – Capacity Progress in FY 2013:

- ✓ Released Engine Version 4.0 in March 2013 with 30 enhancements that covered: 1) a major deicing upgrade; 2) simulations of multiple flight levels on one node-link level; and 3) miscellaneous bug fixes. Engine Version 4.1 was released in September 2013 with 29 enhancements that covered: 1) dynamic taxiing enhancements; 2) dynamic gate re-evaluation; 3) new Performance Data Analysis and Reporting System output format for animation software; 4) airspace movement and blocking enhancements; 5) new output tables to validate runway occupancy data and airspace separations; 6) improved gate logic for efficient gate usage; and 7) various bug fixes.

- ✓ Implemented enhancements to meet requirements of the FAA's North Atlantic fuel burn study to improve cruise altitude logic. Also, made refinements to the fuel burn equations. User friendly methods to analyze fuel burn of specific flights were added to make fuel burn studies more straight forward. Also, added new output tables with detailed fuel burn results to the airport and airspace simulation model.

3.0 R&D Principle 3 - Reduce Environmental Impacts

Systematically expand and apply knowledge to produce useful materials, devices, systems, or methods that will reduce aviation's environmental and energy impacts to a level that does not constrain growth.

Five R&D goals support R&D Principle 3 - Reduce Environmental Impacts with work spread across three budget appropriations (RE&D, F&E, and AIP):

- Goal 1 - Reduced significant community noise impacts in absolute terms.
- Goal 2 - Reduced impact of aviation emissions on air quality and global climate.
- Goal 3 - Improved energy efficiency and assured availability of sustainable alternative jet fuels.
- Goal 4 - Established requirements, policies, procedures, and resources to allow airports in the United States to become environmentally-friendly neighbors.
- Goal 5 - Established data and methodologies to support certification of alternative fuels for General Aviation aircraft.

Table 3.0.1 shows how the FAA's Environment and Energy R&D goals and programs align with the NSTC Energy and Environment Goals. In many cases, FAA R&D programs support more than one NSTC goal.

Table 3.0.1: Alignment of FAA R&D Environmental Goals and Programs with NSTC Energy and Environment Goals

FAA R&D Principle	FAA R&D Programs	NSTC Goals			NSTC Principle	FAA Strategic Initiative
Reduce Environmental Impact	Environment and Energy	Goal 1 - Enable New Aviation Fuels Derived from Diverse and Domestic Resources to Improve Fuel Supply Security and Price Stability	Goal 2 - Advance Development of Technologies and Operations to Enable Significant Increases in the Energy Efficiency of the Aviation System	Goal 3 - Advance Development of Technologies and Operational Procedures to Decrease the Significant Environmental Impacts of the Aviation System	Assuring Energy Availability and Efficiency is Central to the Growth of the Aeronautics Enterprise, and the Environment Must be Protected while Sustaining Growth in Air Transportation	National Airspace System (NAS)
	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics					
	Environment and Energy – Environmental Management Systems and Advanced Noise and Emissions Reduction					
	Operational Assessments - Performance					
	NextGen - Weather Technology in the Cockpit					
	Airport Cooperative Research Program - Environment	Goal 1 - Enable New Aviation Fuels Derived from Diverse and Domestic Resources to Improve Fuel Supply Security and Price Stability Goal 2 - Advance Development of Technologies and Operations to Enable Significant Increases in the Energy Efficiency of the Aviation System		Goal 3 - Advance Development of Technologies and Operational Procedures to Decrease the Significant Environmental Impacts of the Aviation System		
	Airport Technology Research Program - Environment					
	NextGen - Alternative Fuels for General Aviation	Goal 3 - Advance Development of Technologies and Operational Procedures to Decrease the Significant Environmental Impacts of the Aviation System				

In FY 2015, 25 percent of total FAA R&D funding is allocated to R&D Principle 3 - Reduce Environmental Impacts. Program funding levels for the 2014 Enacted and 2015 President's Request are shown in Table 3.0.2. Percent of Program reflects the part of each program's contribution towards R&D Principle 3 in the 2015 President's Request. Table 3.0.2 also lists the section and page number reference for each budget narrative within the FY 2015 CJ for the President's Budget Request. The link to the FY 2015 CJ is: http://www.dot.gov/sites/dot.gov/files/docs/FAA-FY2015-Budget-Estimates.pdf.

Table 3.0.2: Program Funding for R&D Principle 3 - Reduce Environmental Impacts

2015 BLI	Program	CJ Reference (Section/Page)	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2015 Percent of Program
A11.m	NextGen - Alternative Fuels for General Aviation	3C/61	RE&D	6,000	5,700	100%
A12.c	NextGen - Weather Technology in the Cockpit	3C/75	RE&D	400	405	10%
A13.a	Environment and Energy	3C/79	RE&D	14,600	14,921	100%
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	3C/84	RE&D	26,979	19,514	100%
A14.a	System Planning and Resource Management	3C/89	RE&D	501	486	23%
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	3B/45	F&E	9,443	2,500	100%
4A08	Center for Advanced Aviation System Development (CAASD)	3B/294	F&E	1,027	1,027	8%
--	Operational Assessments - Performance	3B/58	F&E	7,555	0	100%
--	Airport Cooperative Research Program - Environment	3D/36	AIP	5,000	5,000	100%
--	Airport Technology Research Program - Environment	3D/26	AIP	1,500	1,513	100%
	Total ($000)			**73,005**	**51,066**	

3.1 Environment and Energy R&D Goals 1 - 3

Reduced significant community noise impacts in absolute terms.

Reduced impact of aviation emissions on air quality and global climate.

Improved energy efficiency and assured availability of sustainable alternative jet fuels.

3.1.1 Environment and Energy (RE&D - A13.a)

The Environment and Energy Program supports Environment and Energy Goals 1, 2, and 3 by characterizing aircraft noise and emissions and their consequential impacts on the environment. The program then provides guidance on mitigating these impacts. 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.

The research milestones and their statuses are shown in Table 3.1.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 3.1.1: Environment and Energy Program Milestones

Year	Milestone	Status	Notes
2013	Examine the suitability of aircraft noise and emissions metrics to establish environmental standards	Completed	2013 NARP Status: Completed
2013	Evaluate noise propagation methodologies to predict surface noise levels	Completed	2013 NARP Status: On schedule
2013	Refine the estimates of aircraft contribution to climate change	Completed	The NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b) Program is also responsible for this milestone 2013 NARP Status: On schedule
2013	Develop a technique to estimate domestic U.S.-wide impacts of aviation emissions on surface air quality	Completed	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Obtain direct measurements of aircraft particulate matter data to support development of internationally approved methodology	On schedule	Milestone was revised to clarify the research Old wording: "Obtain direct measurements of particulate matter data to update environmental modeling tools" 2013 NARP Status: Delayed from 2013 to 2014
2014	Refine methods and tools to estimate impacts of global aviation emissions on surface air quality	On schedule	New milestone
2015	Advance the understanding of noise impacts on social welfare and health	On schedule	New milestone
2015	Develop approved method for measuring particulate matter from gas turbine engines	On schedule	New milestone
2015	Develop methods to account for regional climate impact of aviation emissions	On schedule	New milestone
2015	Improve understanding of the impacts of aircraft emissions in the airport vicinity	On schedule	Milestone was revised to clarify the research Old wording: "Refine methods and tools to estimate impacts of aviation emissions on air quality in the vicinity of the airport" 2013 NARP Status: On schedule
2016	Advance the understanding of noise impacts on social welfare and health	On schedule	2013 NARP Status: On schedule
2016	Refine the estimates of aircraft contribution to climate change using the latest methods and knowledge	On schedule	The NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b) Program is also responsible for this milestone
2016	Develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions	On schedule	New milestone
2017	Advance the understanding of noise impacts on social welfare and health	On schedule	New milestone
2018	Develop air quality model to capture global impacts of aviation emissions	On schedule	New milestone
2019	Develop new standard for particulate matter emissions	On schedule	New milestone

Environment and Energy Program Progress in FY 2013:

- ✓ Conducted research to improve the noise propagation methodology, a key aspect of noise modeling, in the environmental modeling tools. One important factor to ensure accurate calculation of the number of people exposed to significant commercial aircraft noise in the U.S. is proper noise modeling. The FAA has taken great strides in improving the methodology through international collaboration and advancing research. The FAA has

worked with propagation experts in Europe to validate and compare current propagation methodologies between the U.S and European countries. In addition, the international collaboration has led to the availability of data that can be used to validate emerging propagation methodologies and an opportunity to utilize mature propagation methodologies, validated with European models in the FAA environmental tools. In addition, collaboration with NASA has led to the opportunity to collect additional data that can be used to validate emerging propagation methodologies. The overall work in noise propagation will continue to mature and be implemented into the FAA environmental models. These models are used for National Environmental Policy Act review, to complete Noise Exposure Maps under the FAA's Part 150 program, and to provide the FAA's annual noise exposure number, among other uses.

- ✓ Developed a tool to quantify and track year to year changes in health impacts. The tool, based on the Community Multi-scale Air Quality (CMAQ) modeling framework, was used to examine the years 2005 and 2010. The background emissions from non-aviation sources and meteorology were standardized for use in the CMAQ modeling framework, as these important factors can lead to considerable year-to-year variability if not included in the model. The inclusion of non-aviation sources allows for a more consistent and accurate quantification of health impacts due to aviation. While prior approaches had only included health impacts due to particulate matter, a number of additional factors were included to estimate significant health impacts. The tool was used to estimate both premature mortalities and monetary damage for 2005 and 2010, and it will be used to track the trajectory of health impacts for current and future years.

3.1.2 Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction (F&E - 1A08 – NextGen – Environment Portfolio)

The Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction Program supports Environment and Energy Goals 1, 2, and 3 by supporting development and implementation of the NextGen Environmental Management System (EMS). The EMS will dynamically manage NextGen environmental impacts and help to define and identify optimum mitigation actions and their benefits. The program also evaluates the benefits of aviation environmental mitigation options and identifies ways to integrate them into the NAS infrastructure and demonstrate any NAS adaptation required to realize their full benefits. These options include new Continuous Lower Emissions, Energy, and Noise (CLEEN) aircraft technologies, alternative fuels, environmental and energy-efficient operational policies and procedures, environmental standards, and market-based measures.

