Federal Aviation Administration

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

2008 NARP

February 4, 2008 (Revision 2)

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

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Executive Summary

> *"Our plan to reform the aviation system puts incentives in place that will make the system more efficient as well as more responsive to the needs of the aviation community. This is critical if we are to deploy the state-of-the-art technology that can safely handle the dramatic increases in the number and type of aircraft using our skies."*
>
> Secretary of Transportation Mary Peters, February 2007

> *"All of our efforts should be targeted toward building NextGen. That includes our R&D and technology efforts. And we need to directly link our efforts of today – reflected by the Flight Plan – to that of tomorrow, NextGen. The OEP will keep us all on the same road."*
>
> FAA Acting Administrator Bobby Sturgell, March 2007

Aviation is a vital national resource for the United States. It provides opportunities for business, jobs, economic development, law enforcement, emergency response, and personal travel and leisure. It attracts investment to local communities and opens up new domestic and international markets and supply chains. As a result, the United States must have an aviation system that is second to none – a system that can respond quickly to its changing and expanding transportation needs. This can only be achieved through the introduction of new technologies and procedures, innovative policies, and advanced management practices into the aviation system.

The FAA is committed to reducing delays and congestion in our nation's air transportation system. One of the major initiatives to reduce congestion is the development of the next generation air transportation system (NextGen). NextGen includes three performance targets for the year 2025 that, if achieved, will reduce congestion by providing three-times the capacity of our current system with higher efficiency levels than we have today. The FAA has integrated NextGen into its planning activities including its five-year strategic *Flight Plan*. Within the FAA, the *Operational Evolution Partnership (OEP)* provides the complete path of all FAA NextGen related activities.

Research and development (R&D) will help FAA achieve NextGen objectives by identifying challenges, understanding barriers, and developing solutions associated with capacity, safety, environment, controller efficiency, and pilot workload. The *National Aviation Research Plan (NARP)* is an integrated, performance-based plan for the FAA R&D program that supports both the day-to-day operations of the national air transportation system and the future vision for NextGen. The *NARP* uses ten R&D milestones to bridge the near-term goals of the FAA's strategic *Flight Plan* with the long-term goals of the *NextGen Integrated Plan.* 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 NextGen.

The ten R&D milestones are aggressive and challenge researchers to innovate, take risks, and seek non-traditional solutions. Some results will succeed beyond expectations, while others may fall short of the intended target. Research will make the unknown, known. It will identify constraints and barriers, separate solutions that are effective from those that are not, and help transform the nation’s air transportation system by the year 2025.

In fiscal year 2009, the FAA plans to invest a total of $336,629,000 in R&D. This investment spans multiple appropriations for the FAA and includes: $171,028,000 in Research, Engineering and Development; $131,128,000 in ATO Capital; $125,000 in Safety and Operations; and $34,348,000 in the Airport Improvement Program.

Preface

Title 49 of the U.S. Code section 44501(c) requires the Administrator of the Federal Aviation Administration (FAA) to submit the *National Aviation Research Plan (NARP)* to Congress annually with the President's budget. The Plan includes both applied research and development as defined by the Office of Management and Budget Circular A-11[1] and involves research activities funded in four appropriations accounts: Research, Engineering and Development; Air Traffic Organization (ATO) Capital; Airport Improvement Program; and Safety and Operations.

The *NARP* is a portfolio that reflects annual changes to the FAA research and development (R&D) program. The 2005 *NARP* aligned the FAA R&D with the near-term goals of the *Flight Plan* and the long-term goals of the *NextGen Integrated Plan*. The *2006 NARP* strengthened the connection between the near-term and long-term efforts by proposing ten R&D goals with mid-term performance targets. The *2007 NARP* provided a high-level plan for each R&D goal to show how the programs work together to achieve the R&D milestones/targets while supporting both the *Flight Plan* and NextGen.

The *2008 NARP* explains how the R&D programs are progressing toward achieving the R&D milestones/targets. The plan also includes more detailed information on how the R&D programs support both the FAA *Operational Evolution Partnership (OEP)*, which provides the complete path for all FAA NextGen activities including R&D, and the *Joint Planning and Development Office (JPDO) Research and Development Plan for the Next Generation Air Transportation System FY 2009 – FY 2013*, published August 31, 2007, hereafter referred to as the *JPDO R&D Plan*, which provides the R&D requirements for NextGen.

Although the *2008 NARP* provides an update to the *2007 NARP*, there are a few structural changes in 2008. The former Chapter 3 has been updated and moved to Chapter 4, Research Business Management, to allow space for a new chapter on NextGen Alignment. Two new appendices have been added: Appendix B reports R&D accomplishments; and Appendix E maps R&D activities to NextGen requirements.

Chapter 1 of the *NARP* provides an overview of the national aviation system mission, vision, and goals that help the FAA define its R&D needs. Chapter 1 has been updated to reflect changes in the *Flight Plan* and NextGen planning, and it now includes a section on mid-term goals to reflect the importance of the *OEP* and FAA *Enterprise Architecture*.

Chapter 2 includes a master schedule and a high-level plan for each of the ten R&D goals. It integrates the R&D programs with the FAA goals and details how those programs will achieve R&D milestones. It explains how the R&D milestones will be

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

validated, and what outputs are required to achieve each milestone. The chapter now includes a summary of accomplishments in fiscal year 2007 for each R&D goal.

Chapter 3, as a new chapter, describes how the FAA NextGen R&D programs map to the domains and solution sets in the *OEP* and the R&D requirements in the *JPDO R&D Plan*. The FAA NextGen R&D programs and budget are the relevant subset of information presented in Chapter 2. Appendix E provides additional detail on program budgets and mapping of program activities to JPDO R&D requirements.

Chapter 4 provides business information on the R&D sponsors, programs, budget, partnerships, and evaluation. It presents the programs and the budget organized according to the President's budget submission for fiscal year 2009. This chapter has been updated to reflect the new NextGen R&D programs planned to begin in fiscal year 2009.

Appendix A provides the detailed program descriptions for each R&D program, including intended outcomes, outputs, programmatic structure, partnerships, accomplishments, and a five-year program plan.

Appendix B provides the detailed accomplishments for the R&D program in fiscal year 2007. It includes information previously reported in the *R&D Annual Review*.

Appendix C provides the detailed information on FAA partnerships with government, academic, and industry organizations. It lists information for fiscal year 2007 including active agreements with other government agencies, cooperative R&D agreements, patents, and grants. This appendix supports the partnership section in Chapter 4.

Appendix D provides the recommendations of the Research, Engineering and Development Advisory Committee (REDAC) listed according to the reports produced by the committee in fiscal year 2007. The FAA response to each recommendation is included. This appendix supports the evaluation section in Chapter 4.

Appendix E provides a detailed mapping of the FAA NextGen R&D programs and activities to the NextGen R&D requirements presented in the *JDPO R&D Plan*. The information is organized by the 12 categories of R&D needs in the *JPDO R&D Plan* that correspond to the domains and solution sets. This appendix supports Chapter 3.

Appendix F provides a list of acronyms and abbreviations for the *2008 NARP* and its appendices. All appendices are included in a separate volume from the main body of the *NARP*.

1.0 National Aviation System and FAA Research and Development

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

To realize these benefits, the United States must have an aviation system that is responsive to rapidly changing and expanding transportation needs. Increased mobility, higher productivity, and greater efficiency are possible through the introduction of new technologies and procedures, innovative policies, and advanced management practices. Collaborative, needs-driven research and development is central to this process. Research and development (R&D) enables the United States to be a world leader in its ability to move more people and goods by air safely, securely, quickly, affordably, efficiently, and in an environmentally sound manner.

1.1 Mission

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

The nation's aviation system, or air transportation system, provides a service: it moves anyone and anything (e.g., people, goods, aerospace vehicles) through the atmosphere between points on the earth's surface and between the Earth and space. It does this for a wide range of users (e.g., passengers, shippers, general aviation) and purposes (e.g., leisure and business travel, law enforcement, defense, emergency response, surveillance, research).

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

The air transportation system is designed, developed, maintained, and operated through the efforts of various Federal, state, and local government organizations; industry; labor unions; academia; and other domestic and international organizations. The public also plays a key role by paying taxes and user fees that are ultimately used by the government to regulate the aviation industry; develop, maintain and operate the air traffic management system; and provide airport security and other public aviation services.

1.2 Vision

In November 2003, the Secretary of Transportation set forth a vision to transform the nation's air transportation system into a substantially more capable system to ensure America maintains its leadership in global aviation. That vision, created by the Departments of Defense (DOD), Transportation (DOT), Homeland Security (DHS), and Commerce (DOC), the Federal Aviation Administration (FAA), the National Aeronautics and Space Administration (NASA), and the President's Office of Science and Technology Policy (OSTP), is "A transformed aviation system that allows all communities to participate in the global marketplace, provides services tailored to individual customer needs, and accommodates seamless civil and military operations."[2]

Vision: A transformed aviation system that allows all communities to participate in the global market place, provides services tailored to individual customer needs, and accommodates seamless civil and military operations.

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

The basic challenge posed by this vision is to:

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

while simultaneously:

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

To achieve this vision, the Secretary of Transportation established a set of long-term national goals to transform the current aviation system over the next 20 years into a next generation air transportation system (NextGen) that will contribute substantially to

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

continued economic prosperity, national security, and a higher standard of living for all Americans in the 21st century. These national goals are:

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

1.3 Long-term

In 2003, Congress created the multi-agency Joint Planning and Development Office (JPDO)[3] that reports to a Senior Policy Committee, chaired by the Secretary of Transportation, to oversee planning related to NextGen. The JPDO includes representatives from the DOD, DOT, DHS, DOC, FAA, NASA, and OSTP. Working together with industry and academia, the JPDO established a set of long-term system goals and objectives for NextGen.[4]

- **Retain U.S. leadership in global aviation**
  - Retain our role as the world leader in aviation
  - Reduce costs for air transportation
  - Enable services tailored to traveler and shipper needs
  - Encourage performance-based, harmonized global standards for U.S. products and services to keep new and existing markets open

- **Expand capacity**
  - Satisfy future growth in demand (up to 3 times current levels) and operational diversity
  - Reduce transit time and increase predictability (domestic curb-to-curb transit time cut by 30 percent)
  - Minimize the impact of weather and other disruptions (95 percent on time)

- **Ensure safety**
  - Maintain aviation's record as the safest mode of transportation
  - Improve the level of safety of the U.S. air transportation system
  - Increase the safety of worldwide air transportation

- **Protect the environment**
  - Reduce noise, emissions, and fuel consumption
  - Balance aviation's environmental impact with other societal objectives

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[3]Vision 100 – Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003.
[4]Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan* (http://www.jpdo.gov/library/NGATS_v1_1204r.pdf).

- **Ensure our national defense**
  - Provide for the common defense, while minimizing civilian constraints
  - Coordinate a national response to threats
  - Ensure global access to civilian airspace

- **Secure the nation**
  - Mitigate new and varied threats
  - Ensure security efficiently serves demand
  - Tailor strategies to threats, balancing costs and privacy issues
  - Ensure traveler and shipper confidence in system security

To achieve NextGen, the JPDO identified five guiding principles and eight key capabilities.[5] These capabilities provide a systems approach, support policy and cultural shifts, and contain multiple dependencies. The five guiding principles are:

- It's about the user
- System-wide transformation
- Proactive approach to safety risk management
- Global harmonization
- Integrated environmental performance

The eight capabilities are[6]:

- **Network-enabled information access –** This capability gives the right information to the right people at the right time, and meets system information needs of all users in the air and on the ground in a secure and useable form and in real time.

- **Performance-based operations and services –** This capability provides the air transportation system with the ability to transport people and goods to the desired destination on time, enables multiple service levels to a wide range of users, and tailors services to individual needs.

- **Weather-assimilated decision-making –** This capability provides a common weather picture to all pilots, air traffic controllers, and users.

- **Layered adaptive security –** This capability creates layers of defense to detect threats early, provide appropriate intervention using risk-based screening, and respond quickly if a threat materializes.

- **Broad-area precision navigation –** This capability provides navigation services when and where needed to enable aircraft operations in nearly all conditions.

[5] Joint Planning and Development Office, *Next Generation Air Transportation System 2006 Progress Report*, March 2007 (http://jpdo.gov/library/2006_Progress_Report.pdf).
[6] See http://www.jpdo.gov/key_capabilities.asp.

- **Aircraft trajectory-based operations –** This capability manages daily operations based on aircraft trajectories, adjusting the airspace structure to meet user needs and DOD and DHS requirements.
- **Equivalent visual operations –** The capability provides critical information needed to navigate without visual reference and maintain safe distances from other aircraft during non-visual conditions.
- **Super density operations –** This capability enables peak throughput performance at even the busiest airports.

Since its formation, the JPDO has focused its efforts to structure and guide the national transition to the NextGen vision. The products it is creating include:

- The *NextGen Integrated Plan*, December 12, 2004 - This Plan provides goals and objectives for NextGen, including three performance targets for the year 2025 that, if achieved, will reduce congestion by providing three times the capacity of our current aviation system with higher efficiency levels than we have today.
- The *NextGen Concept of Operations* (Version 2.0), June 13, 2007 - The final concept will provide an overall, integrated view of NextGen operations in the 2025 time frame, including key transformations from today's operations. Version 2.0 identifies key research and policy issues that require resolution to achieve NextGen.
- *NextGen Enterprise Architecture* (version 2.0), June 22, 2007 - The *Enterprise Architecture* provides traceability between the NextGen goals and its underlying technology to optimize performance. It compares the current state to the desired state to identify a transition plan to NextGen, and it determines how operations, investments, policies, processes, organizational structures, information, and systems must change to achieve NextGen.
- *NextGen Integrated Work Plan,* July 31, 2007 - This Plan describes the major implementation milestones, dependencies, responsibilities, and resources needed to achieve the end-state vision described in the *Concept of Operations* and detailed in the *NextGen Enterprise Architecture*.
- *NextGen R&D Plan*, August 31, 2007 - The Plan details the R&D requirements for needed technologies and identifies the responsibilities of each JPDO member agency. It focuses on fiscal years 2009 through 2013, and identifies R&D gaps and investment opportunities.

All of these documents will help define the R&D that the government, industry, and academia need to perform to achieve the desired operational capability in the 2025 timeframe. See www.jpdo.gov for additional information.

1.4 Mid-term

The *Operational Evolution Partnership* is the FAA's path to meet NextGen goals and respond to JPDO strategic direction. The new *Operational Evolution Partnership (OEP)* includes strategic milestones through the year 2025 to support the complete transition to NextGen. It includes not only R&D but all FAA NextGen related initiatives.

Currently, *OEP* focuses predominantly on the mid-term (2012-2018), since improvements are needed in this timeframe to deal with growing congestion. As FAA and JPDO long-term planning evolves, the *OEP* will move further towards the NextGen end-state vision for 2025.

The new *OEP* provides a structured framework for the FAA to plan, execute, and implement NextGen. The FAA will use this framework to obtain input from stakeholders; evaluate available technologies; define and prioritize research requirements; identify lead organizations; establish milestones and commitments; identify resource requirements; assess concept maturity; and provide oversight, status, and guidance for initiatives related to NextGen.

Figure 1.1 shows how the new *OEP* is structured and centered on improvements in the three core domains: air traffic operations; airport development; and aircraft and operator requirements.

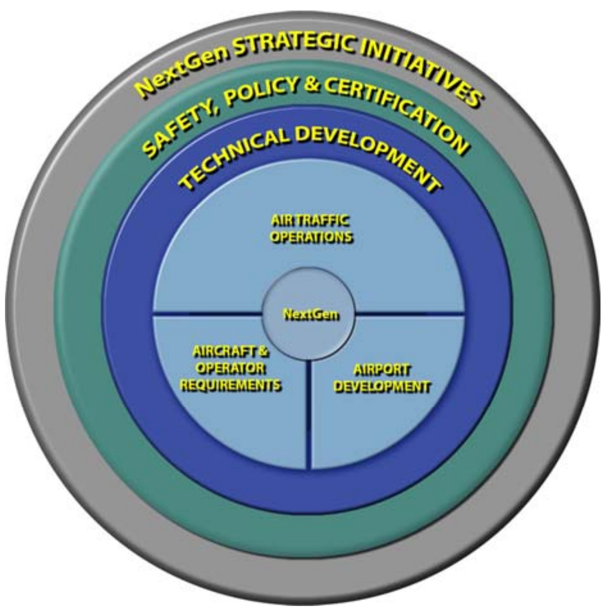

Figure 1.1: The *OEP* Structure and Framework

The new OEP will create a single entry point for new initiatives that cross all FAA lines of business to focus efforts and achieve NextGen in a fully coordinated and transparent manner. Figure 1.2 illustrates the types of research activities included in the new *OEP* process. A project will enter the outer rings. The ring a project enters will depend on project nature and maturity. The outermost ring contains the NextGen strategic initiatives. Tracking begins here and moves inward for applied research projects, concept development and demonstrations, policy determinations, safety analysis, performance standards, certification requirements, and field prototypes. The *OEP* aligns ATO activities and FAA R&D with NextGen objectives. When projects reach sufficient technological and operational maturity, *OEP* tracking follows into the core domains of air traffic operations, aircraft and operator requirements, and airport development as implementation in the National Airspace System (NAS) begins.

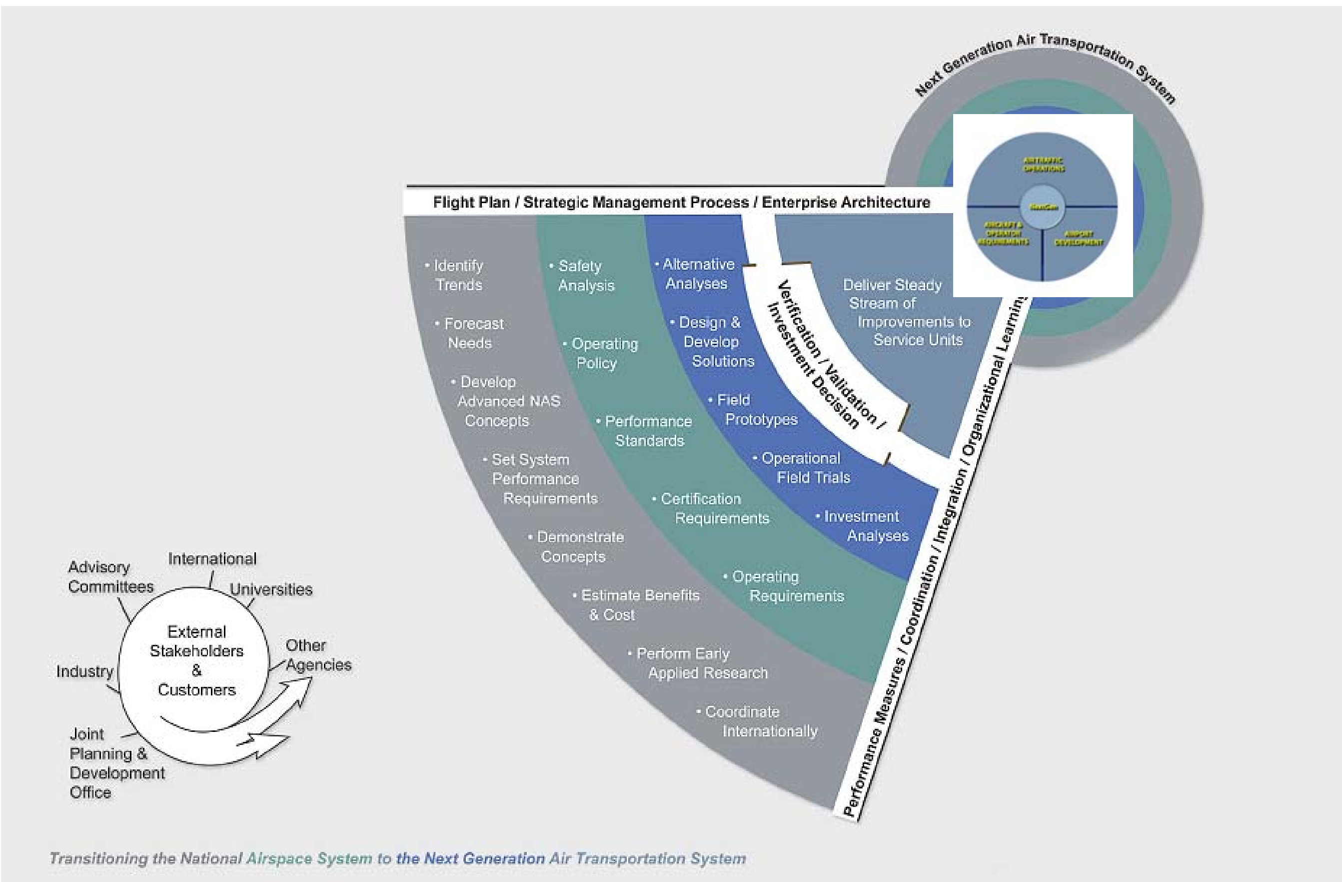

Figure 1.2: The *OEP* Outer Rings

The airport development domain focuses on adding airport infrastructure to provide greater capacity and delay reduction, particularly at the 35 OEP airports and at the 15 metropolitan area airports experiencing the greatest economic and population growth.

The aircraft and operator requirements domain concentrates on new aircraft and avionics functions, particularly pilot displays and controls and new aircraft-based independent sensors to permit trajectory-based operations and management. New technology creates avionics that are multi-functional, integrated, and flexible in nature, as compared to the discrete, stand-alone avionics components of the past.

The air traffic operations domain focuses on seven solution sets targeted to address capacity, efficiency, safety, and security of air transportation operations. These are:

- Initiate trajectory-based operations
- Increase arrivals/departures at high density airports
- Increase flexibility in the terminal environment
- Improve collaborative air traffic management
- Reduce weather impact
- Increase safety, security, and environmental performance
- Transform facilities

Each *OEP* solution set represents a portfolio of transformational capabilities. These capabilities are described more fully in Chapter 3 of this *NARP*. Each capability integrates activities from multiple programs in the FAA and in other agencies.

To enhance FAA performance and management control, each NextGen investment will be managed by FAA through an internal NextGen Service Level Agreement (NSLA). Each NSLA establishes the requirements and funding for the FAA investment, as well as the metrics necessary to ensure the requirements are met.

In the same mid-term time horizon, the agency is also developing the FAA *Enterprise Architecture (EA)*, which will include a transition strategy to NextGen. The *EA* will provide the mid-term target architecture for 2018 and the transition strategy to achieve that architecture. It will provide the operational and technical framework for all FAA capital assets, and will guide the Agency's annual *Capital Investment Plan (CIP)*. The *EA* also will support the NextGen longer-term architecture (2025 target), which is currently being developed by the JPDO. The FAA is working to ensure that the transition roadmaps and resulting architectures of the FAA and NextGen are aligned.

