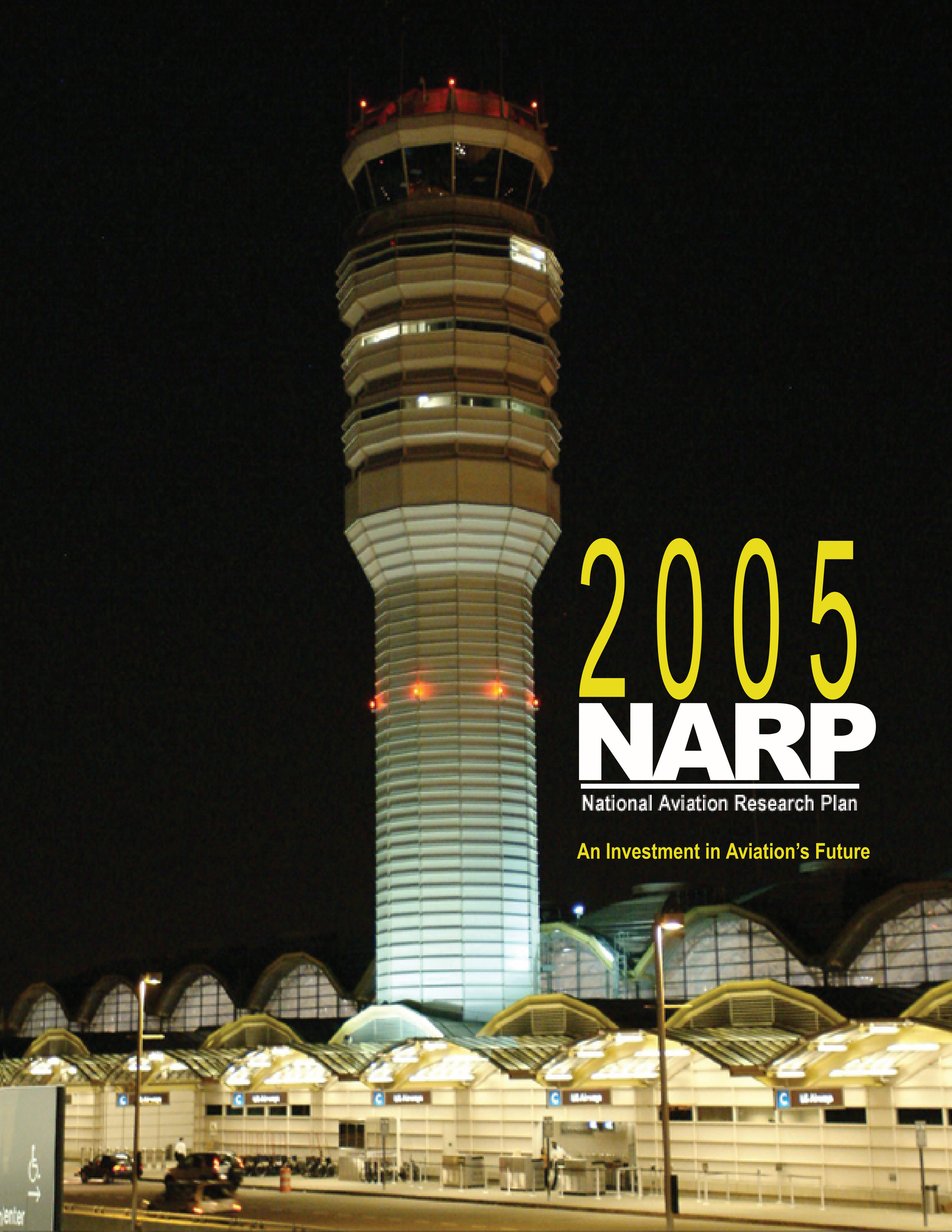
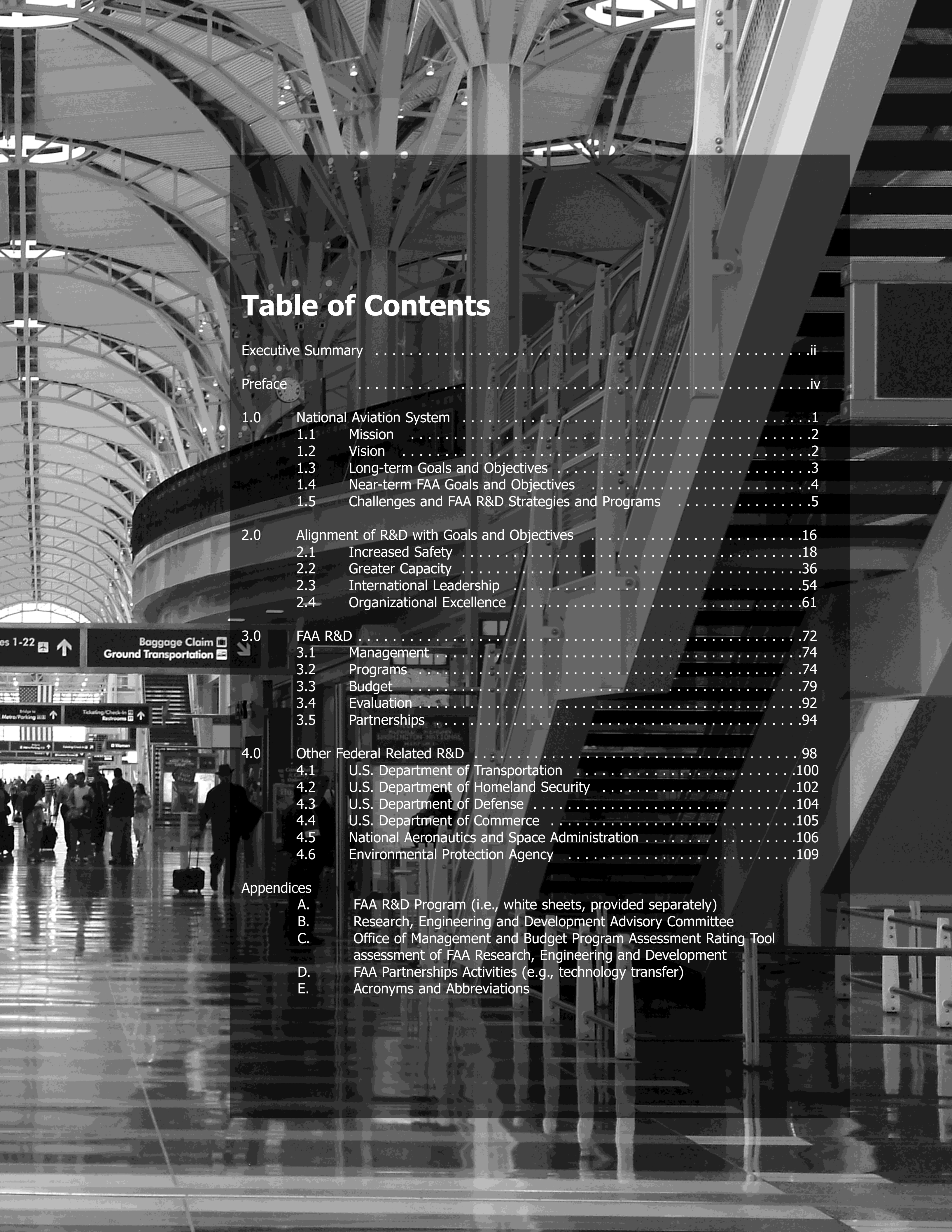


2005 NARP

National Aviation Research Plan

An Investment in Aviation's Future


FRiDAY'S
Gates 23-34
Gates
FRiDAY'S
IN HERE, IT'S ALWAYS FRIDAY.
Gates 1-22



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Executive Summary

Since the Wright Brother's first flight over 100 years ago, aviation researchers have worked to improve navigation tools and field critical safety technologies. Today that legacy continues as Federal Aviation Administration researchers, scientists, and engineers continue to improve the national aviation system that is universally recognized as the safest and most technologically advanced in the world.

The FAA is committed to improving the performance of our aviation system to meet the economic and national security needs of the nation. This commitment is evident in the research and development (R&D) program, which is developing new technologies, tools, and procedures to meet the Agency's goals and objectives, both in the near-term and for years to come. The FAA's strategic plan - *Flight Plan 2005-2009,*[1] describes near-term performance goals and objectives. The long-term performance goals and objectives are described in the Joint Planning and Development Organization (JPDO) framework document[2] and in the *Next Generation Air Transportation System Integrated Plan*.[3]

The *2005 National Aviation Research Plan* (NARP) describes how R&D helps FAA meet its near-term goals while also preparing the Agency to meet the long-term needs of the air transportation system. The Plan defines FAA R&D strategies that address the major operational challenges facing the aviation system - to increase safety, provide greater capacity, ensure international leadership, and achieve organizational excellence. These R&D strategies enable FAA to focus its limited resources on the major safety and capacity challenges facing the system over the next five to ten years and to plan for the next generation air transportation system, nominally targeted for the year 2025.

The 2005 NARP describes the FAA R&D program and budget. It explains how the FAA evaluates its R&D programs to ensure that they are relevant, of high quality, and well managed. It also shows how the R&D program achieves its objectives through various government, industry, and university partnerships. Because aviation research is not solely the responsibility of FAA, the NARP also outlines some of the R&D activities of other federal departments and agencies that complement FAA goals and objectives.

The 2005 NARP also highlights many details of R&D program funding and the results of various evaluation and research efforts.

Funding:

FAA investments in Research, Engineering and Development (R,E&D) in 2006 will remain, as in 2005, at $130,000,000. In current year dollars, funding is further projected to stay relatively constant over the next five years.

FAA investments for R&D-related Facilities and Equipment (F&E) decrease from $127,745,000 in 2005 to $98,643,000 in 2006.

Photo by Lockett Yee

This reduction results partly from the transfer of the Airports Technology Research program to the Airports Improvement Program (AIP) appropriations account. Funding for R&D-related F&E activities is projected to decline further over the next five years to $72,680,000 in 2010.

In 2006, FAA has requested funding for a new AIP program for Airport Cooperative Research totaling $10,000,000. This pro gram was established by Congress in section 712 of Vision 100-Century of Aviation Reauthorization Act. Including the transfer of the Airports Technology Research program from the F&E account, total AIP R&D funding will be $27,500,000. This level is projected to remain constant through 2010 in current year dollars.

Program Evaluation:
In 2004, the Office of Management and Budget (OMB) evaluated the effectiveness of the FAA R,E&D program using the Program Assessment Rating Tool (PART), the same tool with which it rates all federal programs. OMB found the RE&D program to be “Effective,” the highest of the ratings awarded.

2004 Research Highlights:
Established two Air Transportation Centers of Excellence. The Center for Airliner Cabin Research will study cabin air quality and conduct assessments of chemical and biological threats. The Advanced Materials Center will conduct research, engineering and prototype development on the safe and reliable use of advanced materials and composites in large commercial aircraft.

Developed an automated tool of human factors considerations pertinent to the design and certification of flight deck systems for the Aircraft Certification Job Aid. Certification personnel and designers use this tool to ensure that flight deck technologies are user friendly.

Established an Arc Fault Evaluation Laboratory at the William J. Hughes Technical Center where researchers can simulate known aircraft wiring faults in a realistic environment to evaluate and test arc fault protection devices.

Developed and operationally implemented the San Francisco Marine Stratus Forecast System. The tool predicts the time when marine stratus (fog) will dissipate in an airport approach zone, so that air traffic control decision makers can release ground holds before the fog actually clears.

Initiated a collaborative research effort with NASA to determine the relationship between aircraft noise and emissions. The long-term goal is a comprehensive approach and analysis capability that can address all aspects of noise and emissions.

[1] Federal Aviation Administration, *Flight Plan* 2005-2009, November 9, 2004, http://www.faa.gov/aboutfaa/RevisedStrategicPlan/RevisedPlan.pdf

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

[3] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004.

Preface

Title 49 of the U.S. Code section 44501(c) requires the Administrator of the Federal Aviation Administration to submit to the U.S. Senate Committee on Commerce, Science, and Transportation and the U.S. House of Representatives Committee on Science an annual national aviation research plan with the President's budget. Specifically, it requires that: "The plan shall describe, for a five-year period, the research, engineering, and development that the Administrator of the Federal Aviation Administration considers necessary to ensure the continued capacity, safety, and efficiency of aviation in the United States, considering emerging technologies and forecasted needs of civil aeronautics; and to provide the highest degree of safety in air travel." The plan is to be written as a performance report in accordance with Title 31, U.S. Code, and section 1116.

The 2005 NARP builds on previous versions of the plan but shows a much closer linkage between the Agency's research and development activities and the goals and objectives of both the FAA *Flight Plan 2005-2009* and the *Next Generation Air Transportation System Integrated Plan,* being developed by the Joint Planning and Development Office. FAA R&D includes both applied research and development as defined by Office of Management and Budget Circular A-11. It is funded in four appropriations accounts: Research, Engineering and Development; Facilities and Equipment; Airport Improvement Program (requested in 2006); and Operations.

Chapter 1 develops R&D strategies that will enable FAA to address both its near-term goals and objectives as described in *Flight Plan 2005-2009*, and its long-term goals, as established through its participation with the Next Generation Air Transportation System Joint Planning and Development Office. Chapter 2 describes how FAA R&D programs align with these goals and objectives. Chapter 3 describes the FAA R&D program, including its management, mission, vision, programs, and budget. It describes how FAA evaluates its R&D to ensure that programs are relevant, of high quality and well managed. The chapter also describes how the program achieves its objectives through various government, industry and university partnerships. Last, Chapter 4 describes the roles and aviation-related R&D of other federal departments and agencies that complement FAA programs, and thereby help the Agency to achieve its goals and objectives.

Detailed information on FAA R&D programs; reviews by the Research, Engineering and Development Advisory Committee; program assessments by the Office of Management and Budget; partnership activities; and acronyms and abbreviations are contained in Appendices A through E, respectively.

Photo by Jay Kivowitz

2004 NARP "Then"	2005 NARP "Now"
Executive Summary Highlights significant changes since last year.	Executive Summary Provides a short summary of the document including 2004 R&D program highlights for funding, program evaluation, and research results. Preface Explains the stucture of the plan, and highlights significant changes since last year.
1. FAA R&D Program Overview Provides an overview of the R&D program	1. National Aviation System Explains the National Aviation System in terms of mission, vision, long-term goals, near-term goals and challenges. It defines FAA R&D strategies and programs that address these goals and challenges. 2. Alignment of R&D with Goals and Objectives Explains how R&D programs support the goals, objectives and performance targets identified in Chapter 1 for the National Aviation System. Provides more detail on notional targets for the long-term; identifies trends, challenges, and strategies; and, provides applicable R&D strategies, programs, and recent results. 3. FAA R&D Focuses on FAA R&D in particular. Provides a summary of the FAA R&D programs, budgets, evaluation results, and partnerships with government, industry, and academia. 4. Other Federal Related R&D Identifies the roles of other federal departments and agencies, and provides information on related R&D.
2. Program Information Provides budget white sheets for each program grouped by goal areas of safety, capacity, and operational excellence. Each white sheet provides detailed information for a particular program including budget and schedule.	Appendix A Provides budget white sheets for each program grouped by funding appropriation. Each white sheet provides detailed information for a particular program including budget and schedule.
Appendix A Provides R,E&D Advisory Committee recommendations with FAA responses.	Appendix B Provides R,E&D Advisory Committee recommendations with FAA responses.
Appendix B Provides a list of NARP budget line items. Appendix C Provides a list of NARP programs.	Chapter 3 and Appendix A Provide a list of NARP programs and budget line items.
	Appendix C Provides the PART assessment of the FAA R,E&D program by Office of Management and Budget. Appendix D Provides detailed information on FAA partnership activities with government, industry, and academia.
Appendix D Provides acronyms and abbreviations.	Appendix E Provides acronyms and abbreviations.

National Aviation System

Mission • Vision • Goals & Objectives • Challenges & R&D Strategies

Aviation is a vital national resource for the United States because of its strategic, economic, and social importance. It provides invaluable opportunities for travel, for new business, for jobs, and for the general growth and development of the U.S. economy. Aviation also serves an important role in attracting investment to local communities and helps stimulate and sustain growth by opening new markets and supply chains, nationally and internationally.

To support our nation's economic growth and vitality, the United States must have an aviation system that can fully respond to the changing needs of businesses and customers. Increased mobility, higher productivity, and greater efficiency can only be realized through the introduction of new technologies and procedures, innovative policies, and advanced management practices developed through collaborative, needs-driven research and development (R&D). R&D will enable the United States to remain a world leader in its ability to move more people and goods by air safely, securely, quickly, and effectively.

The Challenge

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

while simultaneously:

- **Decreasing the number of fatalities and injuries due to aircraft and airport operations;**
- **Eliminating the threat from terrorists and other hostile actions;**
- **Reducing aircraft and airport noise and emissions; and**
- **Decreasing the cost of system operations and improving the quality of air travel.**

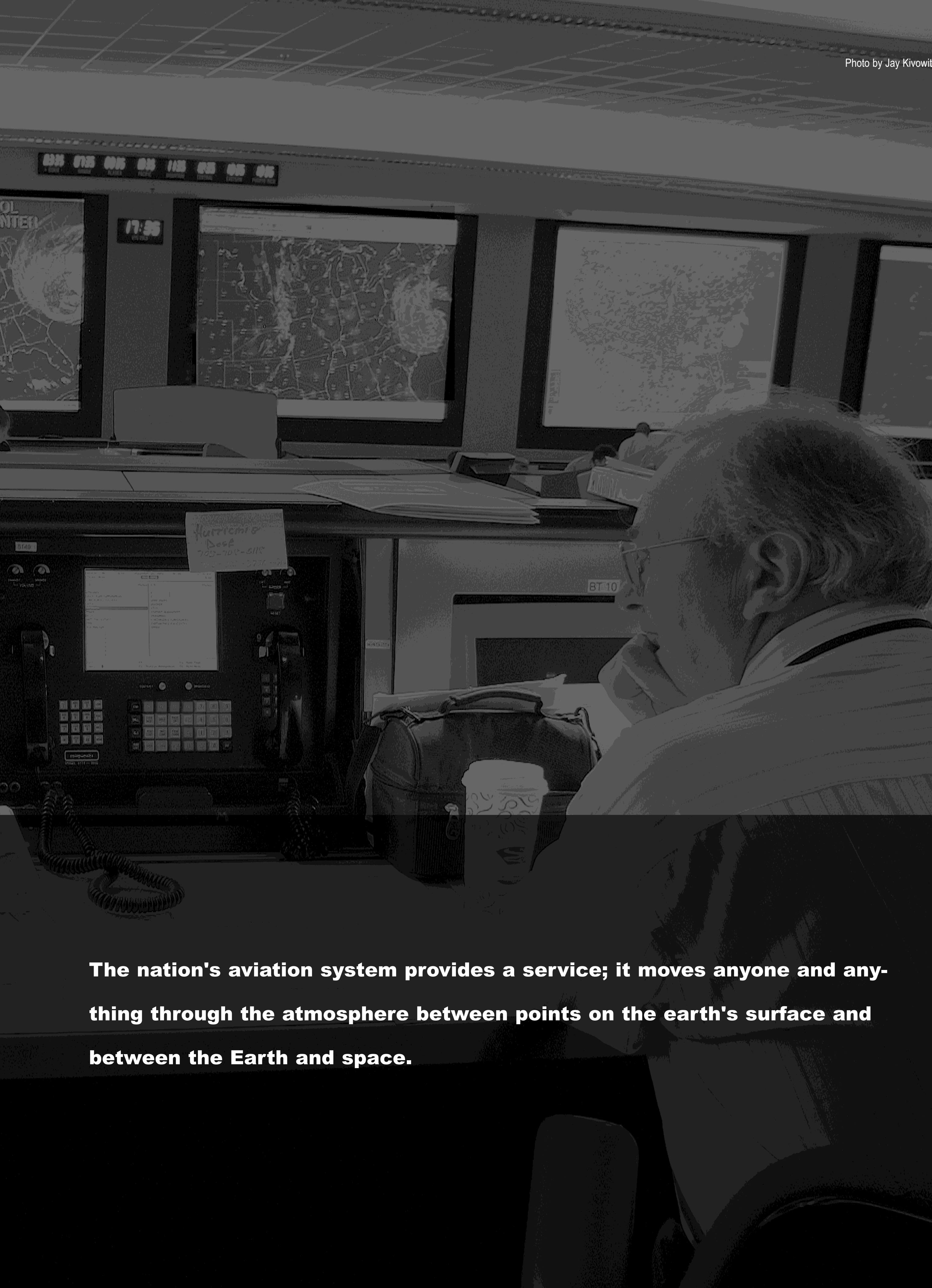


Photo by Jay Kivowitz

The nation's aviation system provides a service; it moves anyone and anything through the atmosphere between points on the earth's surface and between the Earth and space.

1.1 Mission

The purpose of the nation's aviation system, or air transportation system, is to provide 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, including: the flying public (e.g., passengers, general aviation, balloonists); federal, state and local government (e.g., military, forest service, drug enforcement, emergency response, scientific community); business (e.g., travelers, shippers); academia (e.g., researchers); and, others.

Today, 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/airfield configurations, 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 aircraft, military aircraft, general aviation, space launch and re-entry vehicles, rotorcraft, gliders, hot air balloons); infrastructure (e.g., airports/airfields, air traffic management system, space launch and re-entry sites, inter-modal connectors); and workforce (e.g., pilots and crews, air traffic controllers, security screeners, ground personnel). All elements need to be considered together when designing, developing, and operating the system.

The system is designed, developed, maintained, and operated by various federal, state, and local government organizations, industry, labor, academia and other domestic and international organizations. The public also plays a key role in its development by investing in the airlines and aerospace companies and in paying taxes and user fees that are ultimately used by the government to: regulate aspects of 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 the future, the nation's air transportation system must accommodate an increasing number and variety of aerospace vehicles (e.g., uninhabited aerial vehicles), a broader range of air and space operations (e.g., hub and spoke, point-to-point, space launch and re-entry), and business models (e.g., air taxis, regional jets). It will do this across all airspace, at all airports and launch and re-entry sites, and in all weather conditions, while simultaneously improving system performance and ensuring safety.

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

In November 2003, Secretary of Transportation Norman Mineta released a vision to transform our Nation's air transportation system. The vision, created by the Departments of Defense, Transportation, Homeland Security, and Commerce, FAA, National Aeronautics and Space Administration (NASA), and the Office the Science and Technology Policy, envisions "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."[4]

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

1.3 Long-term Goals and Objectives

To achieve this vision, the Secretary of Transportation proposed ***six national goals*** to transform the current aviation system over the next 20 years into a next generation air transportation system that will ensure continued economic prosperity and national security and a higher standard of living for all Americans in the 21st century. These 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.**

To achieve these goals, Congress created a Joint Planning and Development Office (JPDO), managed by the FAA, to oversee planning related to the next generation air transportation system.[5] The JPDO comprises representatives from the Departments of Defense, Transportation, Homeland Security and Commerce, FAA, NASA, and the Office of Science and Technology Policy. Working together with industry, labor, and academia, the JPDO has established long-term system goals and performance characteristics for the system in its *Next Generation Air Transportation System Integrated Plan*.[6]

[5] The Vision 100 - Century of Aviation Reauthorization Act, Public Law 108-176, December 12, 2003.
[6] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 10, 2004, www.jpdo.aero.

Long-term System Goals and Objectives

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 (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

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 travel and shipper confidence in system security

1.4 Near-term FAA Goals and Objectives

The FAA is committed to improving the performance of the nation's aviation system to meet the economic and national security needs of the nation. The *Flight Plan 2005-2009*[7] describes the Agency's near-term performance goals and objectives as follows:

1.4.1 Increased Safety

Achieve the lowest possible accident rate and constantly improve safety.

Demand for air transportation is expected to triple over the next 20 years as more people use air transportation for business, work, recreation, leisure travel, and air cargo services. The number and type of aircraft will increase as will the type of air operations. As a result, improving safety will require not only a significant reduction in the aviation accident rate, but also in the number of accidents. Safety is an important element in maintaining the public's confidence in flying.

1.4.2 Greater Capacity

Work with local governments and airspace users to provide capacity in the United States airspace system that meets projected demand in an environmentally sound manner.

The nation's air transportation system must be flexible and scalable to move an increasing number passengers and goods from their origin to destination on schedules that meet customer needs. Flight routes will likely become more complex as increasingly diverse aerospace transportation services serve a larger number of smaller airports. Advances in technology will likely lead to higher levels of general aviation activity for point-to-point and air taxi operations increasing the use of controlled airspace. The transition from turbo-prop to jet aircraft by regional carriers will likely continue to increase demand for entry into the high-level en route sectors. The expected high rate of growth of international aviation will likely contribute to a similar trend toward direct flights to and from a larger number of new gateway airports around the world. The challenge is to have an air transportation system that is not only efficient but also safe, secure, fast, flexible, environmentally sound, and adaptable to changing operating environments and market forces.

1.4.3 International Leadership

Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner.

The FAA operates the largest and most complex aviation system in the world, controlling almost half of the world's air traffic. It certifies more than 70 percent of the world's large jet aircraft and provides direct or indirect aviation assistance to 129 countries. Over 120 domestic and 90 international air carriers serve the United States on a daily basis. U.S. industry is continuously developing and implementing new technologies to create a safer, more efficient, global airspace system. Open global markets are critical to the continued economic health and national security of the United States. They drive innovation, quality, and efficiency of air transportation services. To ensure global safety, the U.S. government must continue to work with its global partners to harmonize standards and to ensure the compatibility of the regulation and certification processes.

1.4.4 Organizational Excellence

Ensure the success of the FAA's mission through stronger leadership, a better trained workforce, enhanced cost-control measures, and improved decision making based on reliable data.

As the demand for air transportation grows and the pressures mount to contain federal spending, FAA will need to find new ways to provide more and better aviation products and services, faster and cheaper.

[7] Federal Aviation Administration, Flight Plan 2005-2009, November 9, 2004, http://www.faa.gov/aboutfaa/RevisedStrategicPlan/RevisedPlan.pdf.

Fulfilling this mission requires strong leadership, talented people, customer focus, fiscal responsibility, and performance-based management. It will require streamlined processes that will enable the rapid, seamless, and safe introduction of new regulations, standards, procedures, and capabilities into the system. It will require broad application of information technology, not only to provide accurate and reliable information for decision making, but also for the automation of many basic operational and administrative functions.

1.5 Challenges and FAA R&D Strategies and Programs
The FAA R&D program directly supports achievement of the *FAA Flight Plan* near-term goals and objectives and the JPDO long-term goal and objectives. By working with their counterparts in other federal agencies and in the aviation community, the Agency's researchers are leading the way to ensure safety and capacity needs are being met today and in designing the national aviation system of the future.

To ensure scarce resources remain customer focused and targeted on the highest priorities, FAA has defined R&D strategies that address the major short- and long-term operational challenges facing the nation's air transportation system. These strategies are helping FAA identify and bridge the gap between today's near-term safety and efficiency R&D needs and tomorrow's long-term research needs. Only through a coordinated R&D program, can aviation's short- and long-term operational needs be met.

Near-term *Flight Plan* Goal Areas and Objectives

Increased Safety
- Reduce the commercial airline fatal accident rate
- Reduce the number of fatal accidents in general aviation
- Reduce accidents in Alaska
- Reduce the risk of runway incursions
- Measure the safety of the U.S. civil aviation industry with a composite index
- Ensure the safety of commercial space launches
- Enhance the safety of FAA's air traffic systems

Greater Capacity
- Increase airport capacity to meet projected demand
- Increase or improve aviation capacity in the eight major metropolitan areas and corridors that most affect total system delay. For FY 2005, those areas are: New York, Philadelphia, Boston, Chicago, Washington/ Baltimore, Atlanta, Los Angeles Basin, and San Francisco
- Increase on-time performance of scheduled carriers
- Address environmental issues associated with capacity enhancements

International Leadership
- 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
- 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
- Control costs while delivering quality customer service
- Make decisions based on reliable data to improve our overall performance and customer satisfaction

.

1.5.1 Increased Safety

To improve aviation system performance now and into the future, the R&D program must help overcome a number of critical safety challenges. These challenges include:

System Understanding. We need to understand the causal factors of accidents - known, unknown, emerging, and previously unrecognized. We need to understand how the system operates, and the impact of various technologies, regulations, and procedures on system safety. To handle more air travelers, air cargo, and aircraft types with greater security, the national air transportation system will likely have to become more automated. This will require changes in aviation operations and procedures that will impact safety. System modeling and simulation capabilities need to be expanded to allow the government, airlines, airports and others to understand system performance and tradeoffs before making major changes in policy and capital investments.

Human-centered Design. A large percentage of aviation accidents and incidents are attributed to human error. In the future, we must eliminate human error while improving human performance. Technology and human factors need to be integral parts of a human-centered design. New technological aids, such as advanced avionics, on-board flight management systems, aircraft "health" monitoring systems, and other automation aids, all reflecting principles of human-centered design, will reduce the risk of many types of accidents and incidents in the future.

Weather Forecasting. Today, the aviation system needs more accurate short-term weather predictions and high-confidence weather forecasting beyond two hours. Without this capability, air traffic controllers and traffic flow managers routinely increase aircraft separation and reduce operations to maintain safety during severe or adverse weather conditions. The resultant delays often have a cumulative effect throughout the airspace system. Accurate weather prediction and better weather forecasting models and technology are needed to increase both safety and capacity.

Adaptive Systems. The adoption of new technologies and procedures could result in unintended safety issues. Timely validation, certification, and industry-wide equipage of highly sophisticated software-based, safety-critical systems pose a challenge, as does the use of new equipment, materials, designs, and procedures. Successful responses to these challenges will draw on R&D that provides a better understanding of system characteristics, improved tools for testing and inspection, enhanced software validation processes, better appreciation for human factors considerations, and more focused analyses.

Changing Aerospace Industry. Globalization and changes in industry structure and practices pose challenges to maintaining and raising the level of aviation safety and safety oversight. Close coordination with other governments and aviation authorities and harmonization of performance-based standards, practices, and procedures will be necessary.

To address these challenges, the following R&D strategies and programs will help FAA achieve the lowest possible accident rate and constantly improve safety.

Photo by Lockett Yee

R&D Safety Strategies

Strategy 1. Understand how new technologies, concepts, regulations, procedures, and industry relationships could affect aerospace transportation system safety.

Strategy 2. Identify and reduce the risk of accidents due to known and unknown, emerging, or previously unrecognized causal factors.

Strategy 3. Protect passengers and crew by mitigating the consequences of accidents and in-flight/ground incidents.

Strategy 4. Prevent adverse health impacts on passengers, flight crews, and ground personnel.

R&D Programs that support these Safety Strategies

Advanced Materials/Structural Safety (A11.c)
Aeromedical Research (A11.j)
Aging Aircraft (A11.e)
Aircraft Catastrophic Failure Prevention Research (A11.f)
Airport Cooperative Research - Safety (AIP)
Airports Technology Research - Safety (AIP)
Air Traffic Control/Airway Facilities Human Factors (A11.i)
Atmospheric Hazards/Digital Systems Safety (A11.d)
Automatic Dependent Surveillance - Broadcast (1A02D)
Aviation Safety Risk Analysis (A11.h)
Commercial Space Transportation (Ops)
Fire Research and Safety (A11.a)
Flight Deck/Maintenance System Integration Human Factors (A11.g)
General Aviation and Vertical Flight Technology (1A01E)
NAS Safety Assessment (1A01G)
Propulsion and Fuel Systems (A11.b)
Runway Incursion Reduction (1A01B)
Safe Flight 21 - Alaska Capstone (1A02A)
Safe Flight 21 - Ohio River Valley (1A02B)
Safer Skies (1A01F)
Surface Moving Map (1B01D)
Weather Program (A11.k)
Wind Profiling and Weather Research Juneau (1A01J)

1.5.2 Greater Capacity

To improve aviation system performance now and into the future, the R&D program must help overcome a number of critical capacity challenges. These challenges include:

System Understanding. We need to understand how the system operates, and the impact various technologies, concepts, regulations, and procedures will have on system capacity. To handle the projected increases in demand, the national aviation system will likely become much more automated. This is expected to require changes in aviation operations and procedures that could affect safety and capacity in the air and on the ground. System modeling and simulation capabilities need to be expanded to allow the government, airlines, airports, and others to understand system performance and tradeoffs before making major policy changes and capital investment decisions.

Aircraft Separation. Currently, air traffic controllers maintain a buffer between aircraft to ensure that inaccuracies in position will not violate either runway occupancy time separation or wake vortex separation criteria. With better and timelier information on aircraft wake vortices, separation criteria can be reduced, increasing system capacity while improving aircraft safety. Likewise, adverse weather causes the air traffic control system to increase aircraft separation, reducing system capacity during times of severe weather. Wake vortex detection technologies and better weather forecasting models will help to decrease aircraft separation while increasing system efficiency, capacity, and safety.

Situational Awareness. The lack of timely and accurate information both on the ground and in the air results in the need for increased aircraft separation for safety and reduced capacity. Improving situational awareness in the cockpit would provide pilots safer access to a wider range of airports in all weather conditions. Having real-time, precise, and relevant information displayed both in the cockpit and in air traffic control centers on en route aircraft, weather, terrain, and other safety of flight information, would significantly improve air transportation safety, especially in general aviation, while improving overall air transportation system speed and efficiency.

Air Transportation Management.
Cognitive workload limitations, the need for voice communications, and the lack of timely and accurate surveillance information, reduce airspace system capacity especially in high-density sectors and airports. Information technologies, intelligent systems, and human-centered design will help improve system performance and increase system capacity.
Automation and a network-centric air transportation management system could increase the number of aircraft and amount of airspace controllers manage, reduce aircraft separation, and facilitate the movement of people, baggage and goods through airports.

Aircraft Emissions and Noise. Aviation environmental issues impact human health and productivity. Aircraft noise is constraining operations and construction of critical new runways and reducing aircraft engine emissions are becoming increasingly important. One way to address these issues is to improve aircraft fuel efficiency. Fuel efficiency translates directly into real reductions in noise and emissions as well as in fossil fuel consumption and airline operating costs. There is also a need to reduce aircraft noise. Foreign countries are reducing aircraft allowable noise-level requirements at and around their airports, potentially restricting U.S. flight operations abroad.

The following capacity R&D strategies and programs will help FAA address these challenges and meet the nation's projected demand for air transportation in an environmentally sound manner.

Photo by Lockett Yee

R&D Capacity Strategies

Strategy 1. Understand how new technologies, concepts, regulations, procedures, and industry relationships could affect air transportation system capacity.

Strategy 2. Develop, demonstrate, and validate technology that will minimize aircraft separation while ensuring safety.

Strategy 3. Provide a common, real-time and reliable picture of air transportation operations in the air and on the ground.

Strategy 4. Create an automated, human-centered air transportation management system.

Strategy 5. Eliminate the environmental impact of aviation emissions and noise.

R&D Programs that support these Capacity Strategies

Airport Cooperative Research - Capacity (AIP)
Airports Technology Research - Capacity (AIP)
Airspace Management Laboratory (1A01J)
Air Traffic Control/Airway Facilities Human Factors (A11.i).
Automatic Dependence Surveillance - Broadcast (1A02D)
Aviation Safety Risk Analysis (A11.h.)
Center for Advanced Aviation System Development (4A10)
Environment and Energy (A13.a)
General Aviation and Vertical Flight Technology (1A01E)
Joint Planning and Development Office (A12.a)
National Airspace System Requirements (1A01H)
Operations Concept Validation (1A01D)
Safe Flight 21 - Ohio River Valley (1A02B)
Separation Standards (1A01A)
System Capacity Planning and Improvement (1A01C)
Wake Turbulence (A12.b)
Wake Turbulence (1A01K)
Weather Program (A11.k)

1.5.3 International Leadership

To ensure FAA international leadership into the future, the R&D program must help overcome a number of critical challenges. These challenges include:

Changing Aerospace Industry. Globalization and changes in industry structure and practices pose challenges to maintaining and raising the level of aviation safety and safety oversight. Close coordination with other governments and aviation authorities and harmonization of standards, practices, and procedures are necessary to ensure safe global operations.

Global Standards, Regulations and Certification. To retain its international leadership in aviation, the United States must lead the development of global standards in the International Civil Aviation Organization (ICAO) and other forums.

Global Partnerships. International partnerships are essential to the creation and operation of the global air transportation system. To transform the way we use airspace through the use of technology and improved procedures, we must act in concert with countries around the world. We must promote interoperability of emerging technologies for air traffic management to improve safety and enhance global capacity. This includes the development of common standards for navigation and global cooperative efforts over radio spectrum allocation. We must work with key international partners to enable the transfer of aeronautical products, technologies and services that promote civil aviation safety worldwide.

The following R&D strategies and programs will help FAA increase the safety and capacity of the global civil aerospace system in an environmentally sound manner.

Photo by Lockett Yee

R&D Programs that support these International Leadership Strategies

R&D International Leadership Strategies

Strategy 1. Ensure U.S. international civil aviation policies, standards, procedures and processes are based on sound science.

Strategy 2. Help streamline the civil aviation standards and regulatory and certification development processes through research and technology.

Strategy 3. Lead international efforts to foster innovation and to achieve breakthroughs in civil aviation capabilities.

Automatic Dependent Surveillance-Broadcast (1A02D)
Aviation Safety Risk Analysis (A11.h)
Environment and Energy (A13.a)
General Aviation & Vertical Flight Technology (1A01E)
Separation Standards (1A01A)

1.5.4 Organizational Excellence

To improve FAA organization excellence now and into the future, the R&D program must help overcome a number of critical challenges. These challenges include:

Quality People. Attracting, developing, and retaining a diverse and highly skilled workforce will continue to be a challenge in the future as competition for quality and talented workers increases in the marketplace. The FAA, in particular, faces major challenges not only because of the unique skills required by its workers, but also because of the large number of workers who will become eligible for retirement over the next 5 to 10 years. As a result, FAA needs to become a learning environment that empowers, inspires, and encourages its people to deliver the highest quality aviation products and services to the American people. The FAA must be the place of choice to work.

Management Processes. Key to organizational effectiveness and efficiency are the processes FAA uses to define, develop, and deliver its aviation-related products and services. This includes: planning, programming and budgeting; financial management; acquisition management; and operations and maintenance management. To transform the best ideas available domestically and internationally into new aviation products and services quickly, FAA needs processes that have dramatically shorter cycle times and provide higher rates of return on the government's investments in air transportation.

Customer Satisfaction. In the future, FAA will have to provide air traffic services for a larger number and variety of users and accommodate a broader range of air and space operations and business models across all airspace and airports. Consequently, meeting and exceeding customer expectations without interruption will be an increasing challenge. The FAA will have to listen to, communicate with, and be responsive to its customers as never before.

Information Technology. In the future, decision makers will have an increasing need for reliable and timely information about air transportation system performance, customer satisfaction, and organizational effectiveness. A broader use of information technologies and access to real-time information will revolutionize the workplace, enabling employees and organizations to become more efficient and effective in planning activities, managing resources and time, and delivering products and services to customers. The challenge will be to create information systems that ensure security of the information, while enabling on-line, world-wide access to the information, for those who need it, when they need it, and where they need it.

Public-private Partnerships. Government, industry, labor, and academia perform different, but important roles in developing, maintaining, and operating the nation's air transportation system. They cannot perform these roles separately or in mutual isolation. Individually, each component must understand its role and work with the others to create an environment that will produce the best and safest system in the world. Collectively, all need to work in partnership to ensure that the government can do its mission and the commercial sector can compete successfully in the international market place. The challenge is to find the means to encourage cooperative efforts while ensuring that the outcome reflects the public good and national interest.

To address organizational challenges, the following R&D strategies and programs will help ensure the success of FAA's mission through stronger leadership, a better trained work force, enhanced cost-control measures, and improved decision making based on reliable data.

Photo by Fran Chesley

R&D Programs that support these Organizational Excellence Strategies

R&D Organizational Excellence Strategies

Strategy 1. Attract, develop and retain a diverse, highly skilled workforce.

Strategy 2. Create a customer-focused and peer-reviewed strategic planning process.

Strategy 3. Increase organizational efficiency and effectiveness through process reengineering and broader use of information technologies.

Strategy 4. Conduct world-class research.

Strategy 5. Accelerate the transformation of R&D into new aerospace products and services.

Air Traffic Control/Airway Facilities Human Factors (A11.i)
Environment and Energy (A13.a)
Center for Advanced Aviation System Development (4A10)
Systems Planning and Resource Management (A14.a)
William J. Hughes Technical Center Laboratory Facility (A14.b)

Table 1.1 shows how FAA R&D programs address the R&D strategies developed in this chapter. R&D programs that support specific R&D strategies are represented by an X.

