Overview

NASA research continues to contribute directly to aeronautics breakthroughs. As the Agency's lead organization for aeronautics research, NASA's Aeronautics Research Mission Directorate (ARMD) oversees cutting-edge research whose goal is to generate the innovative concepts, tools and technologies that will enable revolutionary advances in future aircraft, as well as to the airspace in which they will fly. NASA has put together a robust research portfolio that addresses these advances and the challenges facing our Nation as it transforms its air transportation system to meet growing capacity needs. In addition, the portfolio ensures aeronautics research and critical core competencies will continue to play a vital role in supporting NASA's human and robotic space exploration activities.

Growth in the air transportation system is vital to the well being of our Nation. In the United States, 151 domestic airlines fly 8,100 aircraft; annual operating revenue for commercial flight stands at $164 billion. Twenty-five percent of U.S.-based company sales depend on air transportation, while the aviation industry directly or indirectly accounts for 634,500 American jobs.

Nevertheless, current needs exceed the limited solutions that aviation currently offers, requiring dramatic improvements in safety, capacity, environmental compatibility, robustness and freedom of mobility throughout the global airspace. In the next two decades, we must develop advances that improve aircraft and system efficiency, reduce aviation's impact on the environment and allow more people to utilize air travel in ways that are more significant than all the gains realized over the last three decades.

Each of NASA's five programs, Aviation Safety, Airspace Systems, Fundamental Aeronautics, Aeronautics Test, and Integrated Systems Research uniquely address specific aeronautical-research needs while taking an integrated approach in addressing critical long term challenges. By continuing to expand the boundaries of aeronautical knowledge for the benefit of the Nation as well as NASA's partners in academia, industry and other government agencies, NASA's programs are also helping to foster a collaborative research environment in which ideas and knowledge are exchanged across all communities.

NASA Aeronautics is now in full execution of a robust fundamental research program that is well aligned with the principles, goals and objectives of the National Aeronautics Research and Development (R&D) Policy and directly supports the development of the Next Generation Air Transportation System (NextGen). NASA's commitment to technical excellence and strong partnerships will ensure our continued focus on those challenges needed to support the needs of the Nation's air transportation system and the Agency's space exploration mission.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aeronautics	511.4	650.0	507.0	514.0	521.0	529.0	536.0
FY 2009 President's Budget Request	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**	**--**
Aeronautics	511.7	446.5	447.5	452.4	456.7	467.7	--
Total Change from FY 2009 President's Budget Request	**-0.3**	**203.5**	**59.5**	**61.6**	**64.3**	**61.3**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted.

Plans for FY 2010

Aeronautics Research

Aeronautics

New Initiatives:

In response to several external mandates and recommendations and based on NASA's own assessment, NASA is initiating a program of integrated, system-level focused activities. The intent of this program is to accelerate the transition of key Next Generation Air Transportation System (NextGen) research and development (R&D) results to industry and government, and to expand development of key testbeds to enable testing of integrated, system-level capabilities. In addition, these activities will inform future foundational research by exposing key technology challenges. The focus of the Integrated Systems Research Program will initially be the development of new vehicle concepts and enabling technologies that will simultaneously reduce fuel burn, noise and emissions. As future opportunities for systems-level research arise, new systems-level research projects will be added to the Integrated Systems Research Program. The Integrated Systems Research Program will begin in FY 2010 at a funding level of $62.4 million.

Major Changes:

Aeronautics research into planetary entry, descent and landing (EDL) has been conducted within the Supersonics and Hypersonics projects of the Fundamental Aeronautics Program. In practice, EDL is an integral part of any space mission and is not divided into distinct hypersonics and supersonics phases. All EDL technology research and development is now combined in the Hypersonics project. This change will provide more focus to technical developments and will also yield technical management efficiencies.

Some of the technologies to be matured within the ISRP project will be drawn from the fundamental technologies within the Subsonic Fixed Wing (SFW) project of the Fundamental Aeronautics Program. With this work transfer the SFW project is streamlining its research content, and this is enabling new efficiencies across the foundational disciplines remaining in the project. Therefore we are transferring funds from SFW to the Airspace Systems Program in order to accelerate the development of new airspace management concepts. Details of these new activities are included in the Airspace Systems Program section.

The Airspace Systems Program has been reorganized from the NextGen Airspace and NextGen Airportal projects into the NextGen Concepts and Technology Development project and the NextGen Systems Analysis, Integration and Evaluation project. The previously planned work on airspace concepts, technologies and systems will continue, but the project structure is now better aligned to the nature of the work being performed.

To enable more efficient tracking and management of the headquarters operations, ARMD is consolidating headquarter's activities currently in the Airspace Systems Program, the Aeronautics Test Program and the Aviation Safety Program into the Fundamental Aeronautics Program. There is no programmatic budget impact to the programs. This results in an increase in the Fundamental Aeronautics Program budget and a corresponding decrease in the other three programs.