1.5 Near-term

The FAA has integrated its strategic planning efforts, as depicted in Figure 1.3. The *Flight Plan 2008-2012* describes the Agency's near-term performance goals and objectives[7]. Beyond the *Flight Plan* horizon, the *OEP* and the *Enterprise Architecture* constitute the mid-term planning framework. The JPDO is responsible for integrating all public and private sector efforts to achieve NextGen by 2025.

[7] Federal Aviation Administration, *2008-2012 Flight Plan*, September 2007 (http://www.faa.gov/about/plans_reports/media/FPP_Flight%20Plan%202008-2012.pdf).

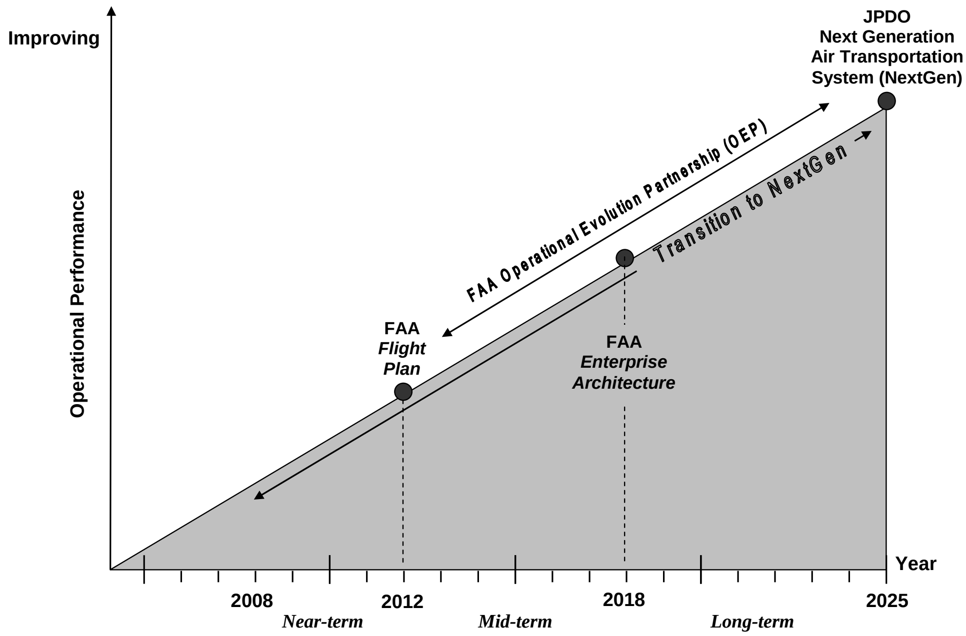

Figure 1.3 – FAA Integrated Planning

While the FAA is committed to supporting the long-term NextGen vision and the mid-term *OEP* needs, it also has the day-to-day responsibility to promote the safe and efficient operation of the current aviation system. The near-term priorities of the FAA are driven by the goals and objectives in its five-year strategic plan, *Flight Plan 2008-2012.* These are:

- **Increased Safety –** Achieve the lowest possible accident rate and constantly improve safety.
  - Reduce commercial air carrier fatalities
  - Reduce the number of fatal accidents in general aviation
  - Reduce the risk of runway incursions
  - Ensure the safety of commercial space launches
  - Enhance the safety of FAA's air traffic systems
  - Implement a Safety Management System (SMS) for the FAA.

- **Greater Capacity –** Work with local governments and airspace users to provide increased capacity in the United States airspace system that reduces congestion and meets projected demand in an environmentally sound manner.
  - Increase capacity to meet projected demand and reduce congestion
  - Increase reliability and on-time performance of scheduled carriers
  - Address environmental issues associated with capacity enhancements

- **International Leadership –** Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner.

- Promote improved safety and regulatory oversight in cooperation with bilateral, regional, and multilateral aviation partners
- Promote seamless operations around the globe in cooperation with bilateral, regional, and multilateral aviation partners

- **Organizational Excellence –** Ensure the success of the FAA's mission through stronger leadership, a better-trained and safer workforce, enhanced cost-control measures, and improved decision-making based on reliable data.
  - Make the organization more effective with stronger leadership, increased commitment of individual workers to fulfill organization-wide goals, and a better prepared, better trained, safer, diverse workforce
  - Improve financial management while delivering quality customer service
  - Make decisions based on reliable data to improve our overall performance and customer satisfaction
  - Enhance our ability to respond to crises rapidly and effectively, including security-related threats and natural disasters

1.6 Research and development

The FAA R&D program includes both applied research and development as defined by the Office of Management and Budget Circular A-11. Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which recognized and specific needs may be met. Development is defined as systematic application of knowledge or understanding directed toward production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.[8]

The FAA uses R&D to achieve its mission goals and objectives. In the past, the R&D program was driven by the near-term operational needs of the aviation system, and a large share of the agency's R&D was focused on specific near-term safety and capacity issues. Today, with the NextGen plan, the R&D program is more flexible, balanced, and dynamic so it can respond simultaneously to the critical near-term needs of the system while providing a foundation for the next generation system.

R&D Mission: 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.

1.6.1 Mission

The FAA R&D mission is to, "Conduct, coordinate, and support domestic and international R&D of aviation-related products and services that will ensure a safe, efficient, and environmentally sound global air transportation system." It supports a range of research activities

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

from materials and human factors to the development of new products, services, and procedures.

1.6.2 Organizational values

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

R&D Vision: Provide the best air transportation system through the conduct of world-class, cutting edge research, engineering and development.

The Agency R&D program adopted the following values:

- **Goal driven –** Achieve the mission. The FAA uses R&D as a primary enabler to accomplish its goals and objectives.
- **World class –** Be the best. The FAA delivers world-class R&D results that are high quality and relevant, and improve the performance of the aviation system.
- **Collaborative –** Work together. The FAA partners with other Federal departments and agencies, industry, and academia to capitalize on national R&D capabilities to transform the air transportation system.
- **Innovative –** Turn ideas into reality. The FAA empowers, inspires, and encourages its people to invent new aviation capabilities. It creates new ways of doing business to accelerate the introduction of R&D results into new and better aviation products and services.
- **Customer focused –** Deliver results. The FAA R&D program delivers quality products and services to the customer quickly and affordably.

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

1.6.3 Research goals

The FAA R&D program supports both the day-to-day operations of the national aerospace system and the development of NextGen. Hence, a long-term focus will have to be balanced with the research needed to address the day-to-day safety and capacity issues of the national aerospace system. To achieve balance between the near- , mid-, and long-term, the FAA defined ten crosscutting R&D goals to focus and integrate its program. As shown in Table 1.1, the R&D goals are aligned with the near-term *Flight Plan* goals, the mid-term *OEP* domains and solution sets, and the long-term goals, guiding principles, and key capabilities identified for NextGen.

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

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

Table 1.1, Alignment of Goals, shows the primary relationship among the *Flight Plan* goals, the FAA R&D[9] goals, the *NextGen Integrated Plan* goals, the NextGen guiding principles and key capabilities, and the *OEP* domains and solution sets.

[9] Each FAA R&D goal is aligned with its primary *Flight Plan* goal recognizing that there may be crossover relationships. For example, high quality teams and individuals is aligned with organizational excellence; however, it will also increase safety and support greater capacity.

<table>
<tr><th>Flight Plan
Goals</th><th>FAA R&D Goals</th><th>OEP
Domains and Solution Sets</th><th>NextGen
Guiding Principles and Key Capabilities</th><th>NextGen Integrated Plan
Goals</th></tr>
<tr><td rowspan="2">Greater Capacity</td><td>Fast, flexible, and efficient</td><td>Airport Development
Air Traffic Operations
Initiate Trajectory-Based Operations
Reduce Weather Impact
Increase Flexibility in the Terminal Environment
Increase Arrivals/Departures at High Density Airports
Improve Collaborative Air Traffic Management
Transform Facilities</td><td>Aircraft trajectory-based operations
Broad-area precision navigation
Equivalent visual operations
Performance-based services
Super-density operations
Weather assimilated into decision-making</td><td>Expand Capacity</td></tr>
<tr><td>Clean and quiet</td><td rowspan="3">Improve Safety, Security, and Environmental Performance

Aircraft and Operator Requirements</td><td>Integrated environmental performance</td><td>Protect the Environment</td></tr>
<tr><td>Increased Safety</td><td>Human-centered design
Human protection
Safe aerospace vehicle
Self separation
Situational awareness
System knowledge</td><td>Proactive safety risk management</td><td>Ensure Safety</td></tr>
<tr><td>--</td><td>--</td><td>Layered adaptive security
Net-enabled information access</td><td>Secure the Nation
Ensure our National Defense</td></tr>
<tr><td>International Leadership</td><td>World leadership</td><td>--</td><td>Global harmonization</td><td rowspan="2">Retain U.S. Leadership in Global Aviation</td></tr>
<tr><td>Organizational Excellence</td><td>High quality teams and individuals</td><td>--</td><td>User focused</td></tr>
</table>

Table 1.1 – Alignment of Goals

2.0 Master Schedule

This chapter presents a Federal Aviation Administration (FAA) research and development (R&D) master schedule to help align, plan, and evaluate R&D activities to support the near-term needs of the *Flight Plan,* the mid-term needs of the *Operational Evolution Partnership (OEP),* and the long-term needs of the next generation air transportation system (NextGen).

The *2005 National Aviation Research Plan (NARP)* aligned the FAA R&D programs with the goals, objectives, and performance targets in the *Flight Plan* and suggested possible connections between the *Flight Plan* performance targets and the goals and objectives in the *NextGen Integrated Plan*.

The *2006 NARP* strengthened the alignment between the near-term and long-term by proposing common performance measures to span the next 20 years. The notional performance targets for 2025 formed ten R&D goals and allowed the creation of R&D milestones/targets. The ten R&D goals are:

- Fast, flexible, and efficient
- Clean and quiet
- High quality teams and individuals
- Human-centered design
- Human protection
- Safe aerospace vehicles
- Self-separation
- Situational awareness
- System knowledge
- World leadership

The 2007 *NARP* provided a high-level plan for each R&D goal to show how the R&D programs are working together to achieve the R&D milestones. Each R&D milestone involves a demonstration. The demonstrations will prove concepts. The purpose of the demonstration is to show that it is possible to meet the notional target by 2025. By pursuing the R&D milestones/targets, we will identify barriers and find solutions that overcome those barriers.

The *2008 NARP* explains how the R&D programs are progressing toward achieving the R&D milestones/targets in a summary of accomplishments for each R&D goal in this chapter. The plan also includes more detailed information on how the R&D programs support both the FAA *Operational Evolution Partnership (OEP)* and the *Joint Planning and Development Office (JPDO) R&D Plan*. This additional information is provided in Chapter 3 and Appendix E.

For each of the ten R&D goals in this chapter, there is a statement of the R&D goal and the R&D milestone/target. Then, there is a method of validation that describes what will be done in terms of modeling, simulation, physical demonstration, or initial standards to demonstrate completion of the R&D milestone. The method of validation is followed by an outline of activities that include the major outputs required to achieve the R&D milestone. The activities are organized to provide insight into what outputs need to be accomplished when, and how each output contributes to the plan. The outputs will be used to measure progress toward achieving the R&D milestone. There is a funding summary for each goal and a summary of accomplishments toward achieving the R&D goal that occurred during the past year.

The plan identifies contributing programs and provides assignments for delivery responsibilities for each program. Multiple programs work together to achieve the final demonstration. Some programs contribute more to near-term results while others focus on long-term objectives. Some programs reflect existing efforts, while others identify new requirements. This approach will help the FAA balance its R&D program to address near-term needs while making progress toward achieving mid-term and long-term goals.

> Figure 2.1, Notional Targets for 2025, explains the derivation of the notional targets. The *NextGen Integrated Plan* objectives are applied to the *Flight Plan* performance targets. The capacity targets provide the connection and drive the other targets for safety and organizational excellence. The intent is to maintain an acceptable level of safety given an increase in capacity to three times current levels. For organizational excellence, the intent is to provide three times capacity without a commensurate increase in cost.
>
> Figure 2.2, R&D Goals and Milestones, shows how the notional targets for 2025 drive the R&D goals and R&D milestones. Achieving the R&D milestones will demonstrate that it is possible to meet the notional target by 2025. The R&D milestones focus on the mid-term to allow time for implementation of new regulations, standards, technologies, systems, and procedures.
>
> Figure 2.3, Concept for Master Schedule, illustrates how the master schedule integrates and focuses the FAA R&D programs through the R&D milestones to achieve the notional targets for 2025 while bridging the goals of the *Flight Plan* and the *NextGen Integrated Plan*.
>
> Table 2.1, Map of R&D Programs to R&D Goals and Milestones, shows how the R&D programs support the R&D goals and R&D milestones. The intent is to identify clear responsibilities so that each program focuses on a specific or limited number of R&D goals.

Flight Plan Goals & Performance Targets[1] (near-term)

Increased Safety
- Reduce commercial air carrier fatalities
- Reduce the number of fatal accidents in general aviation
- Reduce the risk of runway incursions
- Ensure the safety of commercial space launches
- Enhance the safety of FAA air traffic systems
- Reduction of category A/B operational errors
- Implement Safety Management System

Greater Capacity
- Increase average OEP daily airport capacity
- Increase annual service volume at airports
- Sustain adjusted operational availability for facilities
- Increase on-time arrival rates
- Reduce the number of people exposed to noise
- Improve aviation fuel efficiency

International Leadership
- Work with China and India on safety enhancements
- Increase the exchange of aviation products and services
- Strengthen global aviation infrastructure
- Expand the use of NextGen concepts

Organizational Excellence [2]
- Increase Employee Attitude Survey scores
- Reduce costs and improve productivity
- Increase agency scores on the American Customer Satisfaction Index

Notional Targets for 2025

- Reduce commercial air carrier fatalities
- Reduce the number of GA fatal accidents
- Reduce the rate of runway incursions
- No commercial space launch fatalities or injuries
- Reduce the rate of accidents in Alaska
- Reduce the rate of operational errors
- Manage and mitigate risk

- Increase average daily airport capacity to 3 times current levels (proposed)
- Increase on-time arrival rate to 95%
- Reduce gate-to-gate transit time by 30%
- Reduce the number of people exposed to noise
- Improve aviation fuel efficiency

- Reduce time and cost to market for products and services (e.g., regulations, technologies, standards, procedures)
- Increase use of U.S. aviation-related products and services

- Increase controller efficiency to 3 times current levels (proposed)
- Reduce costs and improve productivity
- Increase Employee Attitude Survey scores
- Increase agency scores on the American Customer Satisfaction Index

NextGen Integrated Plan Goals & Performance Targets[3] (long-term)

Ensure Safety

Expand Capacity
- Increase capacity to 3 times current levels
- Reduce curb-to-curb transit time by 30%
- Increase on-time arrival rates to 95%

Protect the Environment

Retain U.S. Leadership in Global Aviation

Ensure Our National Defense

Secure the Nation

Notes:
1 The *Flight Plan* performance targets are generalized to indicate the type of measure used.
2 Organizational Excellence includes additional performance targets that are not listed here.
3 The *NextGen Integrated Plan* includes three performance targets in the objectives under the capacity goal.

Figure 2.1 – Notional Targets for 2025

Notional Targets for 2025	R&D Goals	R&D Milestones
Increased Safety		
– Reduce commercial air carrier fatalities – Reduce the rate of GA fatal accidents – Reduce the rate of accidents in Alaska – No commercial space launch fatalities or injuries	**Human protection**	Demonstrate a two-thirds reduction in the rate of aerospace-related fatalities and significant injuries
	Safe aerospace vehicles	Demonstrate damage and fault tolerant vehicles and systems
– Reduce the rate of runway incursions – Reduce the rate of operational errors	**Self-separation**	Develop initial standards and procedures for self-separation
	Situational awareness	Demonstrate common real-time awareness of ongoing air operations, events, crises, and weather at all types of airports by pilots and controllers
	Human-centered design	Demonstrate that operations (e.g. day and night, all weather), procedures, and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft
– Manage and mitigate risk	**System knowledge**	Understand economic (including implementation) and operational impact of system alternatives
Greater Capacity		
– Increase average daily airport capacity to 3 times current levels (proposed) – Increase on-time arrival rate to 95% – Reduce gate-to-gate transit time by 30%	**Fast, flexible, and efficient**	Demonstrate the system can handle growth in demand up to three times current levels; demonstrate that gate-to-gate transit time can be reduced by 30 percent
– Reduce the number of people exposed to noise – Improve aviation fuel efficiency	**Clean and quiet**	Demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (to enable three times capacity) in a cost effective way and reduce uncertainties in particulate matter and climate impacts to levels that enable appropriate actions
International Leadership		
– Reduce time and cost to market for products and services (e.g., regulations, technologies, standards, procedures) – Increase the use of U.S. aviation-related products and services	**World leadership**	Demonstrate the value of working with international partners to leverage research programs and studies in order to improve safety and promote seamless operations worldwide
Organizational Excellence		
– Increase controller efficiency to 3 times current levels (proposed) – Reduce costs and improve productivity – Increase Employee Attitude Survey scores – Increase agency scores on the American Customer Satisfaction Index	**High quality teams and individuals**	Demonstrate three times improvement in air traffic controller efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operations, procedures, and information