R&D Strategies		A11.a Fire Research and Safety	A11.b. Propulsion and Fuel Systems	A11.c. Advanced Materials/Structural Safety	A11.d. Atmospheric Hazards/Digital System Safety	A11.e. Aging Aircraft	A11.f. Aircraft Catastrophic Failure Prevention Research	A11.g. Flightdeck/Maintenance/System Integration Human Factors	A11.h. Aviation Safety Risk Analysis	A11.i. Air Traffic Control/Airway Facilities Human Factors	A11.j. Aeromedical Research	A11.k. Weather Program	A12.a. Joint Planning and Development Office	A12.b. Wake Turbulence	A13.a. Environment and Energy
Increased Safety	Understand impact of changes.								X						
	Reduce risk of accidents due to known and unknown causes.		X	X	X	X	X	X		X	X	X			
	Protect passengers and crew.	X	X	X	X	X									
	Prevent health impacts.										X				
Greater Capacity	Understand impact of changes.												X		X
	Minimize aircraft separation.											X		X	
	Provide a common picture of operations.											X			
	Develop human-centered air transportation management.							X		X	X				
	Minimize environmental impacts.														X
International Leadership	Ensure U.S. policy is based on sound science.														X
	Streamline standards and processes.														X
	Lead international efforts.														
Organizational Excellence	Build a diverse, highly skilled workforce.									X					
	Create a strategic planning and deployment process.														
	Increase organizational efficiency and effectiveness.														
	Conduct world-class research.										X				
	Accelerate the transformation of R&D.														X

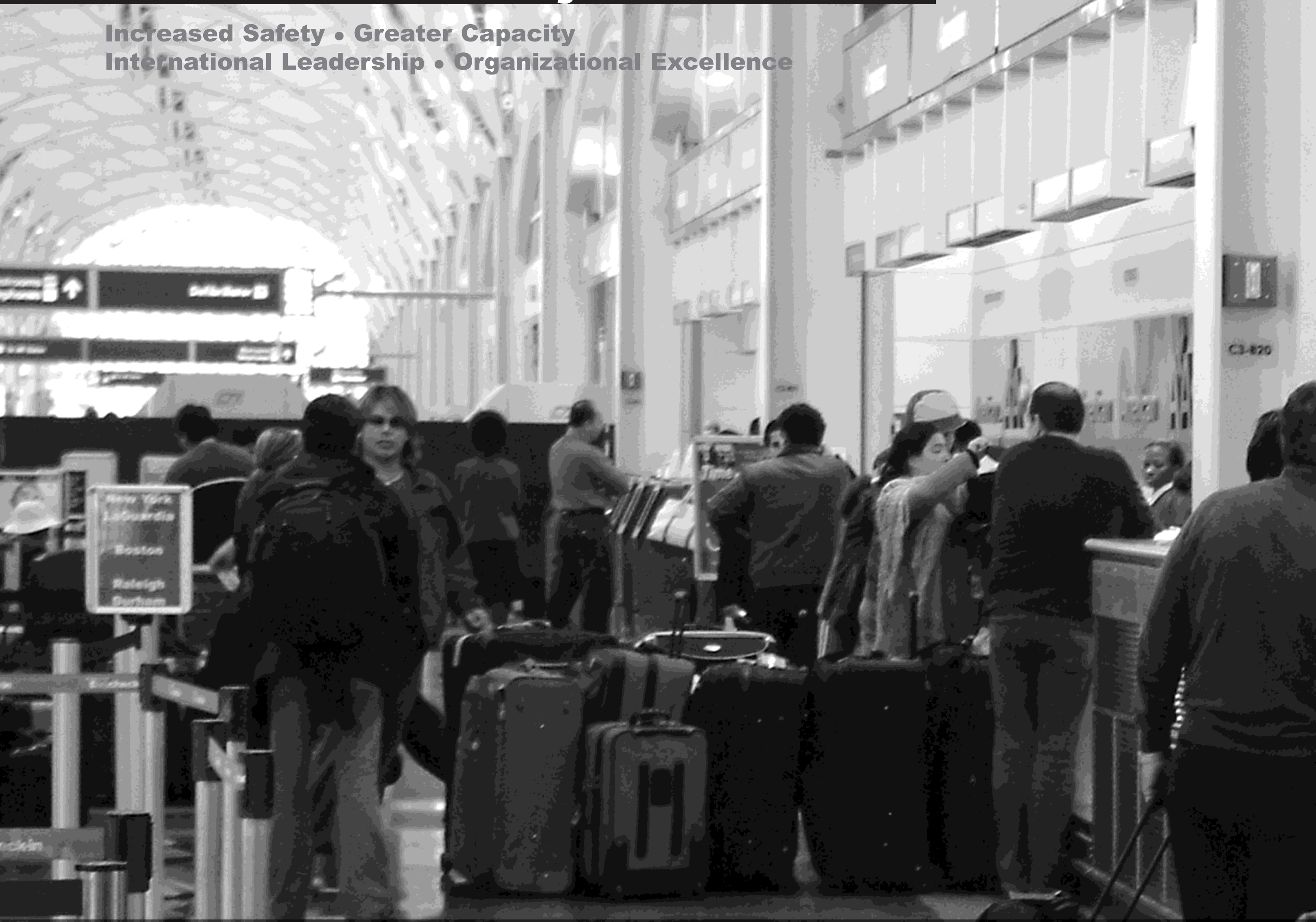
Table 1.1

																		FAA R&D Programs
X	X	X	X	X	X		X										A14.a.	System Planning and Resouce Management
	X																A14.b.	William J. Hughes Technical Center Laboratory Facilities
						X	X				X						1A01A	Separation Standards
															X		1A01B	Runway Incursion Reduction
											X						1A01C	System Capacity Planning and Improvement
												X					1A01D	Operations Concept Validation
							X							X	X		1A01E	General Aviation and Vertical Flight Technology (GA&VF)
																X	1A01F	Safer Skies
																X	1A01G	NAS Safety Assessment
												X					1A01H	NAS Requirements
															X		1A01I	Wind Profiling and Weather Research -- Juneau
									X		X	X					1A01J	Airspace Management Lab
												X					1A01K	Wake Turbulence
															X		1A02A	Safe Flight 21 - Alaska Capstone
										X	X				X		1A02B	Safe Flight 21 - Ohio River Valley
																	1A02C	Surface Moving Maps
							X			X					X		1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
X												X					4A10	Center for Advanced Aviation System Development (CAASD
														X	X	X	AIP	Airports Technology Research - Safety
								X			X	X					AIP	Airport Technology Research - Capacity
														X	X	X	AIP	Airport Cooperative Research - Safety
								X			X	X					AIP	Airport Cooperative Research - Capacity
													X	X	X	X	Ops	Commercial Space Transportation Safety

Mapping of R&D Strategies and Programs

Alignment of R&D with Goals & Objectives

Increased Safety • Greater Capacity
International Leadership • Organizational Excellence



The Federal Aviation Administration is committed to increasing aviation safety and capacity. Its near-term goals and objectives are defined in the FAA *Flight Plan 2005-2009.* The FAA also plays a leadership role in defining the long-term goals and objectives that are defined in the JPDO *Next Generation Air Transportation System Integrated Plan* . Mid-term performance goals are currently under development by the FAA and the JPDO. The FAA's *Operational Evolution Plan* is the FAA's ongoing ten-year (2004-2014) plan to increase the capacity and efficiency of the National Airspace System while enhancing safety and security.

FAA research and development (R&D) needs to support these near-, mid- and long-term goals and objectives. The R&D strategies defined in the previous chapter will help the FAA do this in a balanced way based on the major operational challenges facing the air transportation system. Other federal departments and agencies also support these goals and objectives depending on their roles and missions. The Department of Homeland Security (DHS), for example, has day-to-day responsibility for aviation security. As a result, its research focuses on the near- and mid-term security goals of the air transportation system. The National Aeronautics and Space Administration (NASA), on the other hand, has an aeronautics research mission and focuses its research on the mid- and long-term needs of air transportation.

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[8] Federal Aviation Administration, *Flight Plan* 2005-2009, November 9, 2004, http://www.faa.gov/aboutfaa/RevisedStrategicPlan/RevisedPlan.pdf

[9] Joint Planning and Development Office, *Next Generation Air Transportation System Integrated Plan*, December 2004, www.jpdo.aero.

[10] Federal Aviation Administration National Airspace System *Operation Evolution Plan 2004-2014*, Version 6.0, Executive Summary, January 2004, http://www.faa.gov/programs/oep/

R&D strategies help FAA address the near-, mid-, and long-term needs of the air transportation system.

2.1 Increased Safety

Table 2.1 shows how FAA R&D programs address both the near-term safety goal, objectives and performance targets of the FAA *Flight Plan* and the long term safety goals and objectives of the JPDO *Integrated Plan*. R&D programs that support specific safety objectives and performance targets are represented by an X.

FAA Flight Plan (Near-Term)			
Goal		Objective	Performance Target
Increased Safety	1	Reduce the commercial airline fatal accident rate	Reduce the airline fatal accident rate by 80% from the 1994-1996 baseline to a 3-year rolling average rate of 0.010 per 100,000 departures by FY 2007. Reduce the three-year rolling average fatal accident rate below 0.010 by fiscal year (FY) 2009.
	2	Reduce the number of fatal accidents in general aviation	By FY 2009, reduce the number of general aviation and nonscheduled Part 135 fatal accidents to no more than 319 (from 385, which represents the average number of fatal accidents for the baseline period 1996-1998).
	3	Reduce accidents in Alaska	By FY 2009, reduce accidents in Alaska for general aviation and all Part 135 operations from the 2000-2002 average of 130 accidents per year to no more than 99 accidents per year.
	4	Reduce the risk of runway incursions	By 2009, reduce the number of Category A and B (most serious) runway incursions to no more than 27, equivalent to a rate of 0.390 per million operations.
	5	Measure the safety of the U.S. civil aviation industry with a composite index	By FY 2006, implement a single, comprehensive index that provides a meaningful measure of the safety performance of the U.S. civil aviation system.
	6	Ensure the safety of commercial space launches	No fatalities, serious injuries, or significant property damage to the uninvolved public during licensed space launch and reentry activities.
	7	Enhance the safety of FAA's air traffic systems	(a) By 2009, reduce the number of Category A and B (most serious) operational errors to no more than 563, equivalent to a rate of 3.15 per million activities.
			(b) Apply safety risk management ot at least 30 significant changes in the NAS.

Table 2.1

FAA R&D Programs																							JPDO Integrated Plan (Long-Term)	
Fire Research and Safety	Propulsion and Fuel Systems	Advanced Materials/Structural Safety	Atmospheric Hazards/Digital System Safety	Aging Aircraft	Aircraft Catastrophic Failure Prevention Research	Flightdeck/Maintenance/System Integration Human Factors	Aviation Safety Risk Analysis	Air Traffic Control/Airway Facilities Human Factors	Aeromedical Research	Weather Program	Runway Incursion Reduction	General Aviation and Vertical Flight Technology (GA&VF)	Safer Skies	NAS Safety Assessment	Wind Profiling and Weather Research Juneau	Safe Flight 21 - Alaska Capstone	Safe Flight 21 - Ohio River Valley	Surface Moving Maps	Automatic Dependent Surveillance - Broadcast (ADS-B)	Airports Technology Research - Safety	Airport Cooperative Research -- Safety	Commercial Space Transportation Safety		
A11.a	A11.b.	A11.c.	A11.d.	A11.e.	A11.f.	A11.g.	A11.h.	A11.i.	A11.j.	A11.k.	1A01B	1A01E	1A01F	1A01G	1A01I	1A02A	1A02B	1A02C	1A02D	AIP	AIP	Ops	Objective	Goal
X	X	X	X	X	X	X	X		X	X			X				X	X	X	X	X		Maintain aviation's record as the safest mode of transportation	Ensure Safety
	X	X		X		X	X		X	X		X				X	X	X	X	X	X			
										X					X	X		X	X	X	X			
								X			X		X				X	X	X	X	X			
							X																	
																						X		
								X			X												Improve the level of safety of the U.S. air transportation system	
						X		X						X										

Mapping of FAA R&D Programs to FAA <u>Safety</u> Goals and Objectives

1 Increased Safety

Objective: Reduce the commercial airline fatal accident rate

Performance Measure: Airline fatal accident rate

Description: This measures the number of fatal air carrier accidents per 100,000 departures. A rolling three-year average of the accident rate is used to measure performance against annual targets. The three-year average is calculated by dividing the number of accidents for the previous 36 months by the number of departures. Departures for the current fiscal year are based upon estimates supplied by FAA's economic forecasts. This measure includes both the scheduled and nonscheduled flights of U.S. air carriers and schedule flights of commuter airlines, as defined in the Code of Federal Regulations (CFR), Parts 121 and 135 respectively.

Performance Target: Reduce the airline fatal accident rate by 80 percent from the 1994-1996 baseline to a three-year rolling average rate of 0.010 per 100,000 departures by FY 2007. Reduce the three-year rolling average fatal accident rate below 0.010 by FY 2009.
JPDO Goal: Maintain aviation's record as the safest mode of transportation.

Recent Trends: Based on preliminary estimates for FY 2004, the three-year average fatal accident rate was 0.021 per 100,000 departures, which was below the FY 2004 goal of 0.028. In FY 2003, the three-year average fatal accident rate was 0.024 per 100,000 departures, which was below the FY 2003 goal.

2004 Research Results:

Evacuation of Water. Conducted a series of tests to evaluate evacuation flow rates into water from simulated Type A exits. Results indicated that evacuation flow rates decreased as exit heights above the water increased, and were slower for subjects using flotation seat cushions than for those wearing life vests.

Aircraft Certification Job Aid for Flight Deck Human Factors. Developed a hierarchy of human factors considerations pertinent to the design and certification of flight deck systems for the Aircraft Certification Job Aid. Certification personnel and designers use this tool to ensure that flight deck technologies are user friendly.

Arc Fault Evaluation Laboratory. Established at the William J. Hughes Technical Center to provide researchers with the capability to simulate aircraft wiring faults in a realistic environment and to evaluate and test arc fault protection devices.

Air Transportation Centers of Excellence. Established two Air Transportation Centers of Excellence. The Center for Airliner Cabin Research will research cabin air quality and conduct assessments of chemical and biological threats. The Advanced Materials Center will conduct research, engineering and prototype development on the safe and reliable use of advanced materials and composites in large commercial aircraft.

Inspection Technologies for Detecting Flaws in Composite Materials. Completed assessment of conventional and advanced nondestructive inspection techniques for composite honeycomb aircraft panels and established a baseline of current inspection techniques. Identified a wide array of nondestructive inspection methods and the limitations and optimum applications for specific composite inspection methods.

Photo by Lockett Yee

FAA R&D Programs in Safety

Challenges:
System understanding
Human-centered design
Weather forecasting
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies**:
Evolve to a performance-based National Airspace System to improve navigation

Expand safety oversight and continue research to identify and address causal factors of accidents

Expand FAA industry information sharing efforts to address safety risks

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents
Protect passengers and crew
Prevent health impacts

A11.a.	Fire Research and Safety
A11.b.	Propulsion and Fuel Systems
A11.c.	Advanced Materials/Structural Safety
A11.d.	Atmospheric Hazards/Digital System Safety
A11.e.	Aging Aircraft
A11.f.	Aircraft Catastrophic Failure Prevention Research
A11.g.	Flightdeck/Maintenance/System Integration Human Factors
A11.h.	Aviation Safety Risk Analysis
A11.j.	Aeromedical Research
A11.k.	Weather Program
1A01F	Safer Skies
1A02B	Safe Flight 21 - Ohio River Valley
1A02C	Surface Moving Map
1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
AIP	Airports Technology Research - Safety
AIP	Airport Cooperative Research - Safety

Related Federal R&D Programs:

NASA

Aviation Safety and Security Program (AVS&SP)
- System Safety Technologies
- Vehicle Safety Technologies
- Weather Safety Technologies
- Aircraft & System Vulnerability Mitigation

2 Increased Safety

Objective: Reduce the number of fatal accidents in general aviation

Performance Measure: General aviation fatal accidents

Description: This measure is a count of the total number of fatal general aviation fatal accidents during the fiscal year. It includes on-demand (non-scheduled) and general aviation flights as defined in the Federal Aviation Regulations (FAR), Part 135. General aviation comprises a diverse range of aviation activities, from single-seat homebuilt aircraft, helicopters, balloons, single and multiple engine land and seaplanes, to highly sophisticated extended range turbojets.

Performance Target: By FY 2009, reduce the number of general aviation and nonscheduled Part 135 fatal accidents to no more than 319 (from 385, which represents the average number of fatal accidents for the baseline period 1996-1998). **JPDO Goal:** Maintain aviation's record as the safest mode of transportation.

Recent Trends: The preliminary estimate of performance in FY 2004 is 340 fatal accidents, which is below the FY 2004 target of 349 or fewer fatal accidents. In FY 2003, there were 366 fatal accidents, which met the FY 2003 goal of 374 or fewer fatal accidents. However, there is an upward trend in general aviation fatal accidents over the past several years.

2004 Research Results:

Enhanced Cocaine Analysis. Developed a method for the simultaneous determination of cocaine and related metabolites. Demonstrated method using five aviation fatality cases. Method will simplify postmortem analysis from multiple, cumbersome tests to a single, highly accurate one.

Head-Impact Criteria Component Tester. Conducted 11 sled tests and six component tests to complete the evaluation of the tester, which will simulate the motion and forces that result from occupant head impact on an aircraft structure or seat.

Automatic Detection Surveillance - Broadcast (ADS-B). Added a test bed on the east coast and continued to operate ADS-B surface and terminal area test beds in Memphis, Tennessee, Louisville, Kentucky, and the Gulf of Mexico. In partnership with NASA, conducted nine high and low altitude flight tests in the Gulf of Mexico to evaluate ADS-B and multilateration technologies.

Juneau Wide Area Multilateration System. Began installation of a demonstration system for the airport in Juneau, Alaska. This technology will enable situational awareness in an area that has no radar coverage today.

Alaska Capstone. Issued *The Safety Impact of Capstone Phase I Summary Report*, highlighting significant safety and efficiency results of the program.

Human Error and General Aviation Accidents. Developed a human factors intervention matrix to complement the Human Factors Analysis and Classification System (HFACS). The matrix maps the casual categories in the HFACS against five approaches to human intervention.

Photo from Flight Plan

Challenges:
System understanding
Human-centered design
Weather forecasting
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies:**
Implement technologies and systems to help pilots operate aircraft safely

Establish standard procedures and guidelines for general aviation operators

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents
Protect passengers and crew

FAA R&D Programs in Safety

A11.b.	Propulsion and Fuel Systems
A11.c.	Advanced Materials/Structural Safety
A11.e.	Aging Aircraft
A11.g	Flightdeck/Maintenance/System Integration Human Factors
A11.h.	Aviation Safety Risk Analysis
A11.j.	Aeromedical Research
A11.k.	Weather Program
1A01E	General Aviation and Vertical Flight Technology (GA&VF)
1A02A	Safe Flight 21 - Alaska Capstone
1A02B	Safe Flight 21 - Ohio River Valley
1A02C	Surface Moving Map
1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
AIP	Airports Technology Research - Safety
AIP	Airport Cooperative Research - Safety

Related Federal R&D Programs

NASA

Aviation Safety and Security Program (AVS&SP)

- System Safety Technologies
- Vehicle Safety Technologies
- Weather Safety Technologies

3 Increased Safety

Objective: Reduce accidents in Alaska

Performance Measure: Alaska accidents

Description: This measure is a count of the number of general aviation and Part 135 accidents in Alaska during the fiscal year. This is not a sub-measure of the reduced general aviation fatal accidents performance target. This measure includes scheduled and non-scheduled FAR Part 135, as well as general aviation flights.

Performance Target: By FY 2009, reduce accidents in Alaska for general aviation and all Part 135 operations from the 2000-2002 average of 130 accidents per year to no more than 99 accidents per year. **JPDO Goal:** Maintain aviation's record as the safest mode of transportation.

Recent Trends: The preliminary estimate of performance in FY 2004 is 100 accidents, which is below the FY 2004 target of 125 or fewer accidents. All months in FY 2004 remained at or below the monthly targets with performance improving steadily each month from February through September.

2004 Research Results:

Automatic Detection Surveillance - Broadcast (ADS-B) Infrastructure Planning. Continued preparing for the initial ADS-B infrastructure in southeast Alaska. Focused on expanding the use of proven technologies, pursuing the development of affordable equipment, and prototyping and demonstrating a hybrid satellite-ground infrastructure for communications, navigation, and surveillance.

Volcanic Ash Forecast. Began testing a prototype volcanic ash forecast tool that provides detection information, along with a forecast of the ash plume dispersion so that dispatchers can help aircraft avoid hazardous volcanic ash clouds. When volcanic ash is ingested into aircraft engines, the result can be catastrophic.


Photo by Lockett Yee

FAA R&D Programs in Safety

Challenges:
System understanding
Human-centered design
Weather forecasting
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies:**
Expand and accelerate implementing safety and navigation improvement programs in Alaska

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents
Protect passengers and crew

A11.k.	Weather Program
1A01I	Wind Profiling and Weather Research Juneau
1A02A	Safe Flight 21 - Alaska Capstone
1A02C	Surface Moving Map
1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
AIP	Airports Technology Research - Safety
AIP	Airport Cooperative Research - Safety

Related Federal R&D Programs
NASA
Aviation Safety and Security Program (AVS&SP)
- System Safety Technologies
- Vehicle Safety Technologies
- Weather Safety Technologies

4 Increased Safety

Objective: Reduce the risk of runway incursions

Performance Measure: Runway incursions (A&B)

Description: A runway incursion is any occurrence at an airport involving an aircraft, vehicle, person, or object on the ground that creates a collision hazard or results in a loss of separation between aircraft taking off, intending to take off, landing, or intending to land at an airport. They are grouped in three general categories: operational errors, surface pilot deviations, and vehicle/pedestrian deviations. Runway incursions are reported and tracked at airports that have an operational air traffic control tower. "Operations" are total takeoffs and landings. The measurement includes those incursions with measurable risk of collision, Category A and B. Category A incursions are separation decreases to the point that participants take extreme action to avoid narrowly a collision, or the event results in a collision. Category B incursions are when separation decreases, and there is a significant potential for a collision. The measure reflects the focus of FAA's runway safety effort on Category A and B to reduce the number and rate of incursions with demonstrable risk.

Performance Target: By FY 2009, reduce the number of Category A and B (most serious) runway incursions to no more than 27, equivalent to a rate of 0.390 per million operations. **JPDO Goal:** Maintain aviation's record as the safest mode of transportation.

Recent Trends: The preliminary estimate of performance in FY 2004 is 28 of the most serious types of runway incursions, which is significantly less than the FY 2004 goal of 40. This performance continues a downward trend that began five years ago and reflects a 12.5 percent decrease from FY 2003.

2004 Research Results:

Human Factors Research on Runway Incursions. Developed the Runway Incursion Severity Categorization model as a tool to assign more objective and reliable ratings for the severity of runway incursions and validated the model using data reported from 324 runway incursions.

Digital Airport Map Database. Finalized the specification for digital airport map database in preparation for a formal process certification. Certification will enable the data to be used in certified avionics applications.

Runway Status Lights. Installed a prototype runway status light system at Dallas/Ft. Worth International Airport for operational evaluation. The system consists of an array of red lights deployed at taxiway entrances that are automatically driven by airport surveillance sensors to warn pilots and vehicle operators that a runway is unsafe to enter.

Photo by Lockett Yee

Challenges:
System understanding
Human-centered design
Weather forecasting
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies:**
Identify runway incursion collision risks and influence their reduction

Modify and improve existing surface movement infrastructure

Use advanced modeling and simulation tools to design and develop new equipment, procedures, and training

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents

FAA R&D Programs in Safety

A11.i	Air Traffic Control/Airway Facilities Human Factors
1A01B	Runway Incursion Reduction
1A01F	Safer Skies
1A02B	Safe Flight 21 - Ohio River Valley
1A02C	Surface Moving Map
1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
AIP	Airports Technology Research - Safety
AIP	Airport Cooperative Research - Safety

Related Federal R&D Programs

NASA

Aviation Safety and Security Program (AVS&SP)
- System Safety Technologies
- Vehicle Safety Technologies

5 Increased Safety

Objective: Measure the safety of the U.S. civil aviation industry with a composite index

Performance Measure: Composite safety index

Description: This measure is concerned with the development of the index, not measuring the index itself. For FY 2005, this target will be measured on whether the FAA develops a single composite safety index.

Performance Target: By FY 2006, implement a single, comprehensive index that provides a meaningful measure of the safety performance of the U.S. civil aviation system. **JPDO Goal:** Maintain aviation's record as the safest mode of transportation.

Recent Trends: In FY 2004, FAA met its goal by holding a conference to discuss the index on January 21, 2004.

2004 Research Results:

System-wide Safety Indicator. Produced a draft report entitled, O*n Devising a Single System-wide Indicator about Aviation Safety*. The draft proposes one possible index, based on the mortality risk posed by aviation to passengers, aviation employees, and third parties on the ground. The index is a generalization of a "death risk per flight" statistic that has already been used for several decades.

Photo by Lockett Yee

FAA R&D Programs in Safety

Challenges:
System understanding
Changing aerospace industry

***Flight Plan* Strategies:**
Develop an aviation safety index that measures system risk and performance of the U.S. civil aviation system

R&D Strategies:
Understand impact of changes
Reduce risk of accidents
Protect passengers and crew

A11.h. Aviation Safety Risk Analysis

Related Federal R&D Programs

NASA Aviation Safety and Security Program (AVS&SP)

System Safety Technologies

6 Increased Safety

Objective: Ensure the safety of commercial space launches

Performance Measure: Space launch accidents

Description: The number of fatalities, serious injuries, or amount of property damage to the uninvolved public that results from a commercial space launch or re-entry. This measure focuses only on commercial space launch or re-entry activities licensed and monitored by the FAA. "Significant" property damage is defined as $25,000 or greater.

Performance Target: No fatalities, serious injuries, or significant property damage to the uninvolved public during commercial space launch and re-entry activities.
JPDO Goal: Maintain aviation's record as the safest mode of transportation.

Recent Trends: In FY 2004, FAA achieved its goal. There were 13 licensed launches during the year, of which four involved reusable launch vehicles operating from an inland spaceport. There has not been a single commercial space launch accident in over 165 licensed launches since the first DOT licensed launch took place in 1989.

2004 Research Results:

Reentry Vehicle Hazard Model. Completed a draft handbook, *Development of a Simplified Reentry Vehicle Hazard Model*, that can be used to perform a first-hand estimation of the expected casualty for a given reusable launch vehicle mission.

Aeromedical Guidelines for Commercial Launch Vehicles. Completed the guidelines for environmental control and life support systems and for assuring human survival during commercial launch vehicle operations.

Debris Database. Initiated an effort with NASA to develop a database with detailed information on fragments recovered from the Space Shuttle Columbia. This data will facilitate the development of improved methods for determining public risk assessments.

Flight Safety Systems. Initiated a study to apply a verification methodology to an autonomous flight safety system currently being developed and tested by NASA.

Reusable Launch Vehicle Inspection Techniques. Completed a study of non-destructive evaluation methods relevant to inspecting launch vehicle structures covered by thermal protection systems.

Space Vehicle Reentry. Produced a draft report on a study to understand the effects of radio frequency blackout during reusable launch vehicle reentry and to investigate methods to mitigate any resultant communication outages.

Casualty Criteria for Reusable Launch Vehicles. Completed a study to assess alternate methodologies for establishing equivalent satisfaction of the expected casualty criterion for launch licensing.

Photo from Flight Plan

FAA R&D Programs in Safety

Challenges:
System understanding
Human centered design
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies:**
Continue developing tools, guidance, and regulations for reducing the safety risks for commercial space launches

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents
Protect passengers and crew
Prevent health impacts

Ops   Commercial Space Transportation Safety

7a Increased Safety

Objective: Enhance the safety of FAA's air traffic system

Performance Measure: (a) Operational errors (A&B)

Description: The measure is the number of category A & B (highest severity) operational errors in a fiscal year. An operational error is a violation of separation standards that define minimum safe distances between aircraft, between aircraft and other physical structures, and between aircraft and otherwise restricted airspace. The severity of an operational error is determined by a point value established by the severity index. The severity index determines, for operational errors that occur in-flight, the gravity or degree of the violation of the separation standard. Categories within the severity index are determined by the sum of assigned values for vertical and lateral distances, closure rates, and flight paths. Category A point values sum to 90 points or higher. Category B point values sum to 40-89 points, and the air traffic control factor is determined to be moderate-uncontrolled. Prior to FY 2002, a straight count of all operational errors was used. In FY 2002 only operational errors with less than 80 percent separation were used as a control measure. In FY 2003, the focus was changed to measure the most severe operational errors - Category A or B.

Performance Target: (a) By 2009, reduce the number of Category A and B (most serious) operational errors to no more than 563, equivalent to a rate of 3.15 per million activities. **JPDO Goal:** Improve the level of safety of the U.S. air transportation system.

Recent Trends: The preliminary estimate of performance in FY 2004 is 637 Category A and B operational errors, which does not meet the FY 2004 goal of 629 or fewer. In FY 2003, a total of 680 serious operational errors occurred, exceeding the target value of 642 by 5.9 percent.

2004 Research Results:

Longitudinal Assessment of Age and Performance. Conducted three studies to access the relationship of age to controller performance, including the relationship of en route operational errors to controller age.

Optimizing Human Performance to Reduce Air Traffic Controller (ATC) Operational Error. Demonstrated a web-based version of the JANUS technique to assess how individual, situational, and work-related factors influenced ATC operational errors.

Photo by Lockett Yee

FAA R&D Programs in Safety

Challenges:
System understanding
Human-centered design
Adaptive systems

***Flight Plan* Strategy:**
Identify operational error collision risks and influence their reduction

R&D Strategies:
Understand impact of changes
Reduce the risk of accidents

A11.i. Air Traffic Control/Airway Facilities Human Factors
1A01B Runway Incursion Reduction

7b Increased Safety

Objective: Enhance the safety of FAA's air traffic system

Performance Measure: Safety risk management

Description: Safety risk management is a systematic, explicit, and comprehensive approach for managing safety risk at all levels and throughout the entire scope of an operation and lifecycle of a system. It requires the disciplined assessment and management of safety risk. The safety risk management process ensures that safety-related changes are documented, risk is assessed and analyzed, unacceptable risk is mitigated, hazards are identified and tracked to resolution, the effectiveness of the risk mitigation strategies is assessed, and the performance of the change is monitored throughout its lifecycle.

Performance Target: (b) Apply safety risk management to at least 30 significant changes in the NAS. **JPDO Goal:** Improve the level of safety of the U.S. air transportation system.

Recent Trends: In FY 2004, the FAA developed the FAA safety management system manual. This manual describes the requirements for the various components/functions of the Safety Management System, including safety risk management. The application of safety risk management will be measured against these requirements.

2004 Research Results:

Human Factors Workbench. Created the Workbench that promotes the sharing of knowledge about best practices and the solving of human-system performance challenges in the aviation community.

Future En Route Workstation. Began assessing en route controller workstation needs in the 2015 timeframe; developed candidate changes to current work stations to meet future needs; and completed a human-in-the-loop test plan to validate new workstation concepts.

Photo by Lockett Yee

FAA R&D Programs in Safety

Challenges:
System understanding
Adaptive systems
Changing aerospace industry

***Flight Plan* Strategies:**
Design, develop, and implement a Safety Management System (SMS) that complies with ICAO requirements

R&D Strategies:
Understand impact of changes
Reduce risk of accidents

A11.g. Flightdeck/Maintenance/System Integration Human Factors
A11.i. Air Traffic Control/Airway Facilities Human Factors
1A01G NAS Safety Assessment

Related Federal R&D Programs

NASA

Aviation Safety and Security Program (AVS&SP)

- System Safety Technologies
- Aircraft & System Vulnerability Mitigation
- System Vulnerability Detection

2.2 Greater Capacity

Table 2.2 shows how FAA R&D programs address both the near-term capacity goal, objectives, and performance targets of the *FAA Flight Plan* and the long-term capacity goals and objectives of the JPDO *Integrated Plan*. R&D programs that support specific capacity objectives and performance targets are represented by an X.

FAA Flight Plan (Near-Term)			
Goal		Objective	Performance Target
Greater Capacity	1	Increase airport capacity to meet projected demand	(a) Achieve an average daily airport capacity of 104,338 arrivals and departures per day by 2009 at the 35 OEP airports.
			(b) Open as many as seven new runways, increasing the annual service volume of the 35 OEP airports by at least 1% annually, measured as a five-year moving average, through FY 2009.
			(c) Sustain adjusted operational availability at 99% for the reportable facilities that support the 35 OEP airports.
	2	Increase or improve aviation capacity in the eight major metropolitan areas and corridors that most affect total system delay. For FY 2005, those areas are: New York, Philadelphia, Boston, Chicago, DC/Baltimore, Atlanta, Los Angeles Basin, and San Francisco	Achieve an average daily airport capacity for the eight major metropolitan areas at 44,428 arrivals and departures per day by FY 2009.
	3	Increase on-time performance of scheduled carriers	(a) Through FY 2009, achieve an 86.90% for all flights arriving at the 35 OEP airports, equal to or less than 15 minutes late due to NAS related delays.
			(b) Beginning in FY 2005, increase the number of oceanic en-route altitude change requests that are granted through the end of FY 2009 to 80%.
	4	Address environmental issues associated with capacity enhancements	(a) Reduce the number of people exposed to significant noise by 1% per year through FY 2009, as measured by a three-year moving average, from the three-year average for calendar year 2000-2002.
			(b) Improve aviation fuel efficiency per revenue plane-mile by 1% per year through FY 2009, as measured by a three-year moving average, from the three-year average for calendar year 2000-2002.

Table 2.2

FAA R&D Programs																		JPDO Integrated Plan (Long-Term)	
Aviation Safety Risk Analysis	Air Traffic Control/Airway Facilities Human Factors	Weather Program	Joint Planning and Development Office	Wake Turbulence	Environment and Energy	Separation Standards	System Capacity Planning and Improvement	Operations Concept Validation	General Aviation and Vertical Flight Technology (GA&VF)	NAS Requirements	Airspace Management Lab	Wake Turbulence	Safe Flight 21 - Ohio River Valley	Automatic Dependent Surveillance - Broadcast (ADS-B)	Center for Advanced Aviation System Development (CAASD	Airports Technology Research - Capacity	Airport Cooperative Research -- Capacity		
A11.h.	A11.i.	A11.k.	A12.a.	A12.b.	A13.a.	1A01A	1A01C	1A01D	1A01E	1A01H	1A01J	1A01K	1A02B	1A02D	4A10	AIP	AIP	Objective	Goal
X	X		X	X	X		X					X	X	X	X			Satisfy future growth in demand (up to 3 times current levels) and operational diversity & Reduce transit time and increase predictability (curb-to-curb transit time cut by 30%)	Expand Capacity & Protect the Environment
			X		X		X								X	X	X		
	X														X				
		X	X				X		X		X				X			Satisfy future growth in demand (up to 3 times current levels) and operational diversity	
		X	X												X			Reduce transit time and increase predictability (curb-to-curb transit time cut by 30%) & Minimize the impact of weather and other disruptions (95% on time)	
	X		X			X		X		X				X	X				
			X		X										X			Reduce noise, emissions, and fuel consumption & Balance aviation's environmental impact with other societal objectives	
			X		X	X									X				

Mapping of FAA R&D Programs to FAA <u>Capacity</u> Goals and Objectives

1a Greater Capacity

Objective: Increase airport capacity to meet projected demand

Performance Measure: (a) Airport average daily capacity (35 OEP airports)

Description: Average Daily Airport Arrival Capacity is the sum of the daily hourly-called arrival and departure rates at the 35 *Operational Evolution Plan* (OEP) airports per month, divided by the number of days in the month. Each airport facility determines the number of arrivals and departures it can handle for each hour of each day, depending on conditions, including weather. These numbers are the "called" arrival and departure rates of the airport for that hour. Data are summed for daily, monthly, and annual totals. The annual capacity level for the 35 OEP airports is the weighted sum of the monthly capacity levels.

Performance Target: (a) Achieve an average daily airport capacity of 104,338 arrivals and departures per day by 2009 at the 35 OEP airports. **JPDO Goals:** Satisfy future growth in demand (up to three times current levels) and operational diversity. Reduce transit time and increase predictability (curb-to-curb transit time cut by 30 percent).

Recent Trends: : The preliminary estimate of performance in FY 2004 for the 35 OEP airports was 100,041 operations per day, a 1.6 percent improvement over the FY 2003 figure of 98,488.

2004 Research Results:

Ohio River Valley. Continued a demonstration and test program to validate nine operational technologies, in real-world environments, to understand the capabilities of advanced surveillance systems and air traffic procedures. The enabling technologies under evaluation include: automatic detection surveillance - broadcast, traffic information services broadcast, flight information services broadcast, and surface moving maps.

Surface Management System (SMS). Installed the NASA-developed SMS at Louisville, Kentucky, for use by the Louisville Regional Airline Association and aircraft. The SMS display is used to monitor the airport surface situation and to better react to emergencies.

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management
Aircraft emissions and noise

***Flight Plan* Strategies:**
Evaluate existing capacity levels to set investment and infrastructure priorities

Improve airway access to existing capacity through operational and procedural changes

Improve bad-weather departure and landing capacity with new technologies and procedures

Modify separation standards and procedures to allow more efficient use of congested airspace

Meet the new and growing demands for air transportation services through 2025

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

Minimize environmental impact

A11.h. Aviation Safety Risk Analysis
A11.i. Air Traffic Control / Airway Facilities Human Factors
A12.a. Joint Planning and Development Office
A12.b. Wake Turbulence
A13.a. Environment and Energy
1A01C System Capacity Planning and Improvement
1A01K Wake Turbulence
1A02B Safe Flight 21 - Ohio River Valley
1A02D Automatic Dependent Surveillance - Broadcast (ADS-B)
4A10 Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs

NASA

Airspace Systems Program (ASP)
- Efficient Aircraft Spacing
- Efficient Flight Path Management
- Strategic Airspace Usage

1b Greater Capacity

Objective: Increase airport capacity to meet projected demand

Performance Measure: (b) Annual service volume

Description: Delay curves were developed for each of the 35 OEP airports for the existing airport layout and with new runways, where proposed. FAA determined acceptable delay levels, expected airport operation levels, and developed demand schedules and fleet mixes using Official Airline Guide information supplemented with flight counts from tower logs. Annual Service Volume (ASV) was calculated by means of modeling and simulation. FAA uses this 1998 ASV for the base year. The measure is calculated as a five-year moving average in order to smooth out peaks and valleys associated with the yearly variability in new runway openings.

Performance Target: (b) Open as many as seven new runways, increasing the ASV of the 35 OEP airports by at least 1 percent annually, measured as a five-year moving average, through FY 2009. **JPDO Goals:** Satisfy future growth in demand (up to three times current levels) and operational diversity. Reduce transit time and increase predictability (curb-to-curb transit time cut by 30 percent).

Recent Trends: : In FY 2004, FAA met its goal by opening two new runways and increasing the annual service volume by 1.07 percent, measured as a five-year moving average. These runways will accommodate an additional 370,000 operations annually. In FY 2003, new runways opened at Denver, Miami, and Cleveland added an annual increase of 2.51 percent resulting in a five-year moving average of 0.67 percent. Between FY 2000-2002, new runways opened at Philadelphia (FY 2000), Phoenix (FY 2001), and Detroit (FY 2002) added 0.78 percent to overall capacity totaled over those three years. No new runways were opened in 1999.

2004 Research Results:

National Airport Pavement Test Facility. Completed construction of three new rigid (concrete) pavement test items at the facility. Began full-scale traffic testing using loads simulating fully loaded four- and six-wheel gears. The FAA plans to use the test results to develop new airport pavement design standards applicable to next-generation heavy commercial aircraft, including the Boeing 777 and Airbus 380.

Continuous Descent Approach (CDA). Completed critical test to demonstrate two sets of area navigation procedures that may lead to CDA approval. The tests involved air traffic controllers, pilots, and airplanes in regular revenue service. The procedures reduce noise, fuel consumptions that impact local air quality, and flight time. The tests provided data, which the FAA will use to determine feasibility and cost/benefit of implementing the procedures in the NAS.

Annual Service Volume (ASV) Study. Completed nine ASV studies at the following airports: Bob Hope (Burbank); Dallas-Love; Jacksonville; Louisville; Orlando-Sanford; Providence/T.F. Green; Richmond; Tulsa; and Tucson. The studies were used in an airport capacity study to determine if and where capacity shortfalls will occur at our nation's airports.

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management
Aircraft emissions and noise

***Flight Plan* Strategy:**
Evaluate existing airport capacity levels to set investment and infrastructure priorities

Meet the new and growing demands for air transportation services through 2025

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

Minimize environmental impact

A12.a.	Joint Planning and Development Office
A13.a.	Environment and Energy
1A01C	System Capacity Planning and Improvement
4A10	Center for Advanced Aviation System Development (CAASD)
AIP	Airports Technology Research - Capacity
AIP	Airport Cooperative Research - Capacity

1c Greater Capacity

Objective: Increase airport capacity to meet projected demand

Performance Measure: (c) Adjusted operational availability

Description: Operational availability is the percent of time that National Airspace Performance Reporting System (NAPRS) reportable facilities are operationally available at the 35 OEP airports. Adjusted operational availability (OA_{ADJ}) is the ratio of total available hours less total outage time except for improvements (code 62 outage) to total available hours, expressed as a percent. Time out of service is adjusted to exclude hours when equipment is unavailable due to scheduled improvement (cause code 62) down time.