Major Highlights for FY 2010

In FY2010, the Aeronautics Research Mission Directorate will continue its commitment to conducting long-term cutting edge research for the benefit of the broad aeronautics community. Each of the five programs within ARMD will play a significant role in FY2010 in addressing the challenge of meeting the growing capacity needs of the Next Generation Air Transportation System (NextGen) as well as contributing to the R&D challenges in aviation safety, promising new flight regimes, and aviation environmental impacts. Specifically,

- The Aviation Safety Program will take a proactive approach to safety challenges with new and current vehicles and with operations in the Nation's current and future air transportation system. In addition, the Program is initiating an effort to examine key challenges in verifying and validating flight critical software systems.

- The Airspace Systems Program will develop and enable future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the NextGen.

- The Fundamental Aeronautics Program will continue to develop prediction and analysis tools for reduced uncertainty in design process and advanced multidisciplinary design and analysis capability to guide our research and technology investments and realize integrated technology advances in future aircraft.

- The Aeronautics Test Program will ensure the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities and flight operations assets necessary to meet Agency and National aeronautics needs.

- The Integrated Systems Research Program's initial effort will take an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, local and global emissions, and local air quality) in the area of air vehicle technologies.

Theme Overview

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aviation Safety	66.5	89.3	60.1	59.6	59.2	61.7	62.5
Airspace Systems	100.1	121.5	81.4	82.9	83.9	87.2	88.3
Fundamental Aeronautics	269.6	307.6	228.4	230.0	233.6	239.0	245.9
Aeronautics Test Program	75.1	131.6	74.7	77.1	77.2	76.6	78.7
Integrated Systems Research	0.0	0.0	62.4	64.4	67.1	64.4	60.5
FY 2009 President's Budget Request	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**	**--**
Aviation Safety	66.5	62.6	65.9	65.0	64.5	66.5	--
Airspace Systems	100.1	74.6	72.7	74.2	75.4	78.4	--
Fundamental Aeronautics	269.9	235.4	233.2	235.2	238.6	244.6	--
Aeronautics Test Program	75.1	73.9	75.8	78.0	78.2	78.2	--
Total Change from FY 2009 Request	**-0.3**	**203.5**	**59.5**	**61.6**	**64.3**	**61.3**	**--**

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Office of Science and Technology Policy (OSTP) National Science and Technology Council (NSTC) Committee on Technology chartered an Aeronautics Science and Technology (AS&T) Subcommittee in September 2005. NASA's Associate Administrator for ARMD is a co-chair of the Subcommittee, which drafted the Nation's first Aeronautics Research and Development Policy, released by the White House in December 2006. The policy establishes a set of U.S. aeronautics research objectives, defines the appropriate role of the federal government in aeronautics research and development (R&D), defines the roles and responsibilities of the various departments and agencies in aeronautics R&D, addresses R&D test and evaluation infrastructure, and addresses the coordination of aeronautics research across the federal government. NASA's ARMD efforts are aligned with this policy.

ARMD's research portfolio also aligns very well with the recommendations of the 2006 National Research Council (NRC) Decadal Survey. All five of the Common Themes identified in the Decadal Survey are present across ARMD's research programs, and 47 of the 51 Technical Challenges are also well represented in the portfolio. A detailed response to the survey was documented in a Report to Congress submitted in August 2007.

Finally, in December 2007, the President approved the first National Aeronautics R&D Plan. ARMD's research portfolio is closely aligned with this plan.

Relevance to the NASA Mission and Strategic Goals:

ARMD's focus on long-term, cutting-edge research that expands the boundaries of aeronautical knowledge for the benefit of the broad aeronautics community directly supports NASA's mission to pioneer the future in space exploration, scientific discovery, and aeronautics research. NASA's fundamental aeronautics research will have far-reaching effects on both civilian aviation and space exploration. ARMD's work supports Sub-goal 3E, "Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems." Within this subgoal, each program within ARMD supports an associated outcome:
- The Aviation Safety Program supports Outcome 3E.1, "By 2016 identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).";
- The Airspace Systems Program supports Outcome 3E.2, "By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.";
- The Fundamental Aeronautics Program supports Outcome 3E.3, "By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.";
- The Aeronautics Test Program supports Outcome 3E.4, "Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements."; and
- The Integrated Systems Research Program supports Outcome 3E.5, "For vehicle and propulsion technologies that simultaneously reduce fuel burn, noise, and emissions, by 2016 develop a well-informed trade space, document performance potential, and identify technical risks to a level that enables incorporation of the technologies into the design of new aircraft". Additionally, there are 13 Annual Performance Goals (APGs) linked to these five outcomes. See the performance section of this document for additional details.

Relevance to education and public benefits:

NASA's aeronautics program ensures long-term focus in fundamental research in both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. This approach will enable revolutionary change to both the airspace system and the aircraft that fly within it, leading to a safer, more environmentally friendly, and more efficient national air transportation system. Furthermore, ARMD will disseminate all of its research results to the widest practicable extent.