Figure 2.2 – R&D Goals and Milestones

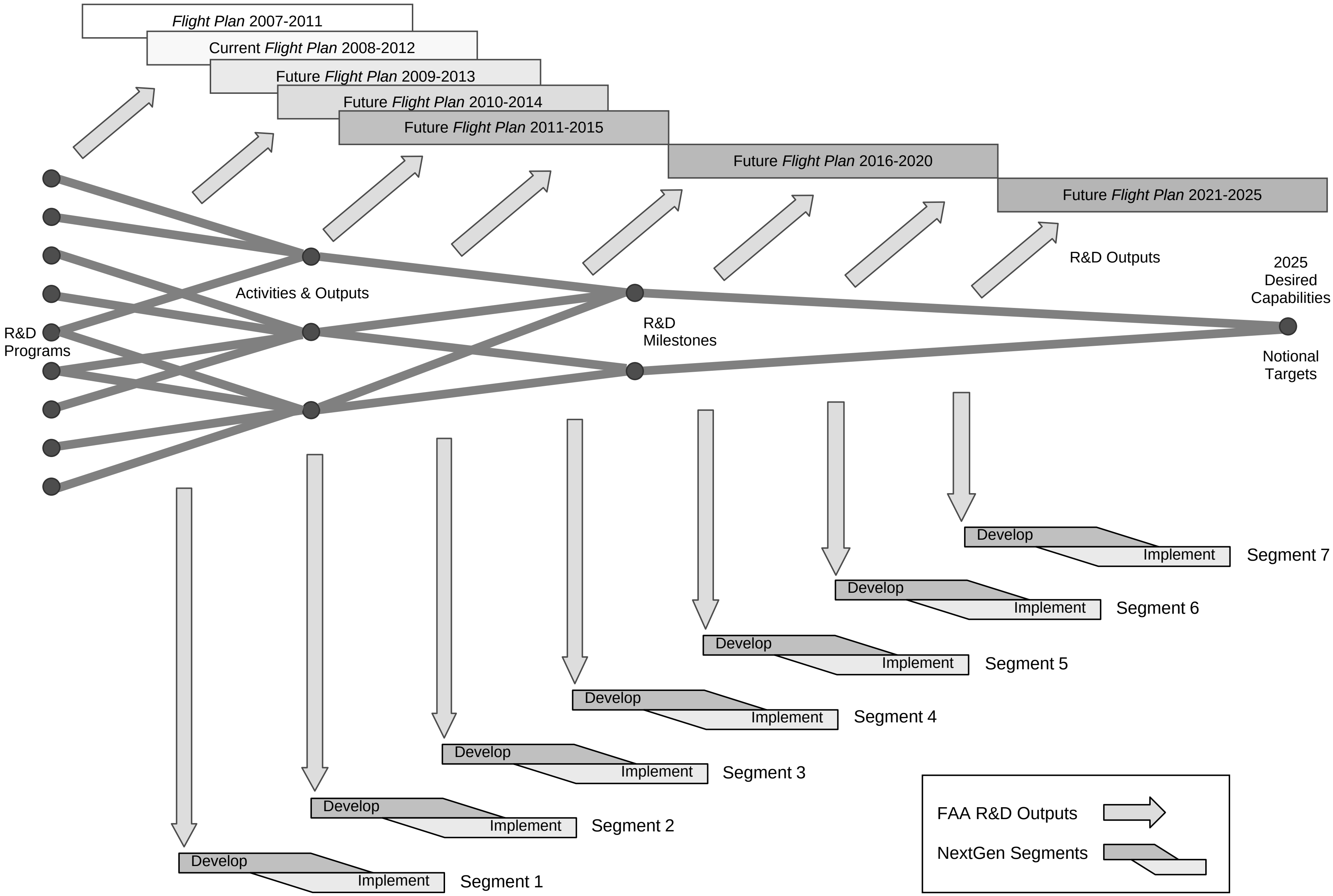

Figure 2.3 – Concept for Master Schedule

			R&D Programs																																											
			Advanced Materials/Structural Safety	Aeromedical Research	Aging Aircraft/Continued Airworthiness	Airspace Management Laboratory	Airspace Redesign	Aircraft Catastrophic Failure Prevention Research	Airport Cooperative Research - Capacity	Airport Cooperative Research - Environment	Airport Cooperative Research - Safety	Airports Technology Research - Capacity	Airports Technology Research - Safety	Air Traffic Control/Technical Operations Human Factors	Atmospheric Hazards/Digital System Safety	Aviation Safety Risk Analysis/System Safety Management	Center for Advanced Aviation System Development (CAASD)	Commercial Space Transportation Safety	Environment and Energy	Fire Research and Safety	Flightdeck/Maintenance/System Integration Human Factors	Joint Planning and Development Office (JPDO)	NAS Weather Requirements	NextGen - Air Ground Integration	NextGen - ATC Technical Ops Human Factors - Air/Ground Integration	NextGen - ATC/Technical Ops Human Factors - Controller Efficiency	NextGen - Demonstrations and Infrastructure Development	NextGen - Environment and Energy - Advanced Noise and Emissions Reduction	NextGen - Environment and Energy - Validation Modeling	NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics	NextGen - New ATM Requirement	NextGen - Operations Concept Validation - Validation Modeling	NextGen - Self Separation	NextGen - System Safety Management Transformation	NextGen - Wake Turbulence - Re-categorization	NextGen - Weather Technology in the Cockpit	Operations Concept Validation	Propulsion and Fuel Systems	Runway Incursion Reduction	System Capacity, Planning and Improvement	System Planning and Resource Management	Unmanned Aircraft Systems Research	Wake Turbulence	Weather Program	Wind Profiling and Weather Research - Juneau	William J. Hughes Technical Center Laboratory Facility
	R&D Goal & Description	R&D Milestone	A11.c.	A11.j.	A11.e.	1A01E	1A01F	A11.f.	–	–	–	–	–	A11.l.	A11.d.	A11.h.	4A09A	–	A13.a.	A11.a.	A11.g.	A12.a.	1A01D	A12.c.	1A09B	1A09A	1A08	1A09C	1A09D	A13.b.	1A09E	1A09F	A12.d.	1A09G	1A09H	A12.e.	1A01C	A11.b.	1A01A	1A01B	A14.a.	A11.l.	A12.b.	A11.k.	1A01I	A14.b.
1	**Fast, flexible, and efficient** *A system that safely and quickly moves anyone and anything, anywhere, anytime on schedules that meet customer needs*	By 2016, demonstrate that the system can handle growth in demand up to three times current levels By 2016, demonstrate that gate-to-gate transit time can be reduced by thirty percent							X			X					X					X					X				X				X								X	X		
2	**Clean and quiet** *A reduction of significant aerospace environmental impacts in absolute terms*	By 2016, demonstrate that aviation noise and emissions can be significantly reduced in absolute terms (to enable three times capacity) in a cost effective way and reduce uncertainties in particulate matter and climate impacts to levels that enable appropriate actions.								X							X		X			Coordinate						X		X																
3	**High quality teams and individuals** *The best qualified and trained workforce in the world*	By 2016, demonstrate three times improvement in air traffic controller efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operations, procedures, and information												X			X					Coordinate				X																				
4	**Human-centered design** *Aerospace systems that adapt to, compensate for, and augment the performance of the human*	By 2016, demonstrate that operations (e.g., day and night, all weather), procedures, and information can be standard and predictable for users (e.g., pilots, controllers, airlines, passengers) at all types of airports and for all aircraft														Coordinate	X				X	Coordinate		X	X										Coordinate	Coordinate										X
5	**Human protection** *No fatalities, injuries, or adverse health impacts due to aerospace operations*	By 2015, demonstrate a two-thirds reduction in the rate of areospace-related fatalities and significant injuries	Coordinate	X							X		X		X			X		X																								X		
6	**Safe aerospace vehicles** *No accidents and incidents due to aerospace vehicle design, structure, and subsystems*	By 2015, demonstrate damage and fault tolerant vehicles and systems	X		X			X							X		X	X		X																		X				X				
7	**Self-separation** *No accidents and incidents due to aerospace vehicle operations in the air and on the ground*	By 2016, develop initial standards and procedures for self-separation												Coordinate								Coordinate											X										Coordinate			
8	**Situational awareness** *Common, accurate, and real-time information of aerospace operations, events, crises, obstacles, and weather*	By 2015, demonstrate common real-time awareness of ongoing air operations, events, crisis, and weather at all types of airports by pilots and controllers									X		X	Coordinate			X					Coordinate	X													X			X				X	X	X	
9	**System knowledge** *A thorough understanding of how the aerospace system operates, the impact of change on system performance and risk, and how the system impacts the nation*	By 2016, understand economic (including implementation) and operational impact of system alternatives			X	X	X									X	X					X							X			X		X			X			X		X				
10	**World leadership** *A globally recognized leader in aerospace technology, systems, and operations*	By 2016, demonstrate the value of working with international partners to leverage research programs and studies in order to improve safety and promote seamless operations worldwide.	Coordinate	Coordinate										Coordinate		Coordinate			Coordinate							Coordinate								Coordinate		Coordinate					X		Coordinate			

Table 2.1 – Map of R&D Programs in 2009 to R&D Goals and Milestones

2.1 Fast, flexible, and efficient

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

R&D milestones/targets

By 2016, demonstrate that the system can handle growth in demand up to three times current levels[10] and demonstrate that gate-to-gate transit time can be reduced by thirty percent.[11]

Method of validation

The approach includes developing and demonstrating NextGen capabilities according to the FAA responsibilities in the JPDO plan and continuing ongoing efforts related to increasing airport capacity and reducing costs. Validation of the R&D milestones will include a combination of modeling, analysis, full scale testing, and initial standards. The capacity evaluation under the system knowledge goal supports the interim assessment of progress and validation of this milestone.

Activities

1. NextGen demonstrations
   Develop and demonstrate NextGen technologies and concepts.

   1.1. Demonstrate super-density operations. (NextGen Demonstrations and Infrastructure Development, JPDO, CAASD)
   - 2008: Demonstrate Traffic Management Advisor (TMA) and Area Navigation / Required Navigation Performance (RNAV/RNP) routing to increase throughput and efficiency for large, super density airports.
   - 2010: Demonstrate greater throughput in congested, domestic, en route airspace using point-in-space metering linked to RNAV/RNP routes.

   1.2. Demonstrate trajectory-based operations. (NextGen Demonstrations and Infrastructure Development, JPDO, CAASD)
   - 2008: Demonstrate improved trajectory-based operations in mixed-equipage, oceanic airspace with actual aircraft and procedures.
   - 2008: Demonstrate standard separation in a full-equipage, fully automated environment with no voice communication.
   - 2011: Demonstrate trajectory-based operations in transitional airspace, between oceanic and domestic en route, using oceanic data link and Advanced Technologies and Oceanic Procedures (ATOP) automation.

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

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

2013: Demonstrate trajectory-based operations in mixed-equipage, high altitude airspace with actual aircraft and procedures.
2015: Demonstrate auto-negotiations between flight automation and ground automation without human intervention.

2. Airport capacity
   Increase airport capacity while reducing costs.
   2008: Increase airport capacity. (Airport Cooperative Research - Capacity)
   2012: Develop new standards and guidelines for runway pavement design. (Airports Technology Research - Capacity)

3. Wake turbulence
   Reduce separation with procedures only.
   2008: Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions. (Wake Turbulence)
   Demonstrate wake turbulence avoidance technologies and procedures.
   2012: Demonstrate wake turbulence separation changes in en-route airspace. (Wake Turbulence)
   2012: Develop safe wake-encounter, wake-avoidance zone and wake-free zone concepts. (Wake Turbulence)
   2012: Determine characteristics of arriving and departing aircraft wakes. (Wake Turbulence)
   2012: Develop new separation standards and procedures for wake-independent departures from parallel runways. (Wake Turbulence)
   2015: Demonstrate reduced longitudinal separations for arrival and departure operations. (NextGen Wake Turbulence - Re-categorization)

4. Aviation weather
   Reduce weather related delays to increase on time arrival rate and reduce transit time. (Weather Program)
   2009: Develop CONUS ceiling, visibility, and flight category forecast capability.
   2010: Implement Mountain-Wave Turbulence Forecasts.
   2011: Develop consolidated conventional weather forecast capability.
   2012: Implement Global Turbulence Forecasts.
   2013: Implement turbulence forecast capability for all flight levels operationally.

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
--	Airport Cooperative Research Program - Capacity	AIP	2,000	5,000	5,000	5,000	5,000	5,000	100% of capacity component
--	Airports Technology Research - Capacity	AIP	8,907	9,109	9,109	9,109	9,109	9,109	100% of total program
4A09A	Center for Advanced Aviation System Development	ATO Capital	8,974	7,439	8,810	11,159	11,648	12,236	26% of total R&D program in FY 2009-2013
--	GPS Civil Requirements	R,E&D	3,100	0	0	0	0	0	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	10,025	10,146	10,192	10,067	9,937	9,799	70% of total program
--	Local Area Augmentation Sysm (LAAS)	ATO Capital	1,000	0	0	0	0	0	100% of total program
1A08	NextGen Demonstration	ATO Capital	10,000	28,000	30,000	30,000	30,000	30,000	50% of R&D program in FY 2008 only
1A09E	NextGen - New ATM Requirement	ATO Capital	0	5,400	27,500	27,900	29,200	31,900	100% of total program
1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	2,000	2,000	2,000	2,000	2,000	100% of total program
--	Wake Turbulence	ATO Capital	3,000	0	1,000	1,000	1,000	1,000	100% of total program
A12.b.	Wake Turbulence	R,E&D	8,000	7,370	7,605	7,865	7,745	7,626	73% of total program
A11.k.	Weather Program	R,E&D	1,689	1,697	1,695	1,662	1,626	1,589	10% of the program
	Total ($000)		56,695	76,161	102,911	105,762	107,265	110,258	

Progress in FY 2007: Fast, flexible, and efficient

- **Airport Pavement Design:** Completed research supporting the delivery of new Advisory Circular 150/5320-6E "Airport Pavement Design and Evaluation." Developed new pavement design program, the FAA Rigid and Flexible Iterative Elastic Layer Design 1.0 (FAARFIELD). FAARFIELD has the potential to save the FAA and airport authorities tens of thousands of dollars in airport pavement redesign efforts. (Airport Technology Research - Capacity)
- **Wake Turbulence Operational Change**: Based on wake turbulence data collected and analyzed by the Wake Turbulence Research Program, the FAA approved the requested change for Lambert-St. Louis International Airport (STL) air traffic control's operation of its closely spaced runways. The change allows STL to conduct dependent instrument landing system (ILS) approaches to both its parallel runways under weather conditions that previously would have caused the airport to shift to single runway operations (effectively closing one of its parallel runways). (Wake Turbulence)
- **Performance Based Navigation:** Conducted controller Human-in-the-loop (HITL) experiments at Palm Beach and Las Vegas TRACONs to obtain feedback on near-term terminal spacing and merging tools and mid-term controller alerting tools based on higher traffic levels and extensive use of Performance-Based Navigation (PBN) terminal routes. (CAASD)
- **Increased Capacity:** Developed a concept for the integration of Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures with Traffic Flow Management (TFM) and other functional capabilities to increase overall

system benefits and movement toward performance-based NAS and NextGen goals. Performed simulations that couple RNAV and RNP with TFM to illustrate increases in user benefits and reduce controller workload per flight hour. (CAASD)

- **Super Density Operations:** Developed and documented a system concept for all-weather super density operations. The concept identifies the airports and metropolitan areas where super density operations will be needed, documents the operational limitations associated with these locations, and identifies potential means for overcoming these limitations. Operational performance improvements were analyzed using simulation models of metropolitan areas, and documented in open publications. (CAASD)
- **Merging and Spacing Concepts:** Developed and executed two pilot and controller HITL simulations that continued to mature the merging and spacing concept, influenced equipment design, illuminated problem areas, and supported initial benefits projections. Simulation results supported FAA certification and the expected operational approval, which will allow the FAA and the airline to start realizing initial benefits. (CAASD)

2.2 Clean and quiet

A reduction of significant aerospace environmental impacts in absolute terms

R&D milestone/target

By 2016, demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms (to enable three times capacity) in a cost-effective way and reduce uncertainties in particulate matter and climate impacts to levels that enable appropriate action.

Method of validation

The approach has four parts: measure current levels in the system; determine the target levels of noise and emissions; build models to assess and predict the impact of change; and develop reduction techniques and assess their cost-benefit. Validation of the R&D milestone will include modeling, physical demonstrations, prototypes, full-scale tests, and software beta tests. The environmental evaluation under the system knowledge goal supports the interim assessment of progress and validation of this milestone.

Activities

1. Baseline measurement

    Measure current levels of aviation related noise and emissions.

    2009: Develop methodologies to quantify and assess the impact of Particulate Matter and Hazardous Air Pollutants (HAP). (Environment and Energy, Airport Cooperative Research - Environment)

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

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

    2012: Expand noise data collection to very light jets, and supersonic aircraft. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2. Threshold levels

    Determine acceptable levels of noise and emissions.

    2009: Develop new standards and methodologies to quantify and assess the impact of aircraft noise and aviation emissions. (Environment and Energy, Airport Cooperative Research - Environment)

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

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

    2011: Determine how aviation generated particulate matter and hazardous air pollutants impact local health, visibility, and global climate. (NextGen

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

3. Prediction

Develop models to predict the impact and benefits of changes.

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

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

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

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

2011: Complete development of first generation ground plume model for aircraft engine exhaust. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

2013: Complete development and field a fully validated suite of tools, including the Aviation Environmental Design and Aviation Environmental Portfolio Management tools, which will allow cost benefit analyses. (Center for Advanced Aviation System Development (CAASD), Environment and Energy, Airport Cooperative Research - Environment)

2014: Update environmental assessments models to incorporate new noise metrics. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

4. Reduction techniques

Develop noise and emission reduction methods.

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

2010: Develop algorithms to optimize ground and airspace operations by leveraging communication, navigation and surveillance technology in the short- to medium-term to optimize aircraft sequencing and timing on the surface and in the terminal area. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics, CAASD)

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

2012: Identify and pursue the development of engine and airframe technologies that will be the most effective at producing environmental benefits. (NextGen - Environment and Energy - Advanced Noise and Emissions Reduction)

2013: Demonstrate optimized airport and terminal area operations that reduce or mitigate aviation impacts on noise, air quality or water quality in the vicinity of the airport. (NextGen - Environment and Energy - Advanced Noise and Emissions Reduction, Airport Cooperative Research - Environment, JPDO)

2013: Establish engine design sensitivities by measuring particles emitted from combustor engine systems. (NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics)

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

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

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
--	Airport Cooperative Research Program - Environment	AIP	3,000	5,000	5,000	5,000	5,000	5,000	100% of environment component
4A09A	Center for Advanced Aviation System Development	ATO Capital	0	158	187	237	248	260	1% of total R&D program in FY 2009-2013
A13.a.	Environment and Energy	R,E&D	15,469	15,608	15,670	15,467	15,253	15,028	100% of total program
A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	16,050	19,700	20,368	20,034	19,700	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	0% coordination only
1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	0	2,500	12,500	12,500	12,500	12,500	100% of total program
	Total ($000)		18,469	39,316	53,057	53,572	53,035	52,488	

Progress in FY 2007: Clean and quiet

- **Environmental Software Tools:** Completed demonstration of a comprehensive suite of environmental software tools: aviation noise/emission sciences, aircraft technology forecasting, and cost of environmental impacts for aviation. These new capabilities are the cornerstone of a new comprehensive approach to assessing environmental policies – helping to guide policies and actions that cost FAA $500 million per year in mitigation costs and industry $5-6 billion in implementation costs. [12] (Environment and Energy)

[12] FAA costs were included in the National Research Council 2002 report "For Greener Skies: Reducing Environmental Impacts of Aviation" and industry costs were based on analyses conducted by the International Civil Aviation Organization Committee on Aviation Environmental Protection (ICAO/CAEP)

- **Alternative Aviation Fuels:** In partnership with the Commercial Aviation Alternative Fuels Initiative (CAAFI), completed a comprehensive feasibility study for commercial alternative aviation fuels, including an assessment of the net environmental impacts, production potential, and costs. The effort is a key step to develop alternative fuels to ensure an affordable and stable supply of environmentally progressive aviation fuels. (Environment and Energy)
- **Aircraft Low Frequency Noise:** The Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence completed a four-year study on aircraft low frequency noise (LFN). The effort provided a much-needed methodology for assessing the potential for a given location to have a low-frequency noise problem. (Environment and Energy)
- **Continuous Descent Approach:** Completed operational implementation of Continuous Descent Arrival (CDA) procedure at Los Angeles International Airport (LAX). The CDA and conventional arrivals are both enhanced due to added optimized aircraft separation criteria that address the broader mix of fleet traffic types. (Environment and Energy)
- **Aircraft Emissions:** The FAA and the Environmental Protection Agency (EPA) completed a congressionally directed study under the Energy Policy Act of 2005 (EPACT) to identify the impact of aircraft emissions in areas of poor air quality and ways to improve fuel efficiency and reduce emissions. The FAA and EPA are using the study findings to help guide emissions mitigation activities. (Environment and Energy)

2.3 High quality teams and individuals

The best qualified and trained workforce in the world

R&D milestone/target

By 2016, demonstrate three times[13] improvement in air traffic controller efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operations, procedures, and information.

Method of validation

The approach includes continued, incremental pursuit of efficiency gains in en route and pursuit of new knowledge and results that produce efficiency gains in terminal and tower. The baseline for all demonstrations will be 2004 traffic levels. Validation of the interim measures and R&D milestone rely on simulation and prototyping. Validation will involve field trials only to the extent that resources and funding are available. This goal contributes to the integrated demonstration under the human-centered design goal.

Activities

1. Increase to 130 percent

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

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

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

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

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

2. Increase to 166 percent.

   Demonstrate 166 percent controller efficiency. (NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency)

   2010: Measure efficiency improvements where aircraft are grouped and en route controllers communicate to the group as a whole.

   2010: Explore the use of digital data link to reduce controller workload in the terminal area including data entry requirements and workload benefits.

   2010: Identify benefits in the terminal domain of variable separation criteria, including enhanced visual flight rules where some responsibility is transferred to the pilot.

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[13] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, http://www.jpdo.gov/library/NGATS_v1_1204r.pdf. Three times increase in air traffic controller efficiency and effectiveness is based on the JPDO objective for 2025 to "Satisfy future growth in demand (up to 3 times current levels) and operational diversity." It assumes that there will be no increase in the number of controllers.

2010: Define requirements and characteristics for merging and spacing tools to support continuous descent approach to reduce controller workload in the terminal area.

3. Increase to 230 percent.

   Demonstrate 230 percent controller efficiency. (NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency)

   2013: Define the new role for the controller that is more strategic in nature in the en route and terminal domains.

   2013: Demonstrate shared situational awareness between pilot and controller.

   2013: Define procedural requirements for controllers to manage and introduce change into the four dimensional (position plus time) dynamic environment.

4. Increase to 300 percent.

   Demonstrate 300 percent controller efficiency. (NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency, JPDO)

   2016: Increase efficiency given the need to manage multiple airport streams for the terminal phases of flight in large metropolitan areas given a mixed-equipage environment.

   2016: Redefine the controllers' role in terms of the services they provide during a given phase of flight as the differences between en route and terminal begin to blur.

5. Selection criteria

   Ensure air traffic service providers have the aptitude and capability required to manage air traffic in the future system. (Air Traffic Control/Technical Operations Human Factors)

   2012: Complete a strategic job analysis of the new roles of air traffic service providers using a highly automated system, sharing separation responsibilities with pilots, and moving toward performance-based services.

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

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,000	10,469	10,768	10,998	11,240	11,494	100% of total program
4A09A	Center for Advanced Aviation System Development	ATO Capital	9,876	5,128	6,073	7,692	8,030	8,435	18% of total R&D program in FY 2009-2013
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	0% coordination only
1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	3,800	11,700	11,700	11,700	11,700	100% of total program
	Total ($000)		19,876	19,397	28,541	30,390	30,970	31,629	

Progress in FY 2007: High quality teams and individuals

- **En Route Controller Workstation Design:** Completed human factors design of new en route controller workstation. Estimated 30 percent increase in traffic to be handled safely by each en route controller. (Air Traffic Control/Technical Operations Human Factors)
- **Electronic Flight Data Interfaces:** Developed and applied for two patents for two prototype Electronic Flight Data Interfaces (EFDIs) for use in airport traffic control towers. The EFDIs are part of a concept research program to examine the feasibility of using electronic flight data instead of paper flight progress strips. (Air Traffic Control/Technical Operations Human Factors)
- **Improved Controller Productivity:** Developed initial cross-domain NAS operational and system evolution plans and requirements for transitioning to Performance-Based Air Traffic Management concepts that are intended to enhance FAA controller productivity and improve service to users. Provided operational feasibility and validation analysis of candidate productivity-enhancing capabilities for the terminal domain, including extended evaluations of terminal concepts and end-to-end concept demonstrations. Conducted initial analyses of the safety of the proposed system and of aircraft intent data necessary to support the proposed system. (CAASD)

2.4 Human-centered design

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

R&D milestone/target

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

Method of validation

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

Activities

1. Roles and responsibilities

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

   2013: Develop a transition plan to implement pilot separation responsibility integrated with change in controller role. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration)

2. Human system integration

   Define human and system performance requirements for design and operation of aircraft and air traffic management systems. (Flightdeck/Maintenance/System Integration Human Factors, Air Traffic Control/Technical Operations Human Factors)

   2010: Define procedural requirements for separation assisted by Cockpit Display of Traffic Information (CDTI).

   2011: Identify requirements for use of probabilistic weather information by pilots and controllers.

3. Error management

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

   2013: Provide design guidance for computer-human interfaces to reduce information overload and resulting errors.

2013: Develop training and procedural requirements for corrective mechanisms to compensate for pilot skills degradation or automation failure.

2013: Develop guidance on cognitive and contextual factors that improve human performance and reduce errors.

4. Integrated demonstrations

Conduct incremental and full mission demonstrations to increase the likelihood of successful implementation of research results.