Performance Target: (c) Sustain adjusted operational availability at 99 percent for the reportable facilities that support the 35 OEP airports. **JPDO Goals:** Satisfy future growth in demand (up to three times current levels) and operational diversity. Reduce transit time and increase predictability (curb-to-curb transit time cut by 30 percent).

Recent Trends: : In FY 2004, operational availability for the 35 OEP airports was 98.95 percent, which was below the goal of 99 percent. In FY 2004, there was a 0.38 percent increase in scheduled downtime due to improvement projects. FAA met its target in FY 2003.

2004 Research Results:

Communication and Coordination between Technical Operations and Air Traffic Control. Collected and analyzed data on communication and coordination within Technical Operations Service Unit's Operations Control Centers and made recommendations for improvement. When communications fails, there is a potential for service interruptions and equipment outages and delays of aircraft.

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management

***Flight Plan* Strategies:**
Improve airway access to existing capacity through operational and procedural changes

Improve bad-weather departure and landing capacity with new technologies and procedures

Modify separation standards and procedures to allow more efficient use of congested airspace

R&D Strategy:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

A11.i. Air Traffic Control/Airway Facilities Human Factors
4A10 Center for Advanced Aviation System Development (CAASD)

2 Greater Capacity

Objective: Increase or improve aviation capacity in the eight major metropolitan areas and corridors that most affect total system delay. For FY 2005, those areas are: New York, Philadelphia, Boston, Chicago, Washington/Baltimore, Atlanta, Los Angeles Basin, and San Francisco

Performance Measure: Airport average daily capacity (8 Major Metro Areas)

Description: Average Daily Airport Arrival Capacity at the eight metropolitan areas is the sum of the daily hourly-called arrival and departure rates at the airports in the metropolitan areas of New York, Philadelphia, Boston, Chicago, Washington/Baltimore, Atlanta, Los Angeles, and San Francisco, per month divided by the number of days in the month. The annual capacity level for the eight major metropolitan area airports is the weighted sum of the monthly capacity levels. Each airport facility determines the number of arrivals and departures it can handle for each hour of each day, depending on conditions, including weather. These numbers are the "called" arrival and departure rates of the airport for that hour. Data are summed for daily, monthly, and annual totals.

Performance Target: Achieve an average daily airport capacity for the eight major metropolitan areas at 44,428 arrivals and departures per day by FY 2009.
JPDO Goal: Satisfy future growth in demand (up to three times current levels) and operational diversity.

Recent Trends: : There are approximately 20 congested airports, each averaging over 20,000 hours of flight delay per year. Delays are likely to increase as passenger travel demand continues to recover and rise. The preliminary estimate of performance at the eight metropolitan areas in FY 2004 was 43,223 operations per day, a 1.9 percent improvement over the FY 2003 figure of 42,418.

2004 Research Results:

San Francisco Marine Stratus Forecast System Operational. Developed a 1-6 hour forecast system to predict the time when the marine stratus will dissipate in the San Francisco approach zone. This enables air traffic decision makers to release ground holds prior to actual clearing and allows the arrival rate to match the acceptance rate. Transferred the technology to the National Weather Service to implement operationally at San Francisco International Airport.

Traffic Management Advisor Multi-Center (TMA-MC). In partnership with NASA, conducted field evaluation of the TMA-MC tool in non-operational shadowing exercises at the New York, Cleveland, Washington, DC, and Boston Centers. These field exercises evaluated the distributed scheduling capability of TMA-MC and the inter-facility procedures needed to meter arrivals into Philadelphia Airport. TMA-MC will enable time-based scheduling of arrivals to airports in the complex airspace of the northeastern United States.

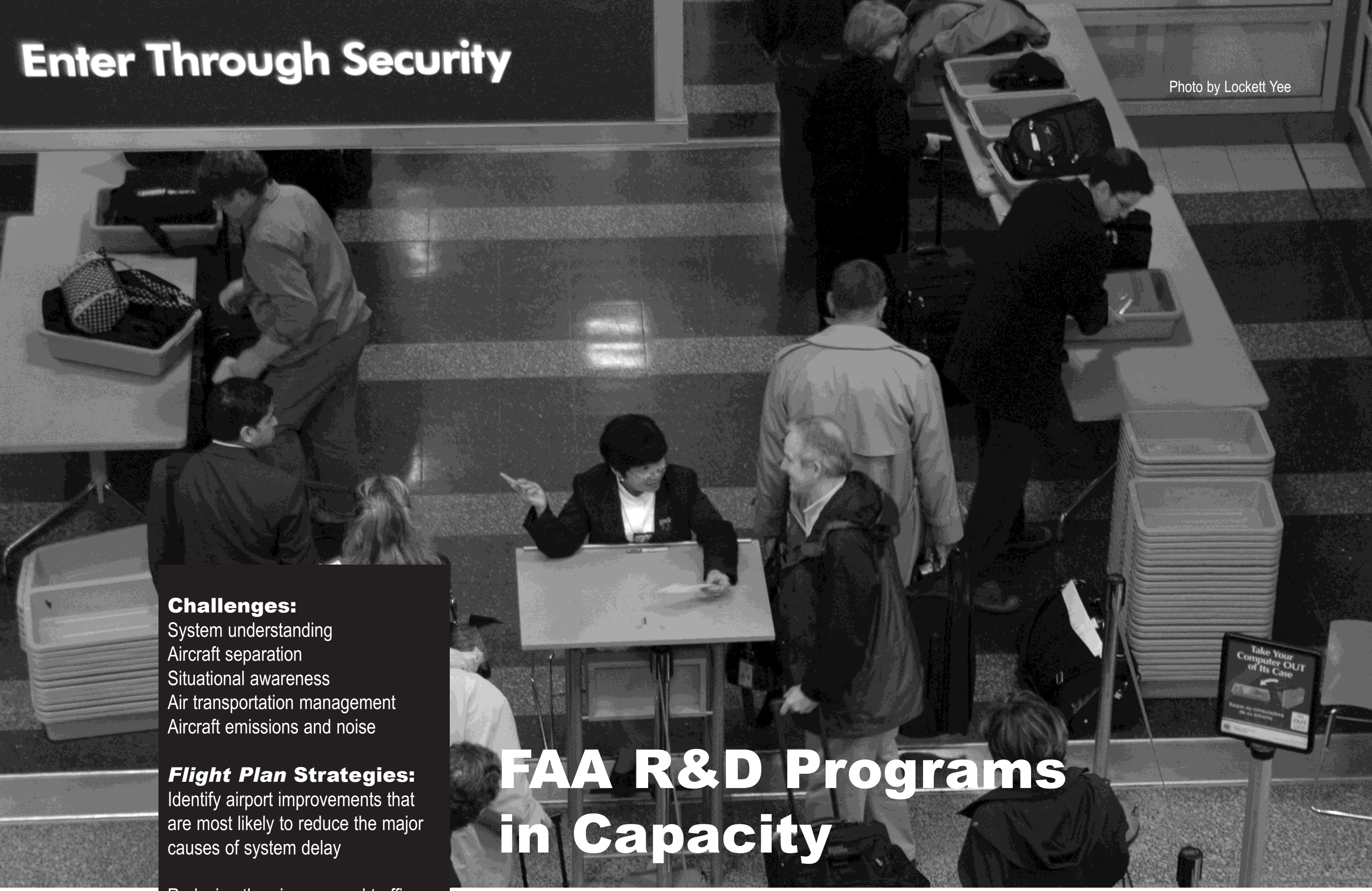

Photo by Lockett Yee

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management
Aircraft emissions and noise

***Flight Plan* Strategies:**
Identify airport improvements that are most likely to reduce the major causes of system delay

Redesign the airspace and traffic flows

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

Minimize environmental impact

FAA R&D Programs in Capacity

A11.k. Weather Program
A12.a. Joint Planning and Development Office
1A01C System Capacity Planning and Improvement
1A01E General Aviation and Vertical Flight Technology (GA&VF)
1A01J Airspace Management Lab
4A10 Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs
NASA

Airspace Systems Program (ASP)
- Human Measures & Performance
- Efficient Aircraft Spacing
- Efficient Flight Path Management
- Strategic Airspace Usage
- Space-Based Technologies

3a Greater Capacity

Objective: Increase on-time performance of scheduled carriers

Performance Measure: (a) On-time NAS arrival

Description: The percentage of all flights arriving at the 35 OEP airports equal to or less than 15 minutes late, based on the carrier flight plan filed with the FAA, and excluding minutes of delay attributed by air carriers to weather, carrier action, security delay, and prorated minutes for late arriving flights at the departure airport. The measure divides the adjusted-sum-of-flights arriving on or before 15 minutes of flight plan arrival time by the total number of completed flights. Air carriers file up-to-date flight plans for their services with the FAA that may differ from their published flight schedules. This metric measures on-time performance against the carriers filed flight plan, rather than what may be a dated published schedule.

Performance Target: : (a) Through FY 2009, achieve an 86.9 percent for all flights arriving at the 35 OEP airports equal to or less than 15 minutes late due to NAS-related delays. **JPDO Goals:** Reduce transit time and increase predictability (curb-to-curb transit time cut by 30 percent). Minimize the impact of weather and other disruptions (95 percent on time).

Recent Trends: The preliminary estimate of performance in FY 2004 was 88.35 percent, a decline of 1.5 percentage points from the FY 2003 figure of 89.84 percent.

2004 Research Results:

Weather Support to Decision Making (WSDM). Increased the two hour WSDM precipitation forecast to four hours enhancing safety and efficiency by providing users longer lead times for more effective strategic decisions.

Weather Information Needs in Terminal Radar Approach Control (TRACON). Began to assess controller weather information needs and weather display designs for TRACON controllers. Created dependent system measures for the effect of advanced weather information on efficiency and tactical operations, and how location of weather information on the display affects controller workload.

En Route Decent Advisor (EDA). Conducted a full evaluation of the prototype EDA system, completing a major development milestone. The EDA, developed by NASA Ames Research Center, is an advanced decision support tool intended for use by the en route controller to handle traffic in transition airspace.

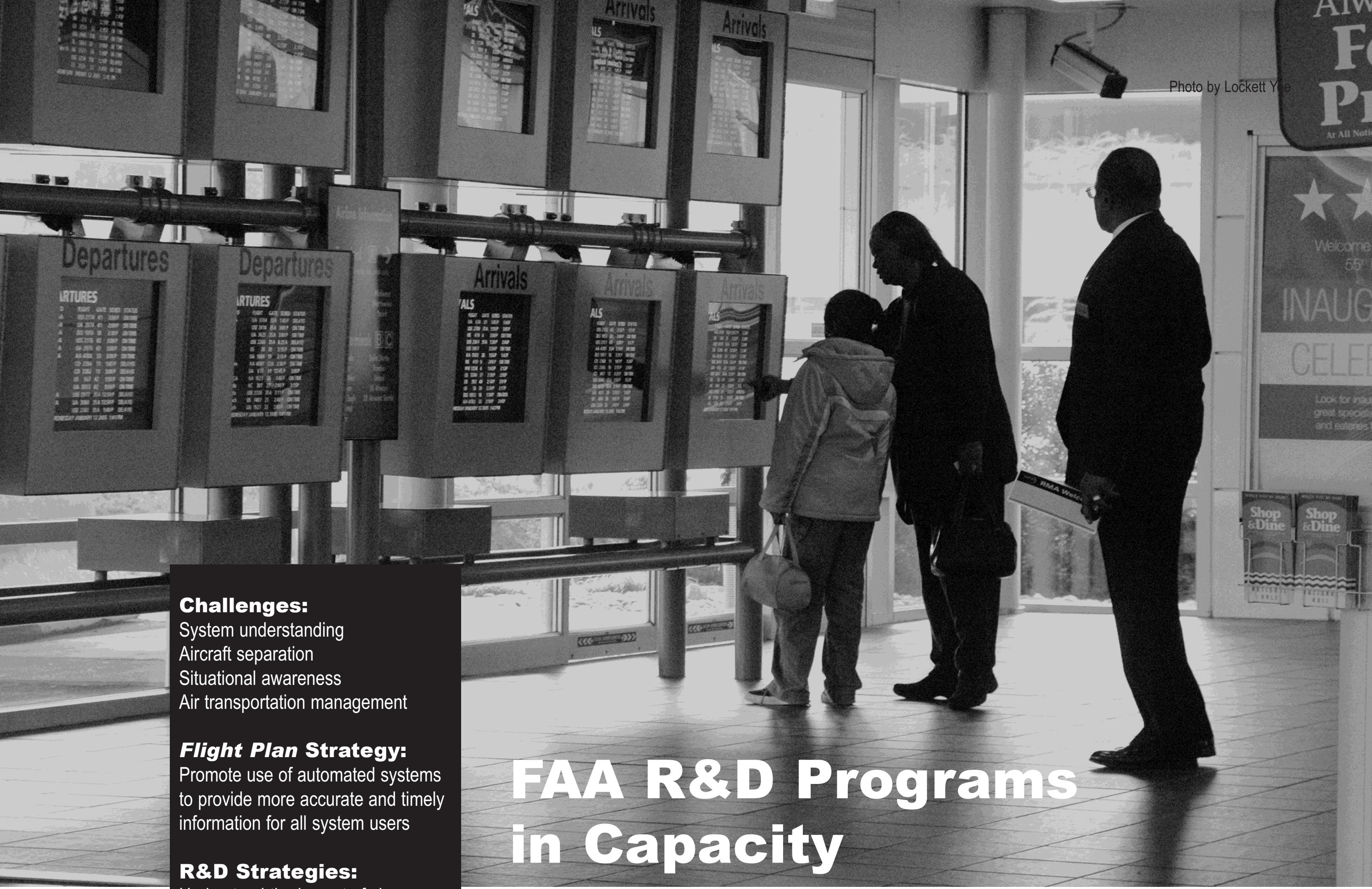

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management

***Flight Plan* Strategy:**
Promote use of automated systems to provide more accurate and timely information for all system users

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

A11.k. Weather Program
A12.a. Joint Planning and Development Office
4A10 Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs

NASA

Airspace Systems Program (ASP)

- Human Measures & Performance
- Efficient Aircraft Spacing
- Efficient Flight Path Management
- Strategic Airspace Usage
- Space-Based Technologies

3b Greater Capacity

Objective: Increase on-time performance of scheduled carriers

Performance Measure: (b) Oceanic en-route altitude change requests

Description: An oceanic en-route altitude change request is a message sent from the aircraft to ATC requesting a new altitude assignment. For the calculation of this metric, en-route altitude change requests with a response are counted. The request is considered granted if the controller clears the flight to the requested altitude. Clearances to a different altitude are not considered granted. The percent of oceanic en-route altitude change requests granted is calculated by dividing the number of granted requests by the total number of valid requests. Oceanic en-route altitude change requests are counted from flights communicating via the High Frequency (HF) Radio Operator and via Controller Pilot Data Link Communications (CPDLC) in Oakland and New York Oceanic airspace.

Performance Target: (b) Beginning in FY 2005, increase the number of oceanic en-route altitude change requests that are granted through the end of FY 2009 to 80 percent. **JPDO Goals:** Reduce transit time and increase productivity (curb-to-curb transit time cut by 30 percent). Minimize the impact of weather and other disruptions (95 percent of the time).

Recent Trends: None.

2004 Research Results:

Oceanic Weather Improvement. Began testing an oceanic turbulence tool that provides up to a 12-hour forecast of clear air turbulence conditions over the ocean. At present, aircrews for long-range oceanic flights receive a general weather briefing before departure, including a summary of flight level winds and expected en route weather conditions.

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management

***Flight Plan* Strategy:**
Restructure airspace to ensure efficient traffic flow between oceanic and domestic airspace

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

A11.i	Air Traffic Control/Airway Facilities Human Factors
A12.a.	Joint Planning and Development Office
1A01A	Separation Standards
1A01D	Operations Concept Validation
1A01H	NAS Requirements
1A02D	Automatic Dependent Surveillance - Broadcast (ADS-B)
4A10	Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs

NASA

Airspace Systems Program (ASP)
- Human Measures & Performance
- Efficient Aircraft Spacing
- Efficient Flight Path Management
- Strategic Airspace Usage
- Space-Based Technologies

4a Greater Capacity

Objective: Address environmental issues associated with capacity enhancements

Performance Measure: (a) Noise exposure

Description: Number of people in residential areas around airports (in thousands) who are exposed to significant noise levels from aircraft. Significant noise level is defined as Day Night Sound Level of 65 decibels or more.

Performance Target: (a) Reduce the number of people exposed to significant noise by one percent per year through FY 2009, as measured by a three-year moving average, from the three-year average for calendar year 2000-2002. **JPDO Goals:** Reduce noise, emissions, and fuel consumption. Balance environmental impact of aviation with other societal objectives.

Recent Trends: In FY 2004, the number of people exposed was reduced by 9 percent for a cumulative reduction of 23 percent from the 2000-2002 average baseline. The significant improvement over targeted goals in noise reduction grew out of the confluence of a number of external factors, including the economic downturn, the impact of September 11, 2001, on the industry, and the severe acute respiratory syndrome (SARS) outbreak, which caused passengers who were afraid of contracting SARS to avoid air travel. The large-scale premature retirement of older stage 3 aircraft (Boeing 727, DC-9, and MD-80), along with these other factors, produced a dramatic downturn in operations. This combination of lower operations and the rapid reduction in the average age of operating fleets produced the dramatic improvements in noise exposure. Assuming that the industry will recover over the next few years, the level of improvements witnessed last year is unlikely to persist.

2004 Research Results:

FAA Integrated Noise Model (INM). Continued development of both a fielded system of the Model (INM 6.2) and a research system (INM 7.0). INM 6.2 supports improved modeling of terrain and expands the noise/performance modeling capability to include much more fidelity on aircraft procedures. It is used worldwide to evaluate aircraft noise impacts in the vicinity of airports. The modeling system is designed to help airports meet federal legal requirements on noise exposure and to facilitate long-term aviation planning.

Aviation Environmental Design Tool (AEDT). The Transportation Research Board (TRB) completed a study to scope the new analytical tool that will allow integrated assessment of noise and emissions impact at the local and global levels.

Photo by Lockett Yee

Challenges:
System understanding
Aircraft separation
Air transportation management
Aircraft emissions and noise

***Flight Plan* Strategy:**
Develop better technologies and analytical tools to evaluate aircraft noise and emissions

R&D Strategies:
Understand the impact of change

Minimize aircraft separation

Develop human-centered air transportation management

Minimize environmental impact

FAA R&D Programs in Capacity

A12.a. Joint Planning and Development Office
A13.a. Environment and Energy
4A10 Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs:

NASA

Airspace Systems Program (ASP)
- Virtual Airspace Modeling and Simulation
- Efficient Flight Path Management
- Strategic Airspace Usage

Vehicle Systems Program (VSP)
- Flight & Systems Demonstrations
- Quiet Aircraft Technology

4b Greater Capacity

Objective: Address environmental issues associated with capacity enhancements

Performance Measure: (b) Aviation fuel efficiency

Description: Reduce the fuel burned per revenue plane mile for commercial aircraft operation. This target will be measured using the System for Assessing Aviation Global Emissions (SAGE).

Performance Target: (b) Improve aviation fuel efficiency per revenue plane-mile by one percent per year through FY 2009, as measured by a three-year moving average, from the three-year average for calendar year 2000-2002. **JPDO Goals:** Reduce noise, emissions, and fuel consumption. Balance aviation's environmental impact with other societal objectives.

Recent Trends: FY 2004 performance was calculated to be a 4.5 percent improvement in fuel efficiency for the three-year efficiency average (2001-2003) as compared to the baseline.

2004 Research Results:

Voluntary Airport for Emissions Program. Upgraded the Emissions and Dispersion Modeling System (EDMS) in order to assess emission savings from actions to reduce ground emissions. EDMS calculates emissions from airport sources and models the air quality at an airport. It enables computation of on-road and off-road vehicle emission factors and provides more accurate techniques for computing total hydrocarbon and volatile organic hydrocarbon emissions. EDMS supports airport applications for FAA program funding and emissions reduction credits from the Environmental Protection Agency (EPA).

Particulate Matter Research. FAA, NASA, the Environmental Protection Agency (EPA), and the Department of Defense took a major step to address the issues of particulate matter and hazardous air pollutants through Aircraft Particle Emissions Experiment (APEX), which is characterizing particle and trace gas precursor species from a NASA-owned DC-8. The FAA's primary research objective is to help airports determine if their operations will comply with upcoming National Ambient Air Quality Standards for particles sized 2.5 microns in diameter or below. APEX data will also enhance the ability of the EDMS to predict particle matter inventories and, eventually, hazardous air pollutant concentrations from aircraft engines.

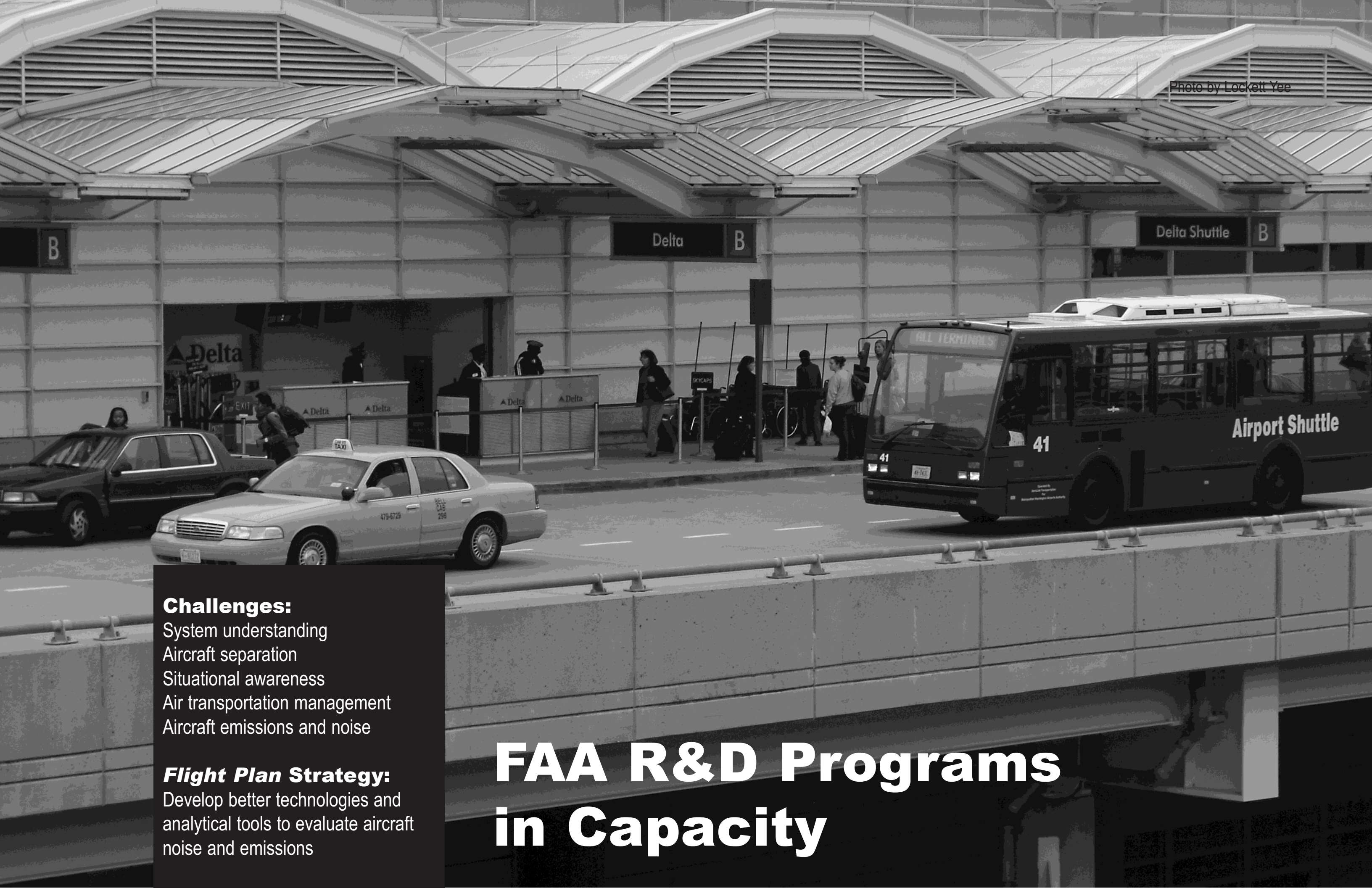

Photo by Lockett Yee

FAA R&D Programs in Capacity

Challenges:
System understanding
Aircraft separation
Situational awareness
Air transportation management
Aircraft emissions and noise

***Flight Plan* Strategy:**
Develop better technologies and analytical tools to evaluate aircraft noise and emissions

R&D Strategy:
Understand the impact of change

Minimize aircraft separation

Provide a common picture of operations

Develop human-centered air transportation management

Minimize environmental impact

A12.a. Joint Planning and Development Office
A13.a. Environment and Energy
1A01A Separation Standards
4A10 Center for Advanced Aviation System Development (CAASD)

Related Federal R&D Programs:

NASA

Airspace Systems Program (ASP)
- Virtual Airspace Modeling and Simulation
- Efficient Flight Path Management
- Strategic Airspace Usage

Vehicle Systems Program (VSP)
- Efficient Aerodynamic Shapes & Integration
- Flight & Systems Demonstrations
- Integrated Tailored Aerostructures
- Low Emissions Alternate Power
- Ultra-Efficient Engine Technology

2.3 International Leadership

Table 2.3 shows how FAA R&D programs address both the near-term international leadership goal, objectives and performance targets of the FAA *Flight Plan* and the long-term international leadership goals and objectives of the JPDO *Integrated Plan*. R&D programs that support specific international leadership objectives and performance targets are represented by an X.

FAA Flight Plan (Near-Term)			
Goal	Objective		Performance Target
International Leadership	1	Promote improved safety and regulatory oversight in cooperation with bilateral, regional, and multilateral aviation partners	(a) Advance U.S. aviation safety leadership in developing regions by significantly increasing safety infrastructure in 10 priority countries by FY 2009 through implementation of model law and regulations for safety oversignt, extensive technical assistance and training activity, and concluding bilateral agreements.
			(b) Conclude four new or expanded bilateral agreements with current partners.
			(c) Secure an increase of 20% every year in intellectual and financial assistance for international aviation activities from the United States and international government organizations, multilateral banks, and industry.
			(d) Promote the creation of four new regional aviation authorities or organizations capable of meeting globally accepted safety standards.
	2	Promote seamless operations around the globe in cooperation with bilateral, regional, and multilateral aviation partners	(a) Expand the utilization of U.S. NAS technologies and procedures to six priority countries.
			(b) Ensure that international environmental standards, recommended practices, and guidance material adopted by ICAO are globally and uniformly applied, reflect the best available technology that can be integrated into the fleet, provide real environmental benefit, are economically sound, and take interdependencies between environmental parameters into account.

Table 2.3

FAA R&D Programs: A11.h. Aviation Safety Risk Analsysis	A13.a. Environment and Energy	1A01A Separation Standards	1A01E General Aviation and Vertical Flight Technology (GA & VF)	1A02D Automatic Dependent Surveillance - Broadcast (ADS-B)	JPDO Integrated Plan (Long-Term): Objective	Goal
					Retain our role as the world leader in aviation & Increase the safety of worldwide air transportation	Retain U.S. Leadership in Global Aviation & Ensure Safety & Protect the Environment
X		X	X	X	Encourage performance-based harmonized global standards for U.S. products and services to keep new and existing markets open	
	X				Retain our role as world leader in aviation & Balance aviation's environmental impact with other societal objectives	

Mapping of FAA R&D Programs to FAA International Leadership Goals and Objectives

2a International Leadership

Objective: Promote seamless operations around the globe in cooperation with bilateral, regional, and multilateral aviation partners

Performance Measure: (a) National Airspace System (NAS) Technologies

Description: In 2005, the FAA will assist one (1) priority country with the implementation and/or use of U.S. NAS technologies and procedures. The FAA will expand this promotion of U.S. NAS technologies and procedures to an additional (1) priority country in each of 2006, 2007, and 2008, and then two (2) countries in 2009.

Performance Target: (a) Expand the use of U.S. NAS technologies and procedures to six priority countries.
JPDO Goal: Encourage performance-based, harmonized global standards for U.S. products and services to keep new and existing markets open.

Recent Trends: In FY 2004, FAA met or exceeded all of its performance goals for international leadership.

2004 Research Results:

Global Communications, Navigation Surveillance System (GCNSS). Continued to explore the role of satellites in providing a highly integrated and secure common information network and a broadband, two-way, secure, communications capability for air traffic management (ATM) and in-flight security. Demonstrated the capability to up link and down link via satellite aircraft parameters, broadband video for cockpit ATM flight conflict monitoring, and air-to-ground in-flight security monitoring for Federal Air Marshals. Demonstrated the use of satellites as a means to provide communications and surveillance coverage in the Gulf of Mexico, where such services are unavailable. Demonstrated a highly integrated, secure, networking capability that will share precise information with other agencies (e.g., Department of Homeland Security, Department of Defense, airline operation centers) and provide real-time, seamless surveillance coverage for use in ATM.

Photo by Lockett Yee

FAA R&D Programs in International Leadership

Challenges:
Changing aerospace industry
Global standards, regulations and certification
Global partnerships

***Flight Plan* Strategy:**
Advocate global implementation of ATM operational concept and promote harmonization and interoperability of emerging technologies to enhance global safety, capacity, and system efficiency

R&D Strategies:
Ensure U.S. policy is based on sound science

Streamline standards, regulatory and certification processes

Lead international efforts

A11h. Aviation Safety Risk Analysis
1A01A Separation Standards
1A01E General Aviation and Vertical Flight Technology (GA&VF)
1A02D Automatic Dependent Surveillance - Broadcast (ADS-B)

Related Federal R&D Programs:

NASA

Airspace Systems Program (ASP)

Space-Based Technologies

2b International Leadership

Objective: Promote seamless operations around the globe in cooperation with bilateral, regional, and multilateral aviation partners

Performance Measure: (b) Global Environmental standards

Description: This measure covers the critical phase of an internationally acceptable approach to dealing with environmental standards, practices, and guidance material across the world. Agreement amongst international stakeholders at these bodies is essential to permitting a harmonized international approach. This performance target is measured by successful adoption of an internationally agreed approach on these issues acceptable to the United States.

Performance Target: (b) Ensure that international environmental standards, recommended practices, and guidance material adopted by the International Civil Aviation Organization (ICAO) are globally and uniformly applied, reflect the best available technology that can be integrated into the fleet, provide real environmental benefit, are economically sound and take interdependencies between environmental parameters into account. **JPDO Goal:** Retain our role as world leader in aviation. Balance aviations environmental impact with other societal objectives.

Recent Trends: In FY 2004, FAA met or exceeded all of its performance goals for international leadership.

2004 Research Results:

ICAO Committee on Aviation Environmental Protection (CAEP). Played leadership role in developing ICAO environmental standards in ICAO's CAEP. CAEP and the United Nations Framework Convention Secretariat confirmed that the capabilities of the FAA-developed System for Assessing Aviation's Global Emissions (SAGE) are applicable to future work programs and requirements. The SAGE model will be used to support these activities.

Photo by Lockett Yee

FAA R&D Programs in International Leadership

Challenges:
Changing aerospace industry
Global standards, regulations and certification
Global partnerships

***Flight Plan* Strategy:**
Work within ICAO Committee on Aviation Environmental Protection to develop and adopt global environmental standards, best practices, and written guidance

R&D Strategies:
Ensure U.S. policy is based on sound science

Streamline standards, regulatory and certification processes

Lead international efforts

A13.a. Environment and Energy

Related Federal R&D Programs

U.S. Climate Change Science Program

NASA

- **Airspace Systems Program (ASP)**
  - Efficient Aircraft Spacing
  - Ultra Efficient Engine Technology
- **Vehicle Systems Program (VSP)**
  - Quiet Aircraft Technology

2.4 Organizational Excellence

Table 2.4 shows how FAA R&D programs address both the near-term organizational excellence goal, objectives and performance targets of the FAA *Flight Plan* and the long-term organizational excellence goals and objectives of the JPDO *Integrated Plan*. R&D programs that support specific organizational excellence objectives and performance targets are represented by an X.

FAA Flight Plan (Near-Term)			
Goal	Objective		Performance Target
Organizational Excellence	1	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	(a) Increase Employee Attitude Survey scores in the areas of management effectiveness and accountability by at least 5%.
			(b) Directly relate 100% of all employee performance plans to FAA strategic goals and their organization's performance plans.
			(c) Reduce the time it takes to fill mission critical positions by 20% over the FY 2003 baseline.
	2	Control costs while delivering quality customer service	(a) Develop and implement a centrally managed and highly visible cost control program to lead the agency in reducing costs. Each FAA organization will contribute at least one cost reduction activity each year to its Business Plan with measurable, significant cost savings.
			(b) Close out 85 percent of cost reimbursable contracts that become eligible for close out during each fiscal year.
	3	Make decisions based on reliable data to improve our overall performance and customer satisfaction	(a) By FY 2009, make sure 90 percent of major system acquisition investments are within 10% of budget.
			(b) By FY 2009, 90 percent of major system acquisition investments are on schedule.
			(c) Achieve 90% of all performance targets in the Flight Plan.
			(d) Increase agency scores on the American Customer Satisfaction Index.
			(e) Achieve zero cyber security events that significantly disable or degrade FAA services

Table 2.4

FAA R&D Programs					JPDO Integrated Plan (Long-Term)	
Air Traffic Control/ Airway Facilities Human Factors	Environment and Energy	System Planning and Resouce Management	William J. Hughes Technical Center Laboratory Facilities	Center for Advanced Aviation System Development		
A11.i.	A13.a.	A14.a.	A14.b.	4A10	Objective	Goal
X		X				Retain U.S. Leadership in Global Aviation
		X				
X		X			Reduce costs for air transportation	
					Enable services tailored to traveler and shipper needs	
		X	X	X		
	X					

Mapping of FAA R&D Programs to FAA Organizational Excellence Goals and Objectives

1a Organizational Excellence

Objective: 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

Performance Measure: (a) Employee attitude survey

Description: This target is measured as the percentage increase from the baseline score for twelve specific items on the Employee Attitude Survey (EAS) administered in FY 2003. The next performance target is due after the FY 2006 EAS administration. This measure focuses on the management effectiveness and accountability sections of the Survey.

Performance Target: (a) Increase Employee Attitude Survey scores in the areas of management effectiveness and accountability by at least 5 percent. **JPDO Goal:** Retain U.S. leadership in global aviation.

Recent Trends: The survey is administered every other year. The last survey occurred in September 2003 and was reported in January 2004. The 2003 survey represents the baseline. The next survey will occur in FY 2006.

2004 Research Results:

Employee Satisfaction. In 2003, mailed 48,900 EAS's and received 22,720 valid surveys back (46 percent return rate). Identified positive results in 2003 compared with 2000: job satisfaction up 3 percent; satisfaction with pay up 9 percent; organizational commitment up 4 percent; customer support up 5 percent; satisfaction with communication up 4 percent; and model work environment success up 5 percent. Identified areas that need further improvement: trust in management with 23 percent favorable; recognition and rewards with 27 percent favorable; performance accountability less than 40 percent favorable. Identified actions for FY 2005 to improve future EAS results and help FAA meet the *Flight Plan* target. The 2003 baseline was 35 percent positive, so the 2006 target is an increase to 40 percent positive.

Photo by Lockett Yee

FAA R&D Programs in Organizational Excellence

Challenges:
People
Processes
Customers
Information
Governance

***Flight Plan* Strategy:**
Improve our ability to acquire, develop and retain a diverse, highly skilled workforce

R&D Strategies:
Build a diverse, highly skilled workforce

A11.i. Air Traffic Control/Airway Facilities Human Factors
A14.a. System Planning and Resource Management

1b Organizational Excellence

Objective: 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.

Performance Measure: (b) Performance plans

Description: The measure is the number of performance plans that are directly linked to FAA strategic goals and their organization's performance plans. This measure includes all FAA employees, manager, and executive performance plans.

Performance Target: (b) Directly relate 100 percent of all employee performance plans to FAA strategic goals and their organization's performance plans. **JPDO Goal:** Retain U.S. leadership in global aviation.

Recent Trends: In 2004, 84.56 percent of FAA employees, managers, and executives had individual performance plans linked to the strategic goals in the *Flight Plan* and organizational business goals. This exceeded the 80 percent goal for FY 2004.

2004 Research Results:

National Aviation Research Plan (NARP). Developed the *2005 NARP* to better align R&D programs to the goals and objectives of both the FAA *Flight Plan* and the JPDO *Next Generation Air Transportation System Integrated Plan*.

Photo by Lockett Yee

FAA R&D Programs in Organizational Excellence

Challenges:
People
Processes
Customers
Information
Governance

***Flight Plan* Strategy:**
Increase the commitment of all employees to fulfill organizational goals

R&D Strategies:
Build a diverse, highly skilled workforce

Create a strategic planning and deployment process

Increase organizational efficiency and effectiveness

A14.a. System Planning and Resource Management

2a Organizational Excellence

Objective: Control costs while delivering quality customer service.

Performance Measure: (a) Cost control program

Description: Each FAA organization will have a cost control activity in its business plan. The Office of the Assistant Administrator for Financial Services/Chief Financial Officer (CFO), through the Office of Financial Controls, will monitor progress against these organizational targets to assure that the cost control contributions are defined, measured and achieved.

Performance Target: (a) Develop and implement a centrally managed and highly visible cost control program to lead the Agency in reducing costs. Each FAA organization will contribute at least one cost reduction activity each year to its Business Plan with measurable, significant cost savings. **JPDO Goal:** Reduce costs for air transportation.

Recent Trends: In FY 2004, by putting cost controls in place and having a more efficient, effective workforce, FAA met its FY 2004 goal and funded at least 75 percent of the currently unfunded portion of the *Flight Plan*.

2004 Research Results:

Air Traffic Control Selection and Training (AT-SAT). Began evaluation of different versions of the AT-SAT tests using Department of Defense participants. The AT-SAT examination provides a means to assess air traffic control specialist applicants and identify those possessing appropriate knowledge, skills, and abilities to succeed. The current version of AT-SAT is based on a single test for each component in the battery, leaving the FAA vulnerable to coaching efforts. In addition, some applicants are able to artificially inflate their AT-SAT scores through repeated testing. These issues will be alleviated through the development of different versions of the tests.

The AT-SAT provides more highly-qualified selectees at a lower cost. The AT-SAT replaces the old nine-week screen which costs $10,000 per applicant, with an eight-hour computer-based exam, which cost only $800 an applicant. The cost savings will be significant, because the Agency plans to hire 12,500 controllers over the next ten years (2005-2014).

National Aviation Research Plan (NARP). Combined the FAA R&D Strategy and NARP into one document in order to streamline the R&D strategic planning process and reduce management support costs.

Photo by Lockett Yee

FAA R&D Programs in Organizational Excellence

Challenges:
People
Processes
Information

***Flight Plan* Strategy:**
Develop and implement ways to better control costs

R&D Strategies:
Build a diverse, highly skilled workforce

Create a strategic planning and deployment process

Increase organizational efficiency and effectiveness

Conduct world-class research

Accelerate the transformation of R&D into products and services

A11.i. Air Traffic Control / Airway Facilities Human Factors
A14.a. System Planning and Resource Management

3b Organizational Excellence

Objective: Make decisions based on reliable data to improve our overall performance and customer satisfaction.

Performance Measure: (b) Acquisition schedule

Description: The schedule target is measured by dividing the total number of missed milestones by the total number of milestones being tracked. Any program with a total variance of more than the 10 percent threshold would be considered not meeting the 90 percent performance target. The schedule measure is set to only those milestones selected. No milestones are added during the year.

Performance Target: (a) By FY 2009, 90 percent of major system acquisition investments are on schedule.
JPDO Goal: Enable services tailored to traveler and shipper needs.

Recent Trends: FAA met the FY 2004 goal with 91 percent of major system acquisitions remaining within the cost and schedule performance goal. Overall, four out of 43 programs had schedule and/or cost variance beyond established thresholds.

2004 Research Results:

William J. Hughes Technical Center. The Safe Flight 21 program office used the Center's flying laboratories to evaluate and verify system requirements and performance. This allowed the program's test personnel to collect a large amount of data from Southern New Jersey to Miami to aide in determining system capability. The Air Traffic Organization's Weather and Radar Processor test team used the laboratory to verify, analyze, test, and evaluate updated software versions (i.e., software versions 8.4a and 8.4b) prior to being released to the operational field sites. The Advanced Technologies Oceanic Procedures test team conducted formal verification and evaluation of the software version Build 2 at the Center. The primary objective of this formal verification and validation phase was to verify the Build 2 System Segment Specification requirements.

Photo from Flight Plan

Challenges:
People
Processes
Customers
Information

***Flight Plan* Strategy:**
Better prepare managers to use cost and performance data in making decisions

R&D Strategies:
Increase organizational efficiency and effectiveness

Accelerate the transformation of R&D into products and services.