ARMD uses the NASA Research Announcement (NRA) process to foster collaborative research partnerships with the academic and private sector communities. The NRA process encourages awardees to spend time at NASA centers in order to enhance the exchange of ideas and expand the learning experience for everyone involved. Furthermore, ARMD has focused its educational activities to better attract the Nation's best and brightest students to aeronautics. These activities include design competitions and the establishment of graduate and undergraduate scholarships and internships.

Performance Achievement Highlights:

Each ARMD program made significant contributions to the advancement of aeronautics research in FY 2008.

A series of human-in-the-loop experiments that explored advanced concepts and technology for separation assurance was conducted by NASA researchers in the Airspace Systems Program in concert with San Jose State University and the Federal Aeronautics Administration. Such technology is critical to relieving air-traffic controller workload, the primary constraint on airspace capacity. At Indianapolis Center, studies examined the performance of six controllers, 20 pilots and separation-assurance automation in the face of nominal and dramatically increased traffic demand. Varying levels of automation support were provided to the controllers and pilots, including automated conflict detection, automated strategic conflict resolution and automated tactical conflict resolution. The test scenarios included routine operations and off-nominal conditions.

Within the Aviation Safety Program, the Integrated Resilient Aircraft Control project successfully designed and implemented two improved adaptive control architectures, known as Gen2A and Gen2B, addressing stability-improvement implementation barriers identified from analysis of aircraft flight tests of an initial direct adaptive control scheme. Both systems have been extensively tested in a high-fidelity, nonlinear piloted simulation and have been cleared through the airworthiness review board. Flight evaluation of the stability and performance characteristics of both designs continues.

NASA's Fundamental Aeronautics Program, in partnership with AFRL, Boeing, and Northrop Grumman, successfully completed testing of several promising powered-lift concepts, which included blowing on and active flow control of flaps, as well as increasing lifting force on an aircraft at slow speeds, such as during takeoff and landing, without increasing drag under cruise conditions. Lift performance was verified in wind tunnel tests at NASA's Langley Research Center, and flow fields characterized to validate computational fluid dynamics tools. Successful deployment of powered-lift concepts will enable short take-off and landings on 3,000-foot runways, increasing capacity through the use of shorter fields and improved low-speed maneuverability in the terminal area.

In 2008, NASA's Aeronautics Test Program (ATP) exceeded its goal of substantially reducing NASA's deferred-maintenance liability for ground test facilities through an ambitious investment project. ATP also commissioned a comprehensive, independent facility condition assessment of its ground test facilities and related infrastructure. Findings and recommendations will be factored into a new program management strategy under development.

For more information, see Sub-goal 3E in the FY 2008 Annual Performance Report at http://www.nasa.gov/pdf/301836main_291255main_NASA_FY08_Performance_and_Accountability_Report.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert	10/2008	An independent assessment of NASA's aeronautics research portfolio was performed by the National Research Council (NRC) to determine how NASA is addressing the research challenges and requirements identified in the NRC Decadal Survey Of Civil Aeronautics. Their recommendations and findings are detailed in the final report, titled "NASA Aeronautics Research: An Assessment", which was released in mid 2008.	N/A

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	66.5	89.3	60.1	59.6	59.2	61.7	62.5
Integrated Vehicle Health Management	21.5	22.2	19.8	18.2	18.3	18.9	18.9
Aircraft Aging and Durability	9.1	13.4	11.4	11.2	11.7	12.1	12.1
Integrated Resilient Aircraft Control	21.8	37.3	16.4	17.0	17.6	18.2	18.2
Integrated Intelligent Flight Deck Technologies	14.1	16.3	12.5	13.3	11.6	12.6	13.4
FY 2009 President's Budget Request	66.5	62.6	65.9	65.0	64.5	66.5	--
Integrated Vehicle Health Management	22.0	19.7	19.9	18.8	18.6	19.2	--
Aircraft Aging and Durability	10.0	10.6	11.3	11.2	12.0	12.4	--
Integrated Resilient Aircraft Control	15.3	17.1	18.5	19.0	18.2	18.8	--
Integrated Intelligent Flight Deck Technologies	19.3	15.2	16.3	16.0	15.7	16.1	--
Changes from FY 2009 Request	0.0	26.7	-5.8	-5.4	-5.3	-4.8	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Overview

By 2025, air traffic within American airspace may double or triple. Radical innovation will be required to meet such demand. The goal of the NextGen is to make passage through increasingly crowded skies efficient and speedy while maintaining or increasing safety. NextGen will achieve its mandates with state-of-the-art networking technology, continually updating its data and sharing that information with pilots and controllers. Aircraft will be able to immediately adjust to changing factors such as weather, traffic congestion, the position of other aircraft, flight trajectories and any terrestrial or airborne security concerns.

NASA's Aviation Safety Program (AvSP) helps to realize NextGen's full potential by examining concerns to further reduce risk in any complex, dynamic operating domain. AvSP's contribution ranges from providing fundamental research in known safety concerns, to working with partners to address the challenges created as we transition to NextGen, where we expect significant increases in air traffic, introduction of new vehicle concepts, continued operation of legacy vehicles, increased reliance on automation, and increased operating complexity.