The research milestones and their statuses are shown in Table 3.1.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 3.1.2: Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction Program Milestones

Year	Milestone	Status	Notes
2013	Evaluate, refine, and apply Environmental Management System decision support tools to the aviation system	Completed	2013 NARP Status: On schedule
2014	Demonstrate collaborative surface management techniques that could reduce fuel burn and emissions	Delayed	Milestone is delayed from 2013 to 2014 as a required field demonstration has yet to be completed 2013 NARP Status: On schedule
2014	Develop report on development and testing of the annual assessment and review process, including an evaluation of progress made towards meeting NextGen environmental goals with an assessment of knowledge gaps and technology needs	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule
2014	Establish Beta Emergency Management System website and collaboration portal that includes communication materials	On schedule	2013 NARP Status: On schedule
2014	Develop a report on refinements to the program offices' collaboration protocols and reward and recognition program	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule
2014	Develop an initial approach to integrate National Environmental Policy Act considerations into existing FAA Acquisition Management System guidance	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule
2014	Perform flight demonstration of Flight Management System (FMS)-engine technology and validation of trajectory optimization algorithm for FMS/ATM Integration	On schedule	Milestone was revised to better reflect the work that is planned Old wording: "Develop a report on tests and demonstrations of Continuous Lower Emissions, Energy, and Noise Air Traffic Management-related aircraft technologies" 2013 NARP Status: On schedule
2014	Develop a report on exploration, demonstrations and assessments of environmentally and energy efficient gate-to-gate operational procedures	Deleted	Milestone was deleted due to changing program priorities 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2015	Assess NAS-wide environmental benefits of Continuous Lower Emissions, Energy, and Noise (CLEEN) aircraft technologies	Delayed	Milestone is delayed from 2014 to 2015 to include CLEEN Phase I technologies that will be matured by 2015 and revised to better reflect the work that is planned Old wording: "Develop a report on NAS-wide assessments of environmental benefits of Continuous Lower Emissions, Energy, and Noise aircraft technologies" 2013 NARP Status: On schedule
2015	Assess NAS-wide impacts of environmental standards for aircraft noise and emissions and other policy measures to limit aircraft emissions and noise and increase fuel efficiency	Delayed	Milestone is delayed from 2014 to 2015 due to time needed to make progress on international discussion and revised to better reflect the work that is planned Old wording: "Develop a report on NAS-wide impacts of environmental standards for aircraft noise and emissions and other policy measures to limit aircraft emissions and noise and increase fuel efficiency" 2013 NARP Status: On schedule
2015	Submit a report on development of the initial operational version of NextGen environmental management system (EMS) framework	On schedule	New milestone
2015	Develop a report on demonstration of Flight Management System/ATM Integration for Trajectory Optimization	On schedule	New milestone
2015	Update report on assessments of NAS-wide environmental benefits of new aircraft technologies including those from the CLEEN program	On schedule	New milestone
2015	Develop a report on assessments of environmentally and energy efficient gate-to-gate operational procedures	On schedule	New milestone
2015	Develop a report on assessments of NAS-wide impacts of environmental standards and policy measures	On schedule	New milestone

Environment and Energy – Environmental Management System and Advanced Noise and Emissions Reduction Program Progress in FY 2013:

- ✓ Demonstrated the benefits of the N-control strategy at BOS (Phase I). Aircraft taxiing on the surface contributes significantly to the fuel burn and emissions at airports. The quantities of fuel burned and emissions of different pollutants are proportional to the taxi times of aircraft, in combination with other factors such as the throttle settings, number of engines that are powered, and pilot and airline decisions regarding engine shutdowns during delays. A simple airport congestion control strategy would be a pushback procedure aimed at reducing congestion on the ground that would consider the situation

on the airport surface (also called the state). The N-control strategy is one such approach, and was first considered in the Departure Planner project. Several variants of this procedure have been reported in literature. The procedure is effectively a simple threshold heuristic: if the total number of departing aircraft on the ground exceeds a certain threshold, further pushbacks are stopped until the number of aircraft on the ground drops below the threshold.

- ✓ Focused Environmental Management System (EMS) development on several fronts that include higher tier management program and stakeholder collaboration programs. In addition, continued work on EMS website development and environmental data management. In particular, work continued to proactively identify "strategic" environmental issues critical to achieving NextGen, consider environmental impacts/constraints as part of operational decision-making, improve coordination and communication across stakeholders, and leverage information/data for better decision-making.

3.1.3 NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics (RE&D - A13.b)

The NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics Program supports Environment and Energy Goals 1, 2, and 3 by developing solutions to mitigate aviation environmental impacts in absolute terms and increase fuel efficiency. It matures aircraft technologies through the CLEEN Program to reduce noise and emissions at the source level. It assesses, demonstrates, and supports qualification of alternative aviation fuels that reduce emissions that impact air quality and climate change. Availability of alternative aviation fuels also increases energy security. The program also supports research to determine the appropriate goals and metrics to manage NextGen aviation environmental impacts needed to support EMS.

The research milestones and their statuses are shown in Table 3.1.3 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 3.1.3: NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics Program Milestones

Year	Milestone	Status	Notes
2013	Refine the estimates of aircraft contribution to climate change	Completed	The Environment and Energy (A13.a) Program is also responsible for this milestone 2013 NARP Status: On schedule
2013	Develop plans for Continuous Lower Energy, Emissions and Noise Phase II activities	Completed	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2013	Demonstrate compatibility of future alternative jet fuel pathways with existing aircraft and infrastructure to expand feedstock options for sustainable fuel production	Completed	2013 NARP Status: On schedule
2014	Demonstrate Continuous Lower Energy, Emissions and Noise Ceramic Matrix Composite nozzle technology	On schedule	Milestone was incorrectly identified as FY 2013 in past NARPs, when in fact it is a FY 2014 milestone; the completion year has been corrected to 2014 but the milestone is not considered to be delayed
2014	Evaluate the environmental and economic sustainability of future alternative turbine engine fuels	On schedule	2013 NARP Status: On schedule
2015	Demonstrate Continuous Lower Energy, Emissions and Noise Engine Weight Reduction and High Temperature Impeller technologies	On schedule	New milestone
2015	Evaluate novel future alternative jet fuels to ensure their compatibility with existing aircraft and fueling infrastructure	On schedule	2013 NARP Status: On schedule
2015	Assess the environmental benefits of the first round of Continuous Lower Energy Emissions and Noise airframe and engine technologies	On schedule	2013 NARP Status: On schedule
2015	Initiate Continuous Lower Energy, Emissions and Noise Phase II activities to demonstrate technologies that can reduce energy use, emissions, and noise	On schedule	2013 NARP Status: On schedule
2016	Refine the estimates of aircraft contribution to climate change using the latest methods and knowledge	On schedule	2013 NARP Status: On schedule
2016	Refine the environmental and economic sustainability assessment of renewable alternative turbine engine fuels using the latest methods and knowledge	On schedule	2013 NARP Status: On schedule
2016	Demonstrate Continuous Lower Energy, Emissions and Noise Ultra High Bypass Ratio Gear Turbo Fan Technology	On schedule	New milestone
2017	Demonstrate Continuous Lower Energy, Emissions and Noise Advanced Turbine Components	On schedule	New milestone
2017	Demonstrate technologies that can reduce energy use, emissions, and noise via the second phase of the Continuous Lower Energy, Emissions and Noise program	On schedule	2013 NARP Status: On schedule
2018	Advance approval methodology for alternative jet fuels	On schedule	New milestone
2019	Advance the understanding of alternative jet fuel composition and environmental performance	On schedule	New milestone

NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics Program Progress in FY 2013:

- ✓ Addressed the main goal of the Aviation Climate Change Research Initiative (ACCRI) program: to reduce uncertainties and improve understanding of how aviation impacts the climate. This improvement was achieved by combining observationally based estimates of contrail and contrail-induced cirrus cover effects with modeling simulations.

- ✓ Provided valuable information on the non-carbon dioxide climatic impacts of present-day aviation emissions as well as those from a future (2050) aviation growth scenario through ACCRI.

- ✓ Helped identify new mechanisms wherein aviation impacts the climate. Three pertain to improved understanding of atmospheric chemical effects initiated by aviation emissions, and two pertain to the non-linear effects of aerosols such as sulfates and black carbon on existing and aviation generated cirrus clouds. Further investigation is needed to fully understand and characterize these impacts. The ACCRI program also developed preliminary estimates of climate benefits that could be achieved from the extensive use of alternative fuels.

- ✓ Conducted a market survey to gauge interest and to inform the FAA about technological options for potential maturation under a second phase of the CLEEN program (CLEEN II). The CLEEN program is a NextGen effort to accelerate development and commercial deployment of environmentally promising aircraft technologies and sustainable alternative jet fuels. The FAA has developed draft environmental and fuel burn goals that will be targeted under CLEEN II. These goals, along with a draft version of the statement of work will be discussed at the CLEEN II Industry Day, which was held in December 2013 in Washington, D.C. The FAA expects to release the CLEEN II solicitation in the summer of 2014. CLEEN II will have a five year duration from 2015 to 2020.

- ✓ Used contractual avenues, including CLEEN program to fund alternative jet fuel performance testing by Honeywell, Pratt & Whitney, Boeing and Rolls Royce. Testing included fuel property, material compatibility, engine rig, auxiliary power unit and turbine engine tests of multiple alternative jet fuels including fuels made from sugars, plant oils, waste greases, and waste gases from industrial sources. Results from the testing are crucial to the process of approval of the fuels for use by commercial aviation via ASTM International. FAA continues to working with the U.S. Air Force to jointly fund and accomplish much of this testing. In addition, work to produce novel alternative jet fuels was completed by three innovative alternative fuel companies funded by the FAA. Virent Inc., Lanzatech / Swedish Biofuels and Honeywell UOP delivered fuel samples and preliminary testing of those fuel samples was completed. The fuels are slated to be performance tested this year, and the resulting data will support future fuel approval.

3.1.4 Operational Assessments - Performance (F&E - NextGen)

The Operational Assessments Program supports Environment and Energy Goals 1, 2, and 3 by assessing 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. The program supports NextGen implementation by performing analyses in three areas: Systems Analysis, Environmental Assessments, and NextGen Performance Snapshots. Systems Analysis prepares quantitative estimates of the anticipated operational benefits of the NextGen portfolio. Environmental Assessments establishes the environmental impacts of the current aviation system to quantify the change in environmental measures from NextGen implementation, using assessment tools such as the Aviation Environment Design Tool (AEDT) and Aviation Environment Portfolio Management Tool. The NextGen Performance Snapshots website provides post-implementation performance information at 21 Metroplexes, as well as at selected airports and airspace.

Per OMB, this program will no longer exist as a stand-alone BLI beginning in FY 2015. As such, activities for this program will not appear in the NARP after 2014. Milestones for 2015 were not input for this program, since the program's work has now been integrated into the NextGen Laboratories at WJHTC program and is no longer considered research.