FAA R&D Programs in Organizational Excellence

A14.a. System Planning and Resource Management
A14.b. William J. Hughes Technical Center Laboratory Facilities
4A10 Center for Advanced Aviation System Development (CAASD)

3c Organizational Excellence

Objective: Make decisions based on reliable data to improve our overall performance and customer satisfaction

Performance Measure: (c) *Flight Plan*

Description: The measure is the number of performance targets met in a fiscal year divided by the number of performance targets.

Performance Target: (a) Achieve 90 percent of all performance targets in the Flight Plan. **JPDO Goal:** Enable services tailored to traveler and shipper needs.

Recent Trends: In FY 2004, FAA achieved 80 percent (24 of 30) of its performance goals but did not achieve the target of 27 of 30.

2004 Research Results:

Partnership for Air Transportation Noise and Emissions Reduction (PARTNER). Conducted a workshop of aviation environmental stakeholders, including academia, communities, government, and industry, to develop a common vision and approach to dealing with aviation environmental impacts.

Photo by Lockett Yee

FAA R&D Programs in Organizational Excellence

Challenges:
People
Processes
Information

***Flight Plan* Strategy:**
Better prepare managers to use cost and performance data in making decisions

R&D Strategies:
Create a strategic planning and deployment process

Increase organizational efficiency and effectiveness

Conduct world-class research

Accelerate the transformation of R&D into products and services

A13.a. Environment and Energy

FAA Research & Development

Management • Programs • Budget • Evaluation • Partnerships

Federal Aviation Administration research and development (R&D) supports all aspects of aviation from research on materials and human factors to development of new products, services and procedures. It supports: regulation, certification and standards development for aircraft, air operators, manufacturers, aircrews and other aviation personnel; airports; commercial space transportation; environment; modernization, operation and maintenance of the national airspace system (NAS); and aerospace policy formulation, planning and analysis.

The R&D program includes four types of funding: Research, Engineering and Development (R,E&D); Facilities and Equipment (F&E); Airport Improvement Program (AIP); and Operations (Ops). The R&D-related AIP funding is new in the fiscal year (FY) 2006 request. In general, the R,E&D account provides for R&D programs that improve the NAS by increasing its safety, security, productivity, capacity, and environmental compatibility to meet the expected air traffic demands of the future.[11] The F&E account generally provides for the capital investment for the agency by funding the procurement and installation of new equipment, facilities, and construction projects included in the Aviation System Capital Investment Plan. The AIP account generally provides for airport improvement grants, including those emphasizing capacity development, safety and security needs; and provides for grants for aircraft noise compatibility planning and programs.[12] It also funds administrative and technical support costs to support airport programs. The Operations account funds the recurring administrative, operating, and maintenance costs of doing the FAA's business.[13]

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[11] 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.

[12] FAA Budget Estimates FY 2005 submitted for use by The Committees on Appropriations, Appendix 6 Grants-In-Aid for Airports, page 3.

[13] 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.

Photo by Lockett Yee

R&D Mission: Conduct, coordinate, and support domestic and international research and development of aviation-related products and services that will ensure a safe, efficient, and environmentally compatible global air transportation system.

3.1 Management

Management responsibilities for aviation R&D reside in the newly organized FAA Air Traffic Organization (ATO). Within the ATO, the Operations Planning Aviation Research and Development organization manages the Agency's R&D program. Its 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 compatible global air transportation system. It oversees both short- and long-term R&D to enable technical and operational innovation and to support informed decision making in all areas of FAA responsibility. To support FAA goals, R&D addresses the specific needs of various sponsoring organizations, such as the ATO for air traffic management; Aviation Safety (AVS) for safety; Airports (ARP) for airport safety and capacity; Aviation Policy, Planning and Environment (AEP) for aviation environment and energy issues; and Commercial Space Transportation (AST) for regulating commercial space operations.

The ATO Operations Planning Aviation Research and Development organization helps the FAA Administrator and the ATO Chief Operating Officer:

- **Focus R&D on FAA goals and objectives.**
- **Integrate the products of federal R&D into the nation's air transportation system.**
- **Leverage federal aviation-related research.**
- **Foster innovation in the aviation community.**
- **Ensure the FAA remains a recognized world leader in aviation R&D.**

3.2 Programs

The FAA R&D programs are funded in four appropriations accounts: R,E&D, F&E, AIP (requested in FY 2006), and Ops. The F&E-funded R&D programs are in three budget lines: Advanced Technology Development and Prototyping (ATD&P), Safe Flight 21, and the Center for Advanced Aviation System Development (CAASD). The programs summarized below are for the FY 2006 R&D budget request. The white sheets in Appendix A provide additional information for each program.

Research, Engineering and Development (R,E&D)

Fire Research and Safety (A11.a.): 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 improves survivability during a post-crash fire.

Propulsion and Fuel Systems (A11.b.): 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.): Ensures the safety of civil aircraft constructed of advanced materials by developing analytical and testing methods to understand how design, load, and damage can affect composite structures. Develops maintenance and repair methods. Increases the ability of passengers to survive aviation accidents by improving crash characteristics of aircraft structures and by modeling crash events to improve aircraft certification.

Atmospheric Hazards/Digital System Safety (A11.d.): Develops technologies to detect frozen contamination, predict anti-icing fluid failure,

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

and ensure safe operations during and after flight in atmospheric icing conditions. Develops technologies, advisory, and guidance material to ensure safe operation in electromagnetic hazards resulting from electromagnetic interference, cosmic radiation, high intensity radiated fields, and lightning. Ensures the safe operation of emerging, highly complex software-based digital flight controls and avionics systems.

Aging Aircraft (A11.e.): Develops technologies, technical information, procedures, and practices to help ensure the continued airworthiness of aircraft structures and systems. Assesses the causes and consequences of fatigue damage of aging aircraft. Ensures the continued safe operation of aircraft electrical and mechanical systems. Detects and quantifies damage, such as cracking, corrosion, disbanding, and material processing defects through nondestructive inspection techniques. Updates and validates airworthiness standards. Establishes damage-tolerant design and maintenance criteria for rotorcraft and commuter airplanes.

Aircraft Catastrophic Failure Prevention Research (A11.f.): 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. Uses historic accident data to investigate turbine engine "uncontainment" events and propulsion malfunctions

Flightdeck/Maintenance/System Integration Human Factors (A11.g.): Provides the human factors research foundation for FAA guidelines, handbooks, advisory circulars, rules, and regulations to ensure safe and efficient aircraft operations. Improves task performance and training for aircrew, inspectors, and maintenance technicians. Develops and applies error management strategies to flight and maintenance operations. Increases human factors considerations in certifying new aircraft and in designing and modifying equipment.

Aviation Safety Risk Analysis (A11.h.): Ensures that safety oversight keeps pace with the dynamic changes occurring in the aviation environment by better targeting our inspection resources, improving our oversight systems, and providing training for safety-critical employees.

Air Traffic Control/Airway Facilities Human Factors (A11.i.): Identifies and analyzes trends in air traffic operational errors and airway facilities incidents, and develops and implements strategies to mitigate these problems. Manages human error hazards, their consequences, and recovery methods in early stages of system design or procedural development.

Aeromedical Research (A11.j.): 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. Defines cabin air quality and analyzes requirements for occupant protection and aircraft decontamination.

Weather Program (A11.k.): Develops new technologies to provide weather observations, warnings, and forecasts that are accurate, accessible, and efficient.

Joint Planning and Development Office (JPDO) (A12.a.): 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.): Provides a better understanding of the swirling air masses (wakes) trailing downstream from aircraft wingtips to reduce safely separation distances between aircraft, supports the safe use of parallel runways, and facilitates the ability of airports to operate closer to their design capacity.

Environment and Energy (A13.a.): Improves analytic and planning tools that reveal aviation's impacts upon the environment, works with the international aviation community to reduce aviation noise and minimize the impact of aircraft emissions, and develops comprehensive environmental analytical tools that address the interrelationships between noise and emissions and among environmentally beneficial actions affecting various emissions.

System Planning and Resource Management (A14.a.): Helps the R&D programs to meet customer needs, increase program efficiency, and reduce management and operating costs. Increases customer and stakeholder involvement in FAA programs, and fosters greater proliferation of U.S. standards and technology to meet global aviation needs.

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

Facilities and Equipment (F&E)

Separation Standards (1A01A): Reduces the separation distances between aircraft in international airspace to decrease aircraft fuel-burn and transit times over oceans. Standardizes separation criteria in international airspace. Assesses system safety before and after change; determines benefits; publishes regulatory material; completes new rulemaking; develops procedures; and establishes long-term safety oversight functions.

Runway Incursion Reduction (1A01B): Minimizes the chance of injury, death, damage, or loss of property caused by runway accidents or incidents. Selects and evaluates technologies; validates technical performance and operational suitability; and develops a business case to support program implementation. Focuses current program on pilot situational awareness.

System Capacity Planning and Improvement (1A01C): Develops programs to provide capacity enhancements, airport improvements, and modern infrastructure. 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. Develops performance metrics; implements performance measurement tools; and collects, processes, and analyzes data to measure and report performance on a routine basis.

Photo by Lockett Yee

Operations Concept Validation (1A01D): Conducts modeling and simulation to validate new operational concepts for the next generation of decision support systems for pilots and air traffic controllers. Validates performance requirements and identifies research criteria at the system and subsystem level. Assesses safety; identifies risk and takes actions necessary to reduce risk; and examines the interactions required between flight crew or air traffic controllers and the system.

General Aviation and Vertical Flight Technology (GA & VF) (1A01E): Supports the requirements for general aviation for improved communications, navigation, and surveillance services; improved avionics technologies; increased situational awareness; and improved capabilities during bad weather.

Safer Skies (1A01F): Analyzes causes of accidents and develops and implements new intervention technologies and strategies to prevent or reduce the leading causes of commercial aviation accidents, including accidents attributed to uncontained engine failure, controlled flight into terrain, approach and landing, loss of control, runway incursions, and weather.

NAS Safety Assessment (1A01G): Develops a Safety Management System to review programs involved in the modernization of the national airspace system to identify hazards, assess the risk of each hazard, develop mitigation strategies, and verify the effectiveness of each strategy in controlling risk.

NAS Requirements Development (1A01H): Examines current and future National Airspace System needs, and develops preliminary acquisition requirements to fill any identified gaps. Evaluates services and technologies independent of their venders to identify the best options available to increase system efficiency. Develops procedures; defines performance; analyzes impacts, workload, and hazards; and develops system architecture.

Wind Profiling and Weather Research Juneau (1A01I): Funds operations and maintenance of the Juneau Area Wind System operational prototype. The end-state system architecture will consist of the operational prototype software algorithms and a hardware infrastructure that is acceptable for use in the NAS.

Airspace Management Laboratory(1A01J): 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 noise impacts. Studies alternatives for airspace redesign that, when combined with new decision support tools and procedures, will optimize the nation's airspace.

Wake Turbulence (1A01K): Evaluates NASA technology prototypes for decision support tools that may allow reduced wake turbulence departure spacing and increased airport capacity. Develops requirement for validating the tools and displaying the separation information to controllers.

Safe Flight 21 - Alaska Capstone (1A02A): Demonstrates technologies to improve safety and pilot situational awareness by displaying the location of nearby aircraft in an airborne cockpit display; provides critical weather observations to pilots in mountainous passes; and provides "radar-like services" in non-radar areas.

Safe Flight 21 - Ohio River Valley (1A02B): Demonstrates the potential for new technologies and air traffic procedures to increase capacity and efficiency by validating advanced communications, navigation, and surveillance capabilities in a challenging operational environment.

Surface Moving Map (SMM)

(1A02C). As part of the Safe Flight 21 program, provides an airport situational awareness tool that increases the safety of surface movement operations for cockpit crews and airport vehicle operators. Uses Global Positioning System technology to display aircraft/vehicle "own-ship" position on a highly accurate digital airport surface map.

Automatic Dependent Surveillance - Broadcast (ADS-B)

(1A02D): Develops a technique to broadcast derived aircraft position from a satellite navigation system and transmit it to ground receivers and aircraft. Develops system standards for domestic and oceanic airspace and airport surface applications. Facilitates avionics certification and global system interoperability.

Center for Advanced Aviation System Development

(CAASD) (4A10): Identifies and tests new technologies for application to air traffic management, navigation, communication, separation assurance, surveillance technology, and system safety. Conducts R&D and high-level system engineering to meet FAA's long-term requirements.

Airport Improvement Program (AIP)
(requested in FY 2006)

Airports Technology Research - Capacity:

Provides better airport planning and design and improves runway pavement design, construction, and maintenance. Ensures new pavement standards will be ready to support safe international operation of next-generation heavy aircraft. Makes pavement design standards available to users worldwide.

Airports Technology Research - Safety:

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.

Airport Cooperative Research - Capacity:

Addresses airport design (perimeter taxiways) and modeling, mitigation of noise and emissions including run-off from deicing and anti-icing operations, introduction of new large aircraft, and improved pavement maintenance and materials.

Airport Cooperative Research - Safety:

Addresses all aspects of improving airport safety, including improved lighting and marking, mitigation of wildlife hazards, airport design and geometry, reduction of runway incursions, and improvement or aircraft rescue and firefighting.

Operations (Ops)

Commercial Space Transportation Safety:

Examines safety considerations for commercial space transportation, including those that involve crew and passenger health and safety, spacecraft vehicle safety, launch and re-entry risks, public safety, and personal property risk.

R&D Program Budget
Financials at a Glance

3.3 Budget

This section provides three views of the FAA R&D program budget. First, it presents a historic perspective of the R&D budget relative to the total FAA budget from FY 1992 through the FY 2006 request. Second, it presents the FY 2006 budget request for the R&D program, which includes a five-year budget plan for FY 2006-2010. It presents the R&D budget request in four ways: by appropriation, by program sponsor, by R&D category, and by performance goal (according to Exhibit IV of the FY 2006 budget request). Budget numbers for FY 2007-2010 are for planning purposes and subject to change. Third, it provides the aviation research grant obligations for FY 2004.

Historical Budget Trends

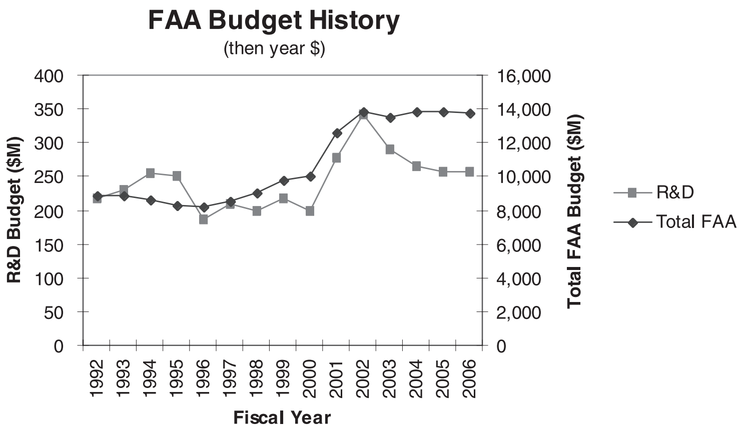


Figure 3.1 - FAA Budget History

Figure 3.1 shows that the total FAA budget has risen from $8.9 billion in FY 1992 to $13.8 billion (requested) in FY 2006, an increase of approximately 55 percent. The FAA R&D program budget was $218 million in FY 1992. The FY 2006 R&D request is $256 million, an increase of approximately 17 percent; it includes programs in R,E&D, F&E, AIP and Ops appropriations. The investment in R&D has not kept pace with the overall investments of the FAA.

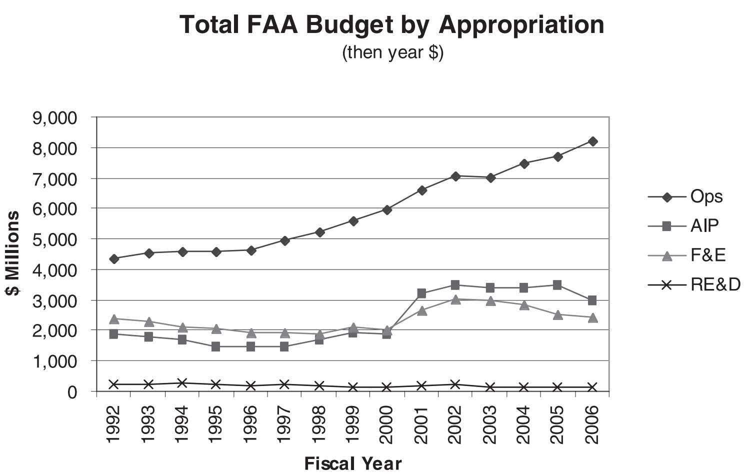


Figure 3.2 -
Total FAA Budget by Appropriation

Figure 3.2 shows the total FAA budget in four appropriations accounts: Operations, AIP, F&E, and R,E&D. The Operations account has the largest budget.

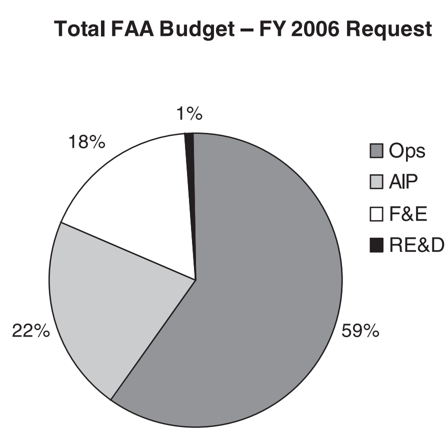


Figure 3.2a-
Total FAA Budget-
FY 2006 Request

Figure 3.2a provides a detailed breakout of the total FAA budget request for FY 2006 by appropriations account.

Figure 3.3 - R&D Program Budget

Figure 3.3 shows that the FAA R&D program was funded entirely by the R,E&D budget prior to FY 1999. In FY 1999, Congress moved many of the air traffic and airports related R&D programs from the R,E&D budget to the F&E budget. As a result, the R&D program began to include both R,E&D and F&E funded programs. In FY 2001, Commercial Space Transportation R&D, which is funded by the Operations budget, was included as part of the R&D program. In FY 2002, Congress transferred the CAASD R&D program from R,E&D to F&E. In FY 2003, the R&D program began to include all R&D work funded by the F&E CAASD line item, which is approximately 50 percent of the total F&E CAASD line item. In the FY 2006 R&D program budget request, FAA is proposing to fund airports related R&D in the AIP budget rather than in the F&E budget. As a result of this proposed change, the R&D budget request for FY 2006 includes programs in all four appropriation accounts.

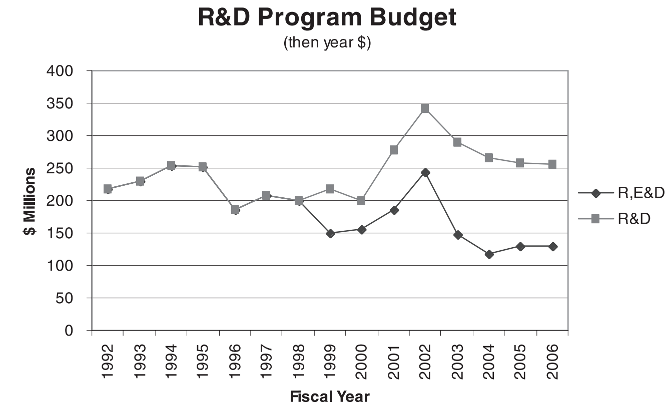


Figure 3.4 - FAA R&D Program as a Percent of Total FAA Budget

Figure 3.4 shows the FAA R&D budget as a percent of the total FAA budget for FY 1992 through the request for FY 2006. In FY 1992, the R&D program was 2.5 percent of the total FAA budget. Ten years later in FY 2002, the R&D budget reached a high of $342 million (see figure 3.1), which represented 2.5 percent of the total FAA budget. In the FY 2002 R,E&D budget, Congress provided an additional $50 million from a Department of Defense supplemental appropriation for the FAA security program. In FY 2003, the FAA security program was transferred to the Transportation Security Administration and removed from the FAA budget. Between FY 2002 and FY 2005, the R&D program declined from 2.5 percent of the total FAA budget to 1.86 percent. In the FY 2006 budget request, the R&D program represents 1.85 percent of the total FAA budget request.

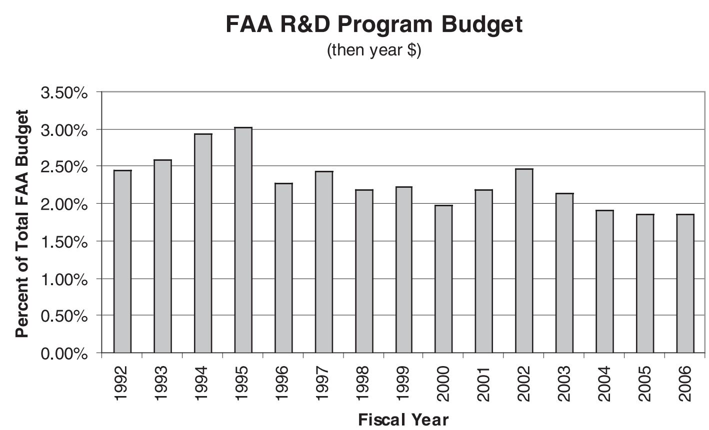
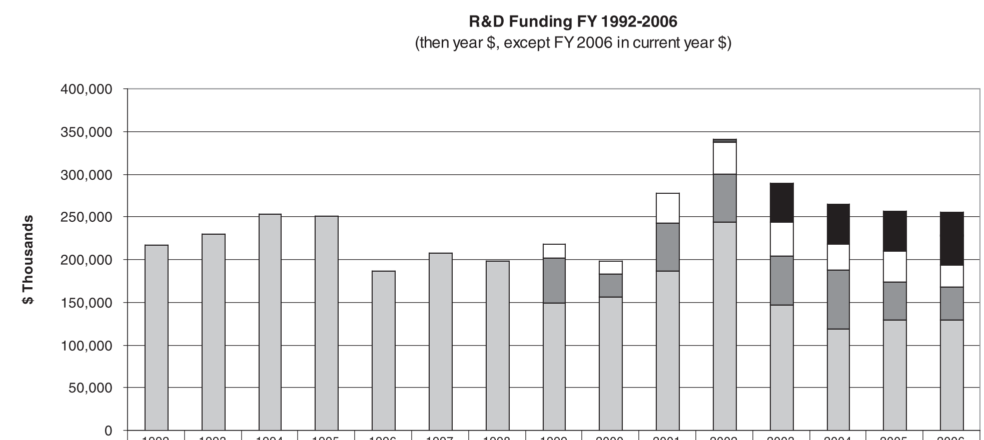


Figure 3.5 - R&D Program Budget History for FY 1992-2005 and FY 2006 Request

Figure 3.5 shows a history of the R&D program budget by appropriations account for FY 1992-2005. The figures for FY 2006 represent the President's budget.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
■ AIP															27,500
▢ Ops										100	100	157	113	110	125
■ F&E FFP2											4,000	300			
■ F&E CAASD												45,268	47,108	46,794	34,243
□ F&E SF-21								16,000	16,000	34,923	36,800	39,740	30,121	36,708	26,500
▢ F&E ATD&P								52,566	26,696	56,356	55,991	56,828	69,686	44,243	37,860
▢ R,E&D	218,000	230,000	254,000	251,592	186,703	208,412	199,183	150,000	156,495	186,589	244,839	147,485	118,734	129,880	130,000

Fiscal Year

Budget Request by Appropriation Account

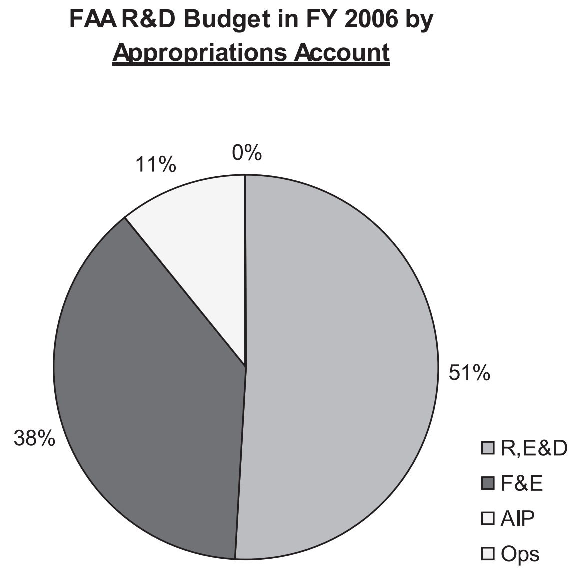


Figure 3.6 -
Percent of FY 2006 Budget Request by Appropriation Account

Figure 3.6 shows that the FAA R&D program is funded primarily by the R,E&D and F&E accounts. However, the Commercial Space program is authorized to expend Operations funding for R&D activities, so it is funded by Ops. In the FY 2006 budget request, FAA is asking Congress to fund the Airport Technology R&D program with the AIP appropriation account rather than the F&E account and to add a new program - Airport Cooperative Research - in the AIP appropriation account. As a result of this change, the R&D budget request for FY 2006 is funded with 51 percent R,E&D, 38 percent F&E, 11 percent AIP, and less than 1 percent Ops.

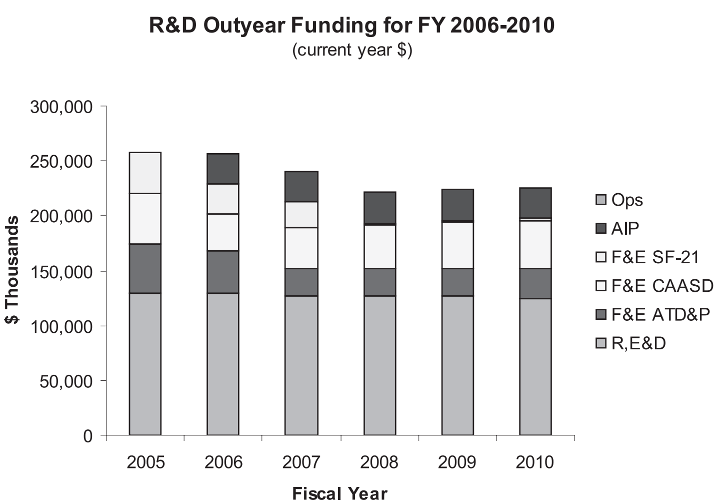


Figure 3.7 -
R&D Program Out-year Funding for FY 2006-2010

Figure 3.7 shows the R&D program in the out-years. To further explain their location within the F&E budget, the F&E programs are grouped by line items. They are Advanced Technology Development and Prototyping (ATD&P) line item 1A01, Safe Flight 21 (SF-21) line item 1A02, and Center for Advanced Aviation System Development (CAASD) line item 4A10. Not all programs in these F&E line items are R&D. Only R&D is shown.

Table 3.1
2005 National Aviation Research Plan (NARP)
FAA R&D Program Budget by **Appropriations Account**

Project Number	Budget Line Item	Program	Appropriation Account	2005 Enacted Budget ($000)	2006 Requested ($000)	2007 Planned ($000)	2008 Planned ($000)	2009 Planned ($000)	2010 Planned ($000)	
Research, Engineering and Development (R,E&D)										
061-110	A11.a	Fire Research and Safety	R,E&D	6,525	6,244	6,239	6,321	6,404	6,435	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	7,115	4,049	3,964	3,968	3,974	3,918	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	6,643	2,613	2,596	2,621	2,647	2,649	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,086	3,441	3,430	3,470	3,512	3,522	
065-110	A11.e.	Aging Aircraft	R,E&D	18,998	19,007	18,541	18,524	18,508	18,190	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,107	3,340	3,238	3,224	3,210	3,136	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	11,700	8,181	8,028	8,049	8,071	7,977	
060-110	A11.h.	Aviation Safety Risk Analysis	R,E&D	8,571	4,932	4,833	4,843	4,852	4,789	
082-110	A11.i.	Air Traffic Control/Airway Facilities Human Factors	R,E&D	9,391	9,654	9,627	9,742	9,859	9,889	
086-110	A11.j.	Aeromedical Research	R,E&D	10,079	6,889	6,975	7,119	7,268	7,385	
041-110	A11.k.	Weather Program	R,E&D	20,671	20,582	19,767	19,569	19,364	18,739	
027-110	A12.a.	Joint Planning and Development Office (JPDO)	R,E&D	5,059	18,100	17,409	17,251	17,086	16,561	
041-150	A12.b.	Wake Turbulence	R,E&D	4,262	2,296	2,213	2,196	2,177	2,115	
091-110/111/116	A13.a.	Environment and Energy	R,E&D	11,795	16,008	15,464	15,364	15,258	14,855	
011-130	A14.a.	System Planning and Resource Management	R,E&D	516	1,271	1,225	1,207	1,195	1,154	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,362	3,393	3,451	3,532	3,615	3,686	
			TOTAL R,E&D	**129,880**	**130,000**	**127,000**	**127,000**	**127,000**	**125,000**	
Facilities and Equipment (F&E)										
M08.28-01	1A01A	Separation Standards	F&E ATD&P	2,480	2,500	2,500	2,500	2,500	2,500	
S09.02-00	1A01B	Runway Incursion Reduction	F&E ATD&P	9,027	6,500	5,000	5,000	5,000	5,000	
M08.28-00	1A01C	System Capacity, Planning and Improvement	F&E ATD&P	3,968	6,500	6,500	6,500	6,500	6,500	
M08.29-00	1A01D	Operations Concept Validation	F&E ATD&P	1,984	3,000	3,000	3,000	3,000	3,000	
M35.01-00	1A01E	General Aviation and Vertical Flight Technology (GA & VF)	F&E ATD&P	1,488	1,500	2,000	2,000	2,000	2,000	
M08.28-03	--	Domestic Reduction Vertical Separation Minima (DRVSM)	F&E ATD&P	2,182	0	0	0	0	0	
M42.01-00	1A01F	Safer Skies	F&E ATD&P	3,373	3,400	3,000	3,000	3,000	3,000	
M08.32-01	1A01G	NAS Safety Assessment	F&E ATD&P	992	1,500	1,000	1,200	1,200	1,200	
M34.01-00	--	Airports Technology - Capacity	F&E ATD&P	8,700	0	0	0	0	0	/2
M34.01-00	--	Airports Technology - Safety	F&E ATD&P	3,700	0	0	0	0	0	/2
M08.27-00	1A01H	NAS Requirements	F&E ATD&P	1,488	800	2,000	2,000	2,000	3,200	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	F&E ATD&P	4,861	3,160	0	0	0	0	
M08.28-02	1A01J	Airspace Management Lab	F&E ATD&P	0	7,000	0	0	0	0	
M08.36-01	1A01K	Wake Turbulence	F&E ATD&P	0	2,000	0	0	0	0	
			Subtotal F&E ATD&P	44,243	37,860	25,000	25,200	25,200	26,400	/3
M36.01-00	1A02A	Safe Flight 21 - Alaska Capstone	F&E SF-21	28,768	14,500	16,600	0	0	0	
M36.02-00	1A02B	Safe Flight 21 - Ohio River Valley	F&E SF-21	3,972	8,000	3,400	0	0	0	/4
M36.02-01	1A02C	Surface Moving Maps	F&E SF-21	1,984	2,000	2,000	0	0	0	/4
S10.02-00	1A02D	Automatic Dependent Surveillance Broadcast (ADS-B)	F&E SF-21	1,984	2,000	2,000	2,000	2,000	2,000	
			Subtotal F&E SF-21	36,708	26,500	24,000	2,000	2,000	2,000	/3
M03.02-00	4A10	Center for Advanced Aviation System Development (CAASD)	F&E CAASD	46,794	34,243	36,900	39,360	41,820	44,280	/5
			TOTAL F&E	**127,745**	**98,603**	**85,900**	**66,560**	**69,020**	**72,680**	
Airport Improvement Program (AIP)										
--	--	Airports Technology Research - Capacity	AIP	0	8,525	8,525	8,525	8,525	8,525	
--	--	Airports Technology Research - Safety	AIP	0	8,975	8,975	8,975	8,975	8,975	
--	--	Airport Coorperative Research Program -- Capacity	AIP	0	5,000	5,000	5,000	5,000	5,000	/6
--	--	Airport Coorperative Research Program -- Safety	AIP	0	5,000	5,000	5,000	5,000	5,000	/6
			TOTAL AIP	**0**	**27,500**	**27,500**	**27,500**	**27,500**	**27,500**	
Operations (Ops)										
--	--	Commercial Space Transportation Safety	Ops	110	125	125	125	125	125	
			TOTAL Ops	**110**	**125**	**125**	**125**	**125**	**125**	
			GRAND TOTAL	**$257,735**	**$256,228**	**$240,525**	**$221,185**	**$223,645**	**$225,305**	

/1 Funding estimates for fiscal years 2007 through 2010 are in planning phase and may change.
/2 In FY 2005 the Airports Technology Program is funded in F&E and the number shown in this table includes $2.4M (for 18 FTE), which is contained in Activity 5 of the F&E budget. The balance of $10M is contained in the F&E ATD&P line item. The breakout for capacity and safety differs from that shown in the FY 2006 budget submission for FY 2005, although the total is the same.
/3 The R&D program under ATD&P does not include IOT&E, and the R&D program under Safe Flight 21 does not include Alaska Weather Cameras or IOT&E.
/4 Safe Flight 21 - Ohio River Valley and Surface Moving Maps are combined into a single white sheet write-up in Appendix A.
/5 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 55.3% of the total CAASD line item amount in FY 2005 and 49.2% in FY 2006 and beyond.
/6 Airport Coopeative Research Program - Safety and Airport Cooperative Research Program - Capacity are combined into a single white sheet write-up in Appendix A.

Table 3.1 - R&D Budget Request by Appropriation Account

Table 3.1 shows the FAA R&D budget request for FY 2006, including the five-year plan through 2010, grouped by appropriation account. The R,E&D, AIP and Ops requests remain stable in the out-years; however, there is fluctuation in the F&E out-year request. The F&E CAASD line item increases over the five-year period, while the F&E ATD&P and F&E SF-21 line items decline. In the out-years, both F&E ATD&P and F&E SF-21 decline as programs complete development and transition to acquisition programs. Although F&E funding declines in the out-years, FAA anticipates that the JPDO will identify new air traffic related R&D requirements in the next five years.

Programs exiting F&E ATD&P R&D in 2007:
Wind Profiling and Weather Research Juneau
Airspace Management Lab
Wake Turbulence

Programs exiting F&E SF-21 R&D in 2008:
SF-21 Alaska Capstone
SF-21 Ohio River Valley
Surface Moving Maps

Budget Requests by Sponsoring Organization

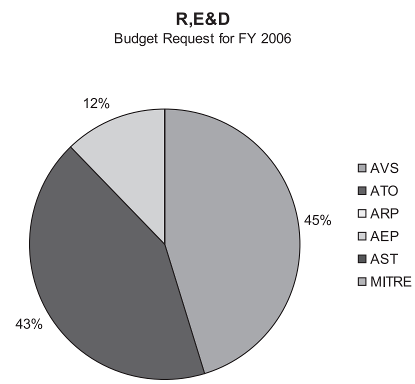


Figure 3.8a

Figure 3.8a shows the R,E&D budget request for FY 2006. AVS sponsors 45 percent of the R,E&D program, ATO sponsors 43 percent, and AEP sponsors 12 percent. This chart does not include the three other appropriations in the R&D program. It only includes R,E&D.

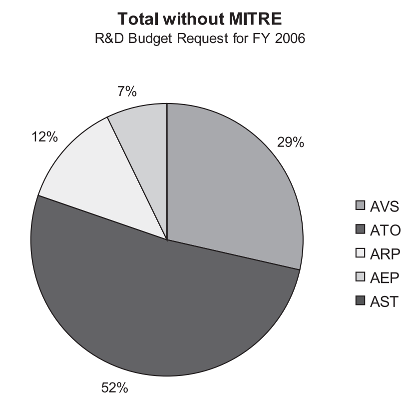


Figure 3.8b

Figure 3.8b shows the R&D budget request for FY 2006 including all four appropriations except for the MITRE CAASD program, which is funded under F&E and sponsored by ATO. Excluding CAASD, ATO sponsors 52 percent of the FY 2006 R&D program, AVS sponsors 29 percent, ARP sponsors 12 percent, AEP sponsors 7 percent, and AST sponsors less than 1 percent of the R&D program.

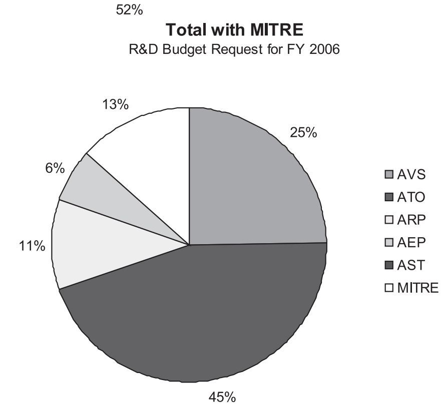


Figure 3.8c

Figure 3.8c shows the total R&D budget request for FY 2006 including MITRE CAASD, which represents 13 percent of the total R&D program. With CAASD, ATO sponsors 58 percent of the program.

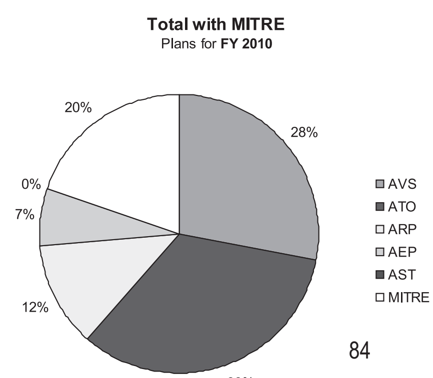


Figure 3.8d

Figure 3.8d shows the total R&D budget plan for FY 2010. The sponsors, other than ATO, retain a relatively stable percent of the R&D program between FY 2006 and FY 2010. ATO R&D shrinks from 45 percent to 33 percent as programs are completed and transition from R&D to acquisition. MITRE CAASD grows from 13 percent to 20 percent of the R&D program.

Table 3.2
2005 National Aviation Research Plan (NARP)
FAA R&D Program Budget by Sponsoring Organization

Project Number	Budget Line Item	Program	Appropriation Account	2005 Enacted Budget ($000)	2006 Requested ($000)	2007 Planned ($000)	2008 Planned ($000)	2009 Planned ($000)	2010 Planned ($000)
Aviation Safety (AVS)									
061-110	A11.a	Fire Research and Safety	R,E&D	6,525	6,244	6,239	6,321	6,404	6,435
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	7,115	4,049	3,964	3,968	3,974	3,918
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	6,643	2,613	2,596	2,621	2,647	2,649
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,086	3,441	3,430	3,470	3,512	3,522
065-110	A11.e.	Aging Aircraft	R,E&D	18,998	19,007	18,541	18,524	18,508	18,190
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,107	3,340	3,238	3,224	3,210	3,136
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	11,700	8,181	8,028	8,049	8,071	7,977
060-110	A11.h.	Aviation Safety Risk Analysis	R,E&D	8,571	4,932	4,833	4,843	4,852	4,789
086-110	A11.j.	Aeromedical Research	R,E&D	10,079	6,889	6,975	7,119	7,268	7,385
		Subtotal	**R,E&D**	74,824	58,696	57,844	58,139	58,446	58,001
M35.01-00	1A01E	General Aviation and Vertical Flight Technology (GA & VF)	F&E ATD&P	1,488	1,500	2,000	2,000	2,000	2,000
M42.01-00	1A01F	Safer Skies	F&E ATD&P	3,373	3,400	3,000	3,000	3,000	3,000
		Subtotal	**F&E**	4,861	4,900	5,000	5,000	5,000	5,000
		Regulation and Certification		**79,685**	**63,596**	**62,844**	**63,139**	**63,446**	**63,001**
Air Traffic Organization (ATO)									
082-110	A11.i.	Air Traffic Control/Airway Facilities Human Factors	R,E&D	9,391	9,654	9,627	9,742	9,859	9,889
041-110	A11.k.	Weather Program	R,E&D	20,671	20,582	19,767	19,569	19,364	18,739
027-110	A12.a.	Joint Planning and Development Office (JPDO)	R,E&D	5,059	18,100	17,409	17,251	17,086	16,561
041-150	A12.b.	Wake Turbulence	R,E&D	4,262	2,296	2,213	2,196	2,177	2,115
011-130	A14.a.	System Planning and Resource Management	R,E&D	516	1,271	1,225	1,207	1,195	1,154
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,362	3,393	3,451	3,532	3,615	3,686
		Subtotal	**R,E&D**	43,261	55,296	53,692	53,497	53,296	52,144
M08.28-01	1A01A	Separation Standards	F&E ATD&P	2,480	2,500	2,500	2,500	2,500	2,500
S09.02-00	1A01B	Runway Incursion Reduction	F&E ATD&P	9,027	6,500	5,000	5,000	5,000	5,000
M08.28-00	1A01C	System Capacity, Planning and Improvement	F&E ATD&P	3,968	6,500	6,500	6,500	6,500	6,500
M08.29-00	1A01D	Operations Concept Validation	F&E ATD&P	1,984	3,000	3,000	3,000	3,000	3,000
M08.28-03	--	Domestic Reduction Vertical Separation Minima (DRVSM)	F&E ATD&P	2,182	0	0	0	0	0
M08.32-01	1A01G	NAS Safety Assessment	F&E ATD&P	992	1,500	1,000	1,200	1,200	1,200
M08.27-00	1A01H	NAS Requirements	F&E ATD&P	1,488	800	2,000	2,000	2,000	3,200
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	F&E ATD&P	4,861	3,160	0	0	0	0
M08.28-02	1A01J	Airspace Management Lab	F&E ATD&P	0	7,000	0	0	0	0
M08.36-01	1A01K	Wake Turbulence	F&E ATD&P	0	2,000	0	0	0	0
M36.01-00	1A02A	Safe Flight 21 - Alaska Capstone	F&E SF-21	28,768	14,500	16,600	0	0	0
M36.02-00	1A02B	Safe Flight 21 - Ohio River Valley	F&E SF-21	3,972	8,000	3,400	0	0	0
M36.02-01	1A02C	Surface Moving Maps	F&E SF-21	1,984	2,000	2,000	0	0	0
S10.02-00	1A02D	Automatic Dependent Surveillance Broadcast (ADS-B)	F&E SF-21	1,984	2,000	2,000	2,000	2,000	2,000
M03.02-00	4A10	Center for Advanced Aviation System Development (CAASD)	F&E CAASD	46,794	34,243	36,900	39,360	41,820	44,280 /2
		Subtotal	**F&E**	110,484	93,703	80,900	61,560	64,020	67,680
		Air Traffic Organization		**153,745**	**148,999**	**134,592**	**115,057**	**117,316**	**119,824**
Airports (ARP)									
M34.01-00	--	Airports Technology - Capacity	F&E ATD&P	8,700	0	0	0	0	0
M34.01-00	--	Airports Technology - Safety	F&E ATD&P	3,700	0	0	0	0	0
--	--	Airports Technology Research - Capacity	AIP	0	8,525	8,525	8,525	8,525	8,525
--	--	Airports Technology Research - Safety	AIP	0	8,975	8,975	8,975	8,975	8,975
--	--	Airport Coorperative Research Program -- Capacity	AIP	0	5,000	5,000	5,000	5,000	5,000
--	--	Airport Coorperative Research Program -- Safety	AIP	0	5,000	5,000	5,000	5,000	5,000
		Airports		**12,400**	**27,500**	**27,500**	**27,500**	**27,500**	**27,500**
Aviation Policy, Planning and Environment (AEP)									
091-110/111/116	A13.a.	Environment and Energy	R,E&D	11,795	16,008	15,464	15,364	15,258	14,855
		Aviation Policy, Planning and Environment (AEP)		**11,795**	**16,008**	**15,464**	**15,364**	**15,258**	**14,855**
Commercial Space Transportation (AST)									
--	--	Commercial Space Transportation Safety	Ops	110	125	125	125	125	125
		Commercial Space Transportation Safety		**110**	**125**	**125**	**125**	**125**	**125**
		TOTAL		**$257,735**	**$256,228**	**$240,525**	**$221,185**	**$223,645**	**$225,305**

/1 Funding estimates for fiscal years 2007 through 2010 are in planning phase and may change.
/2 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 55.3% of the total CAASD line item amount in FY 2005 and 49.2% in FY 2006 and beyond.