2012: Demonstrate the transition of self-separation responsibility to pilots. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration, CAASD)

2013: Demonstrate procedures for weather and wake separation on the flight deck. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration, NextGen - Wake Turbulence - Re-categorization, NextGen - Weather Technology in the Cockpit)

2014: Functional demonstration – demonstrate integrated pilot and controller functional capabilities. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration, William J. Hughes Technical Center Laboratory Facility)

2016: Full mission demonstration – demonstrate integrated NextGen air and ground capabilities for pilot separation responsibility and controller efficiency. (NextGen - Air Ground Integration, NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration, NextGen - Wake Turbulence - Re-categorization, NextGen - Weather Technology in the Cockpit, William J. Hughes Technical Center Laboratory Facility, JPDO, Aviation Safety Risk Analysis/System Safety Management, CAASD)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	0	0	0	0	0	0	0% coordination only
4A09A	Center for Advanced Aviation System Development	ATO Capital	340	649	768	973	1,016	1,067	2% of total R&D program in FY 2009-2013
A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	9,200	7,465	7,580	7,604	7,630	7,656	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	0% coordination only
A12.c	NextGen - Air Ground Integration	R,E&D	0	2,554	11,337	11,720	11,521	11,322	100% of total program
1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	0	2,900	7,700	7,700	7,700	7,700	100% of total program
1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	0	0	0	0	0	0% coordination only
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	0	0	0	0	0	0% Coordination only
A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,415	3,536	3,674	3,804	3,941	4,084	100% of total program
1A02A	Safe Flight 21 - Alaska Capstone	ATO Capital	7,500	0	0	0	0	0	50% of total program
	Total ($000)		20,455	17,104	31,059	31,801	31,808	31,829	

Progress in FY 2007: Human-centered design

- **Controller Performance Standards:** Developed performance standards for the air traffic controller occupations in tower, TRACON, and en route facilities as part of the workforce training initiative called "Air Traffic Control Optimum Training Solution". (Air Traffic Control/Technical Operations Human Factors)
- **Pilot Visual Approaches:** Developed training and assessment strategies to assure effective performance on visual approaches by pilots with low training time on commercial jet operations. (Flightdeck/Maintenance/System Integration Human Factors)
- **General Aviation Pilot Aging:** Collaborated with industry on proposals to research the effects of aging among general aviation pilots. This is being done jointly with industry associations, including the Aircraft Owners and Pilots Association. (Flightdeck/Maintenance/System Integration Human Factors)
- **Notice to Airmen:** Formed and led industry working groups to discuss the human factors shortcomings of NOTAMS, the safety impact on air carrier operations, and possible NOTAMS re-design proposals. FAA researchers will work to direct NOTAMS redesign efforts to conform to appropriate human factors standards. (Air Traffic Control/Technical Operations Human Factors)
- **Tower Cab Design:** Analyzed the impact of the tower window glass on the ability of the controller to discriminate objects on the airport surface. They published a report on tower glass specifications and field tests with assessments on human visibility performance. (Air Traffic Control/Technical Operations Human Factors)

2.5 Human protection

No fatalities, injuries, or adverse health impacts due to aerospace operations

R&D milestone/target

By 2015, demonstrate a two-thirds reduction in the rate of aerospace-related fatalities and significant injuries.[14]

Method of validation

The approach includes preventing injuries during regular operations and protecting people in the event of a crash. Validation of the supporting milestones will include demonstrations, modeling, simulations, full scale testing, and initial standards. Validation of the R&D milestone will include analysis of U.S. accident data. Results from the safe aerospace vehicle goal will contribute to the interim and final measurements of the reduction. The safety evaluation under the system knowledge goal will support the interim assessment of progress and validation of the R&D milestone. The demonstration will show that the R&D is complete, and it is possible to meet the targeted operational improvement.

Activities

1. Safe evacuation

   Prevent injuries or fatalities during evacuations

   2012: Define composite fuselage and very large transport safety design criteria for safe evacuation of aircraft. (Fire Research and Safety)

   2012: Develop aircraft rescue and fire fighting procedures and equipment standards to address double-decked large aircraft. (Airport Technology Research - Safety)

   2012: Validate mathematical models to evaluate whether aircraft designs meet requirements for evacuation and emergency response capability. (Aeromedical Research)

2. Turbulence

   Prevent injuries and fatalities due to turbulence.

   2011: Implement convectively-induced turbulence forecast capability operationally. (Weather Program)

[14] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, http://www.jpdo.gov/library/NGATS_v1_1204r.pdf. The two thirds reduction in the rate of aviation fatalities and injuries is based on the JPDO objective for 2025 to, “Satisfy future growth in demand (up to 3 times current levels) and operational diversity.” Two-thirds assumes that the number of fatalities or injuries will be the same as today’s.

3. Hazardous weather
   Prevent injuries and fatalities due to hazardous weather.
   2012: Provide guidance for certification of aircraft to operate in super cooled large droplet environments. (Atmospheric Hazards/Digital System Safety)

4. Occupant restraint
   Improve occupant restraint systems to reduce injuries and fatalities.
   2010: Establish design criteria for restraint systems that protect occupants at the highest impact levels that the aircraft structure can sustain. (Aeromedical Research, Advanced Materials/Structural Safety)

5. Airports
   Prevent injuries and fatalities due to aircraft overrun.
   2011: Evaluate new formulations for soft ground arrestor systems. (Airport Technology Research - Safety, Airport Cooperative Research - Safety)
   2011: Complete development of airport design methods to improve runway friction. (Airport Technology Research - Safety)

6. Cabin air quality
   Reduce health risk to aircrew and passenger due to cabin environmental threats.
   2010: Develop and analyze methods to detect and analyze aircraft cabin contamination including chemical-biological hazards and other airborne irritants. (Aeromedical Research)

7. Commercial space
   Identify the requirements for safe commercial space transportation operations.
   2008: Conduct a study to provide a basic understanding of what is necessary in an Informed Consent form for commercial space flight participants. (Commercial Space Transportation Safety)
   2008: Conduct a study to determine the need to develop a temporal wind database to support the launch of wind weighted unguided suborbital rockets launched from nonfederal launch sites. (Commercial Space Transportation Safety)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.c.	Advanced Materials/Structural Safety	R,E&D	0	0	0	0	0	0	0% coordination only
A11.j.	Aeromedical Research	R,E&D	7,760	8,395	8,699	8,976	9,267	9,573	100% of total program
--	Airport Cooperative Research Program - Safety	AIP	3,000	3,000	3,000	3,000	3,000	3,000	60% of safety component
--	Airports Technology Research - Safety	AIP	3,432	3,584	3,584	3,584	3,584	3,584	35% of total program
A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	1,072	1,451	1,476	1,485	1,494	1,503	30% of total program
--	Commercial Space Transportation Safety	S&O	64	63	63	63	63	63	50% of total program
A11.a.	Fire Research and Safety	R,E&D	6,174	5,586	5,728	5,825	5,928	6,035	84% of total program
A11.k.	Weather Program	R,E&D	1,520	1,527	1,526	1,495	1,463	1,430	9% of total program
	Total ($000)		23,022	23,606	24,075	24,428	24,798	25,187	

Progress in FY 2007: Human protection

- **Side Facing Seats:** Completed several Post Mortem Human Subject tests and Anthropomorphic Test Dummy tests to acquire and correlate side-facing seat neck injury data. Began evaluating the data to establish requirements for final tests before establishing side facing seat criteria. (Advanced Materials/Structural Safety)
- **Emergency Airliner Evacuation:** Maintained a cooperative research agreement with Rutgers University to develop and validate a mathematical model that will support evaluation of airliner design for emergency evacuation. The model includes multiple airliner models, seating configurations, exit locations, passenger loads and other features to predict exit rates. (Aeromedical Research)
- **Seat and restraint design and testing:** Collaborated with industry to develop and evaluate a module that makes the models user-friendlier and increases the potential for widespread application. Industry-wide use and acceptance of dynamic mathematical models to test seat and restraint system design is instrumental in establishing certification criteria; however, current models require a high level of engineering and modeling expertise for effective use. (Aeromedical Research)
- **Aeromedical data system:** Initiated development of an Aircraft Accident/Injury and Autopsy Data System (AA-IADS) to provide injury description and injury mechanism analysis to support the development of prevention/mitigation strategies. This aeromedical data system will combine NTSB accident data, FAA accident and incident data, autopsy report, injury data, toxicology reports and airman medical data to analyze injury mechanism information relative to equipment and aircraft design. (Aeromedical Research)
- **Medical certification criteria:** Developed airman medical certification criteria for commercial aerospace operations and preliminary guidelines for life support equipment in commercial launch vehicles. (Aeromedical Research)

- **Medication analysis:** Developed analytical methods to determine the distribution of selective serotonin reuptake inhibitor (SSRI) medications in postmortem specimens and identified specimen types that may be suitable for estimating blood concentrations of SSRIs in the event that blood is unavailable for analysis. While the use of SSRI medications is increasing, SSRI medication use by pilots is not permitted by the FAA. (Aeromedical Research Program)
- **Ground Arrestor Systems:** Evaluated new formations for soft ground arrestor systems. Awarded an Airport Cooperative Research Program (ACRP) contract for developing an improved civil aircraft arresting system. Installed an Engineered Material Arresting System (EMAS) test bed at U.S. Army Cold Regions Research and Engineering Lab (CRREL) for freeze-thaw evaluation. (Airport Technology Research - Safety)
- **Improved Runway Friction:** Completed development of airport design methods to improve runway friction. Completed data collection phase of the Runway Friction Measurement Project at NASA Wallops Flight Facility. Data will be used to update Table 3-2 in Advisory Circular 150/5320-12C. Trapezoidal runway grooves installed for testing at Quantico, VA. (Airport Technology Research-Safety)
- **Firefighting for New Double-Decked Aircraft:** Completed assembly and baseline fire testing of New Large Aircraft (NLA) fire test mock-up at Tyndall Air Force Base. Installed and began testing the next-generation high reach extendable turret. (Airport Technology Research- Safety)
- **Crew Duty and Rest:** Conducted a study to determine appropriate rest and duty restrictions for space crews. This study was conducted by reviewing what the commercial space transportation industry vehicle and launch operations are currently, and what they may be in the future; and made recommendations for measuring commercial space transportation safety operations of crew duty and rest. (Commercial Space Transportation Safety)
- **Human Space Flight Training Preparation Study:** Developed a survey to help the industry to understand the opportunities in critical aviation and space flight training fields, by supplying profiles of training providers as well as a final report summarizing the survey results. (Commercial Space Transportation Safety)
- **Composite Material Flammability:** Characterized the flammability behavior of structural composite material similar to that planned for the Boeing 787 (B-787) aircraft. This data will support the development of fire safety design criteria in future aircraft with composite fuselage and wings. (Fire Research and Safety)
- **Burn-through Resistance Burner:** Developed an improved fire test apparatus to measure the post-crash fire burn-through resistance of thermal acoustic insulation. The new FAA requirement for improved burn-through resistance, which provides more time to escape during a survivable post-crash fire, becomes effective on September 2, 2009. (Fire Research and Safety)
- **Seat Cushions Fire Test Criteria:** Developed new fire test criteria for lightweight seat cushions that provide a more objective assessment of their potential fire hazard during a post-crash fire. (Fire Research and Safety)

2.6 Safe aerospace vehicles

No accidents and incidents due to aerospace vehicle design, structure, and subsystems

R&D milestone/target

By 2015, demonstrate damage and fault tolerant vehicle and systems.

Method of validation

The approach includes: preventing accidents due to engine failures, structural failures and system failures; developing a fireproof cabin; integrating unmanned aircraft into the system; and addressing safety problems specific to general aviation. Validation of the R&D milestone will include modeling, flight simulation, physical demonstration, prototypes, and initial standards. The results from this goal will contribute to the R&D milestone to demonstrate a two-thirds reduction in fatalities and significant injuries under the human protection goal.

Activities

1. Engines

   Prevent engine failures.

   1.1. In-flight icing

   2012: Develop methods to validate engines to operate in environments with high ice water content. (Atmospheric Hazards/Digital System Safety)

   1.2. Engine and component structures

   2012: Complete a certification tool[15] that will predict cracks, establish rotor life, and define inspection requirements. (Propulsion and Fuel Systems)

   2012: Complete development of damage tolerant design methods for aircraft propellers. (Aging Aircraft/Continued Airworthiness)

   1.3. Uncontained engine failures

   2011: Complete requirements for a system that identifies propulsion malfunctions to the flight crew. (Aircraft Catastrophic Failure Prevention Research)

   2012: Develop revised guidance for fuselage protection from uncontained engine failure fragments that includes multiple fragments analysis. (Aircraft Catastrophic Failure Prevention Research)

2. Structures

   Prevent accidents due to structural failure.

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

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

   2012: Define criteria for use of embedded sensors in fault tolerant structures. (Advanced Materials/Structural Safety)

[15] Design Assessment Reliability and Inspection (DARWIN)

3. Systems

   Prevent accidents due to system failures.

   3.1. Avionics

   2012: Improve guidelines to expedite the certification of multiple (20 to 30) software packages into a single avionics system. (Atmospheric Hazards/Digital System Safety)

   3.2. Electrical

   2010: Develop guidelines for adequate clearance to prevent arcing in aircraft electrical wiring systems. (Aging Aircraft/Continued Airworthiness)

   3.3. Flight controls

   2010: Evaluate the ease of operation and certification of flight control designs. (Aging Aircraft/Continued Airworthiness)

4. Unmanned aircraft

   Integrate Unmanned Aircraft System (UAS) into the civil airspace.

   2012: Conduct field evaluation of detect, sense, and avoid technology; command, control, and communications technologies; and flight termination procedures. (Unmanned Aircraft Systems Research, CAASD)

5. General aviation

   Reduce general aviation accidents.

   2012: Complete validation of certification process for health and usage monitoring systems (HUMS) for operational implementation. (Aging Aircraft/Continued Airworthiness)

   2012: Develop rotorcraft damage tolerance methods and standards to establish guidance for certification. (Aging Aircraft/Continued Airworthiness)

6. Commercial space

   Identify the requirements for safe commercial space transportation vehicles.

   2008: The FAA will conduct a study to survey the existing technologies available for determining wind conditions from the upper troposphere to the stratosphere. The study will address possible modifications of RADAR wind profiler to obtain winds to greater altitudes than currently available. (Commercial Space Transportation Safety)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.c.	Advanced Materials/Structural Safety	R,E&D	7,083	2,920	2,965	2,975	2,986	2,997	100% of total program
A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	15,307	14,005	14,189	14,188	14,187	14,186	96% of total program
A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	2,202	436	458	480	504	529	100% of total program
A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	2,502	3,387	3,445	3,464	3,485	3,507	70% of total program
4A09A	Center for Advanced Aviation System Development	ATO Capital	579	1,899	2,249	2,849	2,974	3,124	7% of total R&D program in FY 2009-2013
--	Commercial Space Transportation Safety	S&O	64	63	63	63	63	63	50% of total program
A11.a.	Fire Research and Safety	R,E&D	1,176	1,064	1,091	1,110	1,129	1,150	16% of total program
A11.b.	Propulsion and Fuel Systems	R,E&D	4,086	3,669	3,720	3,724	3,729	3,733	100% of total program
A11.l.	Unmanned Aircraft Systems Research	R,E&D	2,453	1,576	1,620	1,655	1,690	1,728	84% of total program
	Total ($000)		35,452	29,019	29,800	30,507	30,747	31,016	

Progress in FY 2007: Safe aerospace vehicles

- **Composite Structure Damage Tolerance Certification Standardization:** Completed efforts to bring together world regulators and manufacturers to address standardization of composite damage tolerance validation of civil aircraft structures. This effort included two international workshops; one in the United States and the other in Europe, to assure all international parties participated. (Advanced Materials/Structural Safety)
- **Full-Scale Sandwich Composite Fuselage Panel Damage Tolerance Verification Tests:** Completed testing to determine the scaling effects of sandwich structure panels with damage. This program will validate previous work done to characterize damage state and residual strengths for sandwich composite structure. (Advanced Materials/Structural Safety)
- **Structures:** Evaluated the airworthiness of a retired Beech 1900D airplane. The evaluation included the inspection of airframe and aircraft systems in accordance with the maintenance manuals and applicable supplemental inspection documents, disassembly of critical structural components, and microscopic examination of critical structural details. (Aging Aircraft/Continued Airworthiness)
- **Rotorcraft:** Completed the evaluation of fatigue-crack-growth test methodologies. Determined deficiencies of the existing method and assessed the performance of the newly developed test procedure. The results are being used by the American Society for Testing and Materials (ASTM) E-8 Subcommittee on Fatigue and Fractures to revise the ASTM E-647 test standard. The new test standard can be used to generate data to be used in the damage tolerant analysis on rotorcraft structures and mechanical components. (Aging Aircraft/Continued Airworthiness)

- **Integrated Modular Avionics:** Completed research on Real-Time Operating Systems (RTOS) and component integration considerations in Integrated Modular Avionics (IMA) systems. Research results will be used by certification authorities and industry for integrating RTOS on IMA systems. (Atmospheric Hazards/Digital Systems Safety)
- **Propeller Icing:** Conducted a propeller icing test at the U.S. Air Force McKinley Climatic Laboratory. The primary objective of the propeller testing was to document leading edge and runback ice accretion characteristics in controlled icing conditions on both new metal and composite propeller blades, and in-service metal blades. (Atmospheric Hazards/Digital Systems Safety)
- **Failures of Rocket-powered vehicles:** At the request of the FAA Commercial Space Transportation Advisory Committee (COMSTAC) Reusable Launch Vehicle (RLV) Working Group, conducted a study of historic failure modes of both expendable and reusable rocket powered vehicles to provide insight as to what components of rocket-powered vehicles fail, and why. (Commercial Space Transportation Safety)
- **"Fireproof" Cabin:** Developed advanced non-halogen containing fire-resistant polymers that eliminate the environmental concerns of their halogen-containing counterparts. (Fire Research and Safety)
- **Crew Training:** Developed an in-flight fire fighting training video for cabin crewmembers. The video instructs cabin crew on how to extinguish hidden in-flight fires and prevent this type of fire from spreading out of control and causing an accident. (Fire Research and Safety)
- **Ducting Materials:** Developed an improved fire test method for aircraft ducting materials as part of an FAA program to upgrade the fire resistance requirements of hidden cabin materials. (Fire Research and Safety)
- **Unmanned Aircraft Systems (UAS) Research Planning:** Initiated a new research program focused on 4 UAS technical areas: technology survey; system safety; detect, sense, and avoid (DSA); and command, control, and communications. (Unmanned Aircraft Systems Research)
- **Unmanned Aircraft Systems:** Provided technical and system engineering analysis of UAS operations concerning DSA concepts, air-ground communications requirements, and national and international standards for development and operation, resulting in integrated guidance to commercial and U.S. government operators of UASs. (CAASD)

2.7 Self-separation

No accidents and incidents due to aerospace vehicle operations in the air and on the ground

R&D milestone/target

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

Method of validation

The approach includes conducting research and development to support the standards, procedures, training, and policy required to implement the NextGen operational improvements leading to self-separation. This goal does not develop technology, but it works with the designated technology developer to prepare for the operational use of the technology according to the JPDO schedule identified below. Validation of the R&D milestone will include demonstrating that the research and development is sufficient for the initial policy and standards that are required to certify technology, procedures, and training needed to implement the JPDO plan for self-separation.[16]

Activities (NextGen - Self Separation)

1. Level 1 – Surface/runway operations awareness
   - 2010: Model collision risk for surface movement.
   - 2011: Display aircraft and ground vehicles in the cockpit to guide surface movement during low visibility conditions. (JPDO OI# 0322, 0332)[17]
   - 2015: Enable surface movement in zero visibility conditions guided by cockpit display. (JPDO OI# 0340)

2. Level 2 – Reduced separation
   - 2011: Reduce visual approach minima through avionics-aided separation. (JPDO OI# 0316)
   - 2011: Reduce oceanic spacing to 15x15 nm. (JPDO OI# 0353, 0354)
   - 2011: Reduce longitudinal arrival and departure spacing requirements for dual use runways. (JPDO OI# 0324)
   - 2012: Reduce lateral separation requirements for converging and parallel runway operations. (JPDO OI # 0334, 0335)
   - 2012: Reduce in-trail separation to near VFR levels for single runway departure operations. (JPDO OI# 0326, 0324)
   - 2012: Reduce in-trail separation to near VFR levels for converging and closely spaced parallel runways. (JPDO OI# 0323)
   - 2014: Reduce oceanic spacing to 3 miles. (JPDO OI# 0343)

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[16] Research will be performed by Flightdeck/Maintenance/System Integration Human Factors to support the development of standards, procedures, and training by Flight Standards to implement the JPDO plan for separation. The Air Traffic Control/Technical Operations Human Factors, Wake Turbulence, and CAASD programs support the effort through work conducted under the other goals, but coordinated with this effort.

[17] The JPDO Operational Improvement-numbers (OI#) are from the JPDO *Integrated Work Plan (IWP) for the NextGen*, Version 0.1, July 31, 2007.

2014: Enable multiple aircraft occupancy for single runway arrivals and single runway departures. (JPDO OI# 0341)
2014: Enable dynamic adjustment of longitudinal arrival and departure spacing. (JPDO OI # 0328)
2015: Further reduce longitudinal arrival and departure spacing. (JPDO OI# 0336)
2015: Enable shared separation at non-towered airports. (JPDO OI# 0313, 0315)
2015: Reduce arrival spacing, with altitude offset, for very closely spaced parallel runways. (JPDO OI# 0334, 0335)
2015: Reduce arrival spacing, at co-altitude, for very closely spaced parallel runways. (JPDO OI# 0334, 0335)

3. Level 3 – Shared separation
   2010: Enable oceanic pair-wise separation. (JPDO OI# 0353, 0354)
   2011: Enable en route pair-wise separation. (JPDO OI# 0355, 0356)

4. Level 4 – Self-separation
   2015: Enable self-separation in oceanic airspace. (JPDO OI# 0359)
   2015: Enable self-separation in high-density en route corridors. (JPDO OI# 0337, 0368, 0363)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	0% coordination only
4A09A	Center for Advanced Aviation System Development	ATO Capital	0	633	750	950	991	1,041	2% of total R&D program in FY 2009-2013
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	0% coordination only
A12.d	NextGen - Self Separation	R,E&D	0	8,025	9,805	10,136	9,963	9,790	100% of total program
1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	0	0	0	0	0	0% coordination only
	Total ($000)		0	8,658	10,555	11,086	10,954	10,831	

Progress in FY 2007: Self-separation

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

2.8 Situational awareness

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

R&D milestone/target

By 2015, demonstrate common real-time awareness of ongoing air operations, events, crisis, and weather at all types of airports by pilots and controllers.

Method of validation

The approach includes supporting development of standards and procedures for weather-in-the-cockpit to provide the flight crew awareness of weather conditions and forecasts; demonstrating wake turbulence procedures and technologies to support self-separation; and improving situational awareness at airports. Validation of the R&D milestone will include pilot-in-the-loop simulations, modeling, tests, physical demonstrations, and initial standards and procedures.

Activities

1. Weather

   Demonstrate weather-in-the-cockpit[18].

1.1. Weather products

- 2010: Approve for operational readiness the National Ceiling and Visibility forecast for CONUS. (Weather Program, Flightdeck/Maintenance/System Integration Human Factors)
- 2012: Implement in-flight icing Alaska forecast. (Weather Program)
- 2013: Approve for operational readiness the in-flight icing oceanic nowcast. (Weather Program, Flightdeck/Maintenance/System Integration Human Factors)
- 2013: Approve for operational readiness the volcanic ash forecast. (Weather Program, Flightdeck/Maintenance/System Integration Human Factors)
- 2015: Demonstrate the 2 to 6-hour Consolidated Storm Product for Aviation (CoSPA). (Weather Program, Flightdeck/Maintenance/System Integration Human Factors)

1.2. Policy and guidance

- 2010: Develop design approval guidance for hardware and software standards. (NextGen - Weather Technology in the Cockpit)
- 2010: Develop design approval guidance for archiving data. (NextGen - Weather Technology in the Cockpit)
- 2010: Develop guidance for airman training and evaluation criteria. (NextGen - Weather Technology in the Cockpit)

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

2010: Develop guidance for operational approval of new products and products from non-government vendors. (NextGen - Weather Technology in the Cockpit)

1.3. Requirements and demonstrations

2010: Identify air traffic weather requirements. (NAS Weather Requirements, CAASD)

2012: Demonstrate weather displays for air traffic controllers. (Air Traffic Control/Technical Operations Human Factors)

2. Airports

Ensure safe airport operations.