The research milestones and their statuses are shown in Table 3.1.4 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 3.1.4: Operational Assessments - Performance Program Milestones

Year	Milestone	Status	Notes
2013	Develop and implement NAS-wide demand forecasting, economic and environmental analysis capability with Aviation Environmental Portfolio Management Tool	Completed	2013 NARP Status: Completed
2013	Interface/integrate environmental assessment capability with NextGen NAS models	Completed	2013 NARP Status: On schedule
2013	Complete a customized Performance Data Analysis and Reporting System dataset created for Performance Based Navigation analysis	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2013	Collect and analyze studies from constituent program offices to provide a comprehensive view of NextGen costs and benefits	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2013	Develop the NextGen 2012 Performance Assessment Report	Deleted	Milestone was deleted as it falls under a non-research portion of the program. 2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Interface Aviation Environment Design Tool environmental assessment capabilities with NextGen NAS simulation models	Deleted	Milestone was deleted due to realignment of work program priorities 2013 NARP Status: On schedule
2014	Assess NAS-wide environmental benefits of NextGen implementation to ensure that new capabilities include environmental performance considerations, enabling an integrated implementation of NextGen	On schedule	Milestone was revised to better reflect the work that is planned Old wording: "Update document which analyzes and assesses NAS-wide environmental benefits of NextGen implementation" 2013 NARP Status: On schedule
2014	Update NextGen cost estimates, benefits estimates, and the overall NextGen business case	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2014	Publish an updated NextGen Business Case document	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2014	Evaluate the operational performance impacts of NextGen technologies and procedures, and publish an annual report	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2014	Complete additional upgrades and maintenance of the website for NextGen Performance Snapshots to aid in the tracking and reporting of progress within NextGen	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2014	Update and maintain the NextGen Segment Implementation Plan to aid the planning and deployment of NextGen portfolio in the mid-term timeframe	Deleted	Milestone was deleted as it falls under a non-research portion of the program 2013 NARP Status: On schedule
2015	Develop improved methodology to assess the domestic/regional NAS-wide environmental performance of NextGen	Delayed	Milestone is delayed from 2014 to 2015 due to a broader scope and revised to better reflect the work that is planned Old wording: "Develop Aviation Environment Portfolio Management Tool for domestic/ regional NAS-wide NextGen environmental performance optimization and impact analysis" 2013 NARP Status: On schedule
2015	Release Aviation Environment Design Tool publicly with capability to perform airport to NAS level integrated fuel burn, noise and emissions analyses	On schedule	Milestone completion date corrected to FY 2015 as work is expected to be completed in December 2014 2013 NARP Status: On schedule

Operational Assessments - Performance Program Progress in FY 2013:

- ✓ Established a framework to link models of ATM or air transportation operations to the AEDT, the next generation environmental consequences modeling tool. The two airspace system models that were selected for this integration are the Total Airport and Airspace Modeler (TAAM) and the System-Wide Analysis Capability (SWAC), which represent the extremes of the spectrum of modeling detail and area of application. The first version of AEDT, version 2a, was released on March 21, 2012 and was designed specifically to assess the environmental consequences of airspace redesign actions. The first phase of the integration work was targeted towards understanding the differences between the TAAM and SWAC modeling domains, and the development of a guidance document targeted specifically to the AEDT 2a capabilities. The resulting final document was delivered in 2013 and was designed to support operations and environmental modelers in bridging the data and assumptions gaps to establish a successful workflow for the integration of the two modeling domains.

3.1.5 NextGen - Weather Technology in the Cockpit (RE&D - A12.d)

The NextGen - Weather Technology in the Cockpit Program supports Environment and Energy Goals 1, 2, and 3 by developing, verifying, and validating requirements to support airworthiness standards for improving the quality and quantity of meteorological information to the aircraft to reduce environment impacts (e.g., lower fuel consumption) of current and NextGen operations.

The research milestones and their statuses are shown in Table 3.1.5 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goals.

Table 3.1.5: NextGen - Weather Technology in the Cockpit Program Milestones

Year	Milestone	Status	Notes
2014	Complete wind modeling simulation framework and initial data plots of wind errors (forecast and Flight Management System) versus fuel burn rates for selected NextGen operational applications	Completed	2013 NARP Status: On schedule
2016	Complete service analysis on the weather information and presentations in the cockpit to enhance NAS efficiency in adverse weather	On schedule	Milestone was revised to clarify the research. Old wording: “Complete service analysis on the information and presentations in the cockpit for adverse weather re-route options and ground-air negotiations to enable reduced fuel burn from more efficient reroute decisions due to adverse weather” 2013 NARP Status: On schedule

NextGen - Weather Technology in the Cockpit Program Progress in FY 2013:

- ✓ Developed a wind modeling simulation framework more quickly than originally scheduled due to the use of an existing lab (versus the original plan of building new lab capabilities). The framework was used to successfully run the initial simulations and develop the trade study data plots for Required Time of Arrival in the Terminal Area.

3.1.6 Center for Advanced Aviation System Development (F&E - 4A08)

The Center for Advanced Aviation System Development Program supports Environment and Energy Goals 1, 2, and 3 by conducting research on enabling NAS-wide assessment of noise, emissions, and fuel burn impacts of NextGen operational initiatives.

CAASD made the following progress in FY 2013 towards R&D goals 1 - 3.

- ✓ Developed an integrated analysis capability to determine tradeoffs between operational and environmental goals in the NAS by leveraging existing and well-established air traffic simulation tools and environmental models. Research was focused on harmonizing common inputs and assumptions across the models used in this effort - systemwideModeler and the FAA's Aviation Environmental Design Tool Version 2a SP1 (AEDT). A prototype software tool that transformed systemwideModeler simulation results into appropriate input formats for AEDT was developed to test the integration methods adopted. This software tool can also be used to generate environmental study inputs for AEDT using other simulation outputs or radar track data. Finally, a case study evaluating NAS-wide operational and environmental impacts of proposed NextGen airport capacity improvements was undertaken. This notional case study highlighted the NAS-wide delay savings and fuel burn reductions resulting from airport capacity improvements.

3.2 Environment and Energy R&D Goal 4

Established requirements, policies, procedures, and resources to allow airports in the United States to become environmentally friendly neighbors.

3.2.1 Airport Cooperative Research Program – Environment (AIP)

The Airport Cooperative Research Program – Environment supports Environment and Energy Goal 4 by examining 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.

The research milestones and their statuses are shown in Table 3.2.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 3.2.1: Airport Cooperative Research Program – Environment Milestones

Year	Milestone	Status	Notes
2013	Develop an aircraft departure environmental optimization methodology	Completed	2013 NARP Status: On schedule
2013	Design and implement a measurement campaign of particulate matter emissions from the use of aircraft auxiliary power units and aircraft brake and tire wear during landing	Completed	2013 NARP Status: On schedule
2013	Develop guidance for airport operators and state and local air quality planners that describes the development of the airport emissions component of a State Implementation Plan	Completed	2013 NARP Status: On schedule
2013	Identify applicable federal and state statutes and regulations, federal grant assurances, and FAA directives and advisory documents that apply to airport protection of wildlife on-airport or promotion of compatible land use off-airport	Completed	2013 NARP Status: On schedule
2013	Develop guidelines for airport sound insulation programs	Completed	2013 NARP Status: On schedule
2013	Develop a noise-power-distance and spectral class database for nominal taxi, break-away, and idle thrust levels for use in FAA's Integrated Noise Model	Completed	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2013	Identify available and emerging onsite and offsite technologies for treating storm water impacted by airport deicing activities	Completed	2013 NARP Status: On schedule
2013	Assess the effectiveness of sound insulation programs	Completed	2013 NARP Status: On schedule
2014	Identify and evaluate metrics for and conditions under which aircraft noise affects student learning	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Provide practical mitigation alternatives for managing nuisance microbial communities caused by airport deicing activities	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Develop an interactive electronic tool to assist airport stakeholders in estimating airport construction emissions	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Develop an inventory methodology to help airports quantify aircraft lead emissions at airports	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Develop and validate a research protocol for a large-scale study of aircraft noise exposure/annoyance response relationships across the U.S.	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Assess the predictive accuracy of the FAA's Integrated Noise Model for general aviation aircraft	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Assess the current body of knowledge regarding the impact of airport operations on air quality and public health	Delayed	Milestone is delayed from 2013 to 2014 due to underestimation of project complexity 2013 NARP Status: On schedule
2014	Create best practices for aviation safety associated with planning, developing and constructing energy production and transmission technologies at and around airports	On schedule	2013 NARP Status: On schedule
2014	Produce guidance on the application of whole effluent toxicity testing to airport deicing runoff	On schedule	2013 NARP Status: On schedule
2014	Develop a method for estimating aircraft takeoff thrust settings for a wide variety of commercial and general aviation aircraft, suitable for use in preparing airport emissions inventories	On schedule	2013 NARP Status: On schedule

Year	Milestone	Status	Notes
2014	Review, evaluate, and document current helicopter noise models and identify potential improvements to the Integrated Noise Model and the Aviation Environmental Design Tool to better capture the unique complexity of helicopter operations	On schedule	2013 NARP Status: On schedule
2014	Develop a process to evaluate sustainability practices as they relate to the impacts on day-to-day airport operations and maintenance	On schedule	2013 NARP Status: On schedule
2014	Develop tools and guidance for airports that identify and evaluate storm water management options and provide a set of best management practices to minimize hazards posed to aviation by wildlife	On schedule	2013 NARP Status: On schedule
2014	Develop a primer to help airports address federal and state threatened and endangered species issues on or near their airport	On schedule	2013 NARP Status: On schedule
2015	Develop a decision tool for airports to identify, evaluate, prioritize, and select sustainability practices	Delayed	Milestone is delayed from 2013 to 2015 due to an expanded scope of research 2013 NARP Status: On schedule
2015	Improve, enhance, and update the Sustainable Aviation Guidance Alliance website with new and existing sustainable practices data	Delayed	Milestone is delayed from 2014 to 2015 due to a change in scope 2013 NARP Status: On schedule
2015	Assess the accuracy of the NOx ($NO+NO_2$) emissions and speciation methods used in the Emissions Dispersion Modeling System/AEDT (i.e., OLM, ARM, and PVMRM) to predict NO_2 concentrations, develop and assess alternative methods, and recommend a preferred method for predicting NO_2 concentrations resulting from airport emissions	On schedule	New milestone

3.2.2 Airport Technology Research Program – Environment (AIP)

The Airport Technology Research Program – Environment supports Environment and Energy Goal 4 by establishing 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.

The research milestones and their statuses are shown in Table 3.2.2 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 3.2.2: Airport Technology Research Program – Environment Milestones

Year	Milestone	Status	Notes
2014	Develop the test plan and selection of surveyed airports for the Aircraft Noise and Annoyance Study	Delayed	Milestone is delayed from 2013 to 2014 due to delays in preparing the survey instrument 2013 NARP Status: On schedule
2014	Develop and gain approval for a survey instrument to collect data for the Aircraft Noise and Annoyance Study	On schedule	2013 NARP Status: On schedule
2015	Complete data collection for the Aircraft Noise and Annoyance Study	On schedule	2013 NARP Status: On schedule
2015	Complete the study on analyzing air quality samples from forcible entry testing on composite materials	On schedule	New milestone
2015	Evaluate the effectiveness of using artificial turf in Runway Safety Areas to mitigate the burrowing of the protected Gopher Tortoise	On schedule	New milestone
2016	Complete updates to the dose-response curves for U.S. airports using data collected from the Aircraft Noise and Annoyance Study	On schedule	2013 NARP Status: On schedule

Airport Technology Research Program – Environment Progress in FY 2013:

- ✓ Initiated a project to evaluate the effectiveness of using artificial turf in runway safety areas to mitigate the burrowing of the protected Gopher Tortoise. The evaluations will take place at Orlando-Sanford International Airport (MCO) and will be completed in FY 2015.