Table 3.2 - R&D Budget Summary by Sponsoring Organization

Table 3.2 shows the FAA R&D budget request for FY 2006, by sponsoring organization. Sponsoring organizations include Aviation Safety (AVS), Air Traffic Organization (ATO), AIrports (ARP), Policy, Planning and Environment (AEP), and Commercial Space Transportation (AST).

Table 3.3 - R&D Budget Request for FY 2006

Table 3.3 shows the R&D budget request for FY 2006 including the type of appropriations by sponsor. AVS uses primarily R,E&D with some F&E. ATO uses both F&E and R,E&D. Also, ATO sponsors the MITRE R&D, which is funded under the F&E CAASD line item. ARP is requesting AIP appropriations in FY 2006. AEP uses R,E&D for environment and energy related R&D. AST uses Operations funds for R&D.

FAA Research and Development Program -- Budget Request by Sponsor

	FY 2006 R&D Budget Request					
	R,E&D	**F&E**	**AIP**	**Ops**	**Total without MITRE**	**Total with MITRE**
AVS	$58,696	$4,900	$0	$0	$63,596	$63,596
ATO	$55,296	$59,460	$0	$0	$114,756	$114,756
ARP	$0	$0	$27,500	$0	$27,500	$27,500
AEP	$16,008	$0	$0	$0	$16,008	$16,008
AST	$0	$0	$0	$125	$125	$125
MITRE	$0	$34,243	$0	$0	$0	$34,243
	$130,000	$98,603	$27,500	$125	$221,985	$256,228

Budget Request by R&D Category

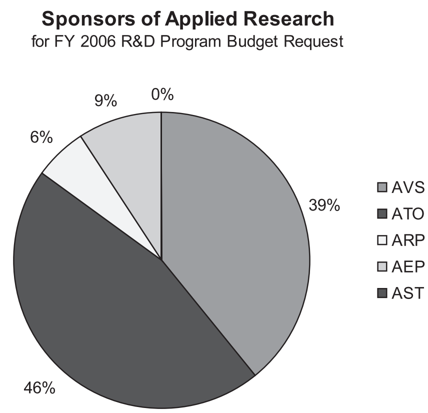


Figure 3.9 -- Sponsors of Applied Research in FY 2006

Figure 3.9 shows the FAA organizations that sponsor applied research. For applied research, AVS sponsors 39 percent of the R&D program, ATO sponsors 46 percent, ARP sponsors 6 percent, AEP sponsors 9 percent, and AST sponsors less than 1 percent.

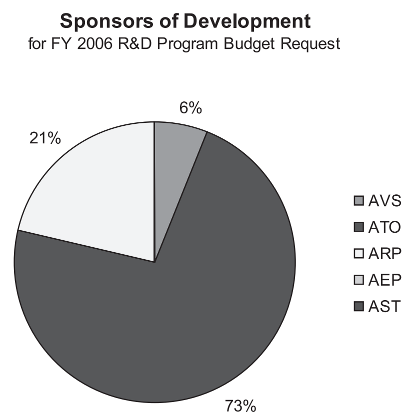


Figure 3.10 - Sponsors of Development in FY 2006

Figure 3.10 shows the FAA organizations that sponsor development. For development, ATO sponsors 73 percent, ARP sponsors 21 percent, AVS sponsors 6 percent, and AST sponsors less than 1 percent.

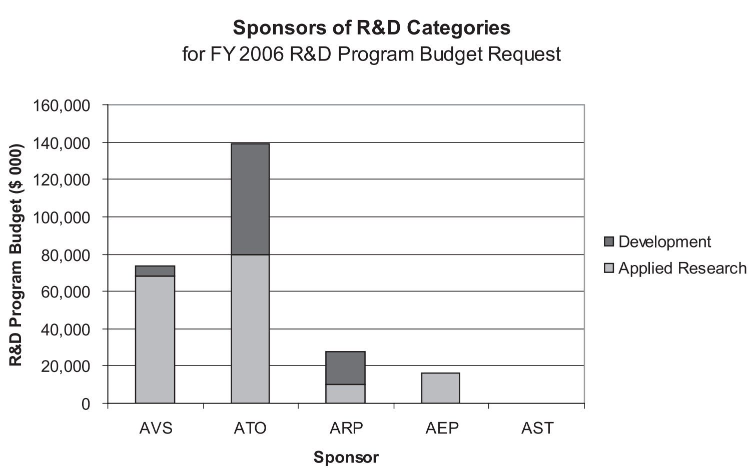


Figure 3.11 - Sponsors of R&D by Category for FY 2006

Figure 3.11 shows each sponsor's program for FY 2006 categorized by applied research and development. The AVS program is primarily applied research. The ATO program is approximately 57 percent applied research and 43 percent development. The ARP program is approximately 36 percent applied research and 64 percent development. The AEP program is applied research. The AST program is half applied research and half development.

Table 3.4
2005 National Aviation Research Plan (NARP)
FAA R&D Program Budget by **Research and Development Category**

Project Number	Budget Line Item	Program	Appropriation Account	2005 Enacted Budget ($000)	2006 Requested ($000)	2007 Planned ($000)	2008 Planned ($000)	2009 Planned ($000)	2010 Planned ($000)	
Applied Research										
061-110	A11.a	Fire Research and Safety	R,E&D	6,525	6,244	6,239	6,321	6,404	6,435	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	7,115	4,049	3,964	3,968	3,974	3,918	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	6,643	2,613	2,596	2,621	2,647	2,649	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	4,086	3,441	3,430	3,470	3,512	3,522	
065-110	A11.e.	Aging Aircraft	R,E&D	18,998	19,007	18,541	18,524	18,508	18,190	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	1,107	3,340	3,238	3,224	3,210	3,136	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	11,700	8,181	8,028	8,049	8,071	7,977	
060-110	A11.h.	Aviation Safety Risk Analysis	R,E&D	8,571	4,932	4,833	4,843	4,852	4,789	
082-110	A11.i.	Air Traffic Control/Airway Facilities Human Factors	R,E&D	9,391	9,654	9,627	9,742	9,859	9,889	
086-110	A11.j.	Aeromedical Research	R,E&D	10,079	6,889	6,975	7,119	7,268	7,385	
041-110	A11.k.	Weather Program	R,E&D	20,671	20,582	19,767	19,569	19,364	18,739	
027-110	A12.a.	Joint Planning and Development Office (JPDO)	R,E&D	5,059	18,100	17,409	17,251	17,086	16,561	
041-150	A12.b.	Wake Turbulence	R,E&D	4,262	2,296	2,213	2,196	2,177	2,115	
091-110/111/116	A13.a.	Environment and Energy	R,E&D	11,795	16,008	15,464	15,364	15,258	14,855	
011-130	A14.a.	System Planning and Resource Management	R,E&D	516	1,271	1,225	1,207	1,195	1,154	
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	3,362	3,393	3,451	3,532	3,615	3,686	
		Subtotal	**R,E&D**	129,880	130,000	127,000	127,000	127,000	125,000	
M03.02-00	4A10	Center for Advanced Aviation System Development (CAASD)	F&E CAASD	46,794	34,243	36,900	39,360	41,820	44,280	/2
		Subtotal	**F&E**	46,794	34,243	36,900	39,360	41,820	44,280	
--	--	Airport Cooperative Research Program -- Capacity	AIP	0	5,000	5,000	5,000	5,000	5,000	
--	--	Airport Cooperative Research Program -- Safety	AIP	0	5,000	5,000	5,000	5,000	5,000	
		Subtotal	**AIP**	0	10,000	10,000	10,000	10,000	10,000	
--	--	Commercial Space Transportation Safety	Ops	55	63	63	63	63	63	/3
		Subtotal	**Ops**	55	63	63	63	63	63	
		Applied Research		**176,729**	**174,306**	**173,963**	**176,423**	**178,883**	**179,343**	
		Percent *Applied Research*		**68.6%**	**68.0%**	**72.3%**	**79.8%**	**80.0%**	**79.6%**	
Development										
M08.28-01	1A01A	Separation Standards	F&E ATD&P	2,480	2,500	2,500	2,500	2,500	2,500	
S09.02-00	1A01B	Runway Incursion Reduction	F&E ATD&P	9,027	6,500	5,000	5,000	5,000	5,000	
M08.28-00	1A01C	System Capacity, Planning and Improvement	F&E ATD&P	3,968	6,500	6,500	6,500	6,500	6,500	
M08.29-00	1A01D	Operations Concept Validation	F&E ATD&P	1,984	3,000	3,000	3,000	3,000	3,000	
M35.01-00	1A01E	General Aviation and Vertical Flight Technology (GA & VF)	F&E ATD&P	1,488	1,500	2,000	2,000	2,000	2,000	
M08.28-03	--	Domestic Reduction Vertical Separation Minima (DRVSM)	F&E ATD&P	2,182	0	0	0	0	0	
M42.01-00	1A01F	Safer Skies	F&E ATD&P	3,373	3,400	3,000	3,000	3,000	3,000	
M08.32-01	1A01G	NAS Safety Assessment	F&E ATD&P	992	1,500	1,000	1,200	1,200	1,200	
M34.01-00	--	Airports Technology - Capacity	F&E ATD&P	8,700	0	0	0	0	0	
M34.01-00	--	Airports Technology - Safety	F&E ATD&P	3,700	0	0	0	0	0	
M08.27-00	1A01H	NAS Requirements	F&E ATD&P	1,488	800	2,000	2,000	2,000	3,200	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	F&E ATD&P	4,861	3,160	0	0	0	0	
M08.28-02	1A01J	Airspace Management Lab	F&E ATD&P	0	7,000	0	0	0	0	
M08.36-01	1A01K	Wake Turbulence	F&E ATD&P	0	2,000	0	0	0	0	
M36.01-00	1A02A	Safe Flight 21 - Alaska Capstone	F&E SF-21	28,768	14,500	16,600	0	0	0	
M36.02-00	1A02B	Safe Flight 21 - Ohio River Valley	F&E SF-21	3,972	8,000	3,400	0	0	0	
M36.02-01	1A02C	Surface Moving Maps	F&E SF-21	1,984	2,000	2,000	0	0	0	
S10.02-00	1A02D	Automatic Dependent Surveillance Broadcast (ADS-B)	F&E SF-21	1,984	2,000	2,000	2,000	2,000	2,000	
		Subtotal	**F&E**	80,951	64,360	49,000	27,200	27,200	28,400	
--	--	Airports Technology Research - Capacity	AIP	0	8,525	8,525	8,525	8,525	8,525	
--	--	Airports Technology Research - Safety	AIP	0	8,975	8,975	8,975	8,975	8,975	
		Subtotal	**AIP**	0	17,500	17,500	17,500	17,500	17,500	
--	--	Commercial Space Transportation Safety	Ops	55	63	63	63	63	63	/3
		Subtotal	**Ops**	55	63	63	63	63	63	
		Development		**81,006**	**81,923**	**66,563**	**44,763**	**44,763**	**45,963**	
		Percent *Development*		**31.4%**	**32.0%**	**27.7%**	**20.2%**	**20.0%**	**20.4%**	
		TOTAL		**$257,735**	**$256,228**	**$240,525**	**$221,185**	**$223,645**	**$225,305**	

/1 Funding estimates for fiscal years 2007 through 2010 are in planning phase and may change.
/2 The amount shown for CAASD includes only the R&D portion of the total CAASD line item amount. R&D represents 55.3% of the total CAASD line item amount in FY 2005 and 49.2% in FY 2006 and beyond.
/3 The Commercial Space Transportation Program is 50 percent applied research and 50 percent development or $62.5K, which is rounded to $63K in this table.

Table 3.4 - R&D Budget Summary by Research and Development Category

Table 3.4 shows the R&D program by research and development category - applied research and development for FY2005-2010. It also includes percent applied research verses percent development. In FY 2006, the program includes 68 percent applied-research and 32 percent development. In FY 2010, the program shifts to 79.6 percent applied research and 20.4 percent development as F&E funded programs complete development and exit the R&D program.

Table 3.5 - Percent R&D by Category and Sponsor for FY 2006

Table 3.5 shows the percentages by sponsor and R&D category for the FY 2006 R&D budget request.

	AVS	ATO	ARP	AEP	AST	Total
Applied Research	93.3%	57.3%	36.4%	100.0%	50.0%	68.0%
Development	6.7%	42.7%	63.6%	0.0%	50.0%	32.0%

Budget Request by Performance Goals

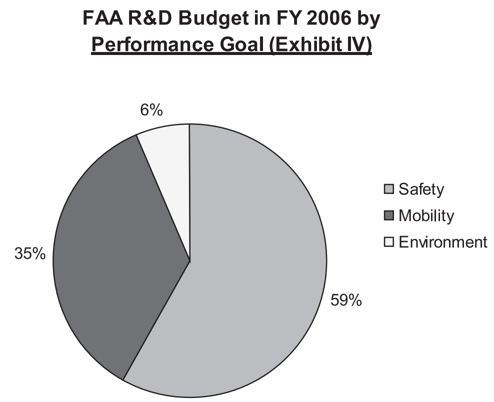


Figure 3.12 - R&D Goal Areas in FY 2006

Figure 3.12 shows how the R&D program addresses the performance goals in Exhibit IV of the FAA budget request for FY 2006. In FY 2006, 59 percent of the R&D program addresses safety, 35 percent addresses mobility, and 6 percent addresses environment.

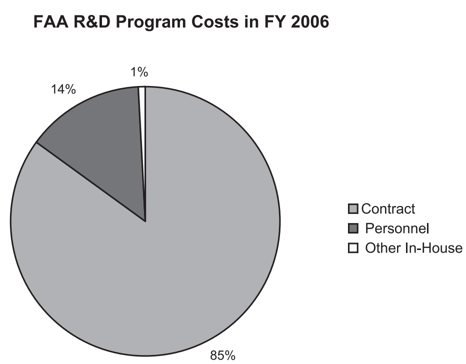


Figure 3.13 - R&D Contract and Personnel Costs in FY 2006

Figure 3.13 shows the R&D program costs for FY 2006. The program costs are 85 percent for contracts, 14 percent for personnel, and 1 percent for other in-house. The R,E&D personnel costs fund scientists and researchers at CAMI and WJHTC who perform research. The F&E personnel costs are not included here, because the F&E account does not identify personnel costs by program. Activity 5, Personnel and Related Expenses, in the F&E budget provides the F&E personnel costs including those for the F&E portion of the R&D program.

Exhibit IV by Appropriation Account for R&D

	R,E&D	F&E	AIP	Ops	Total
Safety	36.00%	16.61%	5.45%	0.05%	58.11%
Mobility	8.26%	21.87%	5.28%		35.41%
Environment	6.48%				6.48%
Total	50.74%	38.48%	10.73%	0.05%	100.00%

Table 3.6 - Exhibit IV by Appropriation Account for R&D in FY 2006

Table 3.6 shows the R&D budget request for FY 2006 organized according to the goals of Exhibit IV in the FAA budget request and by the appropriation accounts in the R&D program. The safety goal includes all four appropriation accounts, but is funded primarily by R,E&D. The mobility goal includes R,E&D, F&E and AIP funding but is primarily funded by F&E. The environmental goal is funded by R,E&D.

Exhibit IV by Sponsor for R&D

	AVS	ATO	ARP	AEP	AST	Total
Safety	24.82%	27.79%	5.45%		0.05%	58.11%
Mobility		30.13%	5.28%			35.41%
Environment		0.23%		6.25%		6.48%
Total	24.82%	58.15%	10.73%	6.25%	0.05%	100.00%

Table 3.7 - Exhibit IV by Sponsor for R&D in FY 2006

Table 3.7 shows the R&D budget request for FY 2006 organized according to the goals of Exhibit IV in the FAA budget request and by sponsor of R&D. The sponsors for safety are AVS, ATO and ARP. The sponsors for mobility are ATO and ARP. The sponsor for environment is AEP primarily, but ATO provides support. The focus of AVS and AST is safety, and AEP is environment. ATO and ARP sponsor programs that address both safety and mobility.

Table 3.8
2005 National Aviation Research Plan (NARP)
FAA R&D Program Budget by **Performance Goals**
(Organized According to Exhibit IV of the FAA FY 2006 Budget Request)

Project Number	Budget Line Item	Program	Appropriation Account	FY 2006 Contract Costs ($000)	FY 2006 Personnel Costs ($000)	FY 2006 Other In-house Costs ($000)	FY 2006 Total Request ($000)	
1. SAFETY								
a. Reduce Commercial Air Carrier Fatal Accident Rate								
061-110	A11.a	Fire Research and Safety	R,E&D	2,632	3,379	233	6,244	
063-110	A11.b.	Propulsion and Fuel Systems	R,E&D	2,816	1,155	78	4,049	
062-110/111	A11.c.	Advanced Materials/Structural Safety	R,E&D	1,289	1,247	77	2,613	
064-110/111	A11.d.	Atmospheric Hazards/Digital System Safety	R,E&D	1,553	1,786	102	3,441	
065-110	A11.e.	Aging Aircraft	R,E&D	14,081	4,631	295	19,007	
066-110	A11.f.	Aircraft Catastrophic Failure Prevention Research	R,E&D	2,737	566	37	3,340	
081-110	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	R,E&D	5,420	2,626	135	8,181	
060-110	A11.h.	Aviation Safety Risk Analysis	R,E&D	3,352	1,494	86	4,932	
082-110	A11.i.	Air Traffic Control/Airway Facilities Human Factors	R,E&D	4,330	5,079	245	9,654	
086-110	A11.j.	Aeromedical Research	R,E&D	1,658	5,091	140	6,889	
041-110	A11.k.	Weather Program	R,E&D	19,418	1,074	90	20,582	
011-130	A14.a.	System Planning and Resource Management	R,E&D	869	31	2	902	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	430	1,924	53	2,407	/1
		Subtotal	**R,E&D**	60,585	30,083	1,573	92,241	/2
S09.02-00	1A01B	Runway Incursion Reduction	F&E ATD&P	6,500	0	0	6,500	
M42.01-00	1A01F	Safer Skies	F&E ATD&P	3,400	0	0	3,400	
M08.32-01	1A01G	NAS Safety Assessment	F&E ATD&P	1,500	0	0	1,500	
W10.01-00	1A01I	Wind Profiling and Weather Research Juneau	F&E ATD&P	3,160	0	0	3,160	
		Subtotal	**F&E**	14,560	0	0	14,560	
--	--	Airports Technology Research - Safety	AIP	7,375	1,200	0	8,575	/3
--	--	Airport Coorperative Research Program -- Safety	AIP	4,933	67	0	5,000	
		Subtotal	**AIP**	12,308	1,267	0	13,575	
		Reduce the Commercial Air Carrier Fatal Accident Rate		**87,453**	**31,350**	**1,573**	**120,376**	
b. Reduce the Number of General Aviation Fatal Accidents								
M35.01-00	1A01E	General Aviation and Vertical Flight Technology (GA & VF)	F&E ATD&P	1,500	0	0	1,500	
M36.01-00	1A02A	Safe Flight 21 - Alaska Capstone	F&E SF-21	14,500	0	0	14,500	
M36.02-00	1A02B	Safe Flight 21 - Ohio River Valley	F&E SF-21	8,000	0	0	8,000	
M36.02-01	1A02C	Surface Moving Maps	F&E SF-21	2,000	0	0	2,000	
S10.02-00	1A02D	Automatic Dependent Surveillance Broadcast (ADS-B)	F&E SF-21	2,000	0	0	2,000	
		Subtotal	**F&E**	28,000	0	0	28,000	
--	--	Airports Technology Research - Safety	AIP	400	0	0	400	/3
		Reduce the Number of General Aviation Fatal Accidents		**28,400**	**0**	**0**	**28,400**	
c. Maintain Zero Commercial Space Transportation Accidents								
--	--	Commercial Space Transportation Safety	Ops	94	31	0	125	
		Maintain Zero Commercial Space Transportation Accidents		**94**	**31**	**0**	**125**	
		TOTAL SAFETY		**115,947**	**31,381**	**1,573**	**148,901**	
2. MOBILITY								
a. Increase Percent of On-time Arrivals								
027-110	A12.a.	Joint Planning and Development Office (JPDO)	R,E&D	16,720	1,313	67	18,100	
041-150	A12.b.	Wake Turbulence	R,E&D	2,059	225	12	2,296	
011-130	A14.a.	System Planning and Resource Management	R,E&D	199	7	0	207	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	99	441	12	552	/1
		Subtotal	**R,E&D**	19,077	1,986	92	21,155	/2
M08.28-01	1A01A	Separation Standards	F&E ATD&P	2,500	0	0	2,500	
M08.28-00	1A01C	System Capacity, Planning and Improvement	F&E ATD&P	6,500	0	0	6,500	
M08.29-00	1A01D	Operations Concept Validation	F&E ATD&P	3,000	0	0	3,000	
M08.27-00	1A01H	NAS Requirements	F&E ATD&P	800	0	0	800	
M08.28-02	1A01J	Airspace Management Lab	F&E ATD&P	7,000	0	0	7,000	
M08.36-01	1A01K	Wake Turbulence	F&E ATD&P	2,000	0	0	2,000	
M03.02-00	4A10	Center for Advanced Aviation System Development (CAASD)	F&E CAASD	34,243	0	0	34,243	/4
		Subtotal	**F&E**	56,043	0	0	56,043	
--	--	Airports Technology Research - Capacity	AIP	7,325	1,200	0	8,525	
--	--	Airport Coorperative Research Program -- Capacity	AIP	5,000	0	0	5,000	
		Subtotal	**AIP**	12,325	1,200	0	13,525	
		Increase Percent of On-time Arrivals		**87,445**	**3,186**	**92**	**90,723**	
		TOTAL MOBILITY		**87,445**	**3,186**	**92**	**90,723**	
4. ENVIRONMENT								
091-110/111/116	A13.a.	Environment and Energy	R,E&D	13,878	1,985	145	16,008	
011-130	A14.a.	System Planning and Resource Management	R,E&D	156	5	0	162	/1
011-140	A14.b.	William J. Hughes Technical Center Laboratory Facility	R,E&D	77	346	10	433	/1
		Subtotal	**R,E&D**	14,112	2,337	155	16,604	/2
		TOTAL ENVIRONMENT		**14,112**	**2,337**	**155**	**16,604**	
		GRAND TOTAL		**217,504**	**36,904**	**1,820**	**256,228**	

Notes:
/1 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 71.0 percent; Mobility at 16.3 percent; and Environment at 12.7 percent. The total other in-house costs for Systems Planning and Resource Management is $3K, which is divided three ways and rounded to the nearest thousand so two entries appear as zero.
/2 Personnel for R,E&D measured in full time equivalent (FTE) is as follows: 266 FTE for Safety; 13 FTE for Mobility; and 19 FTE for Environment.
/3 The Airport Technology Research - Safety program total budget request is divided between reducing the commercial air carrier fatal accident rate ($8,575K) and reducing the number of general aviation fatal accidents ($400K).
/4 The budget request amount shown for CAASD is only the R&D program portion of the total CAASD line item amount (49.2% of the total line item).
/5 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 3.8 - R&D Budget Request for FY 2006 by Performance Goals

Table 3.8 shows the R&D budget request by performance goal as defined in Exhibit IV of the FAA budget request for FY 2006. The R&D programs apply to three goals - safety, mobility, and environment. Many programs apply to more than one goal, however, each is listed under its primary goal for budget reasons. The table provides information on contract costs, and other in-house costs for FY 2006.

Aviation Research Grants in FY 2004

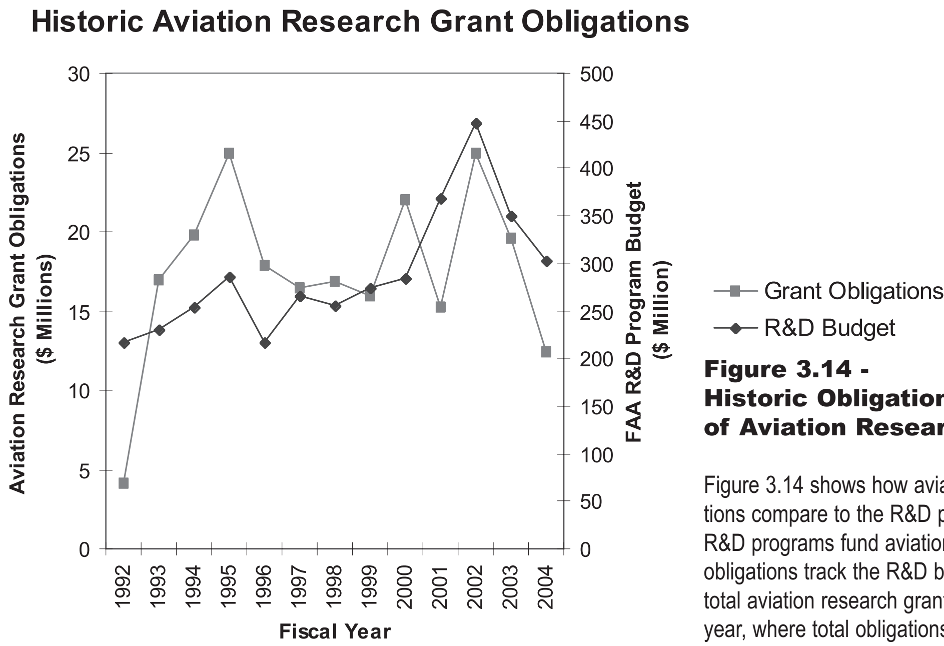


Figure 3.14 - Historic Obligations of Aviation Research Grants

Figure 3.14 shows how aviation research grant obligations compare to the R&D program budget. Because R&D programs fund aviation research grants, grant obligations track the R&D budget. The figure shows total aviation research grant obligations for each fiscal year, where total obligations include new grants awarded for that fiscal year plus follow-on awards to grants originating in prior fiscal years.

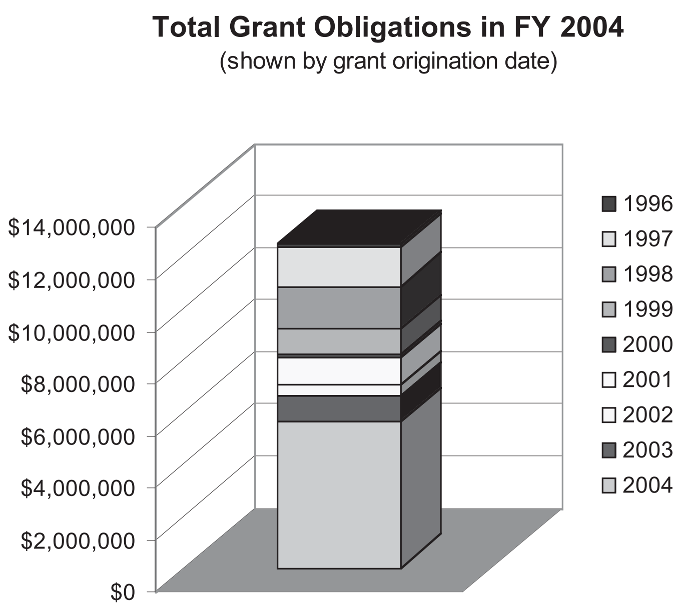


Figure 3.15 - Total Obligations of Aviation Research Grants in FY 2004

Figure 3.15 shows the total obligations for aviation research grants in FY 2004. The total obligations include all new grants awarded in FY 2004 plus follow-on awards that occurred in FY 2004 to grants originating in prior fiscal years. Almost $12.5 million in total obligations occurred in FY 2004.

FAA Fiscal Year 2004
Aviation Research Grants

Appropriation Account	FY 2004 Budget Line Item	Program	Grant Amount	Grant Number / Recipient / Subject/Description
Research, Engineering and Development (R,E&D)				
R,E&D	A11.b.	Propulsion and Fuel Systems	$989,506	2004-G-039 South Dakota State University *Flight Performance of Aviation Grade Ethanol: A Study of Detonation Resistance and Fuel Efficiency*
R,E&D	A11.c.	Advanced Materials/Structural Safety	$1,500,000	2004-G-031 Wichita State University *Development of Specification for an Interactive Aircraft Accident Data Collection and Analysis System*
R,E&D	A11.e.	Aging Aircraft	$224,928	2004-G-042 University of Dayton *Aircraft Tire Retread Escalation Process Research*
R,E&D	A11.g.	Flightdeck/Maintenance/System Integration Human Factors	$68,826	2004-G-032 The Board of Trustees of the University of Illinoise at Urbana-Champaign *National Airspace Human Factors Integration Plan for Unmanned Air Vehicles: An Evaluation of Human Factors Research Issues*
			$325,674	2004-G-041 The University of Texas at Austin - Department of Psychology *Advancing Aviation Safety: Understanding Threats, Errors, and Their Management in Normal Operations.*
R,E&D	A11.h.	Aviation Safety Risk Analysis	$53,071	2004-G-024 Oakland University *Implementation of the Rotor Manufacturing Induced Anomaly Database*
			$48,891	2004-G-028 Robert Wood Johnson Medical School *Identification of Aircraft Touchdown Point in Commercial Operations*
			$85,029	2004-G-037 The Research Foundation of State University of New York *Handbook of system Reliability in Airframe and Engine Inspection*
R,E&D	A11.i.	Air Traffic Control/Airway Facilities Human Factors	$166,385	2004-G-047 Ohio State University *Human Factors Issues for Collaborative Decision Making in the Naitonal Airspace System*
R,E&D	A11.j.	Aeromedical Research	$53,550	2004-G-034 Wright State University *Development of Specification for an Interactive Aircraft Accident Data Collection and Analysis System.*
		Total R,E&D	$3,515,860	
Facilities and Equipment (F&E)				
F&E ATD&P	1C01J	Airports Technology	$1,600,000	2004-G-038 Auburn University Foundation *Hot Mix Asphalt Airfield Pavement Research and Technology Program*
F&E Other		Navigation & Landing Aids	$399,900	2004-G-012 Florida International University *Development of New Control Unit Cabinet for the Federal Aviation Administration*
F&E Other		Free Flight Phase 2	$77,040	2004-G-044 Howard University *TMA Integrated Metrics Assessment Model*
		Total F&E	$2,076,940	
		Grand Total	$5,592,800	

Note: These grants originated in FY 2004. Additional obligations occurred in FY 2004 for grants originating in past years.

Table 3.9 - Aviation Research Grants Awarded in FY 2004

The FAA makes grants to institutions of higher education and nonprofit research organizations to conduct aviation research in areas the Administrator considers necessary for the long-term growth of civil aviation. Table 3.9 shows the new aviation research grants awarded in FY 2004, which totaled over $5.5 million. The table shows which R&D program funded each grant, the amount of the grant, and the grant recipient.

3.4 Evaluation

3.4.1 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 has been working to improve the quality of its processes by using the FAA iCMM to guide its improvement efforts. ICMM builds on the integration concept and provides a single model of best practice for enterprise-wide improvement. It integrates the following additional standards and models: ISO 9001:2000, EIA/IS 731, Malcolm Baldrige National Quality Award and President's Quality Award criteria, CMMI-SE/SW/IPPD and CMMI-A, ISO/IEC TR 15504, ISO/IEC 12207, and ISO/IEC CD 15288.

In 2002, the Office of Aviation R&D created a Portfolio Development Process Guidance/Reference Document to improve its internal management processes. It put many of its programs through a stringent FAA iCMM process to identify internal weaknesses and improve performance. As a result, in 2004 the Office of Management and Budget (OMB) found that FAA management of its RE&D program was "Effective" as part of its evaluation. See section 3.4.2.

Sponsor Reviews. To ensure effective engagement with research stakeholders, the Office of Operations Planning Aviation Research and Development organization uses program planning teams, comprised of internal sponsors (e.g., Office of Aviation Safety for safety, the Office of Airports for airport technology, and the Air Traffic Organization for capacity) and their technical community requirements groups, to review program outcomes and outputs, prioritize and plan research efforts, and make decisions about the research programs.

FAA Reviews. When R&D program formulation is complete, the R,E&D Executive Board, a group of senior executives representing the major FAA lines of business, provides final program approval. This process helps FAA establish research priorities to meet its strategic goals and objectives. Once approved, individual budget "white sheets" are submitted to the Office of the Secretary of Transportation and OMB for use in the President's Budget submission. The white sheets document each R&D program, providing intended outcomes, outputs, programmatic structure, partnerships, and a long-range outlook for the program. The FY2006 white sheets are included in Appendix A.

3.4.2 External Program Reviews

The FAA R&D program receives continuous external review as well to ensure that it meets customer needs and is technically sound. Reviews are conducted by organizations, such as the Research, Engineering and Development Advisory Committee (REDAC), OMB, and the National Academy Aeronautics and Space Engineering Board. In addition, FAA seeks feedback through user surveys and discussion groups; presents semi-annual progress reports at public forums and science reviews; publishes and presents technical papers; obtains formal peer validation of science; trains specific users on product usage; and maintains and shares lessons learned. Research is also presented at national and international conferences and in publicly available technical reports to obtain feedback from the external research community.

Research, Engineering and Development Advisory Committee. Established in 1989, the REDAC advises the Administrator on R&D issues and coordinates FAA's R,E&D activities with industry and other government agencies. The committee considers aviation research needs in six areas: air traffic services, airport technology, aircraft safety, aviation security, human factors, and environment and energy. A maximum of 30 members serve two-year terms on the Committee, representing corporations, universities, associations, consumers and government agencies. The Director of the Operations Planning Aviation Research and Development organization serves as the executive director of the committee. Information on the REDAC can be found on-line at http://research.faa.gov/redac.asp.

During 2004, the REDAC held two committee meetings and twelve subcommittee meetings. The committee produced three reports: the Report of the CNS Oceanic Working Group; recommendations on the JPDO; and a review of the FAA FY 2006 R&D program. Appendix B contains REDAC recommendations sent to the FAA Administrator in these three reports and the Agency's response.

Office of Management and Budget Program Assessment Rating Tool. In 2003, OMB started using a Program Assessment Rating Tool (PART) to rate the effectiveness of federal programs as part of the President's Management Agenda. PART is an accountability tool that attempts to determine the strengths and weaknesses of all federal programs. OMB will evaluate all federal programs over a five-year period for purpose, planning, management, and results/accountability.

In 2004, OMB evaluated FAA's R,E&D program and found it to be "Effective," the highest of the ratings awarded. The PART assessment program summary describes the FAA R,E&D as well-managed and results-oriented with 1) a strategic plan that sets forth clear long-term goals that are tied to program performance measures, 2) program goals developed in conjunction with sponsors and partners (e.g., industry, academia, other agencies, users), and 3) tremendous cost efficiencies through its Centers of Excellence which provide matching non-federal funds for programs. The PART Assessment of FAA R,E&D can be found in Appendix C or at http://www.whitehouse.gov/omb/budget/fy2005/pdf/ap_cd_rom/part.pdf. The FAA response to the assessment can be found at: http://www.whitehouse.gov/omb/budget/fy2005/pma/transportation.pdf.

National Academy Aeronautics and Space Engineering Board (ASEB). 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. It 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. In addition, the ASEB serves as a catalyst for introducing scientific and engineering ideas into existing aerospace programs.[14] Although the ASEB's primary sponsor is the NASA Aeronautics Research Mission Directorate, it also performs technical and policy studies for FAA, the National Science Foundation, the Defense Threat Reduction Agency, Air Force Space Command, and the Air Force Office of Scientific Research.

During 2004, the ASEB conducted three workshops for FAA to facilitate the exchange of ideas within the aerospace community on Uninhabited Air Vehicle (UAV) operations, the use of advanced composite engineering techniques in the Boeing 7E7 aircraft, and the JPDO proposed national plan.

[14] http://www7.nationalacademies.org/aseb/history_of_ASEB.html

3.5 Partnerships

The FAA enhances and expands its R&D capabilities by partnering with other government, academic, or industry organizations. Such partnerships help leverage critical resources, ensuring FAA's R&D program attains its goals.

3.5.1 Federal Government

Other federal departments and agencies conduct aviation-related R&D that directly or indirectly supports FAA goals and objectives. To leverage this R&D, FAA enters into many cooperative-working arrangements through formal agreements, such as memoranda of understanding (MOUs), 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 reflects a new effort by the government to leverage the R&D resources of multiple agencies to transform the nation's air transportation system over the long-term.

Memoranda of Understanding. Joint research activities are performed via MOU that set forth general areas for cooperative endeavor. An MOU is a high level agreement describing a broad area of R&D for the purpose of fostering cooperation between departments or agencies and developing a basis for establishing joint research activities. The FAA and NASA MOUs currently in force are listed in Appendix D.

Photo by Lockett Yee

Interagency Integrated Product Team.

In 1995, FAA and NASA formed the FAA/NASA Interagency Air Traffic Management (ATM) Integrated Product Team (IAIPT). Its mission is to plan and conduct integrated FAA/NASA ATM R&D leading to implementation of operational concepts and associated decision support tools to enhance efficiency, capacity, and flexibility, while maintaining safety, of aircraft operations for the current and future national airspace systems. NASA focuses on developing technology with the potential for long- and short-term NAS improvements while FAA prepares the technology for introduction into the NAS. More information on the IAIPT can be found at http://www.faa.gov/ara/iaipt.

R&D Field Offices. The FAA has two R&D field offices at NASA Research Centers to foster and provide technical coordination of FAA and NASA research that contributes to the modernization and safety enhancements in the NAS. The first field office opened in 1971 at NASA's Ames Research Center located in Moffett Field, California. The second field office, located at NASA's Langley Research Center in Hampton, Virginia, opened in 1978. Both offices report directly to FAA headquarters in Washington, D.C. Additional information can be found at http://faa-www.larc.nasa.gov.

Joint Planning and Development Office. The new JPDO, led by FAA, provides government-wide planning and coordination for aviation R&D. The JPDO is working with the U.S. Departments of Transportation, Homeland Security, Defense, and Commerce, NASA, and the Office of Science and Technology Policy to plan federal aviation R&D strategically and to focus it on the long-term needs of the nation's air transportation system. Through the JPDO, FAA will ensure that aviation-related research and technology being developed by other federal departments and agencies is integrated into the national air transportation system. See http://www.jpo.aero for additional information on the JPDO.

The Climate Change Science Program.

Thirteen federal departments and agencies participate in the U.S. Climate Change Science Program (CCSP) to coordinate scientific research through a set of seven linked interdisciplinary research elements, which together support scientific research across a wide range of interconnected issues of climate and global change. These research elements pertain to major components of 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*[15] contains a more detailed discussion of the research elements and the set of strategic research questions associated with each element. The research elements include: atmospheric composition, ecosystems, global carbon cycle, land use and cover change, human contribution and response, climate variability and change, and global water cycle. The FAA plays a key role in helping to understand the impact of aviation on the environment and, in particular, the impact on the troposphere.