Four AvSP projects are looking at hardware and software systems that will operate in the NextGen. The projects seek to provide increasing capabilities to predict and prevent safety issues, to monitor for safety issues in-flight and mitigate against them should they occur, to analyze and design safety issues out of complex system behaviors, and to constantly analyze designs and operational data for potential hazards. These technologies can be leveraged to support safety in other complex systems, such as NASA long-duration missions in space science and exploration. The program is also initiating an effort to examine key challenges in verifying and validating that flight-critical systems meet the extremely high levels of safety required for NextGen operations.

For example, the goal of AvSP's Integrated Vehicle Health Management project is to develop validated tools, technologies and techniques for automated detection, diagnosis and prognosis of adverse events that occur in flight. A second project, Integrated Intelligent Flight Deck, is pursing flight-deck-related technologies to ensure crew workload and situational awareness are both safely optimized and adapted to the NextGen operational environment.

The AvSP Integrated Resilient Aircraft Control project advances state-of-the-art designs for enhanced stability and maneuverability margins to protect against loss-of-control due to potential adverse events including atmospheric factors, actuator and sensor faults or failures, and complex damage to structures and control components. AvSP's Aircraft Aging and Durability project develops advanced capabilities for detection and mitigation of aging-related hazards before they become critical.

For more information, see http://www.aeronautics.nasa.gov/programs_avsp.htm.

Plans For FY 2010

AvSP is comprised of four projects. All four projects have developed 5-year project plans with milestones and metrics. Highlighted here are key performance deliverables for FY 2010.

Researchers in the Integrated Vehicle Health Management (IVHM) Project will demonstrate, on a representative 2008 baseline current generation electro-mechanical system testbed, improved IVHM via Bayesian methods and/or models for varying operating conditions and demonstrate fault detection/diagnosis on at least three faults types and examine tradeoff between accuracy and diagnosis time. In 2010, this technology will demonstrate (through experimentation) a 95% accuracy in diagnosing faults.

Researchers in the Aircraft Aging and Durability (AAD) Project will develop an atomistically-based model capable of predicting within 25%, the degradation caused by environmental effects on interfaces in selected polymer matrix composite materials. In 2010 the model will be used to predict within 25% the interfacial strength/toughness degradation of at least 2 resin/fiber combinations under a range of environmental exposures.

Researchers in the Integrated Resilient Aircraft Control (IRAC) Project will be developing a tool suite that provides an order of magnitude reduction in analysis time over current Monte-Carlo simulation methods that would be used to locate failure points in the flight envelope for a chosen adaptive control system and a set of adverse events. In 2010 the project will demonstrate confidence levels as good as what can be achieved using direct Monte-Carlo simulation techniques with a factor of ten reduction in computing time over direct Monte Carlo techniques.

Researchers in the Integrated Intelligent Flight Deck (IIFD) Project will deliver (through analysis) flight deck guidelines, information, and display requirements that meet NextGen operational needs as established in 2007 baseline assessment, and without a measurable increase to safety risk. In 2010, simulation studies will indicate improvements in performance, situational awareness, and workload while operating in NextGen-based environments of higher traffic densities, 4D trajectory negotiations, and Aeronautical Information Service/Meteorological Information Service datalink provisions, using advanced flight deck technologies and operations, with no degradation of safety margin over 2007 state of the art.

Project Descriptions and Explanation of Changes

Integrated Vehicle Health Management

The goal of the IVHM Project is to conduct research to advance the state of highly integrated and complex flight-critical health management technologies and systems. These technologies will enable nearly continuous onboard situational awareness of the vehicle health state for use by the flight crew, ground crew, and maintenance depot. Improved safety and reliability will be achieved by onboard systems capable of performing self-diagnostics and self-correction of anomalies that could otherwise go unattended until a critical failure occurs in structures, propulsive systems, avionics hardware, or software. A key enabling technology will be the ability for sharing and processing large amounts of information among the various vehicle subsystems to more accurately diagnose the system health state and execute the logic to self-correct any critical anomalies detected. This data mining capability can also be applied to operational data about both aircraft and airspace.

Aircraft Aging and Durability

The goal of the AAD Project is to develop advanced diagnostic and prognostic capabilities for detection and mitigation of aging-related hazards. The research and technologies to be pursued will decrease the susceptibility of current and next generation aircraft and onboard systems to premature deterioration, thus greatly improving vehicle safety and mission success. Emerging civilian and military aircraft are introducing advanced material systems, fabrication techniques, and structural configurations for which there is limited service history. There will be an emphasis in the AAD project on new material systems/fabrication techniques and the potential hazards associated with aging-related degradation. The intent is to take a proactive approach to identifying aging-related hazards before they become critical, and to develop technology and processes to incorporate aging mitigation into the design of future aircraft. Foundational research in aging science will ultimately yield multidisciplinary subsystem and system-level integrated methods for detection, prediction, and mitigation/management of aging-related hazards for future civilian and military aircraft.