3.3 Environment and Energy R&D Goal 5

Established data and methodologies to support certification of alternative fuels for General Aviation aircraft.

3.3.1 NextGen - Alternative Fuels for General Aviation (RE&D - A11.m)

The NextGen - Alternative Fuels for General Aviation Program supports Environment and Energy Goals 5 by addressing the use of alternative and renewable fuels for GA to lessen aviation environmental impacts on air and water quality. The program develops data and methodologies to support certification of alternative aviation fuels for GA aircraft.

The research milestones and their statuses are shown in Table 3.3.1 below, followed by a summary of the significant progress made in FY 2013 towards achieving the R&D goal.

Table 3.3.1: NextGen - Alternative Fuels for General Aviation Program Milestones

Year	Milestone	Status	Notes
2015	Finalize laboratory and rig test methods	On schedule	New milestone
2016	Develop engine and fuel test methods to evaluate the performance, safety, durability, and operability of unleaded aviation gasoline	On schedule	2013 NARP Status: On schedule
2016	Complete laboratory and rig testing	On schedule	New milestone
2017	Perform initial engine and aircraft testing	On schedule	New milestone
2018	Perform engine and aircraft testing to address remaining areas of concern	On schedule	New milestone
2019	Complete engine and aircraft testing	On schedule	New milestone

NextGen - Alternative Fuels for General Aviation Program Progress in FY 2013

- ✓ Developed and successfully balloted an ASTM International Standard Practice for Detonation detection in aircraft engines in cooperation with the Coordinating Research Council Piston Fuels Group. This method includes reference standards for equipment, installation, calibration, analyses algorithms, power settings, and engine operating testing conditions. To date, the engine and airframe OEMs have diverged in their approach to detonation detection and a formal correlation to the FAA TC ASTM referee method has not been performed. This correlation will inform development of a standardized detonation testing procedure to be used to evaluate all unleaded candidate fuels submitted to the Piston Aviation Fuels Initiative for the replacement of 100 low-lead (100LL) aviation gasoline.

- ✓ Created a data set documenting the performance of a high octane, non-lead containing quality aviation alkylate currently in production. While this significantly reduced octane may not be suitable for many high performance aircraft, the research illustrated the size of the fleet that could operate safely with no changes to aircraft materials, operating

procedures or safety margins. This research will support the eventual balloting of a UL94 unleaded aviation alkylate standard specification at ASTM International.

- ✓ Established a capability to measure bulk gas emissions. The research is significant as it supports the Piston Aviation Fuels Initiative of evaluating engine-out emissions of unleaded candidate replacement fuels in comparison to the existing leaded 100LL to ensure that unleaded replacement fuels are not significantly worse than 100LL regarding engine-out exhaust emissions.

- ✓ Completed initial engine testing investigating the impact of engine inlet air temperature and humidity, fuel temperature, engine cylinder head temperature and engine ignition timing effects on octane requirement. This research informs the development of standard detonation testing procedures for the evaluation of replacement unleaded fuels.

4.0 R&D Business Management

This chapter reviews the FAA R&D portfolio according to the FY 2015 President's Budget submission. It also summarizes the four budget appropriation accounts, shows how much the FAA is spending on R&D, and describes its R&D program execution.

The FAA R&D portfolio supports regulation, certification, and standards development, modernization of the NAS, and policy and planning. To support FAA R&D principles and goals, the R&D addresses the specific needs of sponsoring organizations, including Aviation Safety, Air Traffic Organization, Airports, NextGen, and Policy, International Affairs and Environment. The R&D Management Division under the Assistant Administrator for NextGen manages the FAA R&D portfolio for the Agency.

4.1 Appropriation Accounts

Three of four of the FAA's appropriation accounts fund the R&D portfolio: RE&D; F&E; and AIP. The following sections provide a summary of these three FAA appropriation accounts[8] and how the R&D portfolio is derived from each.

4.1.1 Research, Engineering and Development (RE&D)

The RE&D appropriation 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. The RE&D appropriation account funds roughly half of the programs included in the NextGen R&D portfolio.

4.1.2 Facilities and Equipment (F&E)

The F&E appropriation account funds capital investments relating to air navigation facilities and equipment and aviation safety systems including acquisition costs, installation, testing, initial spares, initial maintenance contracts and training for equipment, facilities, and other construction projects. The F&E appropriation account funds R&D from two groups of programs: Advanced Technology Development and Prototyping and within the NextGen– Portfolios as designated R&D sub budget line items. In general, programs from these groups are in the concept development and demonstration phase prior to an FAA investment decision.

Advanced Technology Development and Prototyping R&D programs develop and validate technology and systems that support air traffic services, including the requirements associated with the evolving air traffic system architecture and improvements in airport safety and capacity. NextGen - Portfolio R&D programs comprise the other half of the F&E Activity R&D Program and have broad applicability across NextGen.

4.1.3 Grants-In-Aid for Airports (AIP)

The AIP appropriation account 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. This appropriation account funds the administrative expenses of the FAA Office of Airports, as well as airport-related R&D conducted in the Airport Cooperative Research Program (ACRP) and the Airport Technology Research Program (ATRP).

The ACRP organization, its procedures, and its administration by the Transportation Research Board (TRB) were established in a 2005 memorandum of agreement (MOA) that was signed by the U.S. Secretary of Transportation, the President of the National Academy of Sciences, and the

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

Administrator of the FAA. The purpose of the ACRP is to research problems shared by airports that are not being addressed by other Federal research programs. Each year, the TRB solicits the public and the aviation industry for research topics on airport issues involving safety, operations, capacity, and environment. The ACRP Oversight Committee reviews the topics submitted and selects the most promising ones for funding.

The purpose of the ATRP is to develop new or improved airport standards or procedures. The FAA Office of Airports sponsors ATRP research projects and reviews project deliverables. Research results are used to update or produce new ACs used by airports and industry to design and construct airport infrastructure, procure airport capital equipment, and support FAA regulatory requirements for airport safety. ATRP research areas include airport safety, airport lighting and marking, airport pavement design and construction, airport design, heliport design, aircraft rescue and firefighting, surface surveillance, airport capacity, mitigation of wildlife hazards, and airport environment.

4.2 R&D Summary Budget Tables

This section provides five tables presenting the FAA R&D budget by appropriation, program sponsor, R&D category, performance goal, and NextGen R&D. It presents the FY 2014 Enacted and FY 2015 President's Request, and planned funding for FY 2016 through 2019, which are estimates and subject to change. The amounts shown for F&E programs reflect only R&D activities and do not include acquisition, operational testing, or other non-R&D activities. The amounts shown for CAASD include only the R&D portion of the total CAASD line item amount, which is 21.4 percent in FY 2014.

4.2.1 Appropriation Account

Table 4.2.1 shows the FAA R&D FY 2014 Enacted and FY 2015 President's Request budgets and the estimated funding through FY 2019, grouped by appropriation account. The F&E appropriation has programs that are not part of the R&D portfolio, as the NARP only presents R&D.

4.2.2 Requesting Organization

Table 4.2.2 shows the FAA R&D FY 2014 Enacted and FY 2015 President's Request budgets and the estimated funding through FY 2019, grouped by requesting organization. Requesting (sponsoring) organizations include Aviation Safety, Air Traffic Organization, Airports, NextGen, and Policy, International Affairs and Environment.

4.2.3 Research Category

The FAA R&D portfolio includes both applied R&D as defined by the OMB Circular A-11.[9] Applied research is the systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Development is the 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. Table 4.2.3 shows the FAA R&D portfolio according to these categories with the percent of applied R&D for FY 2014 through 2019.

4.2.4 Performance Goal

Table 4.2.4 shows the FAA R&D budget by the performance goals defined in Exhibit II of the FAA President's Request for FY 2015. The R&D programs apply to three of the goals in the *U.S. Department of Transportation's Strategic Plan for Fiscal Years 2012–2016*: Safety, Economic Competitiveness, and Environmental Sustainability. Many R&D programs apply to more than one goal. However, for budgeting purposes, most programs are included under only

[9] OMB Circular A-11, Preparation, Submission and Execution of the Budget, July 26, 2013, section 84, page 8, *available at* http://www.whitehouse.gov/OMB/circulars.

one goal. The table provides information on contract costs and personnel costs requested for FY 2015. For Table 4.2.4, System Planning and Resource Management (A14.a) is considered part of Mission Support for the RE&D appropriation account and is pro-rated across the three DOT goals as follows: Safety at 57 percent, Economic Competitiveness at 22 percent, and Environmental Sustainability at 21 percent. William J. Hughes Technical Center Facility (A14.b) is also considered part of Mission Support and is pro-rated between Safety at 72 percent and Economic Competitiveness at 28 percent.

4.2.5 NextGen R&D

Funded by both RE&D and F&E appropriations, the FAA NextGen R&D portfolio is a subset of the FAA R&D portfolio, reported in the NARP, and also in the *NextGen Implementation Plan*. The FAA NextGen R&D portfolio represents 19 percent of the total requested R&D budget reported in the NARP for FY 2015, and it represents 6 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 4.2.5 provides the FAA NextGen R&D portfolio five-year budget plan by line item and appropriation.