Global Earth Observation System of Systems.[16] Over the next decade, a Global Earth Observation System of Systems (GEOSS) will revolutionize our understanding of the Earth and how it works. With benefits as broad as the planet itself, this U.S.-led initiative promises to make peoples and economies around the globe healthier, safer and better equipped to manage basic daily needs. The aim is to make 21st century technology as interrelated as the planet it observes, predicts and protects, providing science on which sound policy and decision-making must be built. The U.S. and developed nations have a unique role in developing and maintaining the system, collecting data, enhancing data distribution, and providing models to help all of the world's nations. For

15 *Strategic Plan for the Climate Change Science Program*, report by the Climate Change Science Program and the Subcommittee on Climate Change Research, July 2003.

16 www.epa.gov/geoss

example, today in the United States, weather is responsible for about two-thirds of aviation delays at a cost of approximately $4 billion annually. It is estimated that $1.7 billion of this cost would be avoided with better observation and forecasts. Within the federal government, 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 pertaining to aviation, including enhanced weather observation, modeling and forecasting, air and water quality monitoring and emissions. Under GEOSS, the Environmental Protection Agency and FAA work together to address the air quality and emissions issues facing aviation, helping the FAA in its regulatory compliance mission.

3.5.2 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, 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 uses various mechanisms to transfer its R&D results. Among these are:

Contracts. FAA R&D contracts range from applied research studies to developing, prototyping, demonstrating, and testing new hardware and software. The FAA also makes contracts with small businesses in compliance with the terms of the Small Business Innovation Research (SBIR) Program. For information on how to contract to do business with FAA, please see: http://www.asu.faa.gov/faaco/kenproj.htm or http://www.eps.gov.

Cooperative Research and Development Agreements. The use of cooperative research and development agreements (CRDAs) allow FAA to share facilities, equipment, services, intellectual property, personnel, and other resources with private industry, academia, or state/local government agencies.

Patents. As part of its commitment to assist industry through technology transfer, 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.

A list of current FAA CRDAs, SBIR awards, and patents is contained in Appendix D.

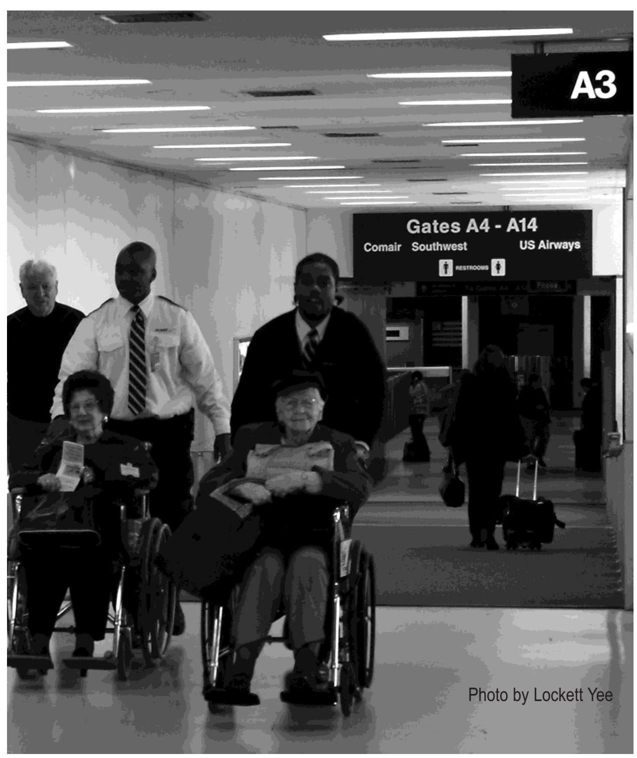


Photo by Lockett Yee

3.5.3 Government and Academia

The FAA also 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 (JUP) for Air Transportation Research is a long-term cooperative research partnership among three universities (Ohio University, MIT, and Princeton) to 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. An additional benefit is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical expertise in industry, academia, and government for the future.

Aviation Research Grants

All colleges, universities, and legally incorporated non-profit research institutions qualify for FAA research grants. FAA grant-funded research may use any scientific methodology deemed appropriate by the grantee. FAA does not require that individual proposals be linked to the immediate needs of its R&D projects. Rather, the evaluation criteria for grant proposals include the potential application of research results to FAA's long-term goals for civil aviation technology. For additional information on FAA's research grant program, see. http://www.tc.faa.gov/logistics/grants.

Air Transportation Centers of Excellence (COEs). The FAA has established seven Centers of Excellence (COEs) through cooperative agreements with academic institutions to assist in mission-critical research and technology. Through these long-term collaborative, cost-sharing efforts, the government and university/industry teams leverage each others resources to advance the technological future of the nation's aviation community. More information on the FAA aviation research grants and COEs can be found in Appendix D and at http://www.coe.faa.gov.


Photo by Lockett Yee

Other Federal Related Research & Development

Department of Transportation • Department of Defense
Department of Homeland Security • Department of Commerce
National Aeronautics and Space Administration
Environmental Protection Agency

Many federal departments and agencies conduct aviation-related research and development (R&D) that either directly or indirectly supports Federal Aviation Administration's goals and objectives. Many of these programs are closely coordinated with FAA through the work of integrated product teams, regularly scheduled meetings and technical conferences. The formation of the Next Generation Air Transportation System Joint Planning and Development Office (JPDO) will further help to integrate federal aviation R&D and to focus it on the mid and long-term needs of the nation's air transportation system.[16]

16 *"Anyone, Anything, Anywhere, Anytime,"* Commission on the Future of the United States Aerospace Industry, November 2002.

Photo by Lockett Yee

4.1 U.S. Department of Transportation

Role of DOT

The Department of Transportation (DOT) develops domestic and international aviation policy; facilitates intermodal planning among federal, state, and local governments to ensure that efficient linkages are created among air, land, and sea modes; and ensures that R&D funding benefits aviation as well as other modes of transportation. DOT also has oversight and management responsibilities for FAA.

Programs

Federal Highway Administration Pavements Research. Conducts research to make pavements that are safe, cost-effective, and long-lasting; can be effectively maintained; and meet the customer's needs. Develops breakthrough technologies and pavement systems that will radically improve the standards for pavement performance and how pavements are managed. Fills critical gaps in pavement knowledge, understanding, and technology.

Federal Highway Administration Long-Term Pavement Performance Program (LTPP). Provides answers to how and why pavements perform as they do. Gathers and analyzes data describing the structure, service condition, and performance of approximately 2,300 in-service test sections in all 50 states, the District of Columbia, Puerto Rico, and the 10 Canadian provinces. The LTPP database is the most comprehensive source of information on pavement performance in the world. Provides performance information on a broad array of pavement designs in a wide range of service conditions, making possible the development, calibration, and validation of pavement performance models.

Photo by Lockett Yee

Federal Highway Administration Highway Operations R&D. Conducts research on the use of Intelligent Transportation Systems and other cutting-edge technologies to move people and goods better, quicker, and safer. Focuses on two key areas, traffic management and enabling technologies. Traffic management research utilizes advanced technologies to develop dynamic control systems that will estimate and predict the status of a traffic network so that decision makers can make proactive traffic management decisions, including the intermodal connections with airports. Funds the Turner Fairbanks Highway Research Center Traffic Research Laboratory that develops and applies advanced technologies to create integrated, cost-effective solutions for managing and controlling the nation's transportation systems to maximize safety, mobility, and productivity.

Nationwide Differential Global Positioning System (NDGPS). Can pinpoint the position of a person or vehicle to within three meters. The NDGPS network of the nation-wide GPS-meteorological observing system allows the National Weather Service to provide more accurate weather forecasting. A higher accuracy version of the system is under development that will provide 10-cm accuracy nationwide. Higher accuracy will enable in-vehicle collision warning systems that could potentially save thousands of lives annually.

Role of FAA

The FAA mission is derived from its legislative charter and supports the DOT Strategic Plan. Its key elements are to: (1) establishes safety standards; (2) issues certificates for aircraft and components, airmen, and air operators; (3) licenses commercial space launches and re-entries and sites used for launch and re-entry; (4) monitors safety; (5) develops and operates the air traffic management system; (6) oversees the federal role in the national airport system; (7) sponsors research to reduce or minimize the environmental impact of emissions and noise on aviation system operations; and (8) sponsors research and education to ensure the aviation and commercial space transportation systems meet the nation's needs. The FAA also has management responsibilities for the JPDO.[17]

Photo by Lockett Yee

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

Role of DHS

The Department of Homeland Security (DHS) is responsible for the security of commercial and general aviation and their airports. To achieve this mission, the Department conducts R&D on a wide range of technologies to improve the detection, treatment and remediation of chemical, biological and radiological threats; facilitate inspection of cargo and people at airports; and secure critical infrastructure including information infrastructure.[18]

4.2 U.S. Department of Homeland Security

Programs

Transportation Infrastructure. Protects vital infrastructure by means of: biometric tools that control access and track passengers, modeling of infrastructure vulnerability and passenger/vehicle flow, and improvement of perimeter protection. While placing initial focus on airports, ensures these designs can be adapted to protect all vulnerable transportation modes.

Conveyance Protection. Assesses threat of explosives to aircraft, ferryboats, trains, busses and other transportation vehicles. Identifies and evaluates technologies and methods that can mitigate newly identified and previously known threats.

Human Factors Research. Improves screener/operator efficiency and effectiveness to reduce security manpower requirements. Improves screening equipment to increase screener performance. Evaluates the selection and testing that determines the readiness of screeners for duty, their vigilance under stressful conditions, and their need for periodic training.

Next Generation Passenger Screening. Accelerates the testing and evaluation of non-developmental automated explosive detection systems. Through process and procedure experiments, determines the suitability of each system for use, and anticipates its impact on operations. Systems to be evaluated include: document scanners; trace portals that screen individuals; and nuclear quadrupole resonance systems that screen shoes and carry-on items.


Photo by Lockett Yee

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

Next Generation Explosive Detection Systems. Supports technology development for checked baggage screening under the Phoenix Project. Provides upgrades to the existing explosive detection system (EDS) platforms; combines technologies to enhance detection, improve efficiency and lower false alarm rates; and develops evolutionary technologies to expand detection capabilities, increase throughput levels, and lower system costs.

Other Next Generation Checked Baggage R&D. Improves checked baggage screening through: human factors and ergonomic improvements, on-screen alarm resolution, bag-tag communication, and new-threat analysis. Develops innovative methods for implementing trace detection and other technologies that currently may be limited by cost, size, and environmental issues.

EDS Air Cargo Inspection Pilot Program. Applies new and existing technologies to inspect cargo to be carried on passenger aircraft. Studies the feasibility of expanding the canine screening teams for cargo screening.

Air Cargo Technology Improvement Program. Includes the Automated U.S. Mail Inspection Program. Pursues technological solutions for inspecting cargo and mail being carried on passenger aircraft. Assessments will include a variety of technology solutions.

Pulsed Fast Neutron Analysis (PFNA). Conducts operational assessment of the Pulsed Fast Neutron Analysis (PFNA) system in El Paso, Texas. The system is designed to detect explosives, drugs, money and chemical weapons.

Container Aerodynamic Inspection. Conducts aerodynamic studies for vapor and trace sampling on unit load devices (LD-3), trucks, and sea containers to develop sampling protocols for explosives detection. Determines if an efficient sampling strategy can be developed and used with trace detection to screen cargo.

Photo by Lockett Yee

Role of DoD

The Department of Defense (DoD) is the nation's largest user of civil transportation services. DoD uses the national airspace system for its operations (e.g., air defense), logistics, training, and weapons testing. It develops technology for military aircraft and related communications, navigation and surveillance systems that are used by civil and commercial aviation. It develops, acquires, maintains and operates the air traffic systems for its airfields; trains military air controllers; and develops and operates air and space surveillance systems, secure communications and the Global Positioning System that support its national security mission.

DoD deploys technologies that are used to manage its air forces globally and conducts extensive research in aeronautics, aviation medicine, aging aircraft, airworthiness of new classes of aircraft, crashworthiness, and human factors. Since many of the challenges faced by military, civil, and commercial aviation are similar and have similar technological solutions, much of the Department's research is coordinated with FAA and the National Aeronautics and Space Administration (NASA).[19]

4.3 U.S. Department of Defense

Programs

Joint Tactical Radio System (JTRS).

Employs software-programmable radio technology to deliver voice, data, imagery, and video communications. Modular design adjusts to include new features. Capacity (bandwidth and channels) expands and contracts as needed. Operates with legacy systems to ease its introduction into service. Intended uses include ground vehicles, handheld/manpacks, maritime/fixed sites, aviation, and space. Transports information for the Global Information Grid.

Global Information Grid (GIG). Provides immediate, mission-tailored information to facilitate decision making and secure access worldwide. Collects, processes, distributes, and stores information. Eliminates pre-processing of data to speed delivery of vital information and tags information in a uniform way to allow data-level interoperability. Distributed network promotes security. Immediate delivery of information protects safety. Information sharing expands capacity by integrating automation systems, reducing workload, increasing speed (data delivery, decision making, reaction time), and refining precision.


Photo by Lockett Yee

19 *"Anyone, Anything, Anywhere, Anytime,"* Commission on the Future of the United States Aerospace Industry, November 2002.

U.S. Department of Commerce

4.4

Role of DOC

The Department of Commerce (DoC) and, in particular, its National Oceanic and Atmospheric Administration (NOAA) develops, maintains and operates the National Weather Service (NWS), including the air and space-based systems that provide meteorological and weather forecasting data used by the nation's air transportation system.[20]

Programs

Forecast Systems Laboratory. Funded by the FAA Weather Program, provides icing, turbulence, ceiling and visibility, volcanic ash transport/diffusion, and convection products on the Aviation Digital Data Service. Supports development of tactical weather display upgrades, resolves data link issues through the Flight Information Services Data Link, and researches improvements to numerical weather prediction models and forecast verification methods.

National Severe Storms Laboratory. A NOAA laboratory funded by the FAA Weather Program, uses emerging technologies to exploit existing weather radar data to solve aviation problems. Produces algorithms for storm tracking and prediction, tornado detection, and identifying hazardous storms known as mesocyclones. Focuses on the use of polarized radar data for such purposes as detecting in-flight icing conditions and finding the weather convergence areas that cause the growth of convective storms. Improves both safety and efficiency in the NAS.

Environmental Technology Laboratory. A NOAA laboratory funded by the FAA Weather Program, explores new radar concepts, which are unlocking the secrets of weather processes that impact aviation. Focuses on using two radars operating at different wavelengths, along with radiometers and other sensors, to reveal in-flight icing conditions that could not otherwise be detected. The result will be a safer NAS for low-end general aviation operations as well as better efficiency in terminal area air traffic flow during adverse weather conditions.

Environmental Modeling Center. Develops improvements to numerical weather prediction models including the development of the Weather Research and Forecast model. Seeks new and better weather observations from ground, air, and space-based platforms and develops improved methods to assimilate observed data into the weather models. Research extends beyond aviation; however, the flying community benefits from more accurate, more-timely weather information.

Meteorological Development Laboratory. Develops a National Digital Forecast Database to shift from a product-based business to a service-based business. Rather than provide products to users, provides data in a standardized format that users can tailor for their own products and applications. Develops the Aviation Forecast Preparation System to aid weather forecasters in managing the terminal aerodrome forecasts (TAF) and develops statistical forecasting techniques that support meteorological decision making. The expected result is faster updates to the TAF when weather changes, giving the aviation community a more accurate picture of the weather.

Space Environment Center. Focuses on better models of solar flares that eject radiation and particulate matter toward Earth. The expected result is more accurate and more precise forecasts and advisories of solar-terrestrial effects. This information is especially important to the growing number of aircrews using polar routes, as solar activity impacts navigation, communication, and crew radiation exposure.

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[20] *"Anyone, Anything, Anywhere, Anytime,"* Commission on the Future of the United States Aerospace Industry, November 2002.

Photo by Lockett Yee

Role of NASA

NASA conducts aeronautics research and develops prototype algorithms to support the air traffic management system. The Agency develops new models and simulations used to improve air traffic management, and identifies technologies that can improve aircraft safety.[21]

4.5 National Aeronautics and Space Administration

Programs

The Aeronautics Research Mission Directorate (ARMD) at NASA Headquarters is responsible for managing the Agency's aeronautics research, and defining the investments that it makes on behalf of the Nation. These investments are for long-term high-risk undertakings that are beyond the scope, capacities, or risk limits of others to perform. NASA's aeronautics research consists of three integrated programs described below: Aviation Safety and Security Program; Airspace Systems Program; and Vehicle Systems Program.

Aviation Safety and Security Program (AVS&SP). Addresses the need for preventing both unintentional and intentional actions that could cause damage, harm, and loss of life, and for mitigating the consequences when these types of situations occur. Develops and integrates information technologies to maximize the effectiveness of information distribution for communications, and for the analysis needed to detect unsafe conditions before they lead to accidents or security incidents.[22]

System Safety Technologies (SST). Supports improvements in training, technology design and operational procedures to reduce fatal accident rates. Provides risk management tools that monitor system performance, identify developing conditions that may impact safety, measure safety and performance of the National Airspace System, and predict the system-wide effects of proposed interventions. Supports performance improvements in both air and ground crew by analyzing accident trends, studying current research in human cognition, and formulating strategies focused on decision making, aircraft handling, situational awareness, and resource management to reduce accidents caused by human error.

Vehicle Safety Technologies (VST). Develops technologies to improve human survival rates in accidents and to prevent in-flight fires. Develops airborne technologies to prevent vehicle system failures and loss of aircraft control. Also develops cost effective synthetic vision technologies for all aircraft types (commercial, business, general aviation) to reduce accidents related to poor visibility.

Weather Safety Technologies (WST). Reduces fatal accidents caused by atmospheric conditions, including weather and turbulence, by developing weather information and avoidance/mitigation technologies. Helps eliminate icing as a safety hazard to aircraft, and reduces ice-related flight delays by developing technologies that provide ice prediction, detection, avoidance, and mitigation capabilities.

System Vulnerability Detection. Reduces the vulnerability of the air transportation system to threats and hostile acts and identifies and informs users of potential security vulnerabilities in a timely fashion.

Airspace Systems Program (ASP). Conducts research to enable, through technology development and transfer, major increases in mobility and capacity within the air transportation system. Its objectives are to maximize the movement of aircraft through the system in a predictable and efficient way while maintaining safety, security, and environmental protection. Develops, models, and simulates new concepts of operation to accommodate current and future vehicle systems.[23]

Human Measures and Performance (HMP). Addresses human performance in airspace system designs. Develops training and operational procedures to reduce the potential for error and enable quick and appropriate response to flight-critical situations. Studies the human ability to process

[21] *"Anyone, Anything, Anywhere, Anytime,"* Commission on the Future of the United States Aerospace Industry, November 2002.

[22] NASA Aeronautics Research (brochure NP-2004-07-367-HQ)

[23] NASA Aeronautics Research (brochure NP-2004-07-367-HQ).

information and apply the knowledge to improve the safety and efficiency of displays, controls, interfaces, and procedures in the airspace system. Also conducts software and hardware development, simulation, and flight test of flight control systems.

Small Aircraft Transportation System (SATS). Reduces doorstep-to-destination travel times for trips to or from rural locations using small aircraft. Demonstrates high volume operations at non-towered/non-radar airports, enables lower landing minimums at minimally equipped landing facilities, increases single-pilot crew safety and mission reliability, and develops en route procedures and systems for integrated fleet operation.

Virtual Airspace Modeling & Simulation (VAMS). Conducts trade-off analyses among future air transportation system concepts and technologies. Defines a future system that meets long-term goals by specifying operational concepts, architectures, and technology roadmaps. Assesses the operational concepts, architectures, and technology roadmaps using scenarios, metrics, and evaluation methods. Also supports the trade-off analysis, system development, and assessment by developing and validating modeling and simulation tools and by conducting multi-domain, human-in-the-loop simulations.

Efficient Aircraft Spacing (EAS). Develops decision support tools to help air traffic controllers, airline dispatchers, and pilots improve the air traffic management and control process from gate to gate. Defines, explores, and develops advanced concepts that allow controllers and pilots to share responsibility for aircraft separation.

Efficient Flight Path Management (EFPM). Provides tools and concepts to assist controllers in decision making. Also develops, integrates, and tests tools for controller and pilot collaborative traffic management, en-route descent advice, and routing to enhance traffic flow.


Photo from NASA

Strategic Airspace Usage (SAU). Develops technologies for airborne and surface planning to improve the controller's ability to manage more aircraft and gradually adapt the airspace system to achieve the future concept of operations.

Space-Based Technologies (SBT). Develops communications, navigation, and surveillance technologies, architectures, and systems to improve efficiency of operations of the current and future NAS.

Vehicle Systems Program (VSP).

Focuses on the research, development, and transfer of the key enabling technologies applicable to six vehicle sectors: unmanned air vehicles, personal air vehicles, rotorcraft, Extremely Short Take-Off and Landing (ESTOL), subsonic aircraft, and supersonic aircraft. The technologies will enable environmentally friendly, easily operated, efficient and technologically superior vehicles for existing as well as new commercial applications. New vehicles will also enable NASA science missions that require high altitude, long endurance, and remote operations on Earth or other planets.[24]

Autonomous Robust Avionics (AuRA). Develops a "sentient" air vehicle that makes high-level decisions, flies with reduced or no human intervention, optimizes flight over a range of speeds (subsonic, transonic and supersonic), and performs maintenance on demand. Uses flight tests and simulations to demonstrate fully autonomous vehicle technologies that increase vehicle reliability by a factor of 10.

Efficient Aerodynamic Shapes and Integration (EASI). Develops and demonstrates mature tools and technologies that enhance mobility and reduce the emissions of future aircraft by 25 percent through improvements in aerodynamic efficiency. Also communicates to industry the potential benefits, risks, and implications of these technologies on future air vehicles.

Flight and System Demonstrations (F&SD). Provides flight test support to the Vehicle Systems Program. Develops and maintains design tools, facilities, and environments that allow teams of fewer, more specialized scientists and engineers to design and test highly complex integrated aerospace systems. Maintains a unique flight test capabilities for the nation.

Integrated Tailored Aerostructures (ITAS). Increases vehicle efficiency and maneuverability by developing ultra-light smart materials and structures, aerodynamic concepts, and lightweight subsystems. Enables high-altitude long-endurance vehicles, planetary aircraft, advanced vertical and short takeoff and landing vehicles, and beyond. Also develops, integrates, and demonstrates technologies that improve community access to efficient transportation while maintaining environmentally friendly vehicle performance.

Low Emission Alternative Power (LEAP). Develops unconventional propulsion and power systems to reduce or eliminate environmentally harmful emissions, including carbon dioxide (CO_2) and nitrogen oxides (NOx), and maximize energy efficiency. Also develops and demonstrates technologies for propulsion and power as well as alternate forms of energy.

Quiet Aircraft Technology (QAT). Develops technology that, when implemented, reduces the impact of aircraft noise to benefit airport neighbors, the aviation industry, and travelers.

Ultra-Efficient Engine Technologies (UEET). Develops engine technologies that balance the critical propulsion issues of high performance and reduced emissions to help reduce the impact of aviation on local air quality, ozone levels, and global warming.

24 NASA Aeronautics Research (brochure NP-2004-07-367-HQ)

Environmental Protection Agency 4.6

Role of EPA

The Environmental Protection Agency (EPA) protects human health and the environment. It works for a cleaner, healthier environment for the American people. EPA conducts research on ways to prevent pollution, protect human health, reduce risk and improve environmental conditions. It helps advance our understanding of how to improve the quality of air, water, soil and the way we use resources.

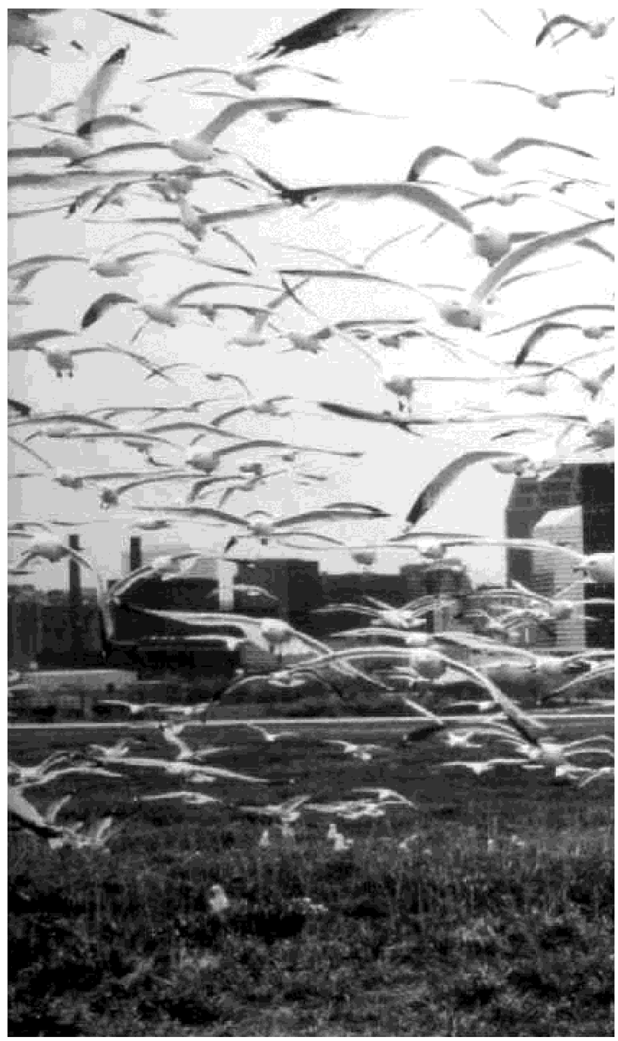
Programs

Air Quality Research.

Conducts research on the impact of air emissions on air quality and human health. Focuses on measuring and estimating emissions from aircraft and other airport-related vehicles. Develops air quality models to understand the impact of airport activities in the context of other air pollution sources in metropolitan areas.

Water Quality Research.

Conducts research in support of its role to regulate storm water runoff under the Clean Water Act, including runoffs resulting from airport deicing and fueling activities. Monitors pollutants through a general permit issued by states. Monitors the quality of drinking water supplied to passengers aboard aircraft in light of concerns about the overall levels of lead in drinking water.



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APPENDIX A

FAA R&D Program (White Sheets)

Detailed information for each FAA R&D program is provided in a separate attachment. The R&D programs included are listed below by appropriation and budget line item and alphabetically by program name.

R&D Programs Listed by Budget Line Item

Research, Engineering and Development (R,E&D)

A11.a. Fire Research and Safety
A11.b. Propulsion and Fuel Systems
A11.c. Advanced Materials/Structural Safety
A11.d. Atmospheric Hazards/Digital System Safety
A11.e. Aging Aircraft
A11.f. Aircraft Catastrophic Failure Prevention Research
A11.g. Flightdeck/Maintenance/system Integration Human Factors
A11.h. Aviation Safety Risk Analysis
A11.i. Air Traffic Control/Airway Facilities Human Factors
A11.j. Aeromedical Research
A11.k. Weather Program
A12.a. Joint Planning and Development Office (JPDO)
A12.b. Wake Turbulence
A13.a. Environment and Energy
A14.a. System Planning and Resource Management
A14.b. William J. Hughes Technical Center Laboratory Facility

Facilities and Equipment (F&E)

1A01A Separation Standards
1A01B Runway Incursion Reduction
1A01C System Capacity, Planning and Improvement
1A01D Operations Concept Validation
1A01E General Aviation and Vertical Flight Technology (GA&VF)
1A01F Safer Skies
1A01G NAS Safety Assessment
1A01H NAS Requirements
1A01I Wind Profiling and Weather Research Juneau
1A01J Airspace Management Lab
1A01K Wake Turbulence
1A02A Safe Flight 21 – Alaska Capstone
1A02B Safe Flight 21 – Ohio River Valley
1A02C Surface Moving Maps
1A02D Automatic Dependent Surveillance Broadcast (ADS-B)
4A10 Center for Advanced Aviation System Development (CAASD)

Airport Improvement Program (AIP)

— Airports Technology Research – Capacity
— Airports Technology Research – Safety
— Airport Cooperative Research Program – Capacity
— Airport Cooperative Research Program – Safety

Operations (Ops)

— Commercial Space Transportation Safety

R&D Programs Listed Alphabetically by Program

R,E&D Advisory Committee recommendations with FAA responses

APPENDIX B

Research Engineering and Development Advisory Committee

The FAA values the ongoing involvement of the Research, Engineering and Development Advisory (R,E&D) Committee in reviewing its current and planned R,E&D programs.* A formal process has been established whereby the agency replies to the Committee's reports. This document summarizes recent Committee recommendations and FAA responses.

FAA's R,E&D Advisory Committee and NASA's Aerospace Technology Advisory Committee (ATAC) will continue joint meetings to establish a framework that allows FAA and NASA to communicate, coordinate, and manage their safety and capacity goals.

Since preparation of the 2004 *FAA National Aviation Research Plan*, the Committee has submitted the following reports to the FAA and received detailed responses:

1. Memorandum for: Norman Y. Mineta, Secretary of Transportation; Jeffrey N. Shane, Under Secretary of Transportation; Marion C. Blakey, Administrator, Federal Aviation Administration; from REDAC Executive Council; Subject: First Meeting, May 16-17, 2004; dated May 26, 2004.

2. Final Report from the Working Group on Oceanic and Sparse Area Communications, Dated June 22, 2004.

3. Subcommittee Guidance on Fiscal Year (FY) 2006-2010 R&D Investments, Dated June 28, 2004.

In 2005, the FAA expects to receive the Committee's recommendations on FAA's planned research and development investments for FY 2007, including detailed recommendations from the standing subcommittees.

The Committee will also be providing recommendations to the Joint Planning and Development Office on the National Plan.

* http://research.faa.gov/redac.asp

1. MEMORANDUM FOR: NORMAN Y. MINETA, SECRETARY OF TRANSPORTATION; JEFFREY N. SHANE, UNDER SECRETARY OF TRANSPORTATION; MARION C. BLAKEY, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION; FROM REDAC EXECUTIVE COUNCIL; SUBJECT: FIRST MEETING, MAY 16-17, 2004; DATED MAY 26, 2004

First, we consider it an honor to be asked to advise you on the future directions of the national air transportation system. We unanimously believe that developing an integrated plan to guide the transformation of the current air transportation system is crucial for the economic health and security of America. With the exception of the electrical utility and telecommunications industries, no other sector of America is so central to the future of our national well-being. We commend you for making this a national priority, and we are honored to be asked to help.

We also want to commend the pioneering work of John Kern, Bob Pearce, Andy Anderegg and the rest of the Joint Planning and Development Office (JPDO) team. They provided us very constructive briefings and facilitated an excellent discussion about the current system and ideas to improve it, We especially want to congratulate them for the work they have done to bring the important constituencies in the Executive Branch together on this effort. This is unprecedented and merits special commendation. The future of the new air transportation system does depend on the collaboration of these agencies, and the collaboration they have developed is critical.

We have outlined below a set of observations and recommendations that reflect the consensus of the Executive Council. We are pleased to amplify on any of these points. Our perspective is to help you, and the Administrator in particular, guide the JPDO during the next critical six months, based on our collective experience and best judgment.

The JPDO is not properly resourced to produce the results you are committed to produce.

While the JPDO has made considerable progress since it was created, the tasks that lie ahead are enormous. We do not believe that the JPDO at its current resource level will be able to produce the results for which you are committed. There are only 10 full time staff members within the JPDO, and their efforts are largely consumed in coordinating the multiple interagency and industry subcommittees and workshops that are feeding material to your effort, and in presenting the broad goals of the JPDO to the many constituencies in the aviation industry. The JPDO lacks sufficient organic strength to produce the plan on schedule.

We fully appreciate the difficulty of standing up new organizations in the government.. The JPDO lacked budget resources until only one month ago. We also understand that under current plans, the upcoming budget request will be only $5 million for fiscal year 2006. Candidly, this is insufficient to develop a very complex roadmap for creating the plan you seek. You need to devote immediate attention to increasing the resource levels for the JPDO.

Legislative mandate is unachievable unless "re-scoped."

We have reviewed the legislation mandating the creation of the JPDO. We do not believe it is possible to create an "integrated plan for a Next Generation Air Transportation System" by December. We believe that it is possible to meet much of the intent of the Congress by developing the required vision statement and a general description of performance characteristics. It should also include a detailed description of the processes (including the necessary modeling and simulation) you envision for developing the plan in full. This will fall far short of being an integrated plan, but it is far belter to devote your efforts to a compelling vision statement than to spread your efforts too widely and produce a plan that cannot withstand the challenge of disparate stakeholders. A clearly articulated statement of objectives that make clear the desired "end-state" for the transformation plan would itself be an accomplishment.

Cogent statement of "the problem" needed.

We found the background material and discussions on future trends in the airline industry very helpful. But the compelling need for a national plan and, ultimately, for transformation must be stated forcefully and in ways that make clear the downsides for not acting on the plan. As we understand it, there are capacity, efficiency and security needs that cannot be met under the current OEP alone and that require moving to this new multi-agency model and transformation plan. These must be put in the clearest and most concrete possible terms and articulated plainly in the plan. The complex and arcane nature of the national air transportation system makes this articulation a challenge. We believe that the ability to develop metrics relating perforrmance of the national air transportation system to our national economy and national security would be critical contributors to making and presenting a convincing case.

The JPDO needs to acquire a "systems engineering" capability.

While the JPDO needs to put primary emphasis on developing a compelling vision statement, it cannot afford to defer the detailed work on performance characteristics for the new system. We do not believe that the current staff of the JPDO, or the broad network of volunteer efforts supporting it, can produce a viable master plan of system performance characteristics. To accomplish this, we believe the JPDO needs to acquire a systems engineering capability. Rather than try to create organic systems engineering capabilities, we believe the JPDO should acquire that capability through an FFRDC and/or industry. The JPDO had been planning to bring on a system integration capability several years in the future, for the purpose of assisting implementation of the plan. This is too late, in our judgment. System engineering and integration expertise is needed immediately, in particular because the bulk of the JPDO's in-house talent is totally consumed by coordination and stakeholder communications.

As the Secretary of Transportation, Under Secretary, and FAA Administrator, you need to help determine priorities over the next six months.

We are amazed at the broad range of issues on the JPDO agenda, and we commend the effort to take a truly national perspective. But, in our view, the range of issues is too large to execute well at this stage. The JPDO will find it very hard to establish priorities because the JPDO is chartered to pull together the interests of all the departmental stakeholders for the new system, reports to an interagency policy committee, and depends heavily on agency "volunteers" for its work. It was our sense that the JPDO was spread thin in an effort to satisfy all stakeholder interests in the new system. Without setting priorities, the JPDO will accomplish too little on too broad a range of issues. We believe that only you, Mr. Secretary, as Chairman of the Senior Policy Committee, can set priorities, with the support of the Administrator and the Under Secretary. You will have to make specific choices on what priorities for plan development should be met in the next six months and which can be set aside temporarily. We believe the JPDO should give you a set of options for the focus of its work, to consider within the next 30 days, and that you should then give the JPDO specific direction for the following five months. Absent that direction, we believe the JPDO will be forced to cover too wide a base and thus accomplish too little in critical areas.

Focus on key questions.

We believe that there are a small, but very important set of key questions, the answers to which will serve as major pillars in any future system. Such questions are, for example:

Can we move to digital links and away from voice command and control? To what degree? When? How?

Will communication systems be satellite-based only, or will we continue to rely on ground-based communication systems as well? What are the spectrum needs and likely spectrum availability to meet those needs in coming years?

What is the plan for full exploitation of GPS modernization and what are the needs for modernization and augmentation?

What are the alternatives and the prospects for expanding airfield throughput?

How do we provide routine access for new types of piloted and autonomous vehicles to the air transportation system?

Will the current patchwork of federal/state/local jurisdictional control remain in place or are there opportunities for rationalizing the governance of the national air transportation system?

What are the security strategies needed to mitigate potential threats to the air transportation system? How can we implement these strategies in an integrated approach (as opposed to adding layers of security—and inefficiency—on top of the current system)?

The answers to these questions will likely shape the entire master plan. As such, getting clarity on these key questions by developing and assessing alternatives early in the process will be essential to the plausibility and durability of the master plan.

Conclusion

Our intent is to meet once more this year, in the fall, and we are working now to find a mutually acceptable date. That meeting will be an opportunity for us to review the status of the JPDO's development of the national plan prior to the December submission of the report to Congress.

We are impressed by the magnitude and importance of the task you have assigned to the JPDO. You are fortunate to have such fine, dedicated individuals working there. Most of all, we believe this task is crucial for the economic vitality and national security of the country in the years ahead. We are honored to be asked to searve in this advisory capacity and stand ready to work with you. It is in this spirit we offer these recommendations, which we believe will be helpful in promoting a system the country needs.

2. FINAL REPORT FROM THE WORKING GROUP ON OCEANIC AND SPARSE AREA COMMUNICATIONS, DATED JUNE 22, 2004 – FAA RESPONSES INCLUDED

Recommendations: The FAA should initiate an activity to develop standards for an oceanic communication system that can meet the needs of advanced oceanic operations. The system should initially meet the requirements for 30/30 separation (30 miles lateral, 30 miles longitudinal), but should have the potential for closer spacings when and if indicated by demand. The standards should be realizable by a system that is economical to install and operate for a broad class of aircraft.

The performance standards should be expressed as Required Communication Performance (RCP).

Specific activities should include:

Designate organizational responsibility within the FAA for the development of oceanic communication standards and systems.

Assess the performance of Iridium, especially its short-message service, as a means of supporting ADS and CPDLC.

Assess the ability of upgraded HFDL to serve as a primary means of communications for oceanic operations.

Examine new approaches[1], e.g. TDMA over INMARSAT.

Reexamine the minimum communication performance required to support reduced oceanic separation standards (initially 30/30, but ultimately lower).

Request RTCA to form a Special Committee on oceanic data link to encourage and provide a forum for industry involvement. An early task for this Special Committee would be defining a standard interface among aircraft flight control systems, CMU and pilots.

Conduct a trade study that examines the user implementation costs and benefits for each of the proposed links and for a broad class of aircraft including cargo, business and military, over the next several decades.

Participate actively in the Eurocontrol NexSAT program.

Continue to work with ICAO and other relevant groups to ensure that new international standards for minimum communication performance are developed and adopted.

Investigate means of reducing FANS installation and/or message traffic costs.

If a potential new communication system emerges from these activities, identify a "lead carrier" oceanic airspace user to initiate the avionics certification process.

FAA Response:

Having reviewed the final report, we concur with the overall recommendations of the group in regards to the need to explore alternative communication media. We also concur with the conclusion that the Federal Aviation Administration (FAA) seeks to leverage communication media developed for commercial and other uses.

Finally, we feel that the original scope of the workgroup's efforts was too narrowly focused on communications. For the purposes of research and development, we would like to see emphasis placed on improving oceanic air traffic management and collaborative decision-making concepts, many of which could directly improve the efficiency of oceanic airspace and provide significant benefit to the airspace users. We would support further analysis to prioritize research and development in communication enhancement against other potential research and development initiatives.

[1] In addition to the approaches discussed here, two additional approaches should be considered. The first is the Boeing Connexion system. While Connexion is primarily focused on large-aircraft passenger communication, it will be carried by many airline aircraft and could potentially be useful for ATC communication. The second is the Boeing/INMARSAT proposal for Aero-BGAN (Broadband Global Aero Network), which appears to have many of the desired attributes. Unfortunately the Working Group did not become aware of the details of this proposed system until after the completion of its data-gathering activities.

3. SUBCOMMITTEE GUIDANCE ON FISCAL YEAR 2006-2010 R&D INVESTMENTS, DATED JUNE 28, 2004 – FAA RESPONSES INCLUDED

a. Subcommittee on Air Traffic Services

1. National Plan for Transformation for Air Transportation: The FAA must play a vital role as a system integrator to validate the foundation developed in the Joint Program Development Office's (JPDO) National Plan. The transformed air transportation system must be scalable to accommodate and encourage growth in domestic and international transportation, accommodate a wide range of aircraft and types of operations, maintain safety and security, and minimize environmental impact and dependency on foreign energy sources. As the system integrator, the FAA must ensure that the transformed system will meet national inter-modal and economic needs. The FAA must:

Develop and validate joint requirements for all agencies and develop viable transition strategies, including early implementation options;

Integrate, evaluate, and validate potential "total-system" solution alternatives in a total system context that addresses all the national goals simultaneously;

Develop a system-wide transformation plan, including transition roadmaps; and

Develop a virtual laboratory across agencies to assess technologies and concepts for early implementation.

Recommendation: We believe the FAA budget for FY 06 of $3.5 million, is insufficient for JPDO and FAA needs. This level of funding will have to be increased to support the development of the JPDO's National Plan and to fund its role of system integrator.

Response: We agree additional requirements and resources are needed for systems integration and the transformation roadmap, and we are in the process of creating a program plan for accomplishing this requirement.