2008: Implement Juneau Airport Wind System. (Wind Profiling and Weather Research - Juneau)

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

2010: Develop advisory material to install new visual guidance systems. (Airport Technology Research - Safety, Airport Cooperative Research - Safety)

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

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

3. Separation Standards

Develop new separation standards.

3.1 Performance-based

2008: Develop separation standards that vary according to aircraft capability and pilot training. (NextGen Demonstrations and Infrastructure Development)

3.2 Wake vortices

2010: Recommend new separation standards and procedures based on aircraft performance. (Wake Turbulence)

2012: Evaluate system-wide safety risk for new separation standards. (Wake Turbulence)

2012: Verify new separation standards maintain or reduce safety risk. (Wake Turbulence)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
--	Airport Cooperative Research Program - Safety	AIP	2,000	2,000	2,000	2,000	2,000	2,000	40% of safety component
--	Airports Technology Research - Safety	AIP	6,373	6,655	6,655	6,655	6,655	6,655	65% of total program
A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	0	0	0	0	0	0	0% coordination only
4A09A	Center for Advanced Aviation System Development	ATO Capital	2,691	6,015	7,123	9,022	9,418	9,893	21% of total R&D program in FY 2009-2013
A12.a.	Joint Planning and Development Office	R,E&D	0	0	0	0	0	0	0% coordination only
1A01D	NAS Weather Requirements	ATO Capital	1,000	1,000	1,000	1,000	1,000	3,300	100% of total program
1A08	NextGen Demonstration	ATO Capital	10,000	0	0	0	0	0	50% of total R&D program in 2008 only
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	8,049	9,867	10,202	10,040	9,878	100% of total program
1A01A	Runway Incursion Reduction	ATO Capital	8,000	10,000	5,000	5,000	3,000	3,000	100% of total program
--	Safe Flight 21 - Alaska Capstone	ATO Capital	7,500	0	0	0	0	0	50% of total program
A12.b.	Wake Turbulence	R,E&D	4,813	2,762	2,764	2,715	2,663	2,609	27% of total program
A11.k.	Weather Program	R,E&D	13,679	13,744	13,733	13,458	13,170	12,867	81% of total program in 2008
1A01I	Wind Profiling and Weather Research Juneau	ATO Capital	4,000	1,100	0	0	0	0	100% of total program
	Total ($000)		60,057	51,325	48,142	50,053	47,946	50,202	

Progress in FY 2007: Situational awareness

- **Airport Planning Guidance:** Initiated rewrite of Advisory Circular AC 150-5060-5 Airport Capacity and Delay. Completed ACRP Synthesis #1, Innovative Finance and Alternative Sources of Revenues for Airports. Completed ACRP Synthesis #2, Aviation Forecasting Methodologies. (Airport Cooperative Research - Capacity)
- **Bird Strike Advisory:** Completed interference testing between 94.1 GHz bird radar and ASDE-X system to ensure compatibility. Installed prototype bird detection radar system and began data acquisition at Seattle-Tacoma Airport. (Airport Technology Research - Safety)
- **Runway Status Lights:** Completed draft report on lighting configuration lateral spacing requirements for Runway Status Lights (RWSL). (Runway Incursion Reduction)
- **End-Around Taxiway Screen Evaluation:** Published “End-Around Taxiway Screen Evaluation” Technical Note, which is being used to develop new end-around taxiway guidance. (Runway Incursion Reduction)
- **Light Emitting Diode research:** Completed research on Light Emitting Diode (LED) vs. incandescent light source brightness perception to ensure visibility. (Runway Incursion Reduction)
- **Graphical Turbulence Guidance Weather Product:** Completed prototype graphical turbulence guidance, FL 100+ (GTG2) weather product, which is ready for FAA/NWS Joint Board approval for operational use. GTG2 provides clear air

turbulence forecasts out to 12 hours for 10,000 feet and above, and is anticipated to become operational in FY 2008. (Weather Program)

- **Current Icing Product:** Implemented Current Icing Product (CIP) upgrade into the Aviation Digital Data Service. CIP alerts users to in-flight icing along their route of flight. (Weather Program)
- **Advanced Automatic Dependent Surveillance – Broadcast (ADS-B) Capabilities:** Developed operational concepts for using ADS-B technology to maintain traffic flows during weather events, including integration with a performance-based ATM environment. (CAASD)
- **Weather Requirements:** Analyzed technical and operational issues related to the FAA’s evolution to System Wide Information Management (SWIM) capability, with emphasis on defining weather applications and dissemination capabilities. (CAASD)

2.9 System knowledge

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

R&D milestone/target

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

Method of validation

The approach includes developing the information analysis and sharing system to support the FAA and NextGen safety initiatives; generating guidelines to help stakeholders develop their own safety management systems; and modeling activities to help measure progress toward achieving safety, capacity, and environmental goals. Validation of the R&D milestone will include analysis, modeling, prototypes, and demonstrations. The evaluation efforts under this goal support the interim assessment of progress and validation of the R&D milestones under the human protection, clean and quiet, and fast, flexible and efficient goals.

Activities

1. Information Analysis and Sharing
   - 1.1 Develop an information management system to serve as the foundation for the analysis of data trends and the identification of potential safety hazards before accidents occur.
     - 2009: Evaluate current information protection and assurance models as well as potential conflicts with privacy and consumer advocacy groups. (JPDO OI# 3020)[19] / (JPDO, NextGen - System Safety Management Transformation)
     - 2012: Validate the Net Enabled Operations (NEO) Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders. (JPDO OI# 3020) / (JPDO, NextGen - System Safety Management Transformation)
     - 2013: Complete the Aviation Safety Information Analysis and Sharing (ASIAS) pre-implementation activities, including concept definition, with other JPDO member agencies, participants, and stakeholders. (JPDO OI# 3020) / (JPDO, NextGen - System Safety Management Transformation)
   - 1.2. Develop a system to increase safety of commercial operations.
     - 2011: Develop automated tools to monitor databases for potential safety issues. (Aviation Safety Risk Analysis/System Safety Management)
     - 2012: Demonstrate a working prototype of network based integration of information extracted from diverse, distributed sources. (Aviation Safety Risk Analysis/System Safety Management)

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[19] The JPDO Operational Improvement-numbers (OI#) are from the JPDO *Integrated Work Plan (IWP) for the NextGen*, Version 0.1, July 31, 2007.

2. Safety Management System
   Produce guidelines for developing processes and technologies to implement a safety management system.
   - 2011: Complete study of risk-based fleet management for small-airplane continued operational safety. (JPDO OI# 3004) (Aging Aircraft/Continued Airworthiness)
   - 2012: Develop risk management concepts, models, and tools for unmanned aircraft systems. (JPDO OI# 3004) (Unmanned Aircraft Systems Research)
   - 2012: Develop risk management concepts, models, and tools for transport category airplanes. (JPDO OI# 3004) (Aviation Safety Risk Analysis/System Safety Management)
   - 2011: Develop proof of concept for NextGen including a prototype to implement on a trial basis with selected participants that involve a cross-section of air service providers. (JPDO OI# 3004) / (JPDO, NextGen - System Safety Management Transformation)
   - 2014: Demonstrate a National Level System Safety Assessment capability that will proactively identify emerging risk across the NextGen. (JPDO OI# 3021)/ (JPDO, NextGen - System Safety Management Transformation)

3. Safety evaluation
   Develop method and metrics to measure progress in reducing the rate of fatalities and significant injuries by two-thirds[20]. (Aviation Safety Risk Analysis/System Safety Management)
   - 2010: Demonstrate a one-third reduction in the rate of fatalities and injuries.
   - 2012: Demonstrate a one-half reduction in the rate of fatalities and injuries.
   - 2015: Demonstrate a two-thirds reduction in the rate of fatalities and injuries.

4. Capacity evaluation
   Develop method, metrics, and models to demonstrate that the system can handle growth in demand up to three times current levels.[21] (JPDO, CAASD, NextGen - Operations Concept Validation - Validation Modeling, System Capacity, Planning and Improvement, Airspace Management Laboratory, Airspace Redesign)
   - 2008: Demonstrate capacity increase to 130% current levels.
   - 2011: Demonstrate capacity increase to 166% current levels.
   - 2013: Demonstrate capacity increase to 230% current levels.
   - 2016: Demonstrate capacity increase to 300% current levels.

[20] This supports demonstration of the R&D milestone under the human protection goal.
[21] This supports demonstration of the R&D milestone under the fast, flexible, and efficient goal.

5. Environmental evaluation
   Develop method, metrics, and models to demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms to enable the air traffic system to handle growth in demand up to three times current levels.[22] (NextGen - Environment and Energy - Validation Modeling, JPDO, CAASD, Operations Concept Validation)
   - 2009: Demonstrate no environmental constraints at 130% capacity.
   - 2011: Demonstrate no environmental constraints at 166% capacity.
   - 2013: Demonstrate no environmental constraints at 230% capacity.
   - 2016: Demonstrate no environmental constraints at 300% capacity.

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	638	584	591	591	591	591	4% of total program
1A01E	Airspace Management Lab	ATO Capital	4,000	4,000	4,000	4,000	4,000	4,000	100% of total program
1A01F	Airspace Redesign	ATO Capital	5,000	3,000	3,000	3,000	3,000	3,000	100% of total program
A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	9,517	12,488	12,589	12,497	12,401	12,300	100% of total program in 2008
4A09A	Center for Advanced Aviation System Development	ATO Capital	2,180	6,252	7,404	9,378	9,789	10,283	22% of total R&D program in FY 2009-2013
1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	0	4,500	7,500	7,500	7,500	7,500	100% of total program
A12.a.	Joint Planning and Development Office	R,E&D	4,296	4,348	4,368	4,315	4,259	4,200	30% of total program
1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	0	4,000	15,000	15,000	15,000	15,000	100% of total program
1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	16,300	19,000	19,700	19,700	20,000	100% of total program
1A01C	Operations Concept Validation	ATO Capital	3,000	7,400	8,000	8,000	8,000	6,000	100% of total program in 2008
1A01B	System Capacity, Planning and Improvement	ATO Capital	6,500	6,500	6,500	6,500	6,500	6,500	100% of total program
A11.l.	Unmanned Aircraft Systems Research	R,E&D	467	300	309	315	322	329	16% of total program
	Total ($000)		35,598	69,672	88,261	90,796	91,062	89,703	

Progress in FY 2007: System knowledge

- **Improved Aircraft Landing Performance:** Completed a study on aircraft landing performance of subsonic narrow-body jet aircraft during ILS approaches. The study discusses methods to identify the aircraft touchdown points during commercial operations by using ILS information, which will support developing guidelines for Landing and Holding Short (LAHSO) and aid in understanding causes of runway overruns. (Aviation Safety Risk Analysis/System Safety Management)
- **Improved Flight Crew Intervention:** Completed the Flight Crew Intervention research initiative. Using a list of key flight deck design characteristics with

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[22] This supports demonstration of the R&D milestone under the clean and quiet goal as it applies to the R&D milestone under the fast, flexible, and efficient goal.

descriptors for different performance, researchers developed a scoring algorithm that combines the design characteristics into an overall level of certification credit for flight crew intervention in the case of system failures. (Aviation Safety Risk Analysis/System Safety Management)

- **Aircraft Maintenance Tool Calibration:** Completed the Tool Calibration Program research project. Best practices and checklists for establishing and monitoring tool calibration were developed to ensure proper calibration of tools used in aircraft maintenance. (Aviation Safety Risk Analysis/System Safety Management)
- **Completed "Big Airspace" Study:** Completed a series of simulation studies employing different techniques to validate the "Big Airspace" concept (a concept for improving operational efficiencies in major metropolitan areas by integrating arrival and departure airspace into one control service and one facility). Demonstrated service provider improvements and operational efficiencies, and a benefit/cost ratio of 2.8 to 11.7 for actual implementation of "Big Airspace" concept. (Operations Concept Validation)
- **Future TFM Concepts:** Developed a foundation for net-enabled TFM core services, and advanced TFM visualization tools using service-oriented architecture technologies. Developed a laboratory prototype of a net-enabled service registry providing descriptions and means of discovery for net-enabled services. Performed demonstrations to evaluate the suitability of these technologies for use in laboratory simulations and (ultimately) system use in the field. (CAASD)
- **Model Future Capacity:** Completed the capacity analysis of the Future Airport Capacity Task (FACT) 2 airports and performed NAS-wide analysis to determine airports, which will need more capacity to meet anticipated demand. (CAASD)
- **Airport Safety Management Systems:** Published "Safety Management Systems for Airports, Volume 1: Overview." An Airport Safety Management System offers a powerful tool for reducing the hazards and risks of aircraft accidents and incidents and runway incursions during approach, takeoff, and ground operations. (Airport Cooperative Research - Safety)

2.10 World leadership

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

R&D milestone/target

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

Method of validation

The approach includes managing research collaborations to increase value, and leveraging research under the existing R&D program to increase value. This goal applies to the R&D program only. Validation of the R&D milestone will include developing agreements and conducting analysis. The research results listed under activity 2 are generated by the other nine goals in this plan. The purpose of this goal is to help plan the use of these products in international partnering activities to produce the highest value. The method of validation for the individual research results is provided under the respective goal for each result.

Activities

1. Management

   Manage ongoing research.

   2008: Manage R&D portfolio, conduct advisory committee reviews of R&D, and publish the *NARP*. (System Planning and Resource Management)

   Manage research collaborations.

   2010: Determine measures for the exchange of research information. (System Planning and Resource Management)

   2011: Develop a strategic mapping for international collaboration. (System Planning and Resource Management)

   2011: Identify a process to measure quality, timeliness, and value of collaboration. (System Planning and Resource Management)

   2016: Determine final value of collaboration. (System Planning and Resource Management)

2. Products

   Leverage research results.

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

   2010: Deploy an Aviation Environmental Design Tool that quantifies and assesses interrelationships among noise and emissions at the local and global levels. (Environment and Energy)

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

   2012: Apply gene expression technology to define human response to aerospace stressors. (Aeromedical Research)

2012: Demonstrate weather-in-the-cockpit. (NextGen - Weather Technology in the Cockpit)

2012: Validate the Net Enabled Operations (NEO) Architecture proof-of-concept for the sharing of aviation safety information among JPDO member agencies, participants, and stakeholders. (JPDO OI# 3020) / (NextGen - System Safety Management Transformation)

2013: Deploy the Aviation Environmental Portfolio Management Tool that will provide the cost/benefit methodology needed to harmonize national aviation policy and environmental policy. (Environment and Energy)

2015: Demonstrate reduced longitudinal separations for arrival and departure operations. (NextGen - Wake Turbulence - Re-categorization)

2016: Demonstrate three times improvement in air traffic controller efficiency (e.g., greater number of aircraft) and effectiveness (e.g., fewer operational errors) through automation and standardization of operation, procedures, and information. (NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency)

Funding requirements

The funding levels listed for years 2010 to 2013 are estimates and subject to change.

			2008	2009	2010	2011	2012	2013	Notes
A11.c.	Advanced Materials/Structural Safety	R,E&D	0	0	0	0	0	0	0% coordination only
A11.j.	Aeromedical Research	R,E&D	0	0	0	0	0	0	0% coordination only
1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	0	0	0	0	0	0% coordination only
4A09A	Center for Advanced Aviation System Development	ATO Capital	0	554	656	831	867	911	2% of total R&D program in FY 2009-2013
A13.a.	Environment and Energy	R,E&D	0	0	0	0	0	0	0% coordination only
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	0	0	0	0	0	0% coordination only
A14.a.	System Planning and Resource Management	R,E&D	1,184	1,817	1,836	1,839	1,803	1,768	100% total program
1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	0	0	0	0	0	0% coordination only
A12.b.	Wake Turbulence	R,E&D	0	0	0	0	0	0	0% coordination only
	Total ($000)		1,184	2,371	2,492	2,670	2,670	2,679	

Progress in FY 2007: World leadership

- **International Cooperation in Composite Damage Tolerance Approach:** Reached cooperation milestone with Transport Canada, EASA, and others on damage tolerance approach to composite structural design and continued operational safety. (Advanced Materials/Structural Safety)
- **Gene expression research:** Completed a study of the effects of moderate alcohol use on gene expression levels in blood. The body's reaction to a stressor can be identified at the genetic level; thus, analysis of genetic reaction may be more accurate in quantifying reaction to a given stress. Gene expression research has a three-part workflow. The first is a screening step where the expression level of all

genes is determined for each level of the stressor of interest. Then, a list of candidate genes for further investigation is developed. These are the genes that change as the level of the stressor changes. Finally, each candidate gene is validated by a method that specifically tests one gene at a time. (Aeromedical Research)

- **Global R&D Collaboration**: During 2007, the FAA and EUROCONTROL organized their seventh annual USA/Europe seminar on Air Traffic Management Research and Development. Researchers from India, China, and Australia also participated. (System Planning and Resource Management)
- **International Cooperation Research**: During 2007, the FAA and EUROCONTROL expanded joint research efforts under their Memorandum of Cooperation in the areas of advanced surface movement systems and automatic dependent-surveillance-broadcast. (System Planning and Resource Management)

3.0 NextGen Alignment

Over the past year, the FAA *Operational Evolution Partnership (OEP)* has conducted an intensive effort to define the path to the next generation air transportation system (NextGen) by working with the Joint Planning and Development Office (JPDO) to ensure alignment of their goals and objectives. In addition, the JPDO identified the R&D needs for NextGen in the *JPDO Research and Development (R&D) Plan*. The FAA NextGen R&D programs, which are planned to begin in fiscal year 2009, will contribute to the R&D needs identified by JPDO and the OEP. This chapter describes how the new FAA NextGen R&D programs map to the *OEP* and *JPDO R&D Plan*.

There are four sections to this chapter. The first section provides definitions of the OEP domains and solution sets. The second section describes NextGen service level agreements (NSLA). The third section describes how the FAA NextGen R&D programs contribute to the needs identified in the *JPDO R&D Plan*. The fourth section presents the FAA NextGen R&D program budget. The final section discusses coordination with JPDO.

Table 3.1 compares the *JPDO R&D Plan* research requirements and the *OEP Version 1.0* domains and solution sets. This chapter uses the terminology from the *JPDO R&D Plan* to align the FAA NextGen R&D programs to the NextGen research requirements.

OEP Version 1.0	JPDO R&D Plan
Air Traffic Operations	
Initiate Trajectory-Based Operations	Trajectory-Based Operations
Reduce Weather Impact	Reduced Impact of Weather
Increase Flexibility in the Terminal Environment	Flexible Terminal Airspace and Expanded Airport Access
Increase Arrivals/Departures at High Density Airports	High-Density Terminal and Airport Operations
Improve Collaborative Air Traffic Management	Collaborative Air Traffic Management
Improve Safety, Security, and Environmental Performance	Safety
	Layered, Adaptive Security
	Environment
Transform Facilities	Transformed Facilities
Aircraft and Operator Requirements	Aircraft, Operator, and Air Transportation User Requirements
Airport Development	Airport and Air Transportation Infrastructure Development
	Cross-Cutting Research and Development

Table 3.1: Mapping Solution Sets and Domain Names from *OEP Version 1.0* to the *JPDO R&D Plan*

3.1 Domains and Solution Sets

This section defines the domains and solution sets of the *OEP*. There are three domains: air traffic operations; aircraft and operator requirements; and airport development. Under the air traffic operations domain there are seven solution sets. The *JPDO R&D Plan* includes a separate area of cross-cutting R&D, which is not included in the *OEP*, but is explained in more detail at the end of this section. The descriptions of the domains and solution sets are adapted from the *OEP* and the *JPDO R&D Plan.*

3.1.1 Air Traffic Operations Domain

This domain focuses on implementing transformational capabilities to improve the U.S. air traffic management system, which encompasses operational rules, regulations and procedures, as well as the infrastructure network of U.S. airspace; air navigation facilities, equipment and services; airports or landing areas; aeronautical charts, information, and services; technical information; and manpower and material. The seven solution sets under the air traffic operations domain are:

1. *Trajectory-Based Operations*

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

2. *Reduced Impact of Weather*

This solution set allows users and controllers to plan operations based on the predicted impact of weather, rather than attempting to mitigate the effects of weather once the weather has changed. Integrated weather information and probabilistic forecasts will lead to better decision making.

3. *Flexible Terminal Airspace and Expanded Airport Access*

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

4. *High-Density Terminal and Airport Operations*

This solution set focuses on increasing capacity at the busiest airports (35 OEP) and in the busiest airspace, to achieve and maintain greater throughput. Requirements include the same capabilities of flexible terminals and airspace, described in item 3 above, as well as integrated tactical and strategic flow capabilities. Additional requirements include higher performance navigation and communications capabilities, more efficient airport surface movements, reduced spacing and separation requirements, and improved overall traffic flow management.

5. *Collaborative Air Traffic Management*

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

6. *Safety, Security and Environmental Performance*

a. *Safety*

This solution set involves sharing and proactively analyzing aviation safety information to assess and manage risks before incidents occur. Additionally, the sharing and analysis of aviation safety information will support safety assessments at the system level. With the projected increase in operations, it is not sufficient to maintain the current low accident rate. Therefore, safety must improve to ensure the number of accidents does not increase. This will require a transition to Safety Management Systems (SMS), a formal, systematic, business-like approach to managing safety risk.

b. *Layered, Adaptive Security*

This solution set applies security measures to transportation, staff, passengers, conveyances, access control, cargo and baggage, airports, and in-flight security. Layered, adaptive security is a risk-informed security system that depends on multiple technologies, policies, or procedures scaled and arranged to deter, prevent, detect, defeat, or mitigate a given threat.

c. *Environment*

This solution set involves activities that relate directly to improvements of aviation energy efficiency and its environmental impacts. The primary environmental constraints on the capacity and flexibility of the NextGen will likely be noise, emissions, local air quality, global climate changes, water quality, and energy production and consumption.