Integrated Resilient Aircraft Control

The goal of the IRAC Project is to conduct research to advance our ability to model and prevent loss-of-control in flight. Taking into account the advanced automation and autonomy capabilities as envisioned by NextGen, the research will pursue methodologies to enable an aircraft to automatically detect, mitigate, and safely recover from an off-nominal condition that could lead to a loss of control. A key component of the research will be to develop technologies that would enable an aircraft control system to automatically adapt or reconfigure itself in the event of a failed or damaged component and the rigorous verification and validation of such adaptive, software-based flight-critical systems.. These adaptive control concepts will likely have applications to future space exploration missions where vehicles will be required to operate and adapt to unknown flight. Likewise, research seeks to better understand causes of upset flight conditions, including icing and structural degradation, and to plan and execute safe trajectories to landing in degraded conditions

Integrated Intelligent Flight Deck Technologies

The goal of the IIFD Project is to develop tools, methods, principles, guidelines, and technologies for revolutionary flight deck systems. In doing so, IIFD seeks to expand our ability to predict and create the comprehensive set of developments (technologies, procedures, and specifications for crew training) demanded for truly novel concepts of operation, such as those proposed for the Next Generation Air Transportation System (NextGen). Trajectories may be defined in distinctly new ways, pilots' tasks may expand to include collaboration and negotiation with other aircraft and with air traffic controllers, and may require managing large disparate sets of information to support a wide range of decisions made both individually and collaboratively. Current projections for NextGen operations also prescribe an increased use of automation, much of which will need to interact with, and support, the cognitive activities of pilots and air traffic controllers. The scope of IIFD also includes the development of a comprehensive surveillance system design that enables robust detection of external hazards with sufficient time-to-alarm for safe maneuvering to avoid the hazards. The products of the IIFD Project should enable system designers to eliminate the safety risk of unintended consequences when introducing new and advanced systems into an operational environment.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2011, demonstrate self-healing material concepts to mitigate damage in structural elements	IVHM	Same
In 2012, demonstrate forecasting technology that can predict known anomalies in large data sources	IVHM	Added future commitment
Demonstrate sensors, software and guidelines that will enable implementation of onboard IVHM by 2016	IVHM	Same
In 2011, develop aging mitigation technique that demonstrates 50% improvement over the 2007 baseline	AAD	Same
Deliver validated tools and methods that enable implementation of aircraft aging mitigations by 2016	AAD	Same
In 2011, validate selected part-task simulation in NextGen-based simulator or flight environment	IIFD	The performance measures for the Program were refined in 2008
In 2012, compare test results to models of human-automation interaction concepts for NextGen	IIFD	Added future commitment
In 2016, deliver tools and flight deck technologies to enable advanced automation to support NextGen	IIFD	Same
In 2011, assess control strategies for aircraft recovery from upset stall conditions	IRAC	Same
In 2012, assess flight planning and control strategies for aircraft recovery from adverse conditions	IRAC	Added future commitment
Deliver multidisciplinary adaptive control design tools for loss-of-control and recovery by 2016	IRAC	Same

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Integrated Vehicle Health Management (IVHM)	Principle Investigator and Project Manager who report to the Program Director	LARC, GRC, ARC, DFRC	FAA, Joint Planning and Development Office (JPDO), Commercial Aviation Safety Team (CAST), NOAA, DoD, Moog, and Boeing
Aircraft Aging and Durability (AAD)	Principle Investigator and Project Manager who report to Program Director	LARC, GRC, ARC	FAA, CAST, DoD, Joint Council on Aging Aircraft (JCAA), Center for Rotorcraft Innovation, Alcoa, Williams International and Luna Innovations.
Integrated Intelligent Flight Deck (IIFD)	Principle Investigator and Project Manager who report to Program Director	LARC, ARC, GRC	FAA, JPDO, CAST, and Boeing
Integrated Resilient Aircraft Control (IRAC)	Principle Investigator and Project Manager who report to Program Director	LARC, DFRC, GRC, ARC	FAA, JPDO, CAST, Air Force Research Lab (AFRL) , American Kestrel Company, and Goodrich

Acquisition Strategy

The Aviation Safety Program spans research and technology from foundational research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The AvSP will award approximately $8.0 million in FY 2010 in grants, contracts, and cooperative agreements, including renewals of multi-year awards made under previous NRAs, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009
Relevance	National Research Council	n/a	The review will assess whether the program: (a) has well-defined, prioritized, and appropriate research objectives; (b)is properly coordinated with the safety research programs of the Federal Aviation Administration and other relevant Federal agencies; (c)has allocated appropriate resources to each of the research objectives; and (d)has suitable mechanisms for transitioning the research results from the program into operational technologies and procedures and certification activities.	12/2009