Additionally, we are trying to identify programs that collectively support the future; JPDO will work to create an inventory and serve as a clearinghouse vehicle that will be useful to agency programs leading to the future.

The creation of virtual labs and development of requirements could be accomplished thru Integrated Product Teams or multi-agency teams as identified in the National Plan.

2. Wake Turbulence: This research holds significant promise for great payoff in safety and capacity benefits. A joint FAA/NASA program is ongoing whose content and research strategy agree with the recommendations of the independent joint study by Lincoln Laboratory and MITRE/Center for Advanced Aviation System Development. This research, if successful, will provide near-term increases in runway throughput through procedural changes, mid-term benefits using weather dependent procedures, and long-term benefits by incorporating automation enabled decision support tools. Potentially this research will yield a low-cost, high-payoff method for increasing airport capacity.

Recommendation: We believe that the current funding of $2 million is insufficient to complete the research required for the current effort and will delay implementation of some capabilities. Also, additional funding will be required to support new concerns brought about by domestic Reduced Vertical Separation Minimum (RVSM), Required Navigation Performance/Radar Navigation (RNP/RNAV) routes, and the introduction of the new Airbus 380.

Response: We recognize that the requested funding will not allow for optimal progress; however, it does allow for the effort to move forward at a reduced rate in a constrained budget/ priority environment and represents a significant FAA commitment to this research area. FAA is still evaluating the requirement for accomplishing wake turbulence research tasks associated with implementation of domestic RVSM, RNP/RNAV routes, and introduction of the new Airbus A-380 aircraft.

3. Weather-Efficiency: The aviation weather program has produced effective and needed products and has more of them under development. The continued reduction in funding will either halt or slow work in many productive research areas.

Recommendation: We support and believe it is critical to have more accurate short-term weather predictions and believe we need mid- and long-term predictions in convective weather. The FAA has really outreached with NASA to make sure both agencies are in sync. We believe the FAA should do the same with the Department of Defense (DoD), which may provide additional required funding.

Response: The REDAC correctly notes the budget impact faced by the Aviation Weather Research Program (..."The continued reduction in funding will either halt or slow work in many productive research areas") and the need for more accurate short- mid- and long-term forecast products. The recommendation said that the program should reach out to DoD, "which may provide additional required funding." The Aviation Weather Research Program does interface with DoD on a routine basis through the JPDO and other public weather events. Since the REDAC meeting, the Aviation Weather Research Program met directly with the DoD officials on two separate occasions (members of the DoD Policy Board on Federal Aviation and the DoD representative to the FAA Management Advisory Council). DoD is willing to provide weather requirements but does not have any financial resources for aviation weather's use.

4. Human Factors: The committee was briefed on the human factors program. We would like to see the Human Factors program look into the future National Air Space (NAS) and assess the role of the controller, the pilot, the maintenance technicians and any new human roles identified. We would also like to assess the number of facilities, their size and the number of people required at each facility for the future NAS.

Response: We agree. We look to NASA and other research partners to perform research and development (R&D) as part of a broader system engineering assessment of future concepts and advanced technologies, and such assessments could subsequently provide increased clarity regarding realistic staffing and facility projections and the assessment of requisite skills and abilities to ensure efficient controller operations. We anticipate that the national plan soon to be released by the JPDO will provide us with a vision on how the future NAS will be structured. We look forward to working with NASA, MITRE, and our FAA research partners on flight deck human factors to ensure that the NAS continues safe and efficient operations by all performers including air traffic controllers, pilots, airway facilities personnel, and aircraft maintainers.

5. System Wide Information Management (SWIM): The committee was briefed on the Global Communications Surveillance System (GCNSS) program. The committee believes the network-centric system is part of the future NAS and would like to know more and understand what and how the various projects fit together to achieve the SWIM functionality.

Response: The GCNSS program is not developing SWIM alone and is dependent on other organizations and programs for input to SWIM system architecture, design, and concept of operations. The primary role of the GCNSS program is to integrate other teams' SWIM related activities. To maintain cognizant awareness and coordinate the interdependencies needed to meet the FAA's SWIM objectives, we use a Teams-leading-Teams organizational structure. The other Teams that GCNSS rely on are:

- Air Traffic Organization Technical Operations (FAA Telecommunications Infrastructure [FTI])
- Air Traffic Organization Terminal Team (Flight Data Object)
- Joint Program Development Office (interagency SWIM policy)

The NAS Service Engineering Team led by Mr. Steve Bradford is responsible for SWIM system engineering. He has a Policy Team, a Technical Team, and Transition Team overseeing integration of the various projects that provide SWIM functionality.

The FTI will be used for network and distribution of SWIM data and information. Surveillance Data Network (SDN) with its sensor manager's and multi-sensor fusion tracker will be used to publish SWIM surveillance information. The Terminal Planning System Engineering Team led by Mr. Jay Merkle is developing the Flight Data Object, which will eventually replace the SDN Surveillance Data Object. In parallel with system engineering and prototyping activities, the JPDO in their National Work Plan is coordinating the efforts of NASA, DoD, and the Department of Homeland Security (DHS) to ensure interoperability of Network Centric Operations. Additionally, the Director of Operations Planning Systems Engineering is writing policy that will require future and some present NAS systems to provide capability to interface with SWIM.

A copy of the GCNSS I final report will be provided to the REDAC Air Traffic Services (ATS) Subcommittee, which includes specific details and diagrams of the SWIM and SDN system architectures.

6. Research Product Implementation: The FAA has and continues to lack the funding or personnel resources to convert research products of its own R&D, or that of NASA, Mitre, and DoD, into field implementable products. We believe the FAA needs to find a way to achieve this important activity if any research programs are to be successful.

Response: We believe an important first step has been taken with the establishment of the new Air Traffic Organization (ATO) to address the Committee's concern for effectively introducing new research programs into the NAS. A major goal of the ATO's Operations Planning organization is to be the link between potential sources of product research and development and the ATO Service Units and with end users. To accomplish this, key organizational elements in the Operations Planning organization have been established. These include, Systems Engineering (determines NAS evolution and communicates shortfalls), Technology Development (identify/assess ideas, coordinate research readiness and Service Unit interface), Research and Development (execute research programs), International and JPDO Liaison (international coordination and JPDO vision formulation and future requirements), and Performance Analysis (measure performance). Success of the Operations Planning organization will be in part measured by the time its takes to prepare new technology for implementation into the NAS. The barriers that must be addressed to be successful include:

- Focusing on the types of research being conducted;
  - Based on JPDO forward interagency planning and System Engineering evolution plans;
  - Assessment, selection, and prioritization of meaningful technology ideas; and
  - Ensure that research products meet the needs of the Service Units
- Defining the interfaces between FAA and NASA and the rest of the research community; and,
  - Clear direction on research objectives, communication/interface with FAA, and research sponsorship; and
  - Influence non-FAA research priorities
- Reading research products;
  - Ensure the broad issues related to certification, standards, interoperability, human factors, etc. are addressed as part of the research process; and
  - Establish business cases based on both financial and user benefits

Removing these barriers, through a more disciplined organizational approach and improved coordination, will allow for the timely implementation of technology improvements.

The activities now being conducted by the Operations Planning organization along with the positive results from the JPDO on long range interagency vision are beginning to structure a work environment that will improve the NAS research to implementation process. Continuing these activities will be critical, as resources remain limited and the need to implement NAS improvements that address both FAA and user benefits continue.

b. Subcommittee on Airports

Recommendation: Include research in human factors on real time display of bird radar in tower.

Response: As part of the development of airport bird strike advisory systems, real-time risk information will be displayed in a mapping format similar to weather information. Human factors issues associated with the use of that information by air traffic control (ATC) and pilots will be addressed by initiating a limited number of tests in FY 06. For ATC, a prototype bird strike risk display will be installed in a control tower, and its use by ATC will be evaluated over a period of time. For pilots, information will be relayed to the cockpit and pilot feedback will be analyzed. Bird strike risks information will also be made available to pilots as part of flight planning. Use of that information, such as increased awareness, during the flight will be assessed with volunteer pilots. Based on these feedbacks, the delivery of real-time bird strike risk information will be refined to ensure that it gets used by users to increase air safety.

Recommendation: Review of the International Civil Aviation Organization (ICAO) taxiway centerline light spacing.

Response: We have initiated a project to study this issue. The fixtures are on order from manufacturer.

Recommendation: Investigation of problems at airports with variation of brightness of Taxiway Centerline Lights.

Response: We agree that this is a concern that needs to be evaluated. The Office of Airport Safety and Standards (AAS) is preparing a request for research to initiate this project.

Recommendation: Further Integrating LEDs Into Existing Airfield Fixtures.

Response: We concur with the need to integrate LEDs into existing airfield fixtures. This work is part of the ongoing Taxiway LED lighting project. A report is due in July 2005.

Recommendation: Coordinate deicing research with aircraft safety division work.

Response: Ryan King from AAR-410 along with Charlie Masters from AAR-470 attended the 2004 Air Force Deicing Working Group Meeting in Las Vegas. At that meeting, we covered a range of topics applicable to both aircraft deicing and runway de/anti-icing. The following topics were discussed: equipment, methodologies, chemical application rates, and types of chemicals, chemical effects on aircraft metals, environmental issues, and alternatives to chemicals. It is interesting to note that much of the concern that is being expressed now about the environmental impacts of deicing chemicals is what sparked the very successful development of environmentally friendly technological alternatives to the chemicals, like infrared. Additionally, we are currently exploring the efficacy and application of anti-icing pavement overlays that may reduce the amount of chemicals needed to achieve effective anti-icing as well as reduce the frequency of the chemical application.

Recommendation: The Subcommittee asked for research on polyurea paints.

Response: A project to evaluate polyurea paints has been initiated.

Recommendation: Consider adding airfield capacity research to program.

Response: Discussions are underway with the AAR-400 Program Director and the Deputy of Airport Planning and Programming (APP) to consider expanding the Airport Technology Research area to include Capacity and Environmental Effects.

c. Subcommittee on Aircraft Safety (SAS)

1. The committee believes that aircraft safety-related areas of Chapters 6 and 8 and select portions of the F&E - activity 1 should be separate from ATO; placement under the Associate Administrator for Regulation and Certification (AVR) is one option. The SAS has reviewed the Advanced Technology and Prototyping budget line items and believes the following should be part of the separation: General Aviation/Vertical Flight Technology, Safer Skies, Airport Research, NAS, Safety Assessment, Cabin Air Quality Research, Separation Standards, and Lithium Technologies.

Response: We understand the committee's recommendation and will take it into consideration as the agency works out the various roles and responsibilities that are involved with the establishment of ATO.

2. UAV is an urgent issue that needs research support. The committee supports the UAV above-target initiative but does not include UAV weather. With regard to flight in weather conditions, the committee believes FAA aircraft standards are adequate for design and production of UAVs. UAV weather capability should be part of the designing and operating certification of UAVs. Weather forecasting and information research should focus on improving forecast resolution and make it available to the aviation community as a whole and not compartmentalized into specialty areas. Finally, other government organizations should contribute to FAA UAV research.

Response: We agree that the Unmanned Air Vehicle (UAV) is important and is working with the JPDO to acquire research funding. AVR has initiated an Unmanned Aircraft Concept Development Team that will direct the resources of the Agency with regard to developing concepts regarding certification, surveillance, operation procedures, etc. With respect to the weather research, the FAA agrees that it should be focused on activities that support the aviation community as a whole. As AVR addresses UAV operational certification, it will address issues associated with UAV weather operations as appropriate.

3. Industry has reported on numerous occasions (e.g., RTCA TF4) that software certification is rapidly becoming the largest roadblock to introducing new technologies in all types of aircraft. The FAA's R, E&D priorities do not reflect this situation. The committee believes that FAA should increase efforts to develop new software assessment and validation tools that would decrease the cost and time involved in certifying software in new and existing digital products. The FAA's lack of support for software digital systems would indicate that it hasn't been presented properly. In order for FAA to better understand industry's problems with certifying software and then develop solutions, FAA should ensure it has adequate interaction with industry, perhaps by increasing the number or expertise of its National Resource Specialists or Chief Scientists in this area. The committee recommends that the software digital systems research requirements be reconsidered.

Response: We reviewed and reconsidered the research presented. It was determined that the specific task called "software assessment and validation tools" has been successfully completed. The research activities presented to the Aircraft Safety Subcommittee that will continue in FY 06 are those necessary to continue developing software assessment and validation tools even though the task titles have changed. The FAA realizes the importance of these tasks; however, the FAA RE&D funding request has been reduced by 30 percent with respect to the FY 04 initial request. That reduced level is maintained in subsequent years. Other commitments related to continued airworthiness and safety of aircraft were rated as a higher priority. The FAA is aware of the emphasis that this Subcommittee and the Air Traffic Services' Subcommittee have placed on software digital system certification and has requested assistance from NASA in this area. The FAA is also continuing to work closely with industry in developing software certification standards. On the issue of additional Chief Scientists, it was recently announced that the Chief Scientist and Technical Advisor for Aircraft Computer Software is returning to the public sector. The FAA will need any assistance the Subcommittee can provide in identifying qualified candidates to fill this position.

4. The committee noticed that there seems to be a proliferation of Centers of Excellence (COEs) proposals, e.g. composites, cabin air quality, and UAVs. The committee is very concerned that this situation will diminish the value of COEs and may result in duplicative activities. The committee recommends that the FAA adopt a deliberative process that will determine if a COE is an appropriate vehicle for sponsoring research and assess the costs/benefits of creating the COE.

Response: We agree and will develop a deliberative process that will determine appropriateness of a COE as a research-funding vehicle.

5. In setting safety-research priorities FAA should give high priority to research recommendations made by the Commercial Aviation Safety Team (CAST) and the General Aviation-Joint Steering Committee (GA-JSC)

Response: We are committed to the CAST and the GA-JSC process. The FAA Office of Aviation Research is a voting member of the CAST, and members of the organization have assisted in drafting R&D recommendations for presentation to the CAST. Several ongoing research activities in the FAA R&D portfolio directly support CAST R&D Safety Enhancements. The FAA will continue to give the CAST and the GAJSC recommendations the highest priority possible and will make every effort to collaborate with NASA and DOD.

d. Subcommittee on Human Factors

1. With the reorganization into an ATO structure, the subcommittee sees a potential for research to have too close a time focus. Sponsors with requirements may not have the long vision needed to begin research whose payoff may be years away, but without which the effectiveness of future systems may be compromised.

Response: We rely on NASA and the JPDO to help define and address mid- to long-term requirements. We continue to work with the ATO to define and execute research addressing near-to mid-term requirements.

2. The Human Factors organization in FAA needs to be able to pursue a long-term research plan as well as to respond to the plans of other groups, e.g., acquisitions. The FAA also needs to recognize that even the best plans need to respond to rapid global and technological changes. Two specific needs seen by the Subcommittee are:

   a. Human Factors issues surrounding the introduction of UAVs into civil operations. This is presently being responded to as an over-target item but requires a fuller study. Such a study should begin by identifying all potential human interfaces to civil UAV operations so that responses to specific items can begin in a timely manner

Response: We recognize the importance of understanding the human factors issues surrounding the introduction of UAVs into civil operations. As a first step in that direction, we have initiated a research activity that will produce the following report by the end of 2004: *The National Airspace Human Factors Integration Plan for Unmanned Air Vehicles: An Evaluation of Human Factors Research Issues.*

b. Human Factors (HF) implications of outsourcing, particularly to offshore locations. The R&D program in HF has addressed parts of this in the maintenance domain, but the advent of instant internet communications has raised the possibility of other functions being outsourced. These could include dispatch, planning, and real-time maintenance advice by operators, as well as such FAA functions as Flight Service. The FAA/HF organization needs to study the potential HF issues for any services that are likely candidates for outsourcing and provide recommendations for maintaining low levels of error.

Response: We agree with the Committee's perspective. When the need for outsourcing in new functional areas arises, then we will evaluate the associated human factors issues.

3. Access for researchers to flight operations and other facilities has become more difficult in the current economic and security climate. The FAA needs to develop a process to ensure access to the operational environment by researchers. Human factors research needs to be grounded in actual operations to ensure validity and acceptance of results. In our report to the September 2003 REDAC, the HF Subcommittee recommended that the FAA act to review the Research Management Plan (RMP) process as it was severely hindering the HF research mission. ("Alternatives to the RMP should be identified for providing coordination for access to facilities for FAA funded research activities".) No action has been taken. The subcommittee recommends elimination of the RMP process.

Response: With the transition to the ATO, it is not clear how the new operational service units may opt to use the RMP approach. Recently, we have been able to arrive at a workable solution, such that all of our human factors research occurring in the field and involving access to controllers is proceeding on schedule. At this point in time, security constraints remain in place limiting access to the flight deck.

4. The FAA is establishing an ATC Safety Management and Oversight process. FAA's HF expertise needs to be a core part of this process to ensure that human roles in achieving safety are considered in depth.

Response: We are currently pursuing several initiatives defining and assessing human factors best practices and tools in safety management systems. The results will provide the foundation to enable effective integration of human factors into the ATO's safety management and AVR's ATC safety oversight processes.

5. Air traffic is expected to increase by a factor of two or even three over the next few decades. Research is needed on human ATC limits on future growth and complexity expanding concurrent small-scale trials. Separation responsibilities is seen as a divide-and-conquer approach until about 2015, but what will human roles be in systems that have to deal with volumes of traffic that preclude traditional approaches? These are difficult questions, and research may need to begin now if timely answers are to be found.

Response: The FAA relies on NASA programs such as Distributed Air Ground – Traffic Management (DAG-TM) to address many of these issues. Additionally, the JPDO plan is to look at trials of new technology that lead to alternative concepts for the future, and the JPDO approach is, pending funding and other constraints, effecting planning and execution of those trials.

6. The Subcommittee was impressed with the work underway in Air Traffic and Airway Facilities. The project on human factors at the OCC was commended for its comprehensive approach to finding HF issues and for its active involvement with upper management to help insure implementation of interventions. This project would benefit from studying the best practices in other countries and other industries. A better case from these can be made for investments based on life-cycle systems costs.

Response: We appreciate their perspective, and we will continue to work areas such as this in the future.

7. Three projects helping integrate HF information showed considerable initiative and are good examples of interagency cooperation.

   a. The projects and requirements database;

   b. The government interagency HF database; and

   c. The HF knowledge portal

All three fulfill real needs within the FAA and are well-designed. They also have considerable value to other agencies, and there is evidence that these agencies are using these tools. Such initiatives should receive publicity within the FAA, and the HF profession as examples of good designs for functionality and usability.

Response: We appreciate their perspective, and we will continue to enhance and use these tools and publicize their availability to potential users inside and outside the FAA.

e. Subcommittee on Environment & Energy

Observation: The intergovernmental JPDO is a Department of Transportation priority. Aviation noise and emissions could limit future aviation growth, and it is critical that FAA maintain a robust environmental R,E&D effort. Increased system capacity and reduction in operational delays are an important means to reduce aviation emissions. FAA R,E&D programs must be well coordinated among separate functional units to ensure program integrity and timely delivery.

Recommendation: AEE needs to be fully engaged in the JPDO process.

Response: The Office of Environment and Energy (AEE) is engaged in the JPDO process. AEE personnel are drafting documentation and are engaged in the review process. AEE is closely coordinating the study on "Long-term Environmental Effects of Aviation" directed by the Congress in the FAA Reauthorization with the JPDO effort, which will ensure commonality of goals and objectives.

Recommendation: FAA must maintain a research effort that is operationally enabling.

Response: We agree that the FAA must fund operationally enabling research. This is certainly very true in the area of environment and energy. For example, in 2004 under our research program we upgraded the Emissions and Dispersion Modeling System (EDMS) to allow assessment of emission savings from actions to reduce ground emissions resulting from the newly launched Voluntary Airport Low Emissions (VALE) program. Also, through a newly established Center of Excellence, Partnership for Air Transportation Noise and Emissions Reduction (PARTNER), the FAA flight demonstrated two sets of area navigation (RNAV) procedures that include the favorable noise abatement features of Continuous Descent Approach (CDA). These are but two examples of environmental "operationally enabling" research.

Observation: AEE has identified the right priorities for the individual elements of its R,E&D threshold program based on the September 2003 constrained FY 05-09 funding scenario. OMB has reduced funding for the AEE R,E&D threshold program below this amount. In particular, the Aviation Portfolio Management Tool (APMT) may be insufficient to meet projected needs. The AMPT, supported by the Aviation Environmental Design Tool, is intended to provide the cost-benefit analysis capability necessary for data-driven decision making.

Recommendation: Increase AMPT funding to $14.35 million over the next five years.[2]

Response: Developing analytical tools to allow us to analyze and mitigate the impact of noise and emissions, interdependently and taking costs into account, is a critical element of our strategic plan. The FAA has increased the R&D budget request to support this initiative. While we share your concern that this level investment introduces a high level of risk, within our constrained budget we simply cannot allocate additional dollars to APMT. However, we are working with the FAA's Federally Funded Research and Development Center (FFRDC), the MITRE Corporation's Center for Advanced Aviation System (CAASD) to help us deliver APMT capabilities in a timely manner.

Observation: The environmental and economic impacts of aviation need to be considered within the context of those from other sources. Lack of measurement techniques and consistent methods to quantify emissions prohibits intermodal comparison. Current modeling capability does not provide decision-makers the tools to analyze intermodal transportation issues.

Recommendation: AEE must address measurement techniques and quantification of emissions in relation to those from other sources. Any R,E&D program augmentation will require new funding.

Response: We agree with your recommendation. First, AEE is working through the PARTNER Center of Excellence and with other government agencies and stakeholders to enhance our understanding of aviation emissions. We are seeking to characterize the emissions (both small particles and condensable gaseous species) from aircraft and airports through measurements, to enhance our ability to model these emissions, and to determine the health effects of emissions. As you recommend, we do seek to put aviation emissions in context of other sources. As we learn more, and especially as we complete the study on "Long-term Environmental Effects of Aviation" directed by the Congress, we will address funding issues. One area which might help in this endeavor is the Airports Cooperative Research Program (ACRP).

Recommendation: FAA work with the Department of Transportation to undertake development of consistent modeling capabilities to facilitate integrated cost-benefit analysis of aviation, rail, marine, and road transport environmental issues.

Response: We agree that it is important to under take environmental cost-benefit analyses using a multimodal approach. Our efforts to develop comprehensive analytical tools to address noise and emissions do consider multi-modal concerns. We are coordinating with the Department of Transportation as we develop our capabilities. However, we feel that it is important to first develop a capability for aviation, which we need to inform our activities within the ICAO Committee on Aviation Environmental Protection. As we mature these tools, our plans include ensuring we consider inter-modal concerns.

[2] FY 05 = $2.5 million; FY 06 = 2.41 million; FY 07 $2.63 million; FY 08 = $3.37 million; FY 09 = $3.44 million

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APPENDIX C

Office of Management and Budget (OMB) Program Assessment Rating Tool assessment of FAA Research, Engineering and Development

2004 Program Assessment Rating Tool) results for the FAA R,E&D programs by the Office of Management and Budget

OMB has developed the Program Assessment Rating Tool (PART) to assess the effectiveness of federal programs and help inform management actions, budget requests, and legislative proposals directed at achieving results. The PART examines various factors that contribute to the effectiveness of a program and requires that conclusions be explained and substantiated with evidence.

The PART questionnaire is divided into four sections: 1) Program Purpose & Design, 2) Strategic Planning, 3) Program Management, and 4) Program Results. Points are awarded to a program based on the answer to each question, and an overall rating of effectiveness is then assigned. There are 5 categories of possible ratings: Effective, Moderately Effective, Adequate, Ineffective, and Results Not Demonstrated.

OMB intends to evaluate all federal programs using PART. This effort began with assessments and ratings of 234 programs, covering approximately 20 percent of the federal budget, followed by publication of the results in the President's FY 2004 Budget.

The 2004 PART assessment found that the FAA is "Effective" in managing its R,E&D research portfolio. Page 318 of the OMP report follows and is available on the web at http://www.whitehouse.gov/omb/budget/fy2005/pdf/ap_cd_rom/part.pdf

The PART investigators provided these high-level observations and recommendations:

Observations:

R,E&D has specific long-term performance measures tied to multi-year objectives that support the accomplishment of FAA's strategic plan.

The program's goals are developed in conjunction with sponsors and partners from industry, universities, other agencies, users, and associations.

The program gains tremendous cost efficiencies through its Centers of Excellence program, which provides matching funds from non-federal sources.

The program's performance plan does not include efficiency measures and targets.

Recommendations:

Include efficiency measures and targets in the FY 2005 President's Budget.

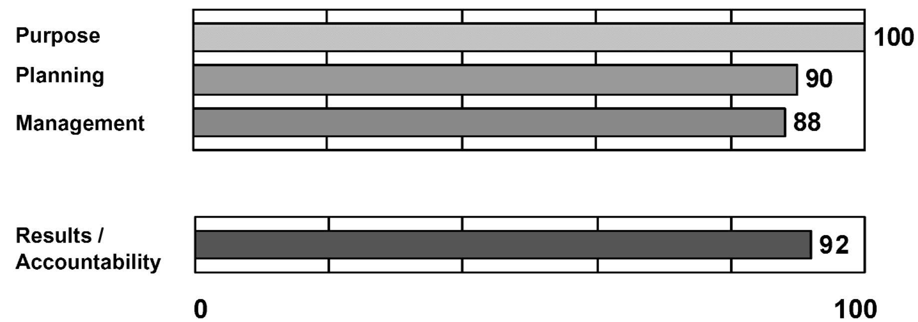
In 2004, implement a new cost accounting system that will allow R,E&D to view financial plans at various reporting levels in real-time.

Continue to work with NASA to ensure there is no duplication of effort and that resources are focused on high-priority national research goals.

OMB's detailed findings follow and are available at the web at http://www.whitehouse.gov/omb/budget/fy2005/pma/transportation.pdf

Program: *Research, Engineering & Development*

Agency: *Department of Transportation*
Bureau: *Federal Aviation Administration*



Key Performance Measures	***Year***	***Target***	***Actual***
Long-term Measure: Turbulence forecast products developed that allow pilots to avoid hazardous flight conditions while improving safety and ensuring efficient airspace use.	2008	6	
Annual Measure: Turbulence-forecast products developed (linked to long-term target to develop five new turbulence forecast products by 2008)	2002	1	1
	2004	1	
	2006	1	
	2007	1	
Long-term Measure: In-flight icing and freezing precipitation aloft forecast products developed that allow pilots to avoid hazardous flight conditions while improving airspace use.	2008	6	

Link to PART details on OMB website.

Rating: *Effective*

Program Type: *Research and Development*

Program Summary:

The FAA's Research, Engineering and Development (R,E&D) program conducts aviation research used to develop standards in the aviation community.

The assessment indicates that the R,E&D program is well-managed and results-oriented. Additional findings include:

- R,E&D has specific long-term performance measures tied to multi-year objectives that support the accomplishment of FAA's strategic plan.
- The program's goals are developed in conjunction with sponsors and partners from industry, universities, other agencies, users, and associations.
- The program gains tremendous cost efficiencies through its Centers of Excellence program, which provides matching funds from non-federal sources.
- The program's performance plan does not include efficiency measures and targets.

In response to these findings, the Administration will:

1. Include efficiency measures and targets in the FY 2005 President's Budget.
2. In 2004, implement a new cost accounting system that will allow R,E&D to view financial plans at various reporting levels in real-time.
3. Continue to work with NASA to ensure there is no duplication of effort and that resources are focused on high-priority national research goals.

Program Funding Level (in millions of dollars)

2003 Actual	2004 Estimate	2005 Estimate
163	113	117

Program Assessment Rating Tool (PART)

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

1.1 **Is the program purpose clear?** Answer: Yes Question Weight: 20%

Explanation: FAA's Research, Engineering & Development (R,E&D) program conducts aviation safety research on: (1) fire and smoke resistance technologies; (2) aircraft maintenance and structural technologies; (3) the relationship between human factors and aviation accidents; and (4) air traffic control.

Evidence: Federal Aviation Act (P.L. 85-726); Title 49, Subtitle VII, Aviation Safety Research Act (P.L. 100-591); Omnibus Reconciliation Act of 1990 (P.L. 101-508).

1.2 **Does the program address a specific and existing problem, interest or need?** Answer: Yes Question Weight: 20%

Explanation: The FAA is the sole certification authority for the United States aviation community; R,E&D provides the research and information necessary for the FAA to regulate and create standards for industry, which leads to a reduction of the aviation fatal accident rate.

Evidence: Federal Aviation Act (P.L. 85-726), Title 49, Subtitle VII; Aviation Safety Research Act (P.L. 100-591); FAA Strategic Plan; R&D Strategy.

1.3 **Is the program designed so that it is not redundant or duplicative of any other Federal, state, local or private effort?** Answer: Yes Question Weight: 20%

Explanation: The program is solely a unique FAA function, and no other organization duplicates this program; FAA does research to establish standards in the aviation community. The FAA is the sole certification authority for the industry. If the program did not exist, no other public or private organization could take its place.

Evidence: Federal Aviation Act (P.L. 85-726), Title 49, Subtitle VII, Aviation Safety Research Act (P.L. 100-591); R&D Strategy; National Aviation Research Plan; FAA Operational Evolution Plan; National Aviation Weather Initiatives.

1.4 **Is the program design free of major flaws that would limit the program's effectiveness or efficiency?** Answer: Yes Question Weight: 20%

Explanation: The program engages both internal and external stakeholders to provide input and assessment of the program on a regular basis. R,E&D also leverages its external partners for people, skills and resources. For example, its Centers of Excellence partners from academia and industry provide R,E&D with matching resources for aviation-related R&D.

Evidence: National Aviation Research Plan/REDAC Recommendations; R&D Portfolio Development Process, Guidance/Reference Document; FAA Joint Resource Council Process; The Product Development Team for In-Flight Icing, 2001 Plan.

1.5 **Is the program effectively targeted, so that resources will reach intended beneficiaries and/or otherwise address the program's purpose directly?** Answer: Yes Question Weight: 20%

Explanation: R,E&D supports the FAA's operational, regulatory, and oversight functions, which, in turn, directly support the flying public. Unlike other federal research programs, each research project focuses on a particular high-priority regulatory activity.

Evidence: National Aviation Research Plan/REDAC Recommendations; R&D Strategy; Research, Engineering and Development Advisory Committee and Subcommittee Recommendations and Reports; R&D Portfolio Development Process, Guidance/Reference Document; FAA Joint Resource Council Process; The Product Development Team for In-Flight Icing, 2001 Plan

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

2.1 Does the program have a limited number of specific long-term performance measures that focus on outcomes and meaningfully reflect the purpose of the program? Answer: Yes Question Weight: 10%

Explanation: The R,E&D program has specific long-term performance measures, tied to specific research programs/projects that support accomplishment of long-term national and agency goals. As one example, as part of the FAA goal to reduce the fatal accident rate, the Weather Research Program has a performance measure to develop 5 turbulence forecast products that allow pilots to avoid hazardous flight conditions improving safety and ensuring efficient airspace use by 2008.

Evidence: R,E&D Budget Linkage sheet; National Research Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility; FAA Operational Evolution Plan; National Aviation Research Plan; ARA Annual Performance Plan (http://www2. faa.gov/ara/perform/); ARA Quarterly and Annual Performance Plan Goal Reports

2.2 Does the program have ambitious targets and timeframes for its long-term measures? Answer: Yes Question Weight: 10%

Explanation: The R,E&D program's annual goals are ambitious. The long-term research goals are mapped to multi-year objectives, which help track the progress of the research through the establishment of annual milestones.

Evidence: FAA Strategic Plan; R&D Strategy; FAA Operational Evolution Plan; ARA Annual Performance Plan; ARA SES Short-Term Incentives; Communications, Navigation, and Surveillance Business Management Handbook; FAA In-flight Icing Plan; In-Flight Icing PDT (#4) Technical Direction, FY 2002

2.3 Does the program have a limited number of specific annual performance measures that can demonstrate progress toward achieving the program's long-term goals? Answer: Yes Question Weight: 10%

Explanation: The R,E&D program has annual performance measures that can demonstrate progress toward achieving the program's long-term goals. Progress toward these goals are measured quarterly.

Evidence: ARA Annual Performance Plan; ARA Quarterly and Annual Performance Goal Reports; ARA SES Short-term Incentives, DOT and FAA Strategic Plans, DOT Performance Plan, FAA Strategic Plan Supplement.

2.4 Does the program have baselines and ambitious targets for its annual measures? Answer: YES Question Weight: 10%

Explanation: The program develops baselines and ambitious targets, in conjunction with sponsors and partners, for all of its annual measures.

Evidence: ARA Annual Performance Plan; ARA Quarterly and Annual Performance Goal Reports; ARA SES Short-term Incentives; National Aviation Research Plan

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

2.5 **Do all partners (including grantees, sub-grantees, contractors, cost-sharing partners, and other government partners) commit to and work toward the annual and/or long-term goals of the program?** Answer: Yes Question Weight: 10%

Explanation: All partners commit to the annual and long-term program goals through a variety of means, such as MOU's, SOW's, Joint Councils, and management plans. Regularly scheduled reviews are conducted to ensure compliance and progress.

Evidence: Memorandums of Understanding; FAA Grants Order; ARA Goal 2 (Human Factors) Integration in Research and Acquisition, Project Deliverables and Status Report; FAA/NASA Management Plan; Communications, Navigation, and Surveillance Business Management Handbook; Statement of Work: Fracture Mechanics Properties Standards; FAA Joint Resource Council Process.

2.6 **Are independent evaluations of sufficient scope and quality conducted on a regular basis or as needed to support program improvements and evaluate effectiveness and relevance to the problem, interest, or need?** Answer: Yes Question Weight: 10%

Explanation: There are many regular and ad-hoc reviews of the program, including: 1) annually, research sponsors review program outcomes and outputs, prioritize and plan research efforts, and make decisions about the program; 2) the R,E&D Advisory Committee (REDAC), comprised of representatives from industry, universities, other agencies, users, and associations, reviews research and makes recommendations about budget and program priorities and merit; 3) external groups, such as the National Academy of Science, review program and results; 4) research is presented at international conferences and in Technical Reports available to the external research community.

Evidence: National Aviation Research Plan/REDAC Recommendations; National Academy of Science and Transportation Research Board Publications; The AVR R&D Requirements Process; Program Planning Team Documents; and R&D Portfolio Development Process, Guidance/Reference Document.

2.7 **Are Budget requests explicitly tied to accomplishment of the annual and long-term performance goals, and are the resource needs presented in a complete and transparent manner in the program's budget?** Answer: NO Question Weight: 10%

Explanation: Last year, R,E&D's Budget request related FAA Strategic goals to resource requests (all direct and indirect costs). Unfortunately, the FAA draft document needed more work and we expect that it will submit a performance-based request this year.

Evidence: FY 2004 Budget, FY 2004 FAA Congressional Justification.

2.8 **Has the program taken meaningful steps to correct its strategic planning deficiencies?** Answer: Yes Question Weight: 10%

Explanation: Realizing the need for a R&D strategy to guide program investments, in FY 2002, FAA published its first five-year R&D Strategy. R,E&D is now examining the programs/projects in the National Aviation Research Plan and mapping them to the R&D Strategy to identify potential gaps in the strategic planning process and to evaluate any gaps to determine the appropriate corrective action, i.e., revision to the Strategy or revision of the Research Plan.

Evidence: R&D Strategy; Draft R&D Strategy Assessment; R&D Portfolio Development Process: Lessons Learned; R&D Executive Board Portfolio Development Process Project Management Plan

Program Assessment Rating Tool (PART)

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

2.RD1 **If applicable, does the program assess and compare the potential benefits of efforts within the program to other efforts that have similar goals?** Answer: Yes Question Weight: 10%

Explanation: In addition to continued reviews by FAA management, research sponsors, and the REDAC subcommittees, each research area works closely with customers and other agencies to ensure continuing relevance of the work. In addition, the program receives continuous external review to ensure that it is meeting customer needs by: meeting with the users; seeking feedback; presenting progress reports at public forums and science reviews; publishing and presenting technical papers; obtaining formal peer validation of science; training specific users on product usage; and maintaining and sharing lessons learned.

Evidence: Research, Engineering and Development Advisory Committee and Subcommittee Recommendations and Reports; Interagency Agreement, Number DTFA01-98-Z-020024 Between the FAA and NOAA; Integrated Icing Forecast Algorithm 9IIFA) Assessment at Regional Airlines -- Final Report; FAA Current Icing Potential (CIP) and Forecast Icing Potential (FIP) Regional Airlines Benefit Analysis; Commercial Aviation Safety Team (CAST) documents.

2.RD2 **Does the program use a prioritization process to guide budget requests and funding decisions?** Answer: Yes Question Weight: 10%

Explanation: Program priorities are determined in concert with internal/external reviews conducted by the REDAC, internal sponsors, and national and Departmental guidance, such as from OMB. Priorities are also outlined in the DOT Research Development, and Technology Plan, as well as in the FAA Strategic Plan and the ARA Performance Plan. Using external input, the R&D Executive Board, through a documented process and working through program planning teams, provides budget guidance for budget planning and allocation.

Evidence: R,E&D Budget Linkage sheet; R&D Executive Board Portfolio Development Process Project Management Plan; National Aviation Research Plan; R&D Strategy; DOT Research, Development, and Technology Plan; ARA Annual Performance Goals; Joint Resource Council Process; Research, Engineering and Development Advisory Committee and Subcommittee Recommendations and Reports; The AVR R&D Requirements Process; Decision-Based Weather Needs for the Air Route Traffic Control Center Management Unit.

3.1 **Does the agency regularly collect timely and credible performance information, including information from key program partners, and use it to manage the program and improve performance?** Answer: Yes Question Weight: 12%

Explanation: The goals in the annual ARA Performance Plan are tracked and reported on quarterly. In addition, projects within the program regularly collect performance information from partners and use it to manage the program and improve performance.

Evidence: ARA Annual Performance Plan; ARA Quarterly and Annual Performance Plan Goal Reports; ARA Goal 2 (Human Factors)--Project Deliverables & FY 02 Status Report; FAA/NASA Wake Turbulence Research Management Plan; FAA/NASA Joint University Program reviews; COE Program reviews.

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

3.2 Are Federal managers and program partners (including grantees, sub-grantees, contractors, cost-sharing partners, and other government partners) held accountable for cost, schedule and performance results? Answer: Yes Question Weight: 12%

Explanation: Program managers are responsible for achieving results and performance measures are included into performance evaluations and annual work plans. In addition, through program and business plans, as well as contractual arrangements and grant language, and through formal agreements, such as Memorandums of Understanding/Agreement, program managers hold partners accountable for cost, schedule, and performance results.

Evidence: ARA Short-Term Incentives; ARA Goal 2 (Human Factors): Project Deliverables & FY 02 Status Report; FAA/NASA Wake Turbulence Research Management Plan.

3.3 Are funds (Federal and partners') obligated in a timely manner and spent for the intended purpose? Answer: Yes Question Weight: 12%

Explanation: The FAA Budget Office ensures that all program funds are obligated in a timely manner in accordance with the program plan. The R,E&D program traditionally obligates 95% of it funds in the first year and unobligated funds are carried forward. Obligations are reviewed monthly, quarterly, and at the end of each fiscal year; corrective action is taken as necessary.

Evidence: ARA Monthly Financial and Personnel Reports

3.4 Does the program have procedures (e.g. competitive sourcing/cost comparisons, IT improvements, appropriate incentives) to measure and achieve efficiencies and cost effectiveness in program execution? Answer: NO Question Weight: 12%

Explanation: R,E&D's performance plan does not include efficiency measures and targets. However, there are many efficiencies realized through assessment of program performance. The program also gains tremendous cost effectiveness through its Centers of Excellence Program, which provide matching funds from non-federal sources, enabling the program to leverage industry sources to help finance critical safety research. Furthermore, the program uses a labor distribution reporting system, which tracks the personnel hours and costs an employee is working on a project.

Evidence: Core Compensation Program information is on-line at http://www1.faa.gov/corecomp/plans_policies.cfm; COE brochure; COE program reviews

3.5 Does the program collaborate and coordinate effectively with related programs? Answer: Yes Question Weight: 12%

Explanation: The R,E&D program actively collaborates with its external partners on related programs and to leverage program funding. For example, the FAA/NASA Interagency Air Traffic Management Integrated Product Team and the FAA/NASA Aviation Safety Program share resources and conduct joint planning to achieve common aviation goals.

Evidence: FAA/NASA Interagency Air Traffic Management Integrated Product Team Integrated Plan; FAA/NASA Integrated Safety Research Plan; FAA Operational Evolution Plan; FAA/NASA MOUs and MOAs; The National Plan for Civil Aviation Human Factors: An Initiative for Research and Application (FAA, NASA, DOD); FAA/NASA Wake Turbulence Management Plan; FAA/NASA Roadmaps

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

3.6 Does the program use strong financial management practices? Answer: Yes Question Weight: 12%

Explanation: The program is free of material internal control weaknesses. Monthly accounting reports monitor fiscal status, the financial system has on-line, real-time inquiry capability for reporting and monitoring obligations. In FY 2004, FAA will implement a new cost accounting system that will strengthen financial management by allowing R,E&D to view plans versus and actual at various reporting levels, directly within the accounting system, and on a real-time basis; drill-down to the individual accounting transaction level; and reduce accounting errors.