7. Transformed Facilities

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

3.1.2 Aircraft and Operator Requirements Domain

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

3.1.3 Airport Development Domain

This domain focuses on adding new airport surface infrastructure at the 35 OEP airports, and in the 15 major U.S. metropolitan areas likely to experience the greatest population and economic growth through 2025. OEP efforts will provide significant capacity increases, including new runways, runway extensions, end-around taxiways; planning and environmental assessments; and growth in metropolitan areas.

3.1.4 *Cross-cutting Research and Development*

Beyond the three OEP domains, the *JPDO R&D Plan* includes a number of research and development initiatives that address crosscutting issues including human error mitigations, risk management, and NextGen mission analyses. There is no direct mapping from the *JPDO R&D Plan* to a single OEP domain. Rather, many different FAA NextGen research efforts and core research programs support this JPDO crosscutting research goal.

3.2 Service Level Agreements

To enhance FAA performance and management control, each NextGen investment will be managed by FAA through an internal NextGen Service Level Agreement (NSLA). Each NSLA establishes the requirements and funding for the FAA investment, as well as the metrics necessary to ensure the requirements are met. The FAA Research and Technology Development Office (AJP-6) will monitor and evaluate each program through a performance-based tracking system, both at the top-level mission goal and at the individual project level. The NSLA process is undergoing a trial in FY 2008 in preparation for a full roll out in FY 2009.

3.3 Research Requirements

In the *JPDO R&D Plan*, R&D requirements are organized into 12 categories, as shown in Table 3.1, similar to the *OEP Version 1.0* domains and solution sets. Each of these categories is comprised of R&D requirements that are decomposed further into specific R&D needs. Table 3.2 and Appendix E show the mapping of the FAA's NextGen R&D programs to the JPDO's R&D requirements.

3.4 Budget

Table 3.3 summarizes the FAA NextGen R&D program five-year budget plan by line item and appropriation.

3.5 Coordination

There are research requirements that are not being addressed by the FAA NextGen R&D program. In many cases these requirements are being addressed by NextGen partner agencies, such as TSA, NASA, NOAA, or by other core or NextGen programs within the FAA. Over the next year, the FAA will continue to work with the JPDO to review requirements and ensure alignment of research priorities.

Key:
- ■ FAA NextGen R&D program addresses JPDO research needs
- ▨ Management applied across all applicable NextGen research needs
- ||| No funding applied - coordination only
- ▦ Work performed by core activity

FAA NextGen R&D Programs

JPDO R&D Requirements		JPDO R&D Plan Needs	1A13A NextGen - ATC/Technical Ops Human Factors - Controller Efficiency	1A13B NextGen - ATC/Technical Ops Human Factors - Air/Ground Integration	1A13C NextGen - Environment and Energy - Advanced Noise and Emission Reduction	1A13D NextGen - Environment and Energy - Validation Modeling	1A13E NextGen - New ATM Requirements	1A13F NextGen - Operations Concept Validation - Validation Modeling	1A13G NextGen - System Safety Management Transformation	1A13H NextGen - Wake Turbulence - Re-categorization	A12.c. NextGen - Air Ground Integration	A12.d. NextGen - Self Separation	A12.e. NextGen - Weather Technology in the Cockpit	A13.b. NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	A14.a. System Planning and Resource Management
Trajectory-Based Operations	1	Performance-based Separation	■	■						■	■	■			▨
	2	Management of Complexity and Demand Volume	■	■							■				▨
	3	Airspace Configuration	■												▨
Reduced Impact of Weather	1	Weather Information Integrated into Decision-Making													
	2	Common Weather Situational Awareness													
	3	Observation and Forecast Qualities											■		▨
Flexible Terminal Airspace and Expanded Airport Access	1	Access to Terminal Airspace for Arrivals and Departures					■				■				▨
	2	Maintain Terminal Airspace and Surface Operations in Low Visibility					■					■			▨
	3	Overly Conservative Wake Vortex Separations								■					▨
High-Density Terminal and Airport Operations	1	Maximizing Individual Runway Capacity	■				■	|||				■			▨
	2	Maximizing Multiple-Runway Capacity					■	■				■			▨
	3	Manage Ramp Operations, Surface Traffic, and Runway Assignments		■			■	■			■	■			▨
	4	Manage High-Density Arrival and Departure Flows													
Collaborative Air Traffic Management	1	Shared Situational Awareness		■			■	■			■				▨
	2	Collaboration and Enhanced Flight Plan Negotiation													
	3	Trajectory and Flow Management	■					■							▨
Safety	1	Safer Systems are Needed													
	2	Identify Proactively Safety Risks and Safety Assurance Process							■						▨
Layered, Adaptive Security															
Environment	1	Keeping air transportation clean and quiet			■	■								■	▨
Transformed Facilities	1	Air Traffic Management Facility Optimization													
	2	Expanded Tower Services and Increased Tower Staff Productivity	■												▨
	3	Air Traffic Management Workforce Skills and Training	▦					■				■			▨
	4	National Communications, Navigation, Surveillance, and Timing Infrastructure													
Aircraft, Operator, and Air Transportation User Requirements	1	Tradeoffs for Aircraft-Related Investments and Policies													
	2	Reduced Time to Introduce Airframe, Avionics, and Procedure Changes										■			▨
	3	Unmanned Aircraft System (UAS) Operations													
Airport and Air Transportation Infrastructure Development															
Cross-Cutting Research and Development	1	Human Error Mitigation and Risk Management		■				■			■	■			▨
	2	NextGen Mission Analysis													

Table 3.2: Mapping FAA NextGen R&D Programs to JPDO R&D Plan Requirements and Needs

Details of R&D NextGen Program in ATO Capital

			2008	2009	2010	2011	2012	2013	Goal	
1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	3,800	11,700	11,700	11,700	11,700	3	Controller efficiency
1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	0	2,900	7,700	7,700	7,700	7,700	4	Air/ground integration
1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	0	2,500	12,500	12,500	12,500	12,500	2	Noise and emission reduction
1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	0	4,500	7,500	7,500	7,500	7,500	9	Validation modeling
1A09E	NextGen - New ATM Requirement	ATO Capital	0	5,400	27,500	27,900	29,200	31,900	1	Supports 3 times capacity
1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	0	4,000	15,000	15,000	15,000	15,000	9	Validation modeling
1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	16,300	19,000	19,700	19,700	20,000	9	Supports JPDO Safety IPT goals
1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	2,000	2,000	2,000	2,000	2,000	1	Technology and standards
1A09	**NextGen - System Development**	**ATO Capital**	**0**	**41,400**	**102,900**	**104,000**	**105,300**	**108,300**		

Details of R&D NextGen Program in R,E&D

			2008	2009	2010	2011	2012	2013	Goal	
A12.b.	NextGen Wake Turbulence	R,E&D	8,000	7,370	7,605	7,865	7,745	7,626	1	Standards and technologies
A12.c	NextGen - Air Ground Integration	R,E&D	0	2,554	11,337	11,720	11,521	11,322	4	Air/ground integration & error management
A12.d	NextGen - Self Separation	R,E&D	0	8,025	9,805	10,136	9,963	9,790	7	Supports standards, procedures, training
A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	8,049	9,867	10,202	10,040	9,878	8	Weather-in-the-cockpit procedures
A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	16,050	19,700	20,368	20,034	19,700	2	Noise and emission reduction
		R,E&D	**8,000**	**42,048**	**58,314**	**60,291**	**59,303**	**58,316**		

Key:

Goal	
1	Fast, flexible, and efficient
2	Clean and quiet
3	High quality teams and individuals
4	Human-centered design
5	Human protection
6	Safe aerospace vehicles
7	Self-separation
8	Situational awareness
9	System knowledge
10	World leadership

Table 3.3 – Highlights of Funding Levels in the NextGen R&D Goals[23]

[23] The total R&D program is summarized in Tables 4.1 through 4.4 of Chapter 4 in this report. The funding levels listed for years 2010 to 2013 are estimates and subject to change. Programs listed under ATO Capital form the components of line item 1A09 – NextGen System Development.

4.0 Research Business Management

This chapter summarizes the research and development (R&D) program according to the FAA's FY 2009 budget submission. The chapter explains what the FAA is doing (programs), how much it is spending (budget), how it performs its programs (partnerships), and how well it executes its programs (evaluation).

4.1 Sponsors

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

4.2 Programs

The R&D programs are funded in four appropriation accounts: Research, Engineering and Development (R,E&D); Air Traffic Organization (ATO) Capital; Airport Improvement Program (AIP); and Safety and Operations (S&O). In general, the R,E&D account funds R&D programs that improve the national airspace system (NAS) by increasing its safety, security, productivity, capacity, and environmental compatibility to meet the expected air traffic demands of the future.[24] The AIP account generally funds airport improvement grants, including those emphasizing capacity development, and safety and security needs; and funds grants for aircraft noise compatibility planning and programs and low emissions airport equipment.[25] It also funds administrative and technical support costs to support airport programs. The ATO Capital account and the Safety and Operations account became new account designations in the FY 2008 budget request. They replaced the former Facilities and Equipment (F&E) and Operations accounts. R&D programs funded under the ATO Capital account include R&D concept development and demonstration prior to an FAA investment decision. The commercial space transportation program's R&D operating expenses are funded under the S&O account.

The programs summarized below are in the FY 2009 R&D budget request. Appendix A provides detailed information for each program, including intended outcomes, outputs, programmatic structure, partnerships, and a five-year program plan.

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[24]FAA Order 2500.8A, *Funding Criteria for Operations, Facilities and Equipment (F&E), and Research, Engineering and Development (R,E&D) Accounts*, dated April 9, 1993.
[25]FAA Budget Estimates FY 2007 submitted for use by The Committees on Appropriations, Section 3D. – Grants-In-Aid for Airports, page 3; and Vision 100 – Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003.

- **Research, Engineering and Development (R,E&D) Appropriation**

  – *Fire Research and Safety (A11.a.)*: The program develops technologies, procedures, test methods, and criteria, to reduce the risk of commercial airline accidents caused by hidden in-flight fires and fuel tank explosions; and it improves survivability during post-crash fires.

  – *Propulsion and Fuel Systems (A11.b.)*: The program develops and validates technologies, tools, methodologies, and materials to enhance the airworthiness, reliability, and performance of civil turbine and piston engines, propellers, fuels, and fuel management systems.

  – *Advanced Materials/Structural Safety (A11.c.)*: The program ensures the safety of civil aircraft constructed of advanced composite materials by developing analytical and testing methods to understand how design, load, and damage can affect composite structures and by developing maintenance and repair methods. The program also increases the ability of passengers to survive aviation accidents by improving the crash characteristics of aircraft structures through modeling and testing crash events, and verification of analytical crash prediction methodologies.

  – *Atmospheric Hazards/Digital System Safety (A11.d.)*: The program develops technologies and methods to detect or prevent frozen contamination and predicts anti-icing fluid failure, and ensures safe operations during and after flight in atmospheric icing conditions. It improves aircraft safety by ensuring the safe operation of advanced flight-critical digital (software-based and programmable logic-based) airborne systems technology. It also assesses how this technology may be safely employed in flight-essential and flight-critical systems such as fly-by-wire, augmented manual flight controls, navigation and communication equipment, and autopilots.

  – *Aging Aircraft/Continued Airworthiness (A11.e.)*: The program develops technologies, technical information, procedures, and practices to help ensure the continued airworthiness of aircraft structures, engines, and systems. It assesses the causes and consequences of fatigue damage of aging aircraft; ensures the continued safe operation of aircraft electrical, mechanical, and flight control systems; detects and quantifies damage through nondestructive inspection techniques; updates and validates airworthiness standards; develops and validates guidance for Health and Usage Monitoring Systems (HUMS) certification; establishes damage-tolerant design and maintenance criteria for rotorcraft, commuter airplanes, and propeller systems; and develops technologies and guidance to ensure safe operation in hazards resulting from electromagnetic interference, high-intensity radiated fields, and lightning.

  – *Aircraft Catastrophic Failure Prevention Research (A11.f.)*: The program develops technologies and methods to assess risk and prevent the occurrence of potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems. It also uses historic accident data to investigate turbine engine un-containment events and propulsion malfunctions.

– *Flightdeck/Maintenance/System Integration Human Factors (A11.g.)*: The program provides the human factors research for guidelines, handbooks, advisory circulars, rules, and regulations that ensure safe and efficient aircraft operations. It improves task performance and training for aircrew, inspectors, and maintenance technicians; develops and applies error management strategies to flight and maintenance operations; and ensures that human factors are considered in certifying new aircraft and in designing and modifying equipment.

– *Aviation Safety Risk Analysis/System Safety Management (A11.h.)*: The program monitors and analyzes aviation system operations and safety risks; and develops risk management methodologies, prototype tools, technical information, procedures, and practices to improve aviation safety. It develops an infrastructure that enables the free sharing of de-identified, aggregate safety information from various government and industry sources in a protected, aggregated manner; and conducts research to evaluate proposed new technologies and procedures, which will improve safety by making relevant information available to the pilot during terminal operations.

– *Air Traffic Control/Technical Operations Human Factors (A11.i.)*: The program identifies and analyzes trends in air traffic operational errors and technical operations incidents, and develops and implements strategies to mitigate errors and incidents. It manages human error hazards, their consequences, and recovery methods in early stages of system design or procedural development; and assesses concepts and technology to modernize workstations, improve controller performance, and reduce staffing requirements.

– *Aeromedical Research (A11.j.)*: The program identifies pilot, flight attendant, and passenger medical conditions that indicate an inability to meet flight demands, both in the absence and in the presence of emergency flight conditions; and defines cabin air quality and analyzes requirements for occupant protection and aircraft decontamination.

– *Weather Program (A11.k.)*: The program develops new technologies to provide weather observations, warnings, and forecasts that are accurate, accessible, and efficient. It works to enable flight deck weather information technologies that allow pilots and aircrews to engage in shared situational awareness and shared responsibilities with controllers, dispatchers, Flight Service Station specialists, and others, pertaining to safe and efficient preflight, en route, and post flight aviation safety decisions involving weather.

- *Unmanned Aircraft Systems Research (A11.l):* The program ensures safe integration of unmanned aircraft systems (UAS) into the nation's aviation system; and provides information to support certification procedures, airworthiness standards, operational requirements, maintenance procedures, and safety oversight activities for UAS civil applications and operations.

- *Joint Planning and Development Office (JPDO) (A12.a.)*: The program plans and designs the next generation air transportation system by coordinating goals, priorities, and implementation requirements within the federal government and with the U.S. aviation community.

- *Wake Turbulence (A12.b.):* The program provides a better understanding of the wake trailing downstream from aircraft wingtips; develops mechanisms for safely reducing wake separation distances between aircraft during en-route and airport operations; and develops safe and efficient separation processes for use with single and multiple runway operations.

- *NextGen - Air Ground Integration (A12.c):* The program addresses the pilot side of the air-ground integration challenge (i.e., the challenge of ensuring that the right information is provided to pilots, at the right time, to make the right decisions). Through the use of modeling, simulation, and demonstration, the program assesses interoperability of tools; develops design guidance; determines training requirements; and verifies procedures for ensuring effective and efficient human system integration in transitions of NextGen capabilities.

- *NextGen - Self Separation (A12.d):* The program addresses the initial standards and procedures for self-separation, from a human factors perspective. It assesses the human factors risks and requirements associated with self-separation policies, procedures, and maneuvers. Research results will provide the technical information and data needed to support the development of standards, procedures, and training by flight standards to implement the JPDO plan for separation.

- *NextGen - Weather Technology in the Cockpit (A12.e):* The program addresses weather-in-the-cockpit, which will enable pilots and aircrews to engage in shared situational awareness and shared responsibilities with controllers, dispatchers, Flight Service Station specialists and others, pertaining to safe and efficient flight involving weather. There are two parts to this program: human factors and weather technology. The Human Factors portion addresses policy, standards, and guidance for the display of weather information and its use, including design guidance, training, procedures, and error management. The weather technology portion develops policy and standards on hardware and software requirements, including update rates, and guidelines and procedures for testing, evaluating, and qualifying weather systems for certification and operation on aircraft.

- *Environment and Energy (A13.a.)*: The program develops and validates methodologies, models, metrics, and tools to assess and mitigate the effect of aircraft noise and aviation emissions; it analyzes and balances the interrelationships between noise and emissions, considers local and global impacts, and determines economic consequences; and it reduces scientific uncertainties related to aviation environmental issues to support decision-making.

- *NextGen Environmental Research - Aircraft Technologies, Fuels, and Metrics (A13.b):* The program addresses the NextGen goal to increase capacity three-fold while reducing significant environmental impacts in absolute terms. The program is focused on reducing current levels of aircraft noise; investigating local air quality, greenhouse gas emissions, and energy use; and advancing alternative fuels for aviation use. The program also supports research to determine the appropriate goals and metrics to manage NextGen aviation environmental impacts that are needed to support Environmental Management Systems (EMSs).

- *System Planning and Resource Management (A14.a.)*: The program manages the R&D programs to meet customer needs, to increase program efficiency, and to reduce management and operating costs. It works to increase customer and stakeholder involvement in the FAA programs, and foster acceptance of U.S. standards and technology to meet global aviation needs.

- *William J. Hughes Technical Center Laboratory Facility (WJHTC) (A14.b.)*: The program provides well-equipped, routinely available facilities to emulate and evaluate field conditions; performs human-in-the-loop simulations; measures human performance; evaluates human factors issues; and provides research aircraft that are specially instrumented and re-configurable.

- **Air Traffic Organization (ATO) Capital Appropriation**

  - *Runway Incursion Reduction (1A01A)*: The program minimizes the chance of injury, death, damage, or loss of property caused by runway accidents or incidents. It selects and evaluates technologies; validates technical performance and operational suitability; and develops a business case to support program implementation. It improves pilot situational awareness with airport visual aids such as runway status lights, final approach runway occupancy signals and other enhanced airport lighting technologies.

  - *System Capacity, Planning and Improvement (1A01B)*: The program delivers products and services to alleviate traffic congestion, system delays, and operational inefficiencies in the aviation system through the development of new runways, new technologies, and modified operational procedures. It also develops performance metrics; implements performance measurement tools; and collects, processes, and analyzes data to measure and report performance on a routine basis.

– *Operations Concept Validation (1A01C)*: The program conducts modeling and simulation to validate new operational concepts for the next generation of decision support systems for pilots and air traffic controllers. It validates performance requirements and identifies research criteria at the system and subsystem level; and assesses safety and environmental impact, identifies risk, and takes actions necessary to reduce risk.

– *NAS Weather Requirements (1A01D):* The program analyzes mission needs and establishes weather requirements for the ATO to increase operational predictability during weather events. It aligns requirements, priorities, programs, and resources and develops metrics to measure and understand the impact of weather on the system; and it evaluates weather-related services and technologies for the ATO.

– *Airspace Management Laboratory (1A01E)*: The program provides a better understanding of the impact of changes to airspace design (sectors and routes) in high-density traffic areas, such as the New York metropolitan airspace, to improve airspace operations, reduce delays, and mitigate environmental impacts. It studies alternatives for airspace redesign that, when combined with new decision support tools and procedures, will optimize the nation's airspace.

– *Airspace Redesign (1A01F)*: The program investigates and demonstrates new airspace concepts and procedures to increase national aviation system capacity. It focuses on the nation's major metropolitan areas to shorten flight distances, to provide more fuel-efficient routes, and to reduce arrival and departure delays.

– *Wind Profiling and Weather Research - Juneau (1A01I):* The program funds operations and maintenance of the Juneau Airport Wind System operational prototype. It implements an end-state system that consists of operational prototype software algorithms and a hardware infrastructure that is acceptable for use in the NAS.

– *NextGen Demonstrations and Infrastructure Development (1A08)*: The program demonstrates and tests concepts related to NextGen including trajectory-based operations and super density operations to mature technologies, support investment decisions, and deploy new capabilities. It identifies early implementation opportunities, refines longer-term objectives, and if results dictate, eliminates certain concepts from further consideration.

- *NextGen - Air Traffic Control/Technical Operations Human Factors - Controller Efficiency (1A09A):* The program addresses human system integration and human performance issues related to achieving three times capacity without a commensurate increase in the number of air traffic service providers. It examines how air traffic service providers can achieve higher efficiency levels through the integration of automation, decision support tools, workstation displays, and procedures.

- *NextGen - Air Traffic Control/Technical Operations Human Factors - Air/Ground Integration (1A09B):* The program addresses the air traffic service provider perspective and works together with the flight deck human factors program to address the air-ground integration required to transition from the current system to NextGen. It addresses changes in responsibilities and liabilities and examines new types of human error modes to manage safety risk.

- *NextGen - Environment and Energy - Advanced Noise and Emissions Reduction (1A09C):* The program identifies advances in communication, navigation, and surveillance or satellite technologies and demonstrates how to leverage their capabilities to increase capacity while reducing noise, fuel burn, and emissions through the use of procedures, sequencing, and timing that optimize en route, arrival, departure, and surface operations.

- *NextGen - Environment and Energy - Validation Modeling (1A09D):* The program develops methods, metrics, and models to demonstrate that significant aviation noise and emissions impacts can be reduced in absolute terms to enable the air traffic system to handle growth in demand up to three times current levels. It measures the improvements provided by the products from the other components of the environment and energy program.

- *NextGen - New Air Traffic Management Requirement (1A09E):* The program supports new procedures and technologies to increase efficiency in the national airspace system and to provide three times current capacity levels. It develops data communication requirements and standards, conflict resolution methods, procedures and technologies to reduce aircraft separation, enhanced surface management technologies, procedures for low visibility conditions, and decision support tools for air and ground operations.

- *NextGen - Operations Concept Validation - Validation Modeling (1A09F):* The program develops methods, metrics, and models to demonstrate that the system can handle growth in demand up to three times current levels at higher efficiency levels than today. It measures the improvements planned by NextGen under the seven solution sets and determines whether or not these improvements will provide the targeted levels of capacity and efficiency.

– *NextGen - System Safety Management Transformation (1A09G):* The program develops a safety information analysis and sharing environment for NextGen to serve as the foundation for trend analysis and the identification and mitigation of potential safety hazards before incidents occur. It also produces guidelines for developing processes and technologies to implement a safety management system across NextGen.

– *NextGen - Wake Turbulence - Re-categorization (1A09H):* The program provides new categories of airspace to allow different fleet mix conditions, reduce wake separation distances while maintaining safety, and increase capacity and efficiency in congested airspace. It develops flexible airspace classifications for use under specific conditions to increase capacity in a given volume of airspace; and it supports dynamic, pair-wise separation between aircraft.

– *Center for Advanced Aviation System Development (CAASD) (4A09)*: The program identifies and tests new technologies for application to air traffic management, navigation, communication, separation assurance, surveillance, and system safety; and conducts R&D and high-level system engineering to meet the FAA's long-term requirements.