Table 4.2.1: Planned R&D Budget by Appropriation Account

2015 BLI	Program	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2016 Estimate ($000)	2017 Estimate ($000)	2018 Estimate ($000)	2019 Estimate ($000)
Research, Engineering and Development (RE&D)								
A11.a	Fire Research and Safety	RE&D	8,000	6,929	7,043	7,181	7,289	7,427
A11.b	Propulsion and Fuel Systems	RE&D	1,800	2,413	2,465	2,530	2,578	2,643
A11.c	Advanced Materials/Structural Safety	RE&D	2,600	2,909	2,969	3,044	3,100	3,174
A11.d	Aircraft Icing/Digital System Safety	RE&D	7,500	5,889	6,010	6,159	6,270	6,420
A11.e	Continued Airworthiness	RE&D	8,000	9,619	9,820	10,069	10,255	10,503
A11.f	Aircraft Catastrophic Failure Prevention Research	RE&D	1,500	1,567	1,603	1,649	1,682	1,727
A11.g	Flightdeck/Maintenance/System Integration Human Factors	RE&D	5,000	9,897	10,088	10,321	10,498	10,732
A11.h	System Safety Management	RE&D	11,000	7,970	8,145	8,354	8,510	8,719
A11.i	Air Traffic Control/Technical Operations Human Factors	RE&D	5,000	5,898	5,959	6,027	6,088	6,157
A11.j	Aeromedical Research	RE&D	7,000	8,919	9,043	9,189	9,306	9,452
A11.k	Weather Program	RE&D	14,200	17,800	18,266	18,849	19,272	19,855
A11.l	Unmanned Aircraft Systems Research	RE&D	8,644	8,974	9,192	9,464	9,664	9,935
A11.m	NextGen - Alternative Fuels for General Aviation	RE&D	6,000	5,700	5,818	5,963	6,072	6,217
A11.n	NextGen - Advanced Systems and Software Validation	RE&D	1,000	0	0	0	0	0
A12.a	NextGen - Wake Turbulence	RE&D	9,000	8,541	8,719	8,940	9,106	9,326
A12.b	NextGen - Air Ground Integration Human Factors	RE&D	11,329	9,697	9,899	10,149	10,335	10,584
A12.c	NextGen - Weather Technology in the Cockpit	RE&D	4,000	4,048	4,123	4,213	4,282	4,373
A13.a	Environment and Energy	RE&D	14,600	14,921	15,276	15,720	16,049	16,495
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	RE&D	26,979	19,514	19,925	20,433	20,811	21,318
A14.a	System Planning and Resource Management	RE&D	2,200	2,135	2,172	2,216	2,251	2,296
A14.b	William J. Hughes Technical Center Laboratory Facility	RE&D	3,440	3,410	3,465	3,530	3,582	3,647
	RE&D TOTAL	**RE&D**	**158,792**	**156,750**	**160,000**	**164,000**	**167,000**	**171,000**
Facilities & Equipment (F&E)								
1A01A	Runway Incursion Reduction Program	F&E	4,776	3,500	5,000	5,000	5,000	5,000
1A01B	System Capacity, Planning and Improvements	F&E	5,349	6,000	6,000	6,500	6,500	6,500
1A01C	Operations Concept Validation and Infrastructure Evolution	F&E	3,821	4,000	4,000	4,000	6,000	6,000
1A01D	Major Airspace Redesign	F&E	4,776	5,000	5,000	5,000	5,000	5,000
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	9,443	2,500	3,500	3,500	3,500	3,500
1A10E	New Air Traffic Management Requirements	F&E	20,775	4,980	11,000	14,000	14,000	14,000
3A09B	Systems Safety Management Transformation	F&E	7,555	5,700	2,000	3,000	3,000	3,000
4A08	Center for Advanced Aviation System Development (CAASD)	F&E	12,840	12,840	12,840	13,910	13,910	13,910
--	Air Traffic Control/Technical Operations Human Factors	F&E	4,721	0	4,000	4,000	4,000	5,000
--	Networked Facilities - Staffed NextGen Towers	F&E	1,889	0	0	0	0	0
--	Operational Assessments - Performance	F&E	7,555	0	0	0	0	0
--	Operations Concept Validation Modeling	F&E	4,722	0	4,900	4,000	4,000	5,000
--	Wake Turbulence - Re-categorization	F&E	1,416	0	1,500	1,800	2,500	2,500
	F&E TOTAL	**F&E**	**89,638**	**44,520**	**59,740**	**64,710**	**67,410**	**69,410**
Grants-In-Aid for Airports (AIP)								
--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Technology Research Program - Capacity	AIP	12,607	12,714	12,714	12,714	12,714	12,714
--	Airport Technology Research Program - Environment	AIP	1,500	1,513	1,513	1,513	1,513	1,513
--	Airport Technology Research Program - Safety	AIP	15,393	15,523	15,523	15,523	15,523	15,523
	AIP TOTAL	**AIP**	**44,500**	**44,750**	**44,750**	**44,750**	**44,750**	**44,750**
	GRAND TOTAL		**$292,930**	**$246,020**	**$264,490**	**$273,460**	**$279,160**	**$285,160**

Table 4.2.2: Planned R&D Budget by Requesting Organization

2015 BLI	Program	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2016 Estimate ($000)	2017 Estimate ($000)	2018 Estimate ($000)	2019 Estimate ($000)
Aviation Safety (AVS)								
A11.a	Fire Research and Safety	RE&D	8,000	6,929	7,043	7,181	7,289	7,427
A11.b	Propulsion and Fuel Systems	RE&D	1,800	2,413	2,465	2,530	2,578	2,643
A11.c	Advanced Materials/Structural Safety	RE&D	2,600	2,909	2,969	3,044	3,100	3,174
A11.d	Aircraft Icing/Digital System Safety	RE&D	7,500	5,889	6,010	6,159	6,270	6,420
A11.e	Continued Airworthiness	RE&D	8,000	9,619	9,820	10,069	10,255	10,503
A11.f	Aircraft Catastrophic Failure Prevention Research	RE&D	1,500	1,567	1,603	1,649	1,682	1,727
A11.g	Flightdeck/Maintenance/System Integration Human Factors	RE&D	5,000	9,897	10,088	10,321	10,498	10,732
A11.h	System Safety Management	RE&D	11,000	7,970	8,145	8,354	8,510	8,719
A11.j	Aeromedical Research	RE&D	7,000	8,919	9,043	9,189	9,306	9,452
A11.l	Unmanned Aircraft Systems Research	RE&D	8,644	8,974	9,192	9,464	9,664	9,935
A11.n	NextGen - Advanced Systems and Software Validation	RE&D	1,000	0	0	0	0	0
	AVS TOTAL		**62,044**	**65,086**	**66,378**	**67,960**	**69,152**	**70,732**
NextGen (ANG)								
A11.m	NextGen - Alternative Fuels for General Aviation	RE&D	6,000	5,700	5,818	5,963	6,072	6,217
A12.a	NextGen - Wake Turbulence	RE&D	9,000	8,541	8,719	8,940	9,106	9,326
A12.b	NextGen - Air Ground Integration Human Factors	RE&D	11,329	9,697	9,899	10,149	10,335	10,584
A12.c	NextGen - Weather Technology in the Cockpit	RE&D	4,000	4,048	4,123	4,213	4,282	4,373
A14.a	System Planning and Resource Management	RE&D	2,200	2,135	2,172	2,216	2,251	2,296
A14.b	William J. Hughes Technical Center Laboratory Facility	RE&D	3,440	3,410	3,465	3,530	3,582	3,647
	Subtotal	**RE&D**	35,969	33,531	34,196	35,011	35,628	36,443
1A10E	New Air Traffic Management Requirements	F&E	20,775	4,980	11,000	14,000	14,000	14,000
3A09B	Systems Safety Management Transformation	F&E	7,555	5,700	2,000	3,000	3,000	3,000
--	Air Traffic Control/Technical Operations Human Factors	F&E	4,721	0	4,000	4,000	4,000	5,000
--	Networked Facilities - Staffed NextGen Towers	F&E	1,889	0	0	0	0	0
--	Operational Assessments - Performance	F&E	7,555	0	0	0	0	0
--	Operations Concept Validation Modeling	F&E	4,722	0	4,900	4,000	4,000	5,000
--	Wake Turbulence - Re-categorization	F&E	1,416	0	1,500	1,800	2,500	2,500
	Subtotal	**F&E**	48,633	10,680	23,400	26,800	27,500	29,500
	ANG TOTAL		**84,602**	**44,211**	**57,596**	**61,811**	**63,128**	**65,943**
Air Traffic Organization (ATO)								
A11.i	Air Traffic Control/Technical Operations Human Factors	RE&D	5,000	5,898	5,959	6,027	6,088	6,157
A11.k	Weather Program	RE&D	14,200	17,800	18,266	18,849	19,272	19,855
	Subtotal	**RE&D**	19,200	23,698	24,225	24,876	25,360	26,012
1A01A	Runway Incursion Reduction Program	F&E	4,776	3,500	5,000	5,000	5,000	5,000
1A01B	System Capacity, Planning and Improvements	F&E	5,349	6,000	6,000	6,500	6,500	6,500
1A01C	Operations Concept Validation and Infrastructure Evolution	F&E	3,821	4,000	4,000	4,000	6,000	6,000
1A01D	Major Airspace Redesign	F&E	4,776	5,000	5,000	5,000	5,000	5,000
4A08	Center for Advanced Aviation System Development (CAASD)	F&E	12,840	12,840	12,840	13,910	13,910	13,910
	Subtotal	**F&E**	31,562	31,340	32,840	34,410	36,410	36,410
	ATO TOTAL		**50,762**	**55,038**	**57,065**	**59,286**	**61,770**	**62,422**
Airports (ARP)								
--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Technology Research Program - Capacity	AIP	12,607	12,714	12,714	12,714	12,714	12,714
--	Airport Technology Research Program - Environment	AIP	1,500	1,513	1,513	1,513	1,513	1,513
--	Airport Technology Research Program - Safety	AIP	15,393	15,523	15,523	15,523	15,523	15,523
	ARP TOTAL		**44,500**	**44,750**	**44,750**	**44,750**	**44,750**	**44,750**
Policy, International Affairs, and Environment (APL)								
A13.a	Environment and Energy	RE&D	14,600	14,921	15,276	15,720	16,049	16,495
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	RE&D	26,979	19,514	19,925	20,433	20,811	21,318
	Subtotal	**RE&D**	41,579	34,435	35,201	36,153	36,860	37,813
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	9,443	2,500	3,500	3,500	3,500	3,500
	Subtotal	**F&E**	9,443	2,500	3,500	3,500	3,500	3,500
	APL TOTAL		**51,022**	**36,935**	**38,701**	**39,653**	**40,360**	**41,313**
	GRAND TOTAL		**$292,930**	**$246,020**	**$264,490**	**$273,460**	**$279,160**	**$285,160**