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Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	100.1	121.5	81.4	82.9	83.9	87.2	88.3
NextGen Concepts and Technology Development	83.3	105.3	53.3	54.5	55.3	57.8	58.7
NextGen Systems Analysis, Integration, and Evaluation	16.8	16.2	28.1	28.4	28.5	29.5	29.6
FY 2009 President's Budget Request	100.1	74.6	72.7	74.2	75.4	78.4	--
NextGen Airspace	83.3	61.3	56.0	57.3	58.5	60.8	--
NextGen Airportal	16.8	13.3	16.7	16.9	16.9	17.5	--
Changes from FY 2009 Request	0.0	46.9	8.7	8.6	8.5	8.9	--

Program Overview

The Airspace Systems Program (ASP) focuses on mastery, intellectual stewardship, and technical excellence in fundamental air traffic management research. The ASP directly addresses the air traffic management research needs of the Next Generation Air Transportation System (NextGen) in collaboration with the member agencies of the Joint Planning and Development Office (JPDO). NASA is working closely with the JPDO as well as other government, industry, and academic partners to enable the formation, development, integration, and demonstration of revolutionary concepts, capabilities, and technologies allowing significant increases in capacity, efficiency, and flexibility of the National Airspace System (NAS). These goals are in direct support of the guidelines in the National Aeronautics Research and Development Policy and Plan.

Increasing the capacity and efficiency of the air transportation system in a manner that does not negatively impact the environment or safety is critically important for the Nation's economic well-being. More than half of the Nation's busiest airports are already at capacity or will reach capacity limits in the next 10-20 years. Creating new capacity en route or on the airport surface is extraordinarily expensive and can take decades to complete, particularly if environmental constraints and safe separation standards are at issue. Specifically, environmental concerns forced 12 major commercial airports to cancel or indefinitely postpone expansion projects since the 1990s. Despite these constraints, air traffic is expected to continue to increase substantially in the next 20 years. All other factors remaining constant, increases will mean longer delays at airports already experiencing delays and create congestion delays at airports not currently experiencing any. The associated environmental impact and economic inefficiencies have been predicted by some to cost the Nation tens of billions of dollars annually. The risk of loss of aircraft separation both during airborne and ground operations could increase as the volume of air traffic exceeds the capacity of the airspace and airports to safely and efficiently accommodate the increased growth.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

Plans For FY 2010

Beginning in FY 2010, ASP will be restructured into two new projects. Previously, the projects in ASP were the NextGen Airspace Project and the NextGen Airportal project. It was determined that the distinctions between airport operations, terminal-area operations and en-route operations were sometimes confusing, leading to time expended determining the line of demarcation between the responsibilities of the two projects. A more significant distinction is the development of air traffic management concepts and the technologies that enable air traffic management improvements and the evaluation of these concepts and technologies at a system level. Accordingly, ARMD has re-organized ASP to rename the two projects the NextGen Concepts and Technology Development project and the NextGen Systems Analysis, Integration and Evaluation project. The previously planned work on airspace concepts, technologies and systems will continue, but the project structure is now better aligned to the nature of the work being performed.

The NextGen Concepts and Technology Development Project will focus on developing capabilities in traffic flow management, dynamic airspace configuration, separation assurance, super density operations, and airport surface operations. Specifically, in FY 2010, the Project will conduct simulations of automated separation assurance subject to sequencing, spacing, and scheduling constraints. The simulations will evaluate a range of controller and pilot roles and responsibilities. Experiments will be designed with common assumptions, scenarios, uncertainty and metrics such that the experimental results generated by different concepts can be directly compared. Additionally, the Project will expand traffic flow management concepts to address weather modeling uncertainty to promote higher predictability and efficiency. In addition, in FY 2010, the Project will develop algorithms to generate robust, optimized solutions for surface traffic planning and control, and initial algorithms for airportal arrival and departure balancing. This will include evaluations of benefits in both nominal and off-nominal conditions with increased airportal traffic density and consideration of environmental constraints. The project will also determine research issues that are on a critical path to airportal metroplex capabilities. Important to all above research activities is the development of human/automation information requirements and decision making guidelines for human-human and human-machine airportal decision making.

The NextGen Systems Analysis, Integration, and Evaluation Project will focus on transition from the laboratory to the field of key systems concepts currently being pursued within the NextGen Concept and Technology Development Project (i.e., surface, terminal, transitional airspace, and en route domains) that will provide operational benefits, and demonstrate these integrated capabilities in relevant flight environments. Through systems analysis, key concepts will be down-selected based on their potential benefit towards improving operational efficiency, and then matured and tested in both fast-time and real-time full mission simulations to determine their technical viability. From this testing, a sub-set of these integrated concepts will be further demonstrated and evaluated through field tests integrating both air and ground capabilities. This work will commence in FY2010 with analysis elements, advancing over several years to culminate in relevant field experiments and demonstrations. This work will be coordinated with the FAA, the JPDO, and the Research Transition Teams of the JPDO to ensure transition of NASA concepts, technologies and procedures to the field to help enable the transition of today's air transportation system to NextGen. Detailed project planning activities are currently underway.