- **Airport Improvement Program (AIP) Appropriation**

– *Airport Cooperative Research - Capacity*: The program addresses airport design, including perimeter taxiways and modeling; mitigation of environmental impacts, including noise and emissions and run-off from deicing and anti-icing operations; introduction of new large aircraft; and improvements in pavement maintenance and materials.

– *Airport Cooperative Research - Environment*: The program examines the impact an airport has on the surrounding environment and advances the science and technology for creating an environmentally friendly airport system. Projects include the study of airport-related hazardous air pollutants, airport impact on climate change, alternative aviation fuels, and advanced noise and emissions models.

– *Airport Cooperative Research - Safety:* The program addresses all aspects of improving airport safety, including improvements in lighting and marking, mitigation of wildlife hazards, airport design and geometry, reduction of runway incursions, and improvement of aircraft rescue and firefighting.

– *Airport Technology Research - Capacity*: The program provides better airport planning and designs and improves runway pavement design, construction, and maintenance. It ensures new pavement standards will be ready to support safe international operation of next-generation heavy aircraft, and makes pavement design standards available to users worldwide.

  - *Airport Technology Research - Safety*: The program increases airport safety by conducting research to improve airport lighting and marking, reduce wildlife hazards near airport runways, improve airport fire and rescue capability, and reduce surface accidents.

- **Safety and Operations (S&O) Appropriation**

  - *Commercial Space Transportation Safety*: The program examines safety considerations for commercial space transportation, including those that involve crew and spaceflight participants' health and safety, spacecraft vehicle safety, launch and re-entry risks, public safety, and personal property risk.

4.3 Budget

This section provides four tables that explain the FAA R&D budget by appropriation, program sponsor, R&D category, and performance goal. It presents the FAA R&D request for the President's budget for FY 2009. The funding levels listed for years 2010 to 2013 are estimates and subject to change.

- **Appropriation account**. -- Table 4.1 shows the FAA R&D budget planned for FY 2009, including the five-year plan through 2013, grouped by appropriation account. The previous section on programs defined the four appropriation types. The ATO Capital budget in Table 4.1 includes four line items: Advanced Technology Development and Prototyping (ATD&P) line item 1A01, NextGen Demonstrations and Infrastructure Development line item 1A08, NextGen System Development line item 1A09, and the CAASD line item 4A09. The ATO Capital appropriation has programs that are not R&D; however, only R&D programs are shown.

- **Sponsoring organization** -- Table 4.2 shows the FAA R&D budget planned for FY 2009, including the five-year plan through 2013, grouped by sponsoring organization. Sponsoring organizations are Aviation Safety, Air Traffic Organization, Airports, Commercial Space Transportation, and Aviation Policy, Planning, and Environment.

- **R&D category** -- The FAA research includes both applied research and development as defined by the Office of Management and Budget Circular A-11[26]. Table 4.3 shows the FAA R&D program according to these categories with the percent of applied research and development for FY 2009 through 2013.

- **Performance goal** -- Table 4.4 shows the FAA R&D budget by performance goal as defined in Exhibit II of the FAA budget request for FY 2009. The R&D

[26] OMB Circular A-11, *Preparation, Submission and Execution of the Budget*, June 2007, section 84, page 8 (www.whitehouse.gov/OMB/circulars).

programs apply to three performance goals – safety, mobility, and environment. Programs may support more than one goal; however, each program is listed only once under its primary goal for budget purposes. The table provides information on contract costs, personnel costs, and other in-house costs planned for FY 2009.

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

Project Number	FY 2009 Budget Line Item	Program	Appropriation Account	2008 Enacted Budget ($000)	2009 Planned ($000)	2010 Planned ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	
Research, Engineering and Development (R,E&D)										
061-110	A11.a.	Fire Research and Safety	R,E&D	7,350	6,650	6,819	6,935	7,057	7,185	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	4,086	3,669	3,720	3,724	3,729	3,733	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	7,083	2,920	2,965	2,975	2,986	2,997	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	3,574	4,838	4,921	4,949	4,979	5,010	
065-110	A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	15,945	14,589	14,780	14,779	14,778	14,777	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	2,202	436	458	480	504	529	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	9,200	7,465	7,580	7,604	7,630	7,656	
060-110	A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	9,517	12,488	12,589	12,497	12,401	12,300	
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,000	10,469	10,768	10,998	11,240	11,494	
086-110	A11.j.	Aeromedical Research	R,E&D	7,760	8,395	8,699	8,976	9,267	9,573	
041-110	A11.k.	Weather Program	R,E&D	16,888	16,968	16,954	16,615	16,259	15,885	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	2,920	1,876	1,929	1,970	2,012	2,057	
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,321	14,494	14,560	14,382	14,195	13,999	
041-150	A12.b.	Wake Turbulence	R,E&D	12,813	10,132	10,369	10,580	10,408	10,235	
--	--	GPS Civil Requirements	R,E&D	3,100	0	0	0	0	0	
111-110	A12.c	NextGen - Air Ground Integration	R,E&D	0	2,554	11,337	11,720	11,521	11,322	
111-120	A12.d	NextGen - Self Separation	R,E&D	0	8,025	9,805	10,136	9,963	9,790	
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	8,049	9,867	10,202	10,040	9,878	
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,469	15,608	15,670	15,467	15,253	15,028	
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	16,050	19,700	20,368	20,034	19,700	
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,184	1,817	1,836	1,839	1,803	1,768	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,415	3,536	3,674	3,804	3,941	4,084	
			TOTAL R,E&D	**146,828**	**171,028**	**189,000**	**191,000**	**190,000**	**189,000**	
Air Traffic Organization (ATO) Capital										
S09.02-00	1A01A	Runway Incursion Reduction	ATO Capital	8,000	10,000	5,000	5,000	3,000	3,000	
M08.28-00	1A01B	System Capacity, Planning and Improvement	ATO Capital	6,500	6,500	6,500	6,500	6,500	6,500	
M08.29-00	1A01C	Operations Concept Validation	ATO Capital	3,000	7,400	8,000	8,000	8,000	6,000	
M08.27-00	1A01D	NAS Weather Requirements	ATO Capital	1,000	1,000	1,000	1,000	1,000	3,300	
M08.28-02	1A01E	Airspace Management Lab	ATO Capital	4,000	4,000	4,000	4,000	4,000	4,000	
M08.28-04	1A01F	Airspace Redesign	ATO Capital	5,000	3,000	3,000	3,000	3,000	3,000	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	ATO Capital	4,000	1,100	0	0	0	0	
M08.36-01	--	Wake Turbulence	ATO Capital	3,000	0	1,000	1,000	1,000	1,000	
N12.02-01	--	Local Area Augmentation Sysm (LAAS)	ATO Capital	1,000	0	0	0	0	0	
			Subtotal Line 1A01	35,500	33,000	28,500	28,500	26,500	26,800	/1
M49.01-02	1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	3,800	11,700	11,700	11,700	11,700	
M49.01-02	1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	0	2,900	7,700	7,700	7,700	7,700	
M49.01-02	1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	0	2,500	12,500	12,500	12,500	12,500	
M49.01-02	1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	0	4,500	7,500	7,500	7,500	7,500	
M49.01-02	1A09E	NextGen - New ATM Requirement	ATO Capital	0	5,400	27,500	27,900	29,200	31,900	
M49.01-02	1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	0	4,000	15,000	15,000	15,000	15,000	
M49.01-02	1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	16,300	19,000	19,700	19,700	20,000	
M49.01-02	1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	2,000	2,000	2,000	2,000	2,000	
			Subtotal Line 1A09	0	41,400	102,900	104,000	105,300	108,300	
M36.01-00	--	Safe Flight 21 - Alaska Capstone	ATO Capital	15,000	0	0	0	0	0	
M49.01-01	1A08	NextGen Demonstration	ATO Capital	20,000	28,000	30,000	30,000	30,000	30,000	/2
M03.02-00	4A09A	Center for Advanced Aviation System Development	ATO Capital	24,640	28,728	34,020	43,092	44,982	47,250	/3
			TOTAL ATO Capital	**95,140**	**131,128**	**195,420**	**205,592**	**206,782**	**212,350**	
Airport Improvement Program (AIP)										
--	--	Airports Technology Research - Capacity	AIP	8,907	9,109	9,109	9,109	9,109	9,109	
--	--	Airports Technology Research - Safety	AIP	9,805	10,239	10,239	10,239	10,239	10,239	
--	--	Airport Cooperative Research Program - Capacity	AIP	2,000	5,000	5,000	5,000	5,000	5,000	/4
--	--	Airport Cooperative Research Program - Environment	AIP	3,000	5,000	5,000	5,000	5,000	5,000	/4
--	--	Airport Cooperative Research Program - Safety	AIP	5,000	5,000	5,000	5,000	5,000	5,000	/4
			TOTAL AIP	**28,712**	**34,348**	**34,348**	**34,348**	**34,348**	**34,348**	
Safety and Operations (S&O)										
--	--	Commercial Space Transportation Safety	S&O	128	125	125	125	125	125	
			TOTAL S&O	**128**	**125**	**125**	**125**	**125**	**125**	
			GRAND TOTAL	**$270,808**	**$336,629**	**$418,893**	**$431,065**	**$431,255**	**$435,823**	

Notes:
/1 The amount shown for ATD&P reflects only R&D activities: it does not include acquisition, operational testing, or other non-R&D activities.
/2 The amount shown for NextGen Demonstration is 40% of the total line item in FY 2008 and 100% in FY 2009 and beyond.
/3 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 30.8% in FY 2008 and 37.8% in FY 2009 and beyond.
/4 Airport Cooperative Research Program for capacity, environment, and safety are combined into a single white sheet write-up in Appendix A.
/5 The funding levels listed for years 2010 to 2013 are estimates and subject to change.

Table 4.1: Planned R&D Budget by Appropriation Account

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

Project Number	FY 2009 Budget Line Item	Program	Appropriation Account	2008 Enacted Budget ($000)	2009 Planned ($000)	2010 Planned ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	
Aviation Safety (AVS)										
061-110	A11.a.	Fire Research and Safety	R,E&D	7,350	6,650	6,819	6,935	7,057	7,185	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	4,086	3,669	3,720	3,724	3,729	3,733	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	7,083	2,920	2,965	2,975	2,986	2,997	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	3,574	4,838	4,921	4,949	4,979	5,010	
065-110	A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	15,945	14,589	14,780	14,779	14,778	14,777	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	2,202	436	458	480	504	529	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	9,200	7,465	7,580	7,604	7,630	7,656	
060-110	A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	9,517	12,488	12,589	12,497	12,401	12,300	
086-110	A11.j.	Aeromedical Research	R,E&D	7,760	8,395	8,699	8,976	9,267	9,573	
041-110	A11.k.	Weather Program	R,E&D	16,888	16,968	16,954	16,615	16,259	15,885	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	2,920	1,876	1,929	1,970	2,012	2,057	
111-110	A12.c	NextGen - Air Ground Integration	R,E&D	0	2,554	11,337	11,720	11,521	11,322	
111-120	A12.d	NextGen - Self Separation	R,E&D	0	8,025	9,805	10,136	9,963	9,790	
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	8,049	9,867	10,202	10,040	9,878	
		Subtotal R,E&D		86,525	98,922	112,423	113,562	113,126	112,692	
M49.01-02	1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	16,300	19,000	19,700	19,700	20,000	
		***Aviation Safety* Total**		**86,525**	**115,222**	**131,423**	**133,262**	**132,826**	**132,692**	
Air Traffic Organization (ATO)										
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,000	10,469	10,768	10,998	11,240	11,494	
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,321	14,494	14,560	14,382	14,195	13,999	
041-150	A12.b.	Wake Turbulence	R,E&D	12,813	10,132	10,369	10,580	10,408	10,235	
--	--	GPS Civil Requirements	R,E&D	3,100	0	0	0	0	0	
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,184	1,817	1,836	1,839	1,803	1,768	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,415	3,536	3,674	3,804	3,941	4,084	
		Subtotal R,E&D		44,833	40,448	41,207	41,603	41,587	41,580	
S09.02-00	1A01A	Runway Incursion Reduction	ATO Capital	8,000	10,000	5,000	5,000	3,000	3,000	
M08.28-00	1A01B	System Capacity, Planning and Improvement	ATO Capital	6,500	6,500	6,500	6,500	6,500	6,500	
M08.29-00	1A01C	Operations Concept Validation	ATO Capital	3,000	7,400	8,000	8,000	8,000	6,000	
M08.27-00	1A01D	NAS Weather Requirements	ATO Capital	1,000	1,000	1,000	1,000	1,000	3,300	
M08.28-02	1A01E	Airspace Management Lab	ATO Capital	4,000	4,000	4,000	4,000	4,000	4,000	
M08.28-04	1A01F	Airspace Redesign	ATO Capital	5,000	3,000	3,000	3,000	3,000	3,000	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	ATO Capital	4,000	1,100	0	0	0	0	
M08.36-01	--	Wake Turbulence	ATO Capital	3,000	0	1,000	1,000	1,000	1,000	
N12.02-01	--	Local Area Augmentation Sysm (LAAS)	ATO Capital	1,000	0	0	0	0	0	
M36.01-00	--	Safe Flight 21 - Alaska Capstone	ATO Capital	15,000	0	0	0	0	0	
M49.01-01	1A08	NextGen Demonstration	ATO Capital	20,000	28,000	30,000	30,000	30,000	30,000	/1
M49.01-02	1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	3,800	11,700	11,700	11,700	11,700	
M49.01-02	1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	0	2,900	7,700	7,700	7,700	7,700	
M49.01-02	1A09E	NextGen - New ATM Requirement	ATO Capital	0	5,400	27,500	27,900	29,200	31,900	
M49.01-02	1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	0	4,000	15,000	15,000	15,000	15,000	
M49.01-02	1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	2,000	2,000	2,000	2,000	2,000	
M03.02-00	4A09A	Center for Advanced Aviation System Development	ATO Capital	24,640	28,728	34,020	43,092	44,982	47,250	/2
		Subtotal ATO Capital		95,140	107,828	156,420	165,892	167,082	172,350	
		***Air Traffice Organization* Total**		**139,973**	**148,276**	**197,627**	**207,495**	**208,669**	**213,930**	
Airports (ARP)										
--	--	Airports Technology Research - Capacity	AIP	8,907	9,109	9,109	9,109	9,109	9,109	
--	--	Airports Technology Research - Safety	AIP	9,805	10,239	10,239	10,239	10,239	10,239	
--	--	Airport Cooperative Research Program - Capacity	AIP	2,000	5,000	5,000	5,000	5,000	5,000	
--	--	Airport Cooperative Research Program - Environment	AIP	3,000	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	
		***Airports* Total**		**28,712**	**34,348**	**34,348**	**34,348**	**34,348**	**34,348**	
Aviation Policy, Planning and Environment (AEP)										
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,469	15,608	15,670	15,467	15,253	15,028	
M49.01-02	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	16,050	19,700	20,368	20,034	19,700	
		Subtotal R,E&D		15,469	31,658	35,370	35,835	35,287	34,728	
M49.01-02	1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	0	2,500	12,500	12,500	12,500	12,500	
M49.01-02	1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	0	4,500	7,500	7,500	7,500	7,500	
		Subtotal ATO Capital		0	7,000	20,000	20,000	20,000	20,000	
		***Aviation Policy, Planning and Environment* Total**		**15,469**	**38,658**	**55,370**	**55,835**	**55,287**	**54,728**	
Commercial Space Transportation (AST)										
--	--	Commercial Space Transportation Safety	S&O	128	125	125	125	125	125	
		***Commercial Space Transportation* Total**		**128**	**125**	**125**	**125**	**125**	**125**	
		TOTAL		**$270,808**	**$336,629**	**$418,893**	**$431,065**	**$431,255**	**$435,823**	

Notes:
/1 The amount shown for NextGen Demonstration is 40% of the total line item in FY 2008 and 100% in FY 2009 and beyond.
/2 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 30.8% in FY 2008 and 37.8% in FY 2009 and beyond.
/3 The funding levels listed for years 2010 to 2013 are estimates and subject to change.

Table 4.2: Planned R&D Budget by Sponsoring Organization

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

Project Number	FY 2009 Budget Line Item	Program	Appropriation Account	2008 Enacted Budget ($000)	2009 Planned ($000)	2010 Planned ($000)	2011 Planned ($000)	2012 Planned ($000)	2013 Planned ($000)	
Applied Research										
061-110	A11.a.	Fire Research and Safety	R,E&D	7,350	6,650	6,819	6,935	7,057	7,185	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	4,086	3,669	3,720	3,724	3,729	3,733	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	7,083	2,920	2,965	2,975	2,986	2,997	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	3,574	4,838	4,921	4,949	4,979	5,010	
065-110	A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	15,945	14,589	14,780	14,779	14,778	14,777	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	2,202	436	458	480	504	529	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	9,200	7,465	7,580	7,604	7,630	7,656	
060-110	A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	9,517	12,488	12,589	12,497	12,401	12,300	
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	10,000	10,469	10,768	10,998	11,240	11,494	
086-110	A11.j.	Aeromedical Research	R,E&D	7,760	8,395	8,699	8,976	9,267	9,573	
041-110	A11.k.	Weather Program	R,E&D	16,888	16,968	16,954	16,615	16,259	15,885	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	2,920	1,876	1,929	1,970	2,012	2,057	
027-110	A12.a.	Joint Planning and Development Office	R,E&D	14,321	14,494	14,560	14,382	14,195	13,999	
041-150	A12.b.	Wake Turbulence	R,E&D	12,813	10,132	10,369	10,580	10,408	10,235	
111-110	A12.c	NextGen - Air Ground Integration	R,E&D	0	2,554	11,337	11,720	11,521	11,322	
111-120	A12.d	NextGen - Self Separation	R,E&D	0	8,025	9,805	10,136	9,963	9,790	
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	0	8,049	9,867	10,202	10,040	9,878	
091-110/111/116	A13.a.	Environment and Energy	R,E&D	15,469	15,608	15,670	15,467	15,253	15,028	
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	0	16,050	19,700	20,368	20,034	19,700	
011-130	A14.a.	System Planning and Resource Management	R,E&D	1,184	1,817	1,836	1,839	1,803	1,768	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,415	3,536	3,674	3,804	3,941	4,084	
		Subtotal	**R,E&D**	143,728	171,028	189,000	191,000	190,000	189,000	
M03.02-00	4A09A	Center for Advanced Aviation System Development	ATO Capital	24,640	28,728	34,020	43,092	44,982	47,250	/1
		Subtotal	**ATO Capital**	24,640	28,728	34,020	43,092	44,982	47,250	
--	--	Airport Cooperative Research Program - Capacity	AIP	2,000	5,000	5,000	5,000	5,000	5,000	
--	--	Airport Cooperative Research Program - Environment	AIP	3,000	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	
		Subtotal	**AIP**	10,000	15,000	15,000	15,000	15,000	15,000	
--	--	Commercial Space Transportation Safety	S&O	64	63	63	63	63	63	/2
		Subtotal	**S&O**	64	63	63	63	63	63	
		Applied Research		**178,432**	**214,819**	**238,083**	**249,155**	**250,045**	**251,313**	
		Percent *Applied Research*		**65.9%**	**63.8%**	**56.8%**	**57.8%**	**58.0%**	**57.7%**	
Development										
--	--	GPS Civil Requirements	R,E&D	3,100	0	0	0	0	0	
		Subtotal	**R,E&D**	3,100	0	0	0	0	0	
S09.02-00	1A01A	Runway Incursion Reduction	ATO Capital	8,000	10,000	5,000	5,000	3,000	3,000	
M08.28-00	1A01B	System Capacity, Planning and Improvement	ATO Capital	6,500	6,500	6,500	6,500	6,500	6,500	
M08.29-00	1A01C	Operations Concept Validation	ATO Capital	3,000	7,400	8,000	8,000	8,000	6,000	
M08.27-00	1A01D	NAS Weather Requirements	ATO Capital	1,000	1,000	1,000	1,000	1,000	3,300	
M08.28-02	1A01E	Airspace Management Lab	ATO Capital	4,000	4,000	4,000	4,000	4,000	4,000	
M08.28-04	1A01F	Airspace Redesign	ATO Capital	5,000	3,000	3,000	3,000	3,000	3,000	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	ATO Capital	4,000	1,100	0	0	0	0	
M08.36-01	--	Wake Turbulence	ATO Capital	3,000	0	1,000	1,000	1,000	1,000	
N12.02-01	--	Local Area Augmentation Sysm (LAAS)	ATO Capital	1,000	0	0	0	0	0	
M36.01-00	--	Safe Flight 21 - Alaska Capstone	ATO Capital	15,000	0	0	0	0	0	
M49.01-01	1A08	NextGen Demonstration	ATO Capital	20,000	28,000	30,000	30,000	30,000	30,000	/3
M49.01-02	1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	0	3,800	11,700	11,700	11,700	11,700	
M49.01-02	1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	0	2,900	7,700	7,700	7,700	7,700	
M49.01-02	1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	0	2,500	12,500	12,500	12,500	12,500	
M49.01-02	1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	0	4,500	7,500	7,500	7,500	7,500	
M49.01-02	1A09E	NextGen - New ATM Requirement	ATO Capital	0	5,400	27,500	27,900	29,200	31,900	
M49.01-02	1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	0	4,000	15,000	15,000	15,000	15,000	
M49.01-02	1A09G	NextGen - System Safety Management Transformation	ATO Capital	0	16,300	19,000	19,700	19,700	20,000	
M49.01-02	1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	0	2,000	2,000	2,000	2,000	2,000	
		Subtotal	**ATO Capital**	70,500	102,400	161,400	162,500	161,800	165,100	
--	--	Airports Technology Research - Capacity	AIP	8,907	9,109	9,109	9,109	9,109	9,109	
--	--	Airports Technology Research - Safety	AIP	9,805	10,239	10,239	10,239	10,239	10,239	
		Subtotal	**AIP**	18,712	19,348	19,348	19,348	19,348	19,348	
--	--	Commercial Space Transportation Safety	S&O	64	63	63	63	63	63	/2
		Subtotal	**S&O**	64	63	63	63	63	63	
		Development		**92,376**	**121,811**	**180,811**	**181,911**	**181,211**	**184,511**	
		Percent *Development*		**34.1%**	**36.2%**	**43.2%**	**42.2%**	**42.0%**	**42.3%**	
		TOTAL		**$270,808**	**$336,629**	**$418,893**	**$431,065**	**$431,255**	**$435,823**	

Notes:
/1 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 30.8% in FY 2008 and 37.8% in FY 2009 and beyond.
/2 The Commercial Space Transportation Program is 50 percent applied research and 50 percent development, which is $62.5K rounded to $63K for FY 2009 and beyond.
/3 The amount shown for NextGen Demonstration is 40% of the total line item in FY 2008 and 100% in FY 2009 and beyond.
/4 The funding levels listed for years 2010 to 2013 are estimates and subject to change.