Table 4.2.3: Planned R&D Budget by Research Category

2015 BLI	Program	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2016 Estimate ($000)	2017 Estimate ($000)	2018 Estimate ($000)	2019 Estimate ($000)
Applied Research								
A11.a	Fire Research and Safety	RE&D	8,000	6,929	7,043	7,181	7,289	7,427
A11.b	Propulsion and Fuel Systems	RE&D	1,800	2,413	2,465	2,530	2,578	2,643
A11.c	Advanced Materials/Structural Safety	RE&D	2,600	2,909	2,969	3,044	3,100	3,174
A11.d	Aircraft Icing/Digital System Safety	RE&D	7,500	5,889	6,010	6,159	6,270	6,420
A11.e	Continued Airworthiness	RE&D	8,000	9,619	9,820	10,069	10,255	10,503
A11.f	Aircraft Catastrophic Failure Prevention Research	RE&D	1,500	1,567	1,603	1,649	1,682	1,727
A11.g	Flightdeck/Maintenance/System Integration Human Factors	RE&D	5,000	9,897	10,088	10,321	10,498	10,732
A11.h	System Safety Management	RE&D	11,000	7,970	8,145	8,354	8,510	8,719
A11.i	Air Traffic Control/Technical Operations Human Factors	RE&D	5,000	5,898	5,959	6,027	6,088	6,157
A11.j	Aeromedical Research	RE&D	7,000	8,919	9,043	9,189	9,306	9,452
A11.k	Weather Program	RE&D	14,200	17,800	18,266	18,849	19,272	19,855
A11.l	Unmanned Aircraft Systems Research	RE&D	8,644	8,974	9,192	9,464	9,664	9,935
A11.m	NextGen - Alternative Fuels for General Aviation	RE&D	6,000	5,700	5,818	5,963	6,072	6,217
A11.n	NextGen - Advanced Systems and Software Validation	RE&D	1,000	0	0	0	0	0
A12.a	NextGen - Wake Turbulence	RE&D	9,000	8,541	8,719	8,940	9,106	9,326
A12.b	NextGen - Air Ground Integration Human Factors	RE&D	11,329	9,697	9,899	10,149	10,335	10,584
A12.c	NextGen - Weather Technology in the Cockpit	RE&D	4,000	4,048	4,123	4,213	4,282	4,373
A13.a	Environment and Energy	RE&D	14,600	14,921	15,276	15,720	16,049	16,495
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	RE&D	26,979	19,514	19,925	20,433	20,811	21,318
A14.a	System Planning and Resource Management	RE&D	2,200	2,135	2,172	2,216	2,251	2,296
A14.b	William J. Hughes Technical Center Laboratory Facility	RE&D	3,440	3,410	3,465	3,530	3,582	3,647
	Subtotal	**RE&D**	158,792	156,750	160,000	164,000	167,000	171,000
--	Airport Cooperative Research Program - Capacity	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000
--	Airport Technology Research Program - Capacity	AIP	12,607	12,714	12,714	12,714	12,714	12,714
--	Airport Technology Research Program - Environment	AIP	1,500	1,513	1,513	1,513	1,513	1,513
--	Airport Technology Research Program - Safety	AIP	15,393	15,523	15,523	15,523	15,523	15,523
	Subtotal	**AIP**	44,500	44,750	44,750	44,750	44,750	44,750
	Applied Research TOTAL		**203,292**	**201,500**	**204,750**	**208,750**	**211,750**	**215,750**
	Applied Research PERCENT		**69.4%**	**81.9%**	**77.4%**	**76.3%**	**75.9%**	**75.7%**
Development								
1A01A	Runway Incursion Reduction Program	F&E	4,776	3,500	5,000	5,000	5,000	5,000
1A01B	System Capacity, Planning and Improvements	F&E	5,349	6,000	6,000	6,500	6,500	6,500
1A01C	Operations Concept Validation and Infrastructure Evolution	F&E	3,821	4,000	4,000	4,000	6,000	6,000
1A01D	Major Airspace Redesign	F&E	4,776	5,000	5,000	5,000	5,000	5,000
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	9,443	2,500	3,500	3,500	3,500	3,500
1A10E	New Air Traffic Management Requirements	F&E	20,775	4,980	11,000	14,000	14,000	14,000
3A09B	Systems Safety Management Transformation	F&E	7,555	5,700	2,000	3,000	3,000	3,000
4A08	Center for Advanced Aviation System Development (CAASD)	F&E	12,840	12,840	12,840	13,910	13,910	13,910
--	Air Traffic Control/Technical Operations Human Factors	F&E	4,721	0	4,000	4,000	4,000	5,000
--	Networked Facilities - Staffed NextGen Towers	F&E	1,889	0	0	0	0	0
--	Operational Assessments - Performance	F&E	7,555	0	0	0	0	0
--	Operations Concept Validation Modeling	F&E	4,722	0	4,900	4,000	4,000	5,000
--	Wake Turbulence - Re-categorization	F&E	1,416	0	1,500	1,800	2,500	2,500
	Development TOTAL		**89,638**	**44,520**	**59,740**	**64,710**	**67,410**	**69,410**
	Development PERCENT		**30.6%**	**18.1%**	**22.6%**	**23.7%**	**24.1%**	**24.3%**
	GRAND TOTAL		**$292,930**	**$246,020**	**$264,490**	**$273,460**	**$279,160**	**$285,160**

Table 4.2.4: Planned R&D Budget by Performance Goal (Budget Exhibit II)

2015 BLI	Program	Appropriation Account	2015 Contract Costs ($000)	2015 Personnel Costs ($000)	2015 Other In-house Costs ($000)	2015 Total Request ($000)
1. Safety						
A11.a	Fire Research and Safety	RE&D	3,262	3,507	160	6,929
A11.b	Propulsion and Fuel Systems	RE&D	1,770	606	37	2,413
A11.c	Advanced Materials/Structural Safety	RE&D	2,006	823	80	2,909
A11.d	Aircraft Icing/Digital System Safety	RE&D	3,983	1,802	104	5,889
A11.e	Continued Airworthiness	RE&D	6,705	2,771	143	9,619
A11.f	Aircraft Catastrophic Failure Prevention Research	RE&D	1,276	271	20	1,567
A11.g	Flightdeck/Maintenance/System Integration Human Factors	RE&D	6,057	3,695	145	9,897
A11.h	System Safety Management	RE&D	5,669	2,216	85	7,970
A11.i	Air Traffic Control/Technical Operations Human Factors	RE&D	718	5,001	179	5,898
A11.j	Aeromedical Research	RE&D	2,994	5,793	132	8,919
A11.k	Weather Program	RE&D	17,128	614	58	17,800
A11.l	Unmanned Aircraft Systems Research	RE&D	7,795	1,126	53	8,974
A11.m	NextGen - Alternative Fuels for General Aviation	RE&D	5,397	303	0	5,700
A14.a	System Planning and Resource Management	RE&D	680	611	43	1,334
A14.b	William J. Hughes Technical Center Laboratory Facility	RE&D	1,227	1,467	65	2,759
	Subtotal	**RE&D**	66,667	30,606	1,304	98,577
1A01A	Runway Incursion Reduction Program	F&E	3,500	0	0	3,500
	Subtotal	**F&E**	3,500	0	0	3,500
--	Airport Cooperative Research Program - Safety	AIP	4,903	97	0	5,000
--	Airport Technology Research Program - Safety	AIP	13,723	1,800	0	15,523
	Subtotal	**AIP**	18,626	1,897	0	20,523
	1. Safety TOTAL		**88,793**	**32,503**	**1,304**	**122,600**
2. Economic Competitiveness						
A12.a	NextGen - Wake Turbulence	RE&D	8,220	157	164	8,541
A12.b	NextGen - Air Ground Integration Human Factors	RE&D	9,285	349	63	9,697
A12.c	NextGen - Weather Technology in the Cockpit	RE&D	3,188	826	34	4,048
A14.a	System Planning and Resource Management	RE&D	160	144	10	315
A14.b	William J. Hughes Technical Center Laboratory Facility	RE&D	290	346	15	651
	Subtotal	**RE&D**	21,143	1,822	286	23,251
1A01B	System Capacity, Planning and Improvements	F&E	6,000	0	0	6,000
1A01C	Operations Concept Validation and Infrastructure Evolution	F&E	4,000	0	0	4,000
1A01D	Major Airspace Redesign	F&E	5,000	0	0	5,000
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	2,500	0	0	2,500
1A10E	New Air Traffic Management Requirements	F&E	4,980	0	0	4,980
3A09B	Systems Safety Management Transformation	F&E	5,700	0	0	5,700
4A08	Center for Advanced Aviation System Development (CAASD)	F&E	12,840	0	0	12,840
--	Air Traffic Control/Technical Operations Human Factors	F&E	0	0	0	0
--	Operational Assessments - Performance	F&E	0	0	0	0
--	Operations Concept Validation Modeling	F&E	0	0	0	0
--	Wake Turbulence - Re-categorization	F&E	0	0	0	0
	Subtotal	**F&E**	41,020	0	0	41,020
--	Airport Cooperative Research Program - Capacity	AIP	4,903	97	0	5,000
--	Airport Technology Research Program - Capacity	AIP	11,240	1,474	0	12,714
	Subtotal	**AIP**	16,143	1,571	0	17,714
	2. Economic Competitiveness TOTAL		**78,306**	**3,394**	**286**	**81,985**
4. Environmental Sustainability						
A13.a	Environment and Energy	RE&D	12,662	1,870	389	14,921
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	RE&D	18,979	418	117	19,514
A14.a	System Planning and Resource Management	RE&D	248	223	16	486
	Subtotal	**RE&D**	31,889	2,511	522	34,921
--	Airport Cooperative Research Program - Environment	AIP	4,903	97	0	5,000
--	Airport Technology Research Program - Environment	AIP	1,338	175	0	1,513
	Subtotal	**AIP**	6,241	272	0	6,513
	4. Environmental Sustainability TOTAL		**38,129**	**2,783**	**522**	**41,434**
	GRAND TOTAL		**$205,228**	**$38,680**	**$2,112**	**$246,020**

Table 4.2.5: NextGen R&D Funding

2015 BLI	Program	Appropriation Account	2014 Enacted ($000)	2015 Request ($000)	2016 Estimate ($000)	2017 Estimate ($000)	2018 Estimate ($000)	2019 Estimate ($000)
NextGen - F&E								
1A08	Environment and Energy - Environmental Management Systems and Advanced Noise and Emissions Reduction	F&E	9,443	2,500	3,500	3,500	3,500	3,500
1A10E	New Air Traffic Management Requirements	F&E	20,775	4,980	11,000	14,000	14,000	14,000
3A09B	Systems Safety Management Transformation	F&E	7,555	5,700	2,000	3,000	3,000	3,000
--	Air Traffic Control/Technical Operations Human Factors	F&E	4,721	0	4,000	4,000	4,000	5,000
--	Networked Facilities - Staffed NextGen Towers	F&E	1,889	0	0	0	0	0
--	Operational Assessments - Performance	F&E	7,555	0	0	0	0	0
--	Operations Concept Validation Modeling	F&E	4,722	0	4,900	4,000	4,000	5,000
--	Wake Turbulence - Re-categorization	F&E	1,416	0	1,500	1,800	2,500	2,500
	F&E TOTAL	**F&E**	**20,303**	**0**	**10,400**	**9,800**	**10,500**	**12,500**
NextGen RE&D								
A11.m	NextGen - Alternative Fuels for General Aviation	RE&D	6,000	5,700	5,818	5,963	6,072	6,217
A11.n	NextGen - Advanced Systems and Software Validation	RE&D	1,000	0	0	0	0	0
A12.a	NextGen - Wake Turbulence	RE&D	9,000	8,541	8,719	8,940	9,106	9,326
A12.b	NextGen - Air Ground Integration Human Factors	RE&D	11,329	9,697	9,899	10,149	10,335	10,584
A12.c	NextGen - Weather Technology in the Cockpit	RE&D	4,000	4,048	4,123	4,213	4,282	4,373
A13.b	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	RE&D	26,979	19,514	19,925	20,433	20,811	21,318
	RE&D TOTAL	**RE&D**	**58,308**	**47,500**	**48,484**	**49,698**	**50,606**	**51,818**
	NextGen R&D TOTAL		**$78,611**	**$47,500**	**$58,884**	**$59,498**	**$61,106**	**$64,318**

4.3 R&D 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.

4.3.1 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.

R&D Executive Board

The FAA's R&D Executive Board (REB) includes senior executives representing the major FAA R&D sponsors. When R&D portfolio formulation is complete, the REB provides portfolio approval. This process helps the FAA establish research priorities to meet its strategic goals and objectives. To ensure effective engagement with research stakeholders, the REB 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. For more information, click on the R&D Executive Board tab at: http://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/about/campus/faa_host/RDM/.

Joint Resources Council

The Joint Resources Council (JRC) is the FAA's corporate-level acquisition decision-making body that provides strategic guidance for 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.