Project Descriptions and Explanation of Changes

NextGen Concepts and Technology Development

The NextGen Concepts and Technology Development Project will develop and explore fundamental concepts that address the optimal allocation of ground and air automation technologies necessary for NextGen . The project will focus NASA's technical expertise and world-class facilities to address the question of where, when, how, and the extent to which automation can be applied to moving aircraft safely and efficiently through the National Airspace System (NAS) including airport surfaces. Research in this project will address Four-Dimensional Trajectory Operations, including advances in the science and applications of multi-aircraft trajectory optimization that solves the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties, and keeping aircraft safely separated. The project's research will develop and test concepts for advanced traffic flow management to provide trajectory planning and execution across the spectrum of time horizons from "strategic planning" to "separation assurance." The project will also conduct research to explore dynamic airspace configuration that addresses the technical challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demands and meets changing constraints of weather, traffic congestion, and a highly diverse aircraft fleet. Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed thoroughly. The Project will respond to the need to achieve the maximum possible productivity in the combined use of gates, taxiways, runways, terminal airspace, and other airportal resources. Since every airport is a unique environment, and demand is not expected to increase equally at each airport as the system grows.

Specific technical goals include:

- Increasing capacity through dynamic allocation of airspace structure and controller resources;
- Effectively allocating demand through departure-time management, route modification, adaptive speed control, etc., in the presence of uncertainty;
- Developing algorithms, automation prototypes, and procedures that relieve the capacity constraints imposed by human-controlled separation of aircraft in transition and cruise airspace;
- Quantifying the performance-enhancing effects of emerging airborne technologies;
- Optimizing surface traffic operations to enable capacity enhancements;
- Exploring transformational approaches, enabled by NextGen capabilities, for increasing airportal throughput;
- Maximizing the capacity of individual runways and multiple runways with airspace and taxi interactions (closely-spaced parallel and converging/intersecting runways);
- Minimizing runway incursion threats in all weather conditions; and
- Balancing arrival and departure traffic management to enable capacity improvements.

NextGen Systems Analysis, Integration, and Evaluation

The high-level goal of the NextGen Systems Analysis, Integration, and Evaluation Project is to conduct systems analysis, integration, and evaluation of key concepts currently being pursued within the surface, terminal, transitional airspace, and en route domains that will provide operational benefits, and demonstrate these integrated capabilities in a relevant environment. Through system analysis, key concepts will be down-selected based on their potential benefit towards increasing efficiency, and then matured and tested in both fast-time and real-time full mission simulations to determine their technical viability. From this testing, a sub-set of these integrated concepts will be further demonstrated and evaluated through field tests integrating both air and ground capabilities. To accomplish this goal, the following technical objectives will be satisfied:

- Define operational issues, factors and concerns that must be considered in conducting system analysis;
- Assess collective impact of these technologies using fast-time modeling and simulation and feed back results into the baseline program to enhance and validate research concepts;
- Examine the feasibility of the integrated concepts and technologies using human performance models and human-in-the-loop simulations;
- Demonstrate the impact of the integrated concepts and technologies using field trials;
- Assess alternate fleet implications on trajectory based operations; and
- Collaborate with industry and government partners to transition technologies that enable increases in capacity and efficiency, while maintaining safety and environmental conditions.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010, conduct simulations of automated separation assurance with sequencing, spacing, and scheduling constraints.	NextGen Concepts and Technology Development Project	Same
In 2011, evaluate Air Navigation Service Provider-based and airborne-based automated separation assurance in the presence of complex traffic, hazardous weather, and sequencing, spacing, and scheduling constraints.	NextGen Concepts and Technology Development Project	Wording change to be consistent with adjustments in program plans to align with NextGen goals
In 2011, validate initial super-density concepts including a set of culminating experiments	NextGen Systems Analysis, Integration, and Evaluation	Same
By 2016, develop future concepts, capabilities, and technologies for NextGen operations.	NextGen Concepts and Technology Development Project	Changed commitment to reflect project restructure.
In 2010, determine the feasibility and benefits of one or more candidate Multi-Sector Planner concepts.	NextGen Systems Analysis, Integration, and Evaluation	New
By 2016, develop and evaluate future airportal concepts, capabilities, and technologies	NextGen Systems Analysis, Integration, and Evaluation	Same

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
NextGen Concepts and Technology Development	Principal Investigator and Project Manager, who report to the Program Director.	ARC, LARC	FAA, JPDO, DOT, Air Force Research Lab (AFRL), Lockheed Martin, Air Services Australia and Eurocontrol
NextGen Systems Analysis, Integration, and Evaluation	Project Manager and Resources Manager, who report to the Program Director	LARC, ARC	FAA, JPDO, and DoT

Acquisition Strategy

The Airspace Systems Program spans research and technology from foundational research to integrated system capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Airspace Systems Program will award approximately $13.6 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	10/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	10/2009