Table 4.3: Planned R&D Budget by Research Category

Table 4.4
FAA R&D Program Budget by **Performance Goals**
(Organized According to Exhibit II of the FAA FY 2009 Budget Request)

Project Number	FY 2009 Budget Line Item	Program	Appropriation Account	FY 2009 Contract Costs ($000)	FY 2009 Personnel Costs ($000)	FY 2009 Other In-house Costs ($000)	FY 2009 Total Planned ($000)	
1. SAFETY								
a. Reduce Commercial Air Carrier Fatal Accident Rate								
061-110	A11.a.	Fire Research and Safety	R,E&D	2,961	3,443	246	6,650	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	2,415	1,168	86	3,669	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	1,838	1,022	60	2,920	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	2,891	1,832	115	4,838	
065-110	A11.e.	Aging Aircraft/Continued Airworthiness	R,E&D	9,839	4,447	303	14,589	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	0	415	21	436	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	4,714	2,587	164	7,465	
060-110	A11.h.	Aviation Safety Risk Analysis/System Safety Management	R,E&D	9,608	2,669	211	12,488	
082-110	A11.i.	Air Traffic Control/Technical Operations Human Factors	R,E&D	4,042	6,128	299	10,469	
086-110	A11.j.	Aeromedical Research	R,E&D	2,038	6,177	180	8,395	
041-110	A11.k.	Weather Program	R,E&D	15,855	979	134	16,968	
069-110	A11.l.	Unmanned Aircraft Systems Research	R,E&D	735	1,080	61	1,876	
011-130	A14.a.	System Planning and Resource Management	R,E&D	903	54	39	995	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	375	1,464	99	1,937	/1
		Subtotal	**R,E&D**	58,214	33,465	2,018	93,696	/2
S09.02-00	1A01A	Runway Incursion Reduction	ATO Capital	10,000	0	0	10,000	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	ATO Capital	1,100	0	0	1,100	
		Subtotal	**ATO Capital**	11,100	0	0	11,100	
--	--	Airports Technology Research - Safety	AIP	8,065	1,774	0	9,839	/3
--	--	Airport Cooperative Research Program - Safety	AIP	3,750	1,250	0	5,000	
		Subtotal	**AIP**	11,815	3,024	0	14,839	
		Reduce the Commercial Air Carrier Fatal Accident Rate		**81,129**	**36,489**	**2,018**	**119,635**	
b. Reduce the Number of General Aviation Fatal Accidents								
--	--	Airports Technology Research - Safety	AIP	400	0	0	400	/3
		Reduce the Number of General Aviation Fatal Accidents		**400**	**0**	**0**	**400**	
c. Maintain Zero Commercial Space Transportation Accidents								
--	--	Commercial Space Transportation Safety	S&O	94	31	0	125	
		Maintain Zero Commercial Space Transportation Accidents		**94**	**31**	**0**	**125**	
		TOTAL SAFETY		**81,623**	**36,520**	**2,018**	**120,160**	
2. REDUCE CONGESTION								
a. Meet Air Transportation Demand								
027-110	A12.a.	Joint Planning and Development Office	R,E&D	12,088	2,173	233	14,494	
041-150	A12.b.	Wake Turbulence	R,E&D	9,734	374	24	10,132	
--	--	GPS Civil Requirements	R,E&D	0	0	0	0	
111-110	A12.c	NextGen - Air Ground Integration	R,E&D	2,485	69	0	2,554	
111-120	A12.d	NextGen - Self Separation	R,E&D	7,956	69	0	8,025	
111-140	A12.e	NextGen - Weather Technology in the Cockpit	R,E&D	7,894	155	0	8,049	
011-130	A14.a.	System Planning and Resource Management	R,E&D	430	26	19	474	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	179	698	47	923	/1
		Subtotal	**R,E&D**	40,766	3,563	323	44,652	/2
M08.28-00	1A01B	System Capacity, Planning and Improvement	ATO Capital	6,500	0	0	6,500	
M08.29-00	1A01C	Operations Concept Validation	ATO Capital	7,400	0	0	7,400	
M08.27-00	1A01D	NAS Weather Requirements	ATO Capital	1,000	0	0	1,000	
M08.28-02	1A01E	Airspace Management Lab	ATO Capital	4,000	0	0	4,000	
M08.28-04	1A01F	Airspace Redesign	ATO Capital	3,000	0	0	3,000	
M49.01-01	1A08	NextGen Demonstration	ATO Capital	28,000	0	0	28,000	
M49.01-02	1A09A	NextGen - ATC/Tech Ops Human Factors (Controller Efficiency)	ATO Capital	3,800	0	0	3,800	
M49.01-02	1A09B	NextGen - ATC/Tech Ops Human Factors (Air/Ground Integration)	ATO Capital	2,900	0	0	2,900	
M49.01-02	1A09E	NextGen - New ATM Requirement	ATO Capital	5,400	0	0	5,400	
M49.01-02	1A09F	NextGen - Operations Concept Development (Validation Modeling)	ATO Capital	4,000	0	0	4,000	
M49.01-02	1A09G	NextGen - System Safety Management Transformation	ATO Capital	16,300	0	0	16,300	
M49.01-02	1A09H	NextGen - Wake Turbulence (Re-categorization)	ATO Capital	2,000	0	0	2,000	
M03.02-00	4A09A	Center for Advanced Aviation System Development	ATO Capital	28,728	0	0	28,728	/4
		Subtotal	**ATO Capital**	113,028	0	0	113,028	
--	--	Airports Technology Research - Capacity	AIP	7,536	1,573	0	9,109	
--	--	Airport Cooperative Research Program - Capacity	AIP	3,750	1,250	0	5,000	
		Subtotal	**AIP**	11,286	2,823	0	14,109	
		Increase Percent of On-time Arrivals		**165,080**	**6,386**	**323**	**171,789**	
		TOTAL MOBILITY		**165,080**	**6,386**	**323**	**171,789**	
4. ENVIRONMENT								
091-110/111/116	A13.a.	Environment and Energy	R,E&D	13,172	2,127	309	15,608	
111-150	A13.b.	NextGen - Environmental Research - Aircraft Technologies, Fuels, and Metrics	R,E&D	15,829	221	0	16,050	
011-130	A14.a.	System Planning and Resource Management	R,E&D	315	19	14	347	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	131	511	34	676	/1
		Subtotal	**R,E&D**	29,447	2,877	357	32,681	/2
M49.01-02	1A09C	NextGen - Environment & Energy (Noise and Emissions Reduction)	ATO Capital	2,500	0	0	2,500	
M49.01-02	1A09D	NextGen - Environment & Energy (Validation Modeling)	ATO Capital	4,500	0	0	4,500	
		Subtotal	**ATO Capital**	7,000	0	0	7,000	
--	--	Airport Cooperative Research Program - Environment	AIP	3,750	1,250	0	5,000	
		TOTAL ENVIRONMENT		**40,197**	**4,127**	**357**	**44,681**	
		GRAND TOTAL		**286,899**	**47,033**	**2,697**	**336,629**	

es:
System Planning and Resource Management and William J. Hughes Technical Center Laboratory Facility are considered Mission Support for the R,E&D program and are pro-rated across the three goals areas as follows: Safety at 54.8 percent; Mobility at 26.1 percent; and Environment at 19.1 percent.
Personnel for R,E&D measured in full time equivalents is as follows: 259 for Safety; 23 for Mobility; and 21 for Environment.
The Airport Technology Research - Safety program total budget request is divided between reducing the commercial air carrier fatal accident rate ($10,239K) and reducing the number of general aviation fatal accidents ($400K).
The budget request amount shown for CAASD is only the R&D program portion of the total CAASD line item amount (37.8% of the total CAASD line item).
Many R&D programs apply to more than one goal area; however, for budgeting purposes most programs are included in only one goal area.

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

4.4 Partnerships

The FAA enhances and expands its R&D capabilities by partnering with other government, academic, and industry organizations. Such partnerships help leverage critical national capabilities to ensure the FAA attains its R&D goals.

4.4.1 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, the FAA uses formal agreements, such as memoranda of understanding/agreement (MOU/MOA); cooperative efforts, such as interagency integrated product teams; and technical coordination, such as on-site personnel at field offices at other federal research laboratories and centers. The establishment of the multi-agency JPDO shows how government can leverage the R&D capabilities of multiple agencies to transform the nation's air transportation system over the long-term.

Joint Planning and Development Office

The JPDO provides government-wide planning and coordination for aviation R&D. The JPDO members include the Departments of Defense, Transportation, Homeland Security, and Commerce, FAA, NASA, and the Office of Science and Technology Policy to plan federal aviation R&D and focus it on the long-term needs of the nation's air transportation system. For more information, see http://www.jpdo.gov/

Memoranda of Understanding/Agreement

Joint research activities are performed via MOUs/MOAs that set forth areas for cooperative endeavor. An MOU is a high-level agreement describing a broad area of research that fosters cooperation between departments or agencies and develops a basis for establishing joint research activities. An MOA is an agreement describing a specific area of research and is used to implement a broader MOU. Appendix B provides the FAA MOUs/MOAs with the National Aeronautics and Space Administration (NASA) and the Department of Defense.

Field Offices

The FAA has field offices at the NASA Ames and Langley Research Centers to foster and provide technical coordination of research that contributes to modernization efforts and safety enhancements of the air transportation system. The first field office opened in 1971 at NASA Ames Research Center located in Moffett Field, California, and the second office opened in 1978 at NASA Langley Research Center in Hampton, Virginia. Both offices report directly to the FAA headquarters.

The Climate Change Science Program

Thirteen Federal departments and agencies participate in the U.S. Climate Change Science Program to coordinate scientific research across a wide range of related climate and global change issues. The research addresses the Earth's environmental and human systems, which are undergoing changes caused by a variety of natural and human-induced causes. *The Climate Change Science Program Strategic Plan*[27] provides the research areas and questions the program addresses. The FAA supports this program by identifying the impact of aviation on the environment, particularly the troposphere. For more information, see http://www.climatescience.gov.

Global Earth Observation System of Systems

The Global Earth Observation System of Systems (GEOSS) provides an umbrella for 15 Federal departments and agencies and several White House offices to work collaboratively to address a wide range of environmental issues including those pertaining to aviation. These include enhanced weather observation, modeling and forecasting, air and water quality monitoring, 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.

4.4.2 Government and Industry

The FAA technology transfer activities meet the objectives of the Stevenson-Wydler Technology Innovation Act of 1980, the Bayh-Dole Act of 1980, the Federal Technology Transfer Act of 1986, the National Cooperative Research and Production Act of 1993, and Executive Orders 12591 and 12618: Facilitating Access to Science and Technology. The purpose is to transfer knowledge, intellectual property, facilities, equipment, or other capabilities developed by Federal laboratories or agencies to the private sector. The FAA does this through the following mechanisms.

Cooperative Research and Development Agreements

The Cooperative Research and Development Agreement (CRDA) is collaborative in nature and allows the FAA to share facilities, equipment, services, intellectual property, personnel resources, and other resources with private industry, academia, or state and local government agencies. For more information on using CRDAs, see http://www.tc.faa.gov/technologytransfer/.

Contracts

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

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

(SBIR) Program. Appendix C provides additional detail on the use of SBIR. For more information, see http://www.asu.faa.gov/faaco/kenproj.htm.

Intellectual Property/Patents

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

4.4.3 Government and Academia

The FAA has an aggressive program to foster research and innovative aviation solutions through the nation's colleges and universities. By doing so, it not only leverages the nation's significant investment in basic and applied research but also helps to build the next generation of aerospace engineers, managers, and operators. The FAA does this through the following mechanisms:

Joint University Program

The FAA/NASA Joint University Program for Air Transportation Research is a long-term cooperative research partnership among three universities: Ohio University, the Massachusetts Institute of Technology, and Princeton University. The universities conduct aviation-related scientific and engineering research. The FAA and NASA benefit directly from the results of specific research projects and the valuable feedback from university researchers regarding the goals and effectiveness of government programs. For more information, see http://research.faa.gov/research_links.

Aviation Research Grants

All colleges, universities, and legally incorporated non-profit research institutions qualify for research grants. Research grants may use any scientific methodology deemed appropriate by the grantee. At the FAA, the evaluation criteria for grant proposals include the potential application of research results to the FAA's long-term goals for civil aviation technology. Appendix C provides a summary of grants issued in 2007. For more information, see http://www.tc.faa.gov/logistics/grants.

Air Transportation Centers of Excellence

The FAA currently has seven Centers of Excellence (COEs) through cooperative agreements with academic institutions to assist in mission-critical research and technology that focus on the areas of advanced materials, airliner cabin environment research, airport technology, airworthiness assurance, general aviation, noise and emissions mitigation, and operations research,. Through these long-term collaborative, cost-sharing efforts, the government and university-industry teams leverage each other's resources to advance the technological future of the nation's aviation community.

Appendix C provides a summary of the COEs. For more information, see http://www.coe.faa.gov.

Aerospace Vehicle Systems Institute

The Aerospace Vehicle Systems Institute is a cooperative industry, government, and academia venture for investigation and standardization of aerospace vehicle systems to reduce life-cycle cost and accelerate development of systems, architectures, tools, and processes. For more information, see http://avsi-tees.tamu.edu.

4.4.4 International

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

EUROCONTROL

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

Transport Canada

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

4.5 Evaluation

Since R&D tends to be long-term in nature, it does not lend itself to traditional return-on-investment analysis, such as net present value. Instead, evaluation of R&D requires consideration of its quality, relevance, and performance. Today, the FAA accomplishes evaluation through both formal and informal reviews performed by internal and external groups.

4.5.1 Internal Program Reviews

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

Integrated Capability Maturity Model (iCMM®)

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

Program Planning Teams

To ensure effective engagement with research stakeholders, the FAA Office of Aviation Research and Technology Development uses program-planning teams comprised of internal sponsors and researchers to review program outcomes and outputs, prioritize and plan research efforts, and recommend research priorities and programs.

R&D Executive Board

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

The OEP Review Board

The OEP Review Board provides oversight, status, prioritization, and guidance on existing proposed NextGen initiatives. It offers an opportunity for FAA and JPDO to plan the transition to NextGen, identify interconnections between the various activities, determine schedule requirements, identify policy changes, and understand funding impacts. The Board also reviews the NextGen portion of the R&D portfolio and approves its budget. The Chair of the OEP Review Board briefs the JPDO Senior Policy Committee on the FAA NextGen program and its annual budget plans. For more information, see http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/oep/ and http://www.jpdo.gov.

Joint Resources Council

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

4.5.2 External Program Reviews

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

Research, Engineering and Development Advisory Committee

Established in 1989, the Research, Engineering and Development Advisory Committee (REDAC) advises the Administrator on R&D issues and coordinates the FAA's research activities with other government agencies and industry. The committee considers aviation research needs in the five areas of NAS operations, airport technology, aircraft safety, human factors, and environment and energy.[28] A maximum of 30 members can serve on the committee and represent corporations, universities, associations, consumers and government agencies. For more information, see http://research.faa.gov/redac/default.aspx.

During 2007, the REDAC held two committee meetings and 11 subcommittee meetings and produced three reports: *Guidance for FAA Fiscal Year 2009* R&D, November 13, 2006; *Separations Standards Working Group Final Report,* September 20, 2006 (FAA Response, May 14, 2007); and *Review of FAA Fiscal Year 2009 Program Plans,* June 12, 2007. Appendix D provides the recommendations from these reports and Agency responses.

Commercial Space Transportation Advisory Committee

Established in 1984, the Commercial Space Transportation Advisory Committee (COMSTAC) advises the Administrator on matters relating to the U.S. commercial space transportation industry, including research and development (R&D) activities. A maximum of 25 members serve on the committee. Each member is recommended by the Administrator and appointed by the Secretary of Transportation for a two-year term. Members represent the commercial space transportation industry, academia, state and local government, and space advocacy groups. The COMSTAC provides annual recommendations for commercial space transportation R&D projects and periodically reviews the FAA R&D reports and activities. For more information, see:
http://www.faa.gov/about/office_org/headquarters_offices/ast/industry/advisory_committee/

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

During 2007, the COMSTAC held two committee meetings and seven working group meetings and produced one report, *The 2007 Commercial Space Transportation Forecasts*, dated May 2007.

National Academy Aeronautics and Space Engineering Board

The National Academy of Science established the Aeronautics and Space Engineering Board (ASEB) in 1967 to focus talents and energies of the engineering community on significant aerospace policies and programs. The board recommends priorities and procedures for achieving aerospace engineering objectives and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance. The board's primary sponsor is NASA, but it also performs studies for other agencies.

The ASEB currently is conducting an independent assessment of the nation's wake turbulence research and development program. The study examines the most important wake turbulence challenges and their effects on air transportation safety, efficiency, and capacity; assesses the current relevant research being conducted by NASA, the FAA, and other Federal government agencies; and assesses non-federal research. The goal is to identify any gaps in research and to propose a strategy for closing the gaps. The study is sponsored by NASA. A final report is planned for release by December 31, 2007.

Transportation Research Board

The National Research Council established the Transportation Research Board (TRB) in 1920 as an advisory board for highway research. In 1974 it was renamed TRB to reflect its expanded services to all modes of transportation. The TRB mission is to promote innovation and progress in transportation through research. It fulfills this mission through the work of its standing committees and task forces. The TRB manages the Airport Cooperative Research Program (ACRP) for the FAA with program oversight and governance provided by representatives of airport operating agencies.

The ACRP Oversight Committee announced their FY 08 projects in August 2007. They will be examining 13 different research areas relating to developing near-term solutions to problems facing airport operators and industry stakeholders such as the Airports Council International (ACI). Among these projects are developing a guidebook for developing an airport performance measurement system; quantifying the contribution to local air quality impacts from airport-related emissions; and developing a comprehensive work plan for a multimodel noise and emissions model.

National Academy of Public Administration

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

In July 2007, the FAA chartered a NAPA study to assist in the FAA's needed transformation needed by FAA to support the next generation air transportation system (NextGen). The study will (1) identify the skill sets required by FAA's Air Traffic Organization (ATO) to integrate and implement NextGen, including, but not limited to, technical and contract management skills and (2) define the strategies to obtain the expertise necessary to manage, integrate, and implement the complex activities inherent in the transformation to NextGen. A report is planned for 2008.

Acronyms and Abbreviations

AA-IADS	Aircraft Accident/Injury and Autopsy Data System
AC	Advisory Circular
ACI	Airports Council International
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Depended Surveillance - Broadcast
AIP	[FAA Budget Appropriation] Airport Improvement Program
AJP-6	[FAA] Research and Technology Development Office
ARP	[FAA – Line of Business] Airports
ASDE-X	Airport Surface Detection Equipment Model X
ASEB	National Academy Aeronautics and Space Engineering Board
ASTM	American Society for Testing and Materials
ATD&P	Advanced Technology Development and Prototyping
ATM	Air Traffic Management
ATO	[FAA – Line of Business] Air Traffic Organization
ATO Capital	[FAA Budget Appropriation]
ATOP	Advanced Technologies and Oceanic Procedures
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAASD	[MITRE] Center for Advanced Aviation System Development
CDA	Continuous-descent Approach
CDTI	Cockpit Display of Traffic Information
CIP	Capital Investment Plan
CIP	Current Icing Product
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
CONUS	Continental Unites States
CoSPA	Consolidated Storm Product for Aviation
CRREL	U.S. Army Cold Regions Research and Engineering Lab
CRDA	Cooperative Research and Development Agreement
DARWIN™	Design Assessment Reliability and Inspection
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
DSA	Detect, Sense, and Avoid
EA	Enterprise Architecture
EASA	European Aviation Safety Agency

EFDI	Electronic Flight Data Interface
EMAS	Engineered Material Arresting System
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPACT	Energy Policy Act of 2005
EUROCONTROL	European Organization for the Safety of Air Navigation
FAA	Federal Aviation Administration
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layer Design 1.0
FACT	Future Airport Capacity Task
FY	Fiscal Year
GA	General Aviation
GEOSS	Global Earth Observation System of Systems
GTG2	Graphical Turbulence Guidance 2 Weather Product
HAP	Hazardous Air Pollutants
HITL	Human-in-the-loop
HUMS	Health and Usage Monitoring Systems
iCMM®	Integrated Capability Maturity Model
ILS	Instrument Landing System
IMA	Integrated Modular Avionics
IWP	Integrated Work Plan
JPDO	Joint Planning and Development Office
JRC	[FAA] Joint Resources Council
LAHSO	Landing and Holding Short
LAX	Los Angeles International Airport
LED	Light Emitting Diode
LFN	Low Frequency Noise
MOA	Memorandum of Agreement
MoC	Memorandum of Cooperation
MOU	Memorandum of Understanding
NAPA	National Academy of Public Administration
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEO	Net Enabled Operations
NextGen	Next Generation Air Transportation System
NLA	New Large Aircraft
NOAA	National Oceanic and Atmospheric Administration

NOTAMS	Notice To Airmen
NOx	Oxides of nitrogen
NSLA	NextGen Service Level Agreement
NTSB	National Transportation Safety Board
NWS	National Weather Service
OEP	Operational Evolution Partnership
OI	Operational Improvement
OMB	Office of Management and Budget
OSTP	[Executive Office of the President] Office of Science and Technology Policy
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PBN	Performance-Based Navigation
R&D	Research and Development
RADAR	Radio Detection and Ranging
REB	[FAA] Research and Development Executive Board
R,E&D	[FAA Budget Appropriation] Research, Engineering and Development
REDAC	[FAA] Research, Engineering and Development Advisory Committee
RLV	Reusable Launch Vehicle
RNAV	Area Navigation
RNP	Required Navigation Performance
RTOS	Real-Time Operating Systems
RWSL	Runway Status Lights
S&O	[FAA Budget Appropriation] Safety and Operations
SBIR	Small Business Innovation Research
SMS	Safety Management System
SSRI	Selective Serotonin Reuptake Inhibitor
STL	Lambert-St. Louis International Airport
SWIM	System Wide Information Management
TFM	Traffic Flow Management
TMA	Traffic Management Advisor
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TSA	Transportation Security Administration
UAS	Unmanned Aircraft Systems
VFR	Visual Flight Rules
WJHTC	William J. Hughes Technical Center