4.3.2 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) provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of the aviation research portfolio. The Committee also assists in ensuring FAA research activities are coordinated with other

government agencies and industry.[10] The REDAC considers aviation research needs in five areas: NAS operations, airport technology, aviation safety, human factors, and environment and energy. During 2013, the REDAC held 2 committee meetings and 10 subcommittee meetings and produced two reports documenting their recommendations. The following link (click on the 'REDAC' tab) provides the recommendations from these reports: http://www.faa.gov/go/redac.

Commercial Space Transportation Advisory Committee

Established in 1984, the Commercial Space Transportation Advisory Committee (COMSTAC) provides information, advice, and recommendations to the FAA Administrator on matters concerning the U.S. commercial space transportation industry. Currently, the Committee has 25 members. Members' professional affiliations constitute a broad cross-section of the commercial space transportation field, including such domains as: commercial expendable and reusable launch vehicle activities, commercial launch site operations, satellite manufacturing and operations, space policy and education, space law, insurance and finance, state government and economic development programs, space advocacy, and trade as well as technical associations. The COMSTAC provides recommendations, findings, and observations concerning commercial space transportation initiatives and may comment as appropriate on R&D reports and activities. For more information, see:
http://www.faa.gov/about/office_org/headquarters_offices/ast/advisory_committee/.

Transportation Research Board

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

The ACRP Oversight Committee announced their FY 2013 projects in August 2012. The selected research projects will examine different research areas that target near-term solutions to problems facing airport operators and industry stakeholders. The projects will report on the state of the practice in critical areas within the industry. These projects include standard subjects in the areas of safety, environment, and capacity. For more information, see:
http://www.trb.org/ACRP/Public/.

[10] *See* 49 U.S.C. § 44508.

5.0 Partnership Activities

The FAA enhances and expands its R&D capabilities through partnerships with other government, industry, academic, and international organizations. Such partnerships help the FAA leverage critical resources and capabilities to ensure that the Agency can achieve its goals and objectives. By partnering with other organizations, the FAA gains access to both internal and external innovators, promotes the transfer of FAA technologies to the private sector for other civil and commercial applications, and expands the U.S. technology base. The FAA uses a variety of partnership mechanisms described in this chapter.

5.1 Federal Government

Other federal departments and agencies conduct aviation-related R&D that directly or indirectly supports the FAA goals and objectives. To leverage this R&D, researchers at the FAA collaborate with their colleagues in government, both foreign and domestic, through cooperative agreements, such as memoranda of understanding (MOUs), MOAs, Interagency Agreements, and International Agreements. The FAA also creates partnerships with other agencies through a variety of interagency committees.

5.1.1 Cooperative Agreements

Both MOUs and MOAs support joint research activities between departments or agencies. An MOU is a high-level agreement describing a broad area of research that fosters cooperation between departments or agencies and develops a basis for establishing joint research activities. An MOU does not require either party to obligate funds and does not create a legally binding commitment. An MOA is an agreement describing a specific area of research under a broader MOU that creates a legally binding commitment and may require the obligation of funds. An MOA may include IAs, which are written agreements between the FAA and other agencies in which the FAA agrees to receive or exchange supplies or services with the other agency. International Agreements establish an R&D relationship between the FAA and foreign governments or quasi-governmental entities.

NASA and the Department of Defense (DoD) are the FAA's closest R&D partners in the federal government. Both agencies cooperate on research with the FAA through an MOU. The FAA also works closely with the Transportation Security Administration (TSA). FAA provides $5 million per year to the TSA through an MOA that establishes the procedures to conduct research in the areas of intruder detection, baggage screening, and equipment evaluation. The MOA also provides the ACRP the ability to submit security research topics to TSA for funding consideration under the TSA airport research program.

5.1.2 Interagency Committees

The FAA creates partnerships with other agencies through a variety of interagency committees and groups. Some of the interagency committees and groups that the FAA is associated with are described below.

The Federal Interagency Committee on Aviation Noise

The Federal Interagency Committee on Aviation Noise was formed by the FAA in 1993 to provide forums for debate over future research needs to better understand, predict and control the effects of aviation noise, and to encourage new technical development efforts in these areas. For more information, see: http://www.fican.org/.

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 U.S. research program which will help the Nation and the world understand, assess, predict, and respond to human-induced and natural processes of global change." Thirteen federal departments and agencies participate in the USGCRP including the 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/.

5.2 Industry

The FAA complies with all applicable federal guidelines and legislation concerning the transfer of technology. The FAA's goal is to transfer knowledge, facilities, equipment, or capabilities developed by its laboratories and R&D programs to the private sector. This helps expand the U.S. technology base and leverage federal R&D investments. 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 U.S. 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 (ICAO), 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 the FAA to share facilities, equipment, services, intellectual property, personnel, and other resources with private industry, academia, and state and local government agencies. CRDAs are a highly effective way to meet congressionally mandated technology transfer requirements. For more information, see: http://faa.gov/go/techtran.

Patents Issued through the U.S. Patent and Trademark Office

The FAA encourages its inventors to patent new technologies through the U.S. Patent and Trademark Office. A patent is a grant of a property right and gives the owner the right to exclude anyone else from making, using, or selling the invention. Inventions patented by FAA inventors are available for commercial licensing with royalty payments shared with the inventor and the agency. Legislation allows inventors to receive up to $150,000 per year over their salary from royalty payments. The FAA has identified approximately 60 active patents resulting from FAA funded agreements. These patented technologies are available for use by the government and its contractors on a cost-free basis when used for government purposes. The agency's Technology Transfer Program Office promotes the agency's patents for commercialization. For more information, see: http://faa.gov/go/techtran.

Small Business Innovation Research

Small Business Innovation Research (SBIR) contracts encourage the private sector to invest in long-term research that helps the federal government meet its R&D objectives. Eligible small businesses compete for Phase I contracts to conduct feasibility-related experimental or theoretical research. The government awards a Phase II contract based on the results of Phase I. The government encourages contractors to pursue other funding sources for Phase III and to attract venture capitalists to commercialize the innovation.

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/.

5.3 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 works with academia in three ways: the Joint University Program (JUP), aviation research grants, and Air Transportation Centers of Excellence (COEs).

5.3.1 Joint University Program

The JUP is a research partnership between the FAA and Ohio University, Massachusetts Institute of Technology, and Princeton University. The program aids in the development of a safer and more efficient air transportation system by identifying promising targets for development, conducting long-term research, and educating technological leaders. The FAA and NASA benefit directly from the results of the research and gain valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit of JUP is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical expertise in industry, academia, and government. For more information, see: http://u2.princeton.edu/~jup/.

5.3.2 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.

5.3.3 Air Transportation Centers of Excellence

The FAA recognizes the critical need to develop the nation's technology base and support the next generation of aviation engineers and scientists. Following a rigorous competitive process to address this need, the FAA COEs establish long-term cooperative agreements with the nation's universities to conduct research and develop in specific mission critical focus areas. The program encourages collaboration between government, academia, and industry to advance aviation technologies and expand our research capabilities through required matching contributions. COE university members match FAA grant awards, dollar for dollar, with contributions from nonfederal sources, and may also provide additional contributions through cost-share contracts. The COE cooperative agreement provides for base funding in support of center research and related activities over a period of 10 years. Following orderly close out, the FAA intends for each partnership to meet COE requirements by becoming a self-sufficient national aviation resource. Self-sufficiency enables the COE university members to continue supporting the FAA; however, the agency is no longer committed to annual base funding levels

and the COE universities may conduct research that is fully funded by the agency or other entities. Because of its developed expertise, COE members are expected to generate interest, support, and be able to compete for and conduct research activities for industry and other government entities.

The FAA has current cooperative agreements with seven competitively selected COEs that have been established as public-private partnerships with academic institutions and their industry and other affiliates throughout the U.S. COE members assist in conducting mission-critical research and technology in areas that focus on topics that include alternative jet fuels and environment, accessibility and sustainability, commercial space transportation, advanced materials, airliner cabin environment research and intermodal transportation research, airport technology, GA, aircraft noise and aviation emissions mitigation, and operations research. Through these long-term cost-sharing efforts, the government and university-industry teams leverage resources to advance the technological future of the nation's aviation industry while educating and training the next generation of aviation scientists and other professionals. The nonfederal affiliates and COE universities have provided more than $250 million in matching contributions to help augment critical FAA research efforts.

Since the inception of the COE program, the FAA Administrator has selected COE teams to focus on 11 topic areas. Four of the centers, Computational Modeling of Aircraft Structures, Aviation Operations Research (NEXTOR), Airworthiness Assurance (AACE), and Airport Technology Research (CEAT), have satisfied their requirements. Currently, NEXTOR serves as a self-sufficient resource for the aviation community, and CEAT continues to conduct major research initiatives to support modernization efforts with ORD. In 2013, the FAA sponsored seven active public-private research centers with academic institutions throughout the U.S. and their industry and other affiliates:

- COE for Alternative Jet Fuels and Environment
- COE for Commercial Space Transportation
- COE for General Aviation Safety, Accessibility and Sustainability
- COE for Research in the Intermodal Transport Environment
- Joint COE for Advanced Materials
- COE Partnership for AiR Transportation Noise and Emission Reduction
- COE for General Aviation Research

For more information, see: http://www.faa.gov/go/coe.

COE for Alternative Jet Fuels and Environment

On September 13, 2013, U.S. Secretary of Transportation Anthony Foxx announced the selection of the COE for Alternative Jet Fuels and Environment. The R&D efforts of this COE will address the following major topic areas related to alternative jet fuels: feedstock development, processing and conversion research, regional supply and refining infrastructure, environmental benefits analysis, aircraft component deterioration and wear assessment, and fuel performance

testing. Areas relating to environmental issues are: aircraft noise and impacts, aviation emissions and impacts, aircraft technology assessment, environmentally and energy efficient gate-to-gate aircraft operations, and aviation modeling and analysis. Under the leadership of Washington State University and the Massachusetts Institute of Technology, the following universities also serve on this team: Boston University, Georgia Tech Research Corporation, Missouri University of Science and Technology, Oregon State University, Pennsylvania State University, Purdue University, Stanford University, University of Dayton, University of Hawaii, University of Illinois, University of North Carolina, University of Pennsylvania, University of Tennessee, and University of Washington. The FAA awarded $100,000 to the 16 member universities late in FY 2013 to establish Phase I of this research partnership.

COE for Commercial Space Transportation

On August 18, 2010, U.S. Secretary of Transportation Ray LaHood announced the selection of the COE for Commercial Space Transportation. The R&D efforts of the COE address four major areas: (1) space launch traffic management and launch operations; (2) launch vehicles, operations, technologies and payloads; (3) human spaceflight; and (4) industry viability, including commercial, policy, international, legal, and regulatory viability. Florida Institute of Technology serves as the administrative coordinator with eight university members, including New Mexico State University, Stanford University, the University of Florida, the New Mexico Institute of Mining and Technology, Florida State University, the University of Central Florida, University of Colorado, and the University of Texas - Medical Branch. The FAA supported related tasks, awarding $1.13 million in grants through nine cooperative agreements with member universities. The universities with their affiliates provided excess matching contributions of $8 million. This COE is expected to be operational through 2015. For additional information, see: http://www.coe-cst.org/.