Evidence: OIG report on FAA's financial statements for FY 2001-2002; FAA Performance and Accountability Report, Independent Audit Report, Financial Statements; all docs can be found on-line http://www1.faa.gov/aba/html_fm/finst.html

3.7 Has the program taken meaningful steps to address its management deficiencies? Answer: Yes Question Weight: 12%

Explanation: In response to R,E&D's human capital issues, FAA conducted an organizational assessment and found skill gaps in the areas of project/program management, leadership, and systems engineering. As a result, core curricula and training were instituted in these areas. Human Factors (HF) specialists were needed in integrated program teams, and, subsequently, HF specialists were hired and placed on those teams.

Evidence: R&D Executive Board Portfolio Development Process Project Management Plan; Draft R&D Strategy Assessment; ICIP documentation.

3.RD1 For R&D programs other than competitive grants programs, does the program allocate funds and use management processes that maintain program quality? Answer: Yes Question Weight: 12%

Explanation: The R,E&D program allocates 100 percent of its funding (less some congressional direction) using a competitive process that ensures good science, proper use of public funds, and is consistent with Circular A-11. Once awarded, contract and grant progresses are regularly evaluated against scientific and technical criteria to ensure quality. Criteria are defined and reviewed internally and with external partners.

Evidence: Circular A-11; FAA's Acquisition Management System; FAA Grant Order; Research, Engineering and Development Advisory Committee and Subcommittee Recommendations and Reports; Center of Excellence Program documents; Small Business and Innovative Research Program.

4.1 Has the program demonstrated adequate progress in achieving its long-term performance goals? Answer: Yes Question Weight: 25%

Explanation: The R,E&D Program is making significant progress in achieving its long-term goals. For FY 2002, the annual accomplishments will allow the R,E&D Program to meet or surpass its long-term goals.

Evidence: R,E&D Budget Linkage sheet; National Research Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility; FAA Operational Evolution Plan; National Aviation Research Plan; ARA Annual Performance Plan (http://www2. faa.gov/ara/perform/); ARA Quarterly and Annual Performance Plan Goal Reports

4.2 Does the program (including program partners) achieve its annual performance goals? Answer: Yes Question Weight: 25%

Explanation: The R,E&D Program met or exceeded its annual performance goals.

Evidence: R,E&D Budget Linkage sheet; National Research Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility; FAA Operational Evolution Plan; National Aviation Research Plan; ARA Annual Performance Plan; ARA Quarterly and Annual Performance Plan Goal Reports

Program: Research, Engineering & Development
Agency: Department of Transportation
Bureau: Federal Aviation Administration
Type(s): Research and Development

Section Scores				Overall Rating
1	2	3	4	Effective
100%	90%	88%	92%	

4.3 **Does the program demonstrate improved efficiencies or cost effectiveness in achieving program goals each year?**

Answer: LARGE EXTENT — Question Weight: 25%

Explanation: Although R,E&D's performance plans do not include efficiency measures or targets, the FAA has succeeded in a number of efforts that make conducting its research more efficient by reducing costs and increasing outputs. For example, R,E&D reduced overhead FTE from 27% to 13% in four years; reduced correspondence processing time from 9,050 minutes to 170 minutes per grant award; and expanded outputs of research per unit cost through Centers of Excellence, which require 50/50 cost sharing.

Evidence: FAA/NASA Interagency Air Traffic Management Integrated Product Team Integrated Plan; FAA/NASA Integrated Safety Research Plan; R&D Portfolio Development Process: Lessons Learned; R&D Portfolio Development Process, Guidance/Reference Document; R&D Executive Board Portfolio Development Process Project Management Plan; R&D Strategy Assessment (draft); FY 1999 Hammer Award; FTE data years FY 2000-2003.

4.4 **Does the performance of this program compare favorably to other programs, including government, private, etc., with similar purpose and goals?**

Answer: NA — Question Weight: 0%

Explanation: There are no evaluations comparing R,E&D to other research programs.

Evidence:

4.5 **Do independent evaluations of sufficient scope and quality indicate that the program is effective and achieving results?**

Answer: Yes — Question Weight: 25%

Explanation: The program is reviewed by an external advisory committee, the congressionally-mandated Research, Development and Engineering Advisory Committee, as well as external bodies, such as the National Academy of Science. These groups believe the Program is effective and achieving good results. The Advisory Committee also meets with NASA's research advisory committee once a year to ensure their is no duplication of effort and that resources are focused on high priority national research goals.

Evidence: Research, Development and Engineering Advisory Committee recommendations and subcommittee reports; National Academy of Science and Transportation Research Board Publications; R&D conference proceedings; FAA Technical Reports.

PART Performance Measurements

Program: Research, Engineering & Development

Agency: Department of Transportation

Bureau: Federal Aviation Administration

Measure: Turbulence forecast products developed that allow pilots to avoid hazardous flight conditions while improving safety and ensuring efficient airspace use.

Additional Information: On average, turbulence causes 45 accidents, 100 injuries, and 40 fatalities with costs exceeding $135M per year

Year	Target	Actual
2008	6	

Measure Term: Long-term

Measure: Turbulence-forecast products developed (linked to long-term target to develop five new turbulence forecast products by 2008)

Additional Information: 2002 Target--Develop clear turbulence product above 20,000 ft in experimental use.2003 Target--Develop clear turbulence product above 20,000 ft fully operational.2004 Target--Develop clear turbulence product above 10,000 ft. 2006 Target--Develop convective induced turbulence product.2007 Target--Develop mountain wave turbulence product.2008 Target--Develop clear turbulence produce for all altitudes.

Year	Target	Actual
2002	1	1
2004	1	
2006	1	
2007	1	
2008	1	

Measure Term: Annual

Measure: In-flight icing and freezing precipitation aloft forecast products developed that allow pilots to avoid hazardous flight conditions while improving airspace use.

Additional Information: Icing is a major safety issue for general aviation and small commuter aircraft; On average icing causes 24 accidents and 31 fatalities per year.

Year	Target	Actual
2008	6	

Measure Term: Long-term

Program: Research, Engineering & Development

Agency: Department of Transportation

Bureau: Federal Aviation Administration

Measure: In-flight icing and freezing precipitation aloft products developed (linked to long-term target to develop six new in-flight icing and freezing precipitation products by 2008).

Additional Information: 2002 Target--Implement year round product guidance and severity/icing type forecasts.2004 Target--Develop forecast icing product.2006 Target--Develop current icing potential severity product. 2007 Target--Develop forecast icing potential, Alaska product.2008 Target--Develop terminal scale forecasting product.

Year	Target	Actual
2002	1	1
2006	1	
2007	1	
2008	1	

Measure Term: Annual

Measure: New technologies, procedures, test methods, and criteria developed for preventing accidents that result from hidden in-flight fires and fuel tank explosions.

Additional Information: Fire caused approximately twenty percent of the 1,153 fatalities on U.S. transport airlines between 1981-1990.

Year	Target	Actual
2008	1	

Measure Term: Long-term

Measure: Technologies, procedures, test methods, and criteria for preventing accidents that result from hidden in-flight fires and fuel tank explosions (linked to long-term target)

Additional Information: 2002 Target--Fabricate and install nitrogen inerting system in 747SP for ground-based inerting of the center wing; Test a seat fabric fiber to determine if it provides a 50% reduction in heat; Propose a technical standard order for flammability test on airline blankets; Finish research on full-scale test evaluation of cargo compartment fire supression system.2003 Target-- Develop and demonstrate thermoset resin for cabin panels with factor of 10 reduction in heat release rate and draft technical report describing results; Conduct 40 hours of flight tests on FAA inerting system using an Airbus A320 and Boeing 747; Draft 2 technical reports describing fuel tank inerting research progress.2004 Target--Draft report comparing fuel tank inerting concentrations during A320 flight tests with model predictions; Conduct 30 hours of flight tests on FAA inerting system in NASA 747 (Edwards AFB). 2005 Target--Draft report describing FAA/NASA inerting system flight tests and fuel vapor measurements; Develop and demonstrate a thermoplastic for cabin molded components with factor of 10 reduction in heat release rate and draft a report describing results .2006 Target--Develop and demonstrate a seat foam with a factor of ten reduction in heat release rate and draft report describing results.2007 Target--Develop and demonstrate a seat fabric fiber with a factor of ten reduction in heat release rate and draft a report decribing the results.

Year	Target	Actual
2002	Complete	Complete

Measure Term: Annual

PART Performance Measurements

Program: Research, Engineering & Development

Agency: Department of Transportation

Bureau: Federal Aviation Administration

Measure: Technologies, procedures, test methods, and criteria for preventing accidents that result from hidden in-flight fires and fuel tank explosions (linked to long-term target)

Additional Information: 2002 Target--Fabricate and install nitrogen inerting system in 747SP for ground-based inerting of the center wing; Test a seat fabric fiber to determine if it provides a 50% reduction in heat; Propose a technical standard order for flammability test on airline blankets; Finish research on full-scale test evaluation of cargo compartment fire supression system.2003 Target-- Develop and demonstrate thermoset resin for cabin panels with factor of 10 reduction in heat release rate and draft technical report describing results; Conduct 40 hours of flight tests on FAA inerting system using an Airbus A320 and Boeing 747; Draft 2 technical reports describing fuel tank inerting research progress.2004 Target--Draft report comparing fuel tank inerting concentrations during A320 flight tests with model predictions; Conduct 30 hours of flight tests on FAA inerting system in NASA 747 (Edwards AFB). 2005 Target--Draft report describing FAA/NASA inerting system flight tests and fuel vapor measurements; Develop and demonstrate a thermoplastic for cabin molded components with factor of 10 reduction in heat release rate and draft a report describing results .2006 Target--Develop and demonstrate a seat foam with a factor of ten reduction in heat release rate and draft report describing results.2007 Target--Develop and demonstrate a seat fabric fiber with a factor of ten reduction in heat release rate and draft a report decribing the results.

Measure Term: Annual

Year	Target	Actual
2004	Complete	
2005	Complete	
2006	Complete	
2007	Complete	

APPENDIX D

Partnership Activities

Detailed information on FAA partnership activities with government partners, industry and academia

The Federal Aviation Administration enhances and expands its research and development (R&D) capabilities by partnering with other government, industry and academic organizations. Such partnerships help the FAA leverage critical resources to ensure that the agency can achieve its goals. By reaching out to other government agencies, the private sector and the academic community, the FAA gains access to both internal and external innovators, promoting the transfer of technology, personnel, information, intellectual property, facilities, methods, and expertise. These partnerships also foster the transfer of FAA technologies to the private sector for other civil and commercial applications. The Agency uses a variety of partnership mechanisms to achieve its goals. These include:

Working with Government Partners
- Memoranda of Understanding

Working with Industry
- Cooperative Agreements
- Small Business Innovative Research
- Patents

Working with Academia
- Joint University Program
- Aviation Grants
- Centers of Excellence

Working with Government Partners. FAA researchers collaborate with their colleagues in government, industry, and academia through memoranda of understanding (MOU) and other mechanisms. NASA is the FAA's closest R&D partner in the federal government. The two agencies cooperate on research through a series of memoranda of understanding (http://faa-www.larc.nasa.gov/). (See Table D.1 for details of the agreements currently in place.)

Table D.1. Current FAA/NASA Memoranda of Understanding

Tracking Number	Subject	Objective
FNA 01	Cockpit/Air Traffic Control (ATC) Integration Research	Pursue, through either cooperative or joint efforts, ATC-related technologies and techniques that will increase NAS capacity and improve the safety and efficiency of flight operations.
FNA 02	Human Factors Research	Perform human factors research to improve the efficiency of air- and ground-based flight operations and enhance safety by reducing the consequences of human error.
FNA 05	Program Support	Strengthen the working relationship between the FAA and NASA by locating FAA engineering field offices at NASA centers to conduct research and communication/coordination, and by providing a mechanism for support of unique programs such as the Aviation Safety Reporting System (ASRS).
FNA 07	Airspace System User Operational Flexibility and Productivity	Achieve, through integrated R&D activities, an air transportation system that better facilitates user operational flexibility and productivity throughout the airspace. In particular, it is envisioned that closely coupling the FAA's expertise in air traffic management (ATM) and NASA's expertise in aeronautics will result in an integrated air-ground system that more fully meets the needs of airspace users for safe, efficient, and cost-effective flight operations.
FNA 08	Aviation Safety Research	Achieve, through joint, cooperative R&D, a significant reduction in the fatal accident rate for all categories of aircraft over the next 25 years. This initiative will address both near-term and long-term requirements. The results of this initiative, when implemented, are anticipated to lead to an 80-percent reduction in the fatal accident rate by year 2007, as compared to the 1994 to 1996 baseline.
FNA 09	Aviation Environmental Compatibility	Establish the roles for the FAA and NASA in achieving broad national goals for environmental compatibility of aviation and provide a framework for FAA and NASA collaboration.
FNA 10	Future Space Transportation Systems	Promote collaborative use by the FAA and NASA of technical information, research results, and potentially funded activities, which will assist each agency in fulfilling its respective roles and responsibilities for research and development of future space transportation systems.

In addition to MOUs, the FAA partners with other agencies through a variety of inter-agency committees and group. For example, the FAA and other interested federal agencies established the Federal Interagency Committee on Aviation Noise (FICAN) to encourage debate and agreement over needs for future aviation noise abatement and new research efforts. FICAN conducts annual public forums in different geographic regions with the intent to align noise abatement research with local public concerns.

Working with Industry. The FAA complies with all applicable federal guidelines and legislation affecting the transfer of technology. FAA's goal is to transfer knowledge, facilities, equipment, or capabilities developed by its laboratories and R&D programs to the private sector. This helps expand the United States technology base and maximize the return on federal R&D investments. Technology transfer mechanisms include:

Cooperative Research and Development Agreements (CRDAs) – These agreements allow the FAA to share facilities, equipment, services, intellectual property, and personnel resources with industry, academia, and state/local governments. CRDAs are a highly effective way to meet congressionally mandated technology transfer requirements.

In FY 2004, the FAA established 21 new CRDAs, bringing the present total of active agreements to 54. Details of the new CRDAs are shown in Table D.2).

Small Business Innovation Research (SBIR) - These contracts encourage the private sector to invest in long-term research that helps the federal government meet its R&D objectives. Eligible small business contractors compete for the first phase of the SBIR cycle as a start-up phase for the conduct of feasibility-related experimental or theoretical research. The second phase is awarded based on the results of Phase I, which is the actual research phase. Contractors are encouraged to enter into CRDAs with the FAA to

Table D.2. FAA Cooperative R&D Agreements, FY 2004

CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completion Date
1993-A-0040	Weather	Development of advanced weather information systems with graphical display products	Harris Corporation Melbourne, FL	02/24/93	02/24/06
1993-A-0043	Weather	Development of advanced weather information systems with graphical display products	WSI Corporation Billerica, MA	09/13/93	09/13/06
1994-A-0065	Airport Technology	Testing of a soft ground arresting system developed to safely stop aircraft that overrun the available length of runway	DATRON Engineered Systems Division (ESCO) Aston, PA	09/07/94	09/07/06
1996-A-0097	Airport Technology	Development of the National Airport Pavement Test Machine	The Boeing Company Seattle, WA	07/29/96	07/29/11
1998-A-0116	Communications, Navigation, and Surveillance	The evaluation of Automatic Dependent Surveillance – Broadcast (ADS-B) technologies in support of the Safe Flight 21 Program	Cargo Airline Association Washington, DC	03/19/99	03/19/05
1998-A-0121	Weather	Utilize state-of-the-art meteorological measurement, sensing, and display equipment to disseminate real-time weather warnings and forecasts to aviation users	Jeppesen Sanderson, Inc. Englewood, CO	04/15/99	04/15/05
1998-A-0122	Aging Aircraft	Cooperative research in aircraft structural integrity, including the use of the Full-Scale Aircraft Structural Test and Evaluation Research facility	McDonnell Douglas Long Beach, CA	10/15/98	12/15/04
2001-A-0160	Aircraft Safety Technology	Type 1 deicing/anti-icing fluid holdover time	American Eagle Airlines, Inc. Dallas, TX	12/21/01	12/21/04
2001-A-0163	Communications, Navigation, and Surveillance	Utilize state-of-the-art meteorological, measurement, sensing, and display equipment to disseminate real-time weather warnings and forecasts to aviation users	Freese-Notis Weather, Inc. Des Moines, IA	03/22/02	03/22/06
2001-A-0164	Airport Technology	Utilize statistical analysis for determining airplane contact risks of varying span airplanes on taxiways of varying separation	The Boeing Company Seattle, WA	04/05/02	04/05/05
2002-A-0171	Capacity and Air Traffic Management Technology	Develop modeling and simulation tools to assist in tech implementation of capacity enhancing capabilities for the National Airspace System	The Boeing Company McLean, VA	07/17/02	07/17/07
1999-A-0124	Weather	Utilize state-of-the-art meteorological measurement, sensing, and display equipment to disseminate real-time weather warnings and forecasts to aviation users	Sonalysts, Inc. Waterford, CT	04/09/99	04/09/05
1999-A-0138	Aircraft Safety Technology	Evaluation of high octane unleaded aviation gasoline for general aviation piston engines	Exxon Mobile Research and Engineering Company Florham Park, NJ	10/19/99	10/19/05

Table D.2. FAA Cooperative R&D Agreements, FY 2004 (continued)

CRDA Number	FAA Program	Subject	Recipient Organization	Award Date	Completion Date
1999-A-0139	Aircraft Safety Technology	Evaluate the use of acoustic emission technology for the inspection of spherical Halon fire bottles and its performance in an industrial environment to identify problems related to its use	Walter Kidde Aerospace Wilson, NC	11/30/99	11/30/04
2001-A-0158	Controller Pilot Data Link Communications	Controller Pilot Data Link Communication Build 1A	ARINC Annapolis, MD	08/24/01	08/24/06
2003-A-0179	Communications, Navigation, and Surveillance	Develop a software tool to convert unpublished instrument procedures	Universal Avionics Systems Corp. Tucson, AZ	03/31/03	03/31/05
2003-A-0181	Communications, Navigation, and Surveillance	Controller Pilot Data Link Communication(CPDLC) Builds 1 and 1A	SITA Information Networking Computing, B.V. Vienna, VA	09/25/03	09/25/08
2003-A-0187	Aeromedical Research	Aircraft decontamination after noxious perturbation of the cabin interior	Strategic Technology Enterprises, Inc. Mentor, OH	10/22/03	10/22/04
2004-A-0189	Office of Innovations and Solution	Video security system to enhance aviation security	Presearch Incorporated Fairfax, VA	01/27/04	01/27/05
2004-A-0193	Environment and Energy	Gasper Air Flow Characterization	B/E Aerospace Holbrook, NY	02/18/04	02/18/05
2004-A-0199	Air Traffic Organization	Research on the Success of the Radical Organizational Change at the Federal Aviation Administration's Air Traffic Organization	University of Maryland at College Park College Park, MD	05/13/04	05/13/05

strengthen their ability to perform well in Phase III, as well as to attract and negotiate successfully with venture capitalists to commercialize the innovation.

In 2004, the FAA submitted one Phase I SBIR contract entitled "Development of the Airborne Internet Collaborative Information Services Environment." One Phase I contract expired during this time. Five (5) other Phase II SBIR contracts are being administered and include:

- Development of an Optimized Semi-Flush Flasher
- Research and Development of Generic Remote Monitoring Subsystem (GRMS)
- Development of Fiber Optic Approach Lighting Systems
- Evaluation of Composite Joints in General Aviation (GA) Structure
- Aircraft Wiring Integrity Verification Using Psuedo-Random Binary Sequence

Patents issued through the U.S. Patent and Trademark Office – When an agency patents new technologies that result from research partnerships, federal law provides benefits both to the sponsoring agency and to firms under contract to perform the research (see http://www.spie.org/web/oer/august/aug97/patent.html). One patent - Reference Sample for Generating Smoky Atmosphere - was issued in 2004. It provides a reference sample for testing fire detectors and a method of testing using the reference samples. Table D.3. lists the U.S. patents issued to the FAA from 1999 through 2002.

Table D.3. Patents Issued for Technologies Developed through FAA R&D

Patent No.	Title/ Description	Date of Patent
6,470,730	Dry transfer method for the preparation of explosives test samples A method of preparing samples for testing explosives and drug detectors of the type that search for particles in air.	10/29/02
6,467,950	Device and Method to Measure Mass Loss Rate of an Electrically Heated Sample A device and a method for measuring the mass loss rate of a sample of combustible material placed on a mass-sensitive platform.	10/22/02
6,464,391	Heat Release Rate Calorimeter for Milligram Samples A calorimeter that measures heat release rates of very small samples (on the order of one to 10 milligrams) without the need to separately and simultaneously measure the mass loss rate of the sample and the heat of combustion of the fuel gases produced during the fuel generation process.	10/15/02
6,116,049	Adiabatic Expansion Nozzle A nozzle for producing a continuous gas/solid or gas/aerosol stream from a liquid having a high room temperature vapor pressure.	09/12/00
5,983,945	Wing Tank Liner A liner for aircraft fuel tanks which limits the amount of fuel that can be spilled in the event of a crash.	11/16/99
5,981,290	Microscale Combustion Calorimeter A calorimeter for measuring flammability parameters of materials using only milligram sample quantities.	11/09/99

Working with Academia

FAA/NASA Joint University Program for Air Transportation Research. This joint FAA/NASA program is a long-term cooperative research partnership among three universities to conduct scientific and engineering research. The FAA and NASA benefit directly from the results of specific research projects, and, less formally, from valuable feedback from university researchers regarding the goals and effectiveness of government programs. An additional benefit is the creation of a talented cadre of engineers and scientists who will form a core of advanced aeronautical expertise in industry, academia, and Government. Research covers a broad scope of technical disciplines that contribute to civil aviation, including air traffic control theory, human factors, satellite navigation and communications, aircraft flight dynamics, avionics and meteorological hazards.
http://www.princeton.edu/~stengel/JUPnew.html

Aviation Grants. FAA awards research grants to qualifying colleges, universities, and legally incorporated nonprofit research institutions. Funded research grants may use any scientific methodology deemed appropriate by the grantee and do not need to be linked to the immediate needs of FAA R&D projects. The evaluation criteria for grant proposals include the potential application of research results to the FAA's long-term goals for civil aviation technology. (See Table D.4 for a list of 2004 FAA research grants.)

Table D.4. FAA Research Grants, FY 2004

FAA Program	Grant Objective	Recipient Institution	Award Date	Completion Date
Navigation Systems Development	Develop a low-cost, high-reliability, modular control cabinet unit to replace currently used control cabinet units at airports around the United States. The control cabinet design will use state-of-the-art components to simplify the design, eliminate expensive components, and support the new lighting and root mean square (RMS) requirements.	Florida International University	2/27/04	2/26,/05
Aircraft Safety Research and Development	Development of the ROMAN Lessons Learned Database is part of an overall initiative to reduce significantly uncontained high energy rotor failures caused by manufacturing induced defects. The goal is to improve safety in general aviation by creating a research tool for the manufactures of turbine components. The knowledge acquired through this project will help advance the area of turbine components manufacturing.	Oakland University	3/17/04	3/16/05
Airport and Aircraft Safety	Design and build a suite of computational tools that identify an aircraft touchdown point in commercial operations. This will help in the required determination of the operational aircraft landing distance, which is critical to the safety of terminal area operations.	Robert Wood Johnson Medical School	4/02/04	4/01/04
Aircraft Safety Research and Development	Conduct research on topics that are essential to improving aviation safety, such as composite materials, crashworthiness, in-flight icing, fatigue and fractures.	Wichita State University	05/25/04	05/24/05
Human Factors and Aviation Medicine	Identify the critical human factors in unmanned air vehicles (UAV) supervision, control, and national airspace integration that will help the FAA develop a 5- year human factors integration plan.	University of Illinois (Urbana-Champaign	06/16/04	06/15/05
Aeromedical Research	Use a structured approach for developing an Interactive Aircraft Accident Injury Database. Apply a user centered approach to develop the requirements and conceptual design of an Interactive Aircraft Accident Data Collection and Analysis System, and collaborate with software developers to provide design input and assist in overseeing the FAA software development database.	Wright State University	06/23/04	06/22/05
Airport Technology	Extend various studies that have been performed regarding airworthiness issues. Specifically, complete a sequence of evaluations of inspection techniques and integrate them into a Handbook of Reliability in Airframe and Engines.	State University of New York	07/15/04	07/14/05
LIST924	Respond to a Congressional requirement (P.L. 108-176, Section 704) to extend the existing cooperative pavement research activities to include asphalt pavements.	Auburn University	07/26/04	07/24/06
Airport and Aircraft Safety	Develop an alternative fuel for aviation gasoline. Aviation grade ethanol has been shown to have many desirable properties as an alternative fuel. This proposal will further investigate the detonation and fuel efficiency properties of the fuel in conjunction with testing already being performed in the industry and by the FAA Technical Center.	South Dakota State University	07/26/04	07/24/07

Table D.4. FAA Research Grants, FY 2004 (continued)

FAA Program	Grant Objective	Recipient Institution	Award Date	Completion Date
Satellite Navigation Program	Analyze and evaluate data that has been collected concerning Loran-C and its ability to mitigate the impact of a global positioning system (GPS) on GPS position, navigation and time applications.	Aviation Management	08/10/04	02/09/05
Human Factors and Aviation Medicine	Promote the use of the Threat and Error Management (TEM) model throughout the industry. Determine the relationship between TEM and existing applications and tools. Make TEM and Line Operations Safety Audits (LOSA), as accessible to large and small carriers, as well as other interested sectors of the industry. Begin data-mining of the LOSA Archive, starting with general industry statistics of threats, errors, and their management, and progressing to more specific issues such as unstable approaches and intentional noncompliance. Develop TEM to provide a common framework across different safety tools by developing a proof of concept showing that LOSA and ASAP, using TEM as a common metric, can be integrated to maximize the safety lessons learned.	University of Texas as Austin, Dept. of Psychology	08/03/04	08/02/05
Aircraft Safety Research and Development	Develop, evaluate, test and recommend updates to aircraft tire retread escalation processes. Advances in tire technology and the introduction of radial tires into the aircraft fleet require updated guidance for the inspection, maintenance, and operation of aircraft tires. Data obtained by this research will eventually be used by the FAA to clarify guidance information contained in AC 145-4.	University of Dayton	08/11/2004	08/20/05

Air Transportation Centers of Excellence. FAA Centers of Excellence are established through cooperative agreements with academic institutions to assist in mission-critical research and technology. Through these long-term collaborative, cost-sharing efforts, the government and university/industry teams leverage their resources to advance the technological future of the nation's aviation community. Currently the FAA sponsors seven as follows.

Airliner Cabin Environment - Established in 2004, the Center of Excellence for Airliner Cabin Environment Research, which is led by Auburn University, will conduct research on cabin air quality and an assessment of chemical and biological threats. Other universities taking part in the effort include Purdue University, Harvard University, Boise State University, Kansas State University, the University of California at Berkeley, and the University of Medicine and Dentistry of New Jersey. http://www.coe.faa.gov

Advanced Materials - Established in 2003, the Center of Excellence for Advanced Materials is lead by the University of Washington and Wichita State University. Center research focuses on: material standardization and shared databases; bonded joints; structural substantiation; damage tolerance and durability; maintenance practices; advanced material forms and processes; cabin safety; life management of materials; and nanotechnology for composite structures. Other members include Edmonds Community College, Northwestern University, Oregon State University, Purdue University, the University of California at Los Angeles, the University of Delaware, Tuskegee University, and Washington State University. http://www.coe.faa.gov

Aircraft Noise and Aviation Emissions Mitigation - Established in 2003 with NASA and Transport Canada as co-sponsors, the Partnership for Air Transportation Noise and Emissions Reduction Center of Excellence is lead by the Massachusetts Institute of Technology. The center seeks to identify, understand, and measure the issues and impacts associated with aircraft noise and aviation emissions, and as appropriate to develop improved solutions to mitigate these problems. It also seeks to reduce uncertainty in emerging issues of climate impact and health and welfare effects of emissions to a level that enables appropri-

ate actions to be undertaken to address their effects. Other members include Boise State University, Florida International University, the Pennsylvania State University, Purdue University, Stanford University, the University of Central Florida, and the University of Missouri-Rolla.
http://web.mit.edu/aeroastro/www/partner/index.html

General Aviation (CGAR) - Established in 2001, the Center of Excellence for General Aviation Research is lead by Embry-Riddle Aeronautical University (ERAU). The center conducts safety-related research and development programs with application to non-commercial aviation. Core members include Wichita State University, the University of North Dakota, Florida A&M, and the University of Alaska.
http://www.coe.faa.gov

Airworthiness Assurance - Established in 1997, the Airworthiness Assurance Center of Excellence is a multi-institutional, multi-disciplinary team that currently includes 31 academic members. The center conducts safety-related research and development programs in aircraft maintenance, inspection and repair, crashworthiness, propulsion and fuel systems safety, and advanced materials.
http://www.coe.faa.gov/aace

Operations Research - Established in 1996, the National Center of Excellence for Aviation Operations Research is lead by five universities: the University of California at Berkeley, Massachusetts Institute of Technology, Virginia Polytechnic Institute, the University of Maryland, and George Mason University. Other core members include 11 additional university partners and 15 industrial affiliates. The Center performs research and development in the areas of traffic management and control, human factors, performance metrics and measurements, safety data analysis, scheduling, workload management and distribution, navigation, communications, data collection and distribution, and aviation economics.
www.nextor.org

Airport Technology - Established in 1995, the Center of Excellence for Airport Technology is lead by the University of Illinois at Urbana-Champaign. The center conducts research in airport pavement technology and wildlife hazard mitigation. Other affiliated universities are Northwestern University, Embry-Riddle Aeronautical University, and North Carolina A&T University. http://cee.uiuc.edu/research/coeairport-tech/

Alphabetical list of acronyms and abbreviations

APPENDIX E

Acronyms and Abbreviations

A

AAAE	American Association of Airport Executives
AACE	Center of Excellence for Airworthiness Assurance
AAR	Office of Aviation Research
AAS	Airport Safety and Standards
AC	[FAA] Advisory Circular
ACI	Aiports Council International
ACI-NA	Airports Council International – North America
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance – Broadcast
ADSIM	Airfield Delay Simulation Model
AEDT	Aviation Environmental Design Tool
AEE	[FAA – AEP] Office of Environment and Energy
AEM	Area Equivalent Method
AEP	[FAA – Staff Office] Aviation Policy, Planning and Environment
AF	Airway Facilities
AFCB	Arc-Fault Circuit Breaker
AIA	Aerospace Industries Association
AIP	Airport Improvement Program
ALPA	Airline Pilots Association
AOPA	Aircraft Owners and Pilots Association
APA	Allied Pilots Association
APEX	Aircraft Particle Emissions Experiment
APMT	Aviation Portfolio Management Tool
APP	[FAA – ARP] Office of Airport Planning and Programming
AQP	Advanced Qualification Program
ARAC	[FAA] Aviation Rulemaking Advisory Committee
ARMD	[NASA] Aeronautics Research Mission Directorate
ARP	[FAA – Line of Business] Airports
ASA	Aircraft Surveillance Application
ASAP	Aviation Safety Action Program
ASEB	National Academy Aeronautics and Space Engineering Board
ASP	[NASA] Airspace Systems Program
ASRA	Aviation Safety Risk Analysis
ASRS	Aviation Safety Reporting System
AST	[FAA – Line of Business] Commercial Space Transportation
ASU	Arizona State University
ASV	Annual Service Volume
ATA	Air Transportation Association
ATAC	[NASA] Aerospace Technology Advisory Committee
ATC	Air Traffic Control
ATC/AF	Air Traffic Control/Airway Facilities
ATD&P	Advanced Technology Development and Prototyping
ATM	Air Traffic Management
ATO	[FAA – Line of Business] Air Traffic Organization
ATS	Air Traffic Services
AT-SAT	Air Traffic Selection and Training
AuRA	[NASA] Autonomous Robust Avionics
AVS	[FAA – Line of Business] Aviation Safety
AVS&SP	[NASA] Aviation Security and Safety Program
AVSI	Aerospace Vehicle Systems Institute
AWTT	Aviation Weather Technology Transfer

C

C&V	Ceiling and Visibility
CAASD	[MITRE] Center for Advanced Aviation System Development
CAEP	[ICAO] Committee on Aviation Environmental Protection
CAMI	Civil Aerospace Medical Institute
CAST	Commercial Aviation Safety Team
CCSP	Climate Change Science Program
CDA	Continuous Descent Approach
CDM	Collaborative Decision-Making
CDTI	Cockpit Display of Traffic Information
CFIT	Controlled Flight into Terrain
CFO	Chief Financial Officer
CFR	Code of Federal Regulations
CGAR	Center for General Aviation Research
CNS	Communications, Navigation, and Surveillance
COE	Center of Excellence
COMSTAC	[FAA] Commercial Space Transportation Advisory Committee
COTS	Commercial Off-the-Shelf
CPDLC	Controller Pilot Data Link Communication
CRC	Coordinating Research Council
CRDA	Cooperative Research Development Agreement
CSPR	Closely Spaced Parallel Runways

D

DAG-TM	Distributed Air Ground – Traffic Management
DARWIN™	Design Assessment for Reliability with Inspection
DHS	U.S. Department of Homeland Security
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DRVSM	Dynamic Vertical Reduced Separation Minima

E

EAL	Enhanced Airport Lighting
EAS	Employee Attitude Survey
EAS	[NASA] Efficient Aircraft Spacing
EASI	[NASA] Efficient Aerodynamic Shapes and Integration
EDA	EnRoute Descent Advisor
EDMS	Emissions and Dispersion Modeling System
EDS	Explosive Detection System
EDS	Environmental Design Space
EEHWG	Electromagnetic Effects Harmonization Working Group
EFPM	[NASA] Efficient Flight Path Management
ELV	Expendable Launch Vehicle
EPA	Environmental Protection Agency
ERAU	Embry-Riddle Aeronautical University
ESTOL	[NASA] Extremely Short Take-off and Landing
EWIS	Electrical Wiring Interconnect System

F

F&E	Facilities and Equipment
F&SD	[NASA] Flight and System Demonstrations
FAA	Federal Aviation Administration
FAR	Federal Air Regulations
FAROS	Final Approach Runway Occupancy Signal
FCC	Federal Communications Commission
FFRDC	Federally Funded Research and Development Center
FG&C	Flight Guidance and Control
FICAN	Federal Interagency Committee on Aviation Noise
FIS-B	Flight Information Services-Broadcast

FOQA	Flight Operations Quality Assurance
FSS	Flight Safety System
FTI	FAA Telecommunications Infrastructure
FY	Fiscal Year

G

GA	General Aviation
GA&VF	General Aviation and Vertical Flight Technology
GA-JSC	General Aviation-Joint Steering Committee
GAMA	General Aviation Manufacturing Association
GCNSS	Global Communications Surveillance System
GEOSS	Global Earth Observation System of Systems
GIG	[DoD] Global Information Grid
GPS	Global Positioning System
GRMS	Generic Remote Monitoring Subsystem

H

HF	Human Factors
HF	High Frequency
HFACS	Human Factors Analysis and Classification System
HIRF	High Intensity Radiated Fields
HMP	[NASA] Human Measures and Performance
HUMS	Health and Usage Monitoring Systems
HVAC	Heating, Cooling, Ventilation, Air Conditioning, and Refrigeration

I

IAIPT	Inter-Agency Air Traffic Management Integrated Product Team
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
iCMM	Integrated Capability Maturity Model
ILS	Instrument Landing System
INM	Integrated Noise Model
IPHWG	Ice Protection Harmonization Working Group
IPRF	Innovative Pavement Research Foundation
IPT	Integrated Product Team
ITAS	[NASA] Integrated Tailored Aerostructures

J

JANUS	Not an acronym. Named for the Roman god who guarded doors and gates. A technique used by human factors researchers to determine incident causal factors.
JAWS	Juneau Airport Wind System
JPDO	Joint Planning and Development Office
JSAT	Joint Safety Analysis Team
JSIT	Joint Safety Implementation Team
JTRS	[DoD] Joint Tactical Radio System
JUP	Joint University Program

L

LAAS	Local Area Augmentation Systems Program
LAHSO	Land and Hold Short Operations
LAN	Local Area Network
LCSS	Low-Cost Surface Surveillance
LEAP	[NASA] Low Emission Alternative Power
LED	Light Emitting Diodes
LIDAR	Light Detection and Ranging
LOSA	Line Operations Safety Audit
LTPP	[DOT] Long-Term Pavement Performance

M

MAGENTA	Modeling System for Assessing Global Noise Exposure
MASPS	Minimum Aviation System Performance Standards

MEHV	Micro-Energy High-Voltage
MMPDS	Metallic Materials Properties Development Standards
MOA	Memorandum of Agreement
MOPS	Minimum Operational Performance Standards
MOU	Memorandum of Understanding
MSD	Multiple-Site Damage

N

NAPRS	National Airspace Performance Rating System
NAPTF	National Airport Pavement Test Facility
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NBAA	National Business Aircraft Association
NDGPS	[DOT] Nationwide Differential Global Positioning System
NDI	Non-Destructive Inspection
NDT	Non-Destructive Testing
NEXRAD	Next-Generation Weather Radar
NEXTOR	National Center of Excellence for Aviation Operations Research
NGATS	Next Generation Air Transportation System
NICE	North Atlantic Implementation Management Group Cost Effectiveness
NLA	New Large Aircraft
NOAA	[DOC] National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
NWS	[DOC] National Weather Service

O

OA_{ADJ}	Adjusted Operational Availability
OCC	Operations Control Center
OEP	Operational Evolution Plan
OMB	[Executive Office of the President] Office of Management and Budget
OOT	Object-Oriented Technology
Ops	[FAA Budget Appropriation] Operations

P

PART	[OMB] Program Assessment Rating Tool
PARTNER	Partnership for AiR Transportation Noise and Emissions Reduction
PDARS	Performance Data and Analysis Reporting System
PFNA	[DHS] Pulsed Fast Neutron Analysis Program
PM	Particulate Matter
PVFR	Precision Visual Flight Rules

Q

QAT	[NASA] Quiet Aircraft Technology
QRAS	Quantification Risk Analysis System

R

RAA	Regional Airport Authorities
RAA	Regional Airline Association
RCP	Required Communication Performance
R&D	Research and Development
R,E&D	[FAA Budget Appropriation] Research, Engineering and Development
REDAC	[FAA] Research, Engineering and Development Advisory Committee
RF	Radio Frequency
RIRP	Runway Incursion Reduction Program
RLV	Reusable Launch Vehicle
RLVWG	Reusable Launch Vehicle Working Group
RMP	Research Management Plan
RMS	Root Mean Square

RNAV	Random Navigation/Area Navigation
RNP	Required Navigation Performance
RRLOE	Rapidly Reconfigurable Line Oriented Evaluations
RTSP	Real-Time Streaming Protocol
RVSM	Reduced Vertical Separation Minimum
RWSL	Runway Status Lights

S

SAE	Society of Automotive Engineers
SAGE	System For Assessing Aviation Global Emissions
SAMA	Small Aircraft Manufacturers' Association
SARPS	Standards and Recommended Practices
SAS	[REDAC] Subcommittee on Aviation Safety
SASP	[ICAO] Separation and Airspace Safety Panel
SATS	[NASA] Small Aircraft Transportation System
SAU	[NASA] Strategic Aerospace Usage
SBIR	Small Business Innovation Research
SBT	[NASA] Space-Based Technologies
SDAT	Sector Design and Analysis Tool
SDN	Surveillance Data Network
SLD	Supercooled Large Droplet
SMAAQ	Screening Model for Airport Air Quality
SMS	Surface Management System
SNI	Simultaneous Non-Interfering
SSID	Supplemental Structural Inspection Documents
SST	[NASA] System Safety Technology
STARS	Standard Terminal Automation Replacement System
SWIM	System Wide Information Management

T

TAF	Terminal Aerodrome Forecasts
TCRG	Technical Community Representative Groups
TDMA	Time Division Multiple Access
TEM	Threat and Error Management
TERPS	Terminal Instrument Procedures
TFM	Traffic Flow Management
TFR	Temporary Flight Restriction
TIS-B	Traffic Information Service-Broadcast
TMA-MC	Traffic Management Advisor – Multi Center
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board

U

UAT	Universal Access Transceiver
UAV	Uninhabited Aerial Vehicle
UEDDAM	Uncontained Engine Debris Damage Assessment Model
UEET	[NASA] Ultra-Efficient Engine Technology
UNFCCC	United Nations Framework Convention

V

VALE	Voluntary Airport Low Emissions
VAMS	[NASA] Virtual Airspace Modeling & Simulation
VF	Vertical Flight
VFR	Volpe National Transportation Systems Center


Do not allow children to play on baggage claim machinery.
Alarm horn and flashing light indicate that conveyor system will start in motion.
Many bags look alike. Please check your claim tag to ensure proper receipt.

Photo by Lockett Yee

The National Aviation Research Plan is an annual publication required by Title 49 of the U.S. Code section 44501(c).

U.S. Department of Transportation
Federal Aviation Administration
800 Independence Ave., SW
Washington, DC 20591

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