COE for General Aviation Safety, Accessibility and Sustainability

On September 27, 2012, U.S. Secretary of Transportation Ray LaHood announced the selection of the new COE for General Aviation, the Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS). This COE was fully operational in 2013 and focuses on the following GA topic areas: flight safety; communication, navigation and surveillance; human factors; weather; airport technology; propulsion and structures; continued airworthiness; and system safety management. Under the leadership of Purdue University, the following universities serve on this team: The Ohio State University, Iowa State University, Georgia Institute of Technology, Florida Institute of Technology, Texas A&M University. The FAA awarded $1.68 million to the six member universities in FY 2013 to begin projects. This COE is generating dollar-for-dollar contributions from nonfederal sources to match COE grant awards. For additional information, see: https://www.pegasas.aero/.

COE for Research in the Intermodal Transport Environment

In 2004, the Administrator selected the COE for Airliner Cabin Environment (ACER) with Harvard University and Purdue University as the technical leads and Auburn University as the administrative lead. Following the Phase I evaluation, the COE expanded scope from airliner

cabin research activities to include the intermodal transport environment. In 2008, it was renamed the COE for Research in the Intermodal Transport Environment (RITE). This COE conducts R&D on cabin air quality, chemical and biological threats, and related topics.

In FY 2010, the FAA entered into final cooperative agreements with each of the RITE COE leads and members in preparation for the COE becoming self-sufficient in 2014. Under the on-going administrative leadership of Auburn University and current technical leadership of Kansas State University, core members include Boise State University, Harvard School of Public Health, Purdue University, and the Rutgers University School of Biomedical and Health Services. The FAA awarded close to $1 million to this COE in FY 2013. The center has generated close to $1 million in matching contributions in FY 2013 and began preparing for close-out activities. For additional information, see: http://www.acer-coe.org/.

Joint COE for Advanced Materials

In 2003, the FAA Administrator, Marion Blakey, selected the Joint COE for Advanced Materials (JAMS) with the University of Washington and Wichita State University as the lead members. This COE conducts R&D on material standardization and shared databases, bonded joints, structural substantiation, damage tolerance and durability, maintenance practices, advanced material forms and processes, cabin safety, life management of materials, and nanotechnology for composite structures. Member universities include: Edmonds Community College, Northwestern University, Oregon State University, Purdue University, University of California at Los Angeles, University of Delaware, Florida International University, University of Utah, Tuskegee University, and Washington State University. The FAA awarded $1.9 million in FY 2013 to support related research and the COE members and affiliates haves generated matching contributions of more than $2.5 million in FY 2013. For additional information, see: http://www.jams-coe.org/.

COE Partnership for AiR Transportation Noise and Emissions Reduction

In 2003, the FAA Administrator, Marion Blakey, selected the COE Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) with Massachusetts Institute of Technology serving as the lead member. This COE has been co-sponsored by NASA and Transport Canada and conducts R&D to identify, understand, measure, and mitigate the impacts of aircraft noise and aviation emissions. PARTNER seeks to reduce uncertainty in issues dealing with climate impact and the health and welfare effects of emissions to actionable levels. Core member universities include: Harvard University, Pennsylvania State University, Purdue University, Stanford University, Missouri University of Science and Technology (formerly University of Missouri - Rolla), University of North Carolina - Chapel Hill, Georgia Institute of Technology, Boston University, University of Illinois at Urbana-Champaign, and the University of Pennsylvania. The FAA awarded $7 million to this COE during the final research phase and the COE members and affiliates have generated matching contributions of $7 million in FY 2013. The COE began preparing for close-out activities. For additional information, see: http://partner.mit.edu/.

COE for General Aviation Research

Established in 2001, Embry-Riddle Aeronautical University served as the lead member for the COE for General Aviation Research (CGAR). This COE has conducted safety related R&D with application to non-commercial aviation in the following areas: NextGen ADS-B, weather in the cockpit, safety management systems, remote airport lighting systems, training standards, and UAS. Core university members have included Wichita State University, University of North Dakota, and the University of Alaska - Fairbanks and Anchorage. The FAA provided final project support in 2013 to assure orderly phase-out of research, educational and related activities. This center generated matching contributions in excess of $280,000 in FY 2013 and entered into close out. For more information, see: http://www.cgar.org/about.asp.

COE for Airport Technology

In 1995, the Administrator selected the COE for Airport Pavement Research with the University of Illinois at Urbana-Champaign as the lead member and North Carolina A&T University as a participating member. This COE initially focused on pavement issues. In 2005, Rensselaer Polytechnic Institute joined the COE and the FAA expanded the scope to include R&D on wildlife hazard mitigation, lighting, and other airport safety topics, and changed its name to the Center of Excellence for Airport Technology. Over the life of this COE, the FAA awarded $17.4 million in grants and the COE provided matching contributions in excess of $18 million. This COE continues to work closely with Chicago O'Hare International Airport (ORD) on modernization efforts. The FAA initiated final close-out activities during FY 2013. For further information, see: http://www.ceat.uiuc.edu/.

5.4 International

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

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 the FAA established the first memorandum of cooperation (MOC), which they updated in 1992 and again in 2004. The aim of the MOC and its governance structure is to broaden the scope of the cooperation between the two organizations and their respective partners in the areas of ATM research, strategic ATM analysis, technical harmonization, operational harmonization, and 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 savings in fuel and emissions across all three of these domains. For more information, see: http://ec.europa.eu/transport/modes/air/environment/aire_en.htm.

Transport Canada

In the spring of 2004, Transport Canada joined FAA and NASA as a sponsor of the PARTNER COE. 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. As a member state of the ICAO, Canada 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. For more information, see: http://www.tc.gc.ca/eng/menu.htm.

The Asia and Pacific Initiative to Reduce Emissions

The Asia and Pacific Initiative to Reduce Emissions (ASPIRE), established in 2008, is a partnership of Asian 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 that 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 use 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 percent by 2016. To achieve this goal, the attendees formed an independent group known as the International Helicopter Safety Team (IHST). The IHST is co-chaired by the FAA and industry. Major industry participants include the Helicopter Association International, the American Helicopter Society International, the Helicopter Association of Canada, Bell Helicopter, Sikorsky Helicopter, Eurocopter, Shell Aircraft, CHC Helicopter, and AgustaWestland. IHST members also established international partnerships in countries with significant helicopter operations and worked to encourage overseas industries to carry out accident analysis and develop safety interventions. Worldwide partners now supporting the work of the IHST include government and industry participants from the U.S., Canada, Brazil, Japan, Australia, India, Russia, and multiple countries in Europe and in the Middle East/North Africa region. 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. While completing these analyses of helicopter accidents and their causes, the IHST and its worldwide partners develop safety toolkits, instructional and educational safety videos, and specific safety recommendations aimed at helping members of the helicopter industry enhance their safety practices and reduce the accident rate. By the end of 2012, the accident rate had been reduced 30 percent since 2001-2005. For more information, see: http://www.ihst.org/Default.aspx?tabid=1507&language=en-US.

Acronyms and Abbreviations

Acronym	Definition
1-9	
3D	Three-Dimensional
A	
AC	Advisory Circular
ACAS-X	Airborne Collision Avoidance System X
ACCRI	Aviation Climate Change Research Initiative
ACRP	Airport Cooperative Research Program
ADDS	Aviation Digital Data Service
ADS-B	Automatic Dependent Surveillance-Broadcast
AEDT	Aviation Environmental Design Tool
AIP	Grants-In-Aid for Airports Appropriation
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
AOPA	Aircraft Owners and Pilots Association
ASPIRE	Asia and Pacific Initiative to Reduce Emissions
ATC	Air Traffic Control
ATM	Air Traffic Management
ATRP	Airport Technology Research Program
B	
BLI	Budget Line Item
BOS	Boston Logan International Airport
C	
CAASD	Center for Advanced Aviation System Development
CAMI	Civil Aeromedical Institute
CAST	Commercial Aviation Safety Team
CIP	Current Icing Product
CJ	Congressional Justification
CLEEN	Continuous Lower Energy, Emissions and Noise
CMAQ	Community Multi-scale Air Quality
CO_2	Carbon Dioxide
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
ConOps	Concept of Operations
CRDA	Cooperative Research and Development Agreement
D	
DARWIN®	Design Assessment Of Reliability With Inspection
DoD	U.S. Department of Defense

Acronym	Definition
DOT	U.S. Department of Transportation
E	
eFAROS	Enhanced Final Approach Runway Occupancy Signal
EMS	Environmental Management System
EUROCONTROL	European Organisation for the Safety of Air Navigation
F	
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layered Design
FE	Finite Element
FIP	Forecast Icing Product
FLM	Front Line Manager
FY	Fiscal Year
G	
GA	General Aviation
GAJSC	General Aviation Joint Steering Committee
GEOSS	Global Earth Observation System of Systems
H	
HiRes	High Resolution
HITL	Human-in-the-Loop
HSI	Human-System Integration
HUMS	Health Usage Monitoring System
I	
ICAO	International Civil Aviation Organization
IHST	International Helicopter Safety Team
ISAM	Integrated Safety Assessment Model
J	
JAMS	Joint COE for Advanced Materials
JPDO	Joint Planning and Development Office
JRC	Joint Resources Council
JUP	Joint University Program
L	
LCGS	Low Cost Ground Surveillance
M	
MEM	Memphis International Airport
MET	Meteorological
MOA	Memorandum/a of Agreement
MOC	Memorandum/a of Cooperation

Acronym	Definition
MOU	Memorandum/a of Understanding
N	
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAWC	Naval Air Warfare Center
NextGen	Next Generation Air Transportation System
NEXTOR	National Center of Excellence for Aviation Operations Research
NOx	Nitrogen Oxide
NSTC	National Science and Technology Council
NTSB	National Transportation Safety Board
O	
OMB	Office of Management and Budget
Ops	Operations Appropriation
ORD	Chicago O'Hare International Airport
P	
PAPI	Precision Approach Path Indicator
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PIV	Personal Identity Verification
Q	
QRG	Quick Reference Guide
R	
R&D	Research and Development
RE&D	Research, Engineering and Development Appropriation
REB	Research and Development Executive Board
REDAC	Research, Engineering, and Development Advisory Committee
RECAT	Re-Categorization of Wake Turbulence Categories
RITE	COE for Research in the Intermodal Transport Environment
RTCA	Radio Technical Commission for Aeronautics
S	
SESAR	Single European Sky ATM Research
SFO	San Francisco International Airport
SVS/EFVS	Synthetic Vision Systems and Enhanced Flight Vision System
SWAC	System-Wide Analysis Capability
SWIM	System Wide Information Management
T	
TAAM	Total Airport and Airspace Modeler
Tech Ops	Technical Operations

Acronym	Definition
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TSA	Transportation Security Administration
U	
UAS	Unmanned Aircraft System
U.S.	United States
U.S.C.	United States Code
USGCRP	U.S. Global Change Research Program
W	
WFA	Wind Forecast Algorithm