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FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	269.6	307.6	228.4	230.0	233.6	239.0	245.9
Subsonic - Rotary Wing	30.8	38.9	26.1	26.1	26.3	27.4	27.9
Subsonic - Fixed Wing	119.6	155.2	101.6	103.7	105.4	107.3	110.8
Supersonics	53.0	55.6	40.6	40.0	40.7	42.0	42.8
Hypersonics	66.2	57.9	60.0	60.2	61.1	62.3	64.4
FY 2009 President's Budget Request	269.9	235.4	233.2	235.2	238.6	244.6	--
Subsonic - Rotary Wing	30.8	25.8	26.6	26.7	26.9	28.0	--
Subsonic - Fixed Wing	119.9	108.4	105.3	107.6	109.1	111.5	--
Supersonics	53.0	44.0	44.9	44.3	45.2	46.6	--
Hypersonics	66.2	57.3	56.4	56.5	57.4	58.4	--
Changes from FY 2009 Request	-0.3	72.2	-4.8	-5.2	-5.0	-5.6	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

Program Overview

Research within NASA's Fundamental Aeronautics Program (FAP) focuses on conducting cutting edge research that addresses many of the the main problems of air transportation including concerns over noise and emissions, sustainability of affordable air travel with increasing cost and availability of jet fuel, airspace mobility to meet increasing demand for air transportation, and lack of progress towards faster means of transportation. The FAP is also dedicated to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation across all flight regimes. Research in revolutionary aircraft configurations, lighter and stronger materials, improved propulsion systems, and advanced concepts for high lift and drag reduction all target the efficiency and environmental compatibility of future air vehicles. The Program also develops physics-based, multidisciplinary design, analysis and optimization tools to enable evaluation of new vehicle designs and to assess, with known uncertainties, the potential impact of design innovations on a vehicle's overall performance. All of these advances will one day realize revolutionary improvements in noise, emissions and performance that enable a new generation of air vehicles to meet the challenges of the NextGen air transportation system.

Fundamental Aeronautics is organized around four projects that focus on research and challenges within a specific flight regime. The Subsonic Fixed Wing Project conducts research on new aircraft configurations and advanced propulsion systems that could dramatically reduce noise, emissions, fuel burn, and runway field length for a variety of subsonic fixed wing vehicles, The Subsonic Rotary Wing Project conducts research on speed and range increases, payload capacity, noise reduction, and propulsive efficiency to enable development of new rotorcraft configurations that enhance mobility of the future air transportation system. Technologies to meet the environmental challenges specifically associated with supersonic flight, such as sonic boom and gaseous emissions, are being addressed by the Supersonics Project. Elimination of these barriers will help realize practical commercial supersonic cruise vehicles that can fly over land. Finally, the Hypersonics Project focuses on long-range, fundamental and multidisciplinary research to enable new air-breathing launch vehicle architectures with more reliability for low-cost access to space.

In addition, the program is conducting planetary entry, descent and landing (EDL) research to address aeronautics-related challenges in both hypersonic and supersonic regimes. Research focusing on areas critical to EDL will result in the development of technologies and design tools that will enable landing of large payloads on other planets in support of NASA's human and robotic exploration missions.

For more information, please see http://www.aeronautics.nasa.gov/fap/

Plans For FY 2010

The Subsonic Rotary Wing (SRW) Project will demonstrate control concepts through flight simulation that will contribute to development of a flight control optimization tool for variable speed engine and transmission systems with no negative handling qualities. Current rotorcraft feature drivetrain components and main rotors which operate at nearly constant speed from hover through forward flight and current control systems are tailored to those operational attributes. Higher forward flight speeds are needed in order to make rotorcraft competitive with fixed wing aircraft for short and medium range missions in the NextGen. Higher flight speeds and optimum aerodynamic performance of main rotors from hover through forward flight require a wide variation in drivetrain and main rotor speed. This effort will explore through flight simulation the new control concepts needed to safely operate rotorcraft with such variable-speed drive systems.

The Subsonic Fixed Wing (SFW) Project will complete and validate the first generation of a multidisciplinary analysis and design toolset to evaluate the trades between noise, emissions, and performance of future aircraft. Accuracy of the toolset will be assessed by comparing predictions of noise, emissions, fuel-burn, takeoff/landing performance, and aircraft weight to known characteristics from single-aisle (B737/CFM56) and twin-aisle (B777/GE90) aircraft. The toolset will then be used to predict the performance benefits of unconventional aircraft configurations (such as hybrid wing-body) to guide the Project in development of enabling technologies for such configurations.

The Supersonics Project will develop and assess the accuracy of Computational Fluid Dynamics (CFD) tools for predicting the performance and operability of engine inlets for low-boom supersonic aircraft designed to significantly reduce the annoyance from sonic booms during flights over land. The design of engine inlets for commercial supersonic aircraft with cruise Mach numbers below Mach 2 challenges current design practice. Such inlets must not generate any large regions of separated flow since these regions create pressure distortions that impact stable engine operation. Traditional development practice is to develop and test inlets and engines separately, yet they must work in concert on the aircraft. Computational tools capable of simulating coupled inlet/engine systems, of predicting the severity of flow separations in the inlet, and predicting the impact of those separations on stable engine operation are critical enablers to the design of low-boom aircraft. This effort will assess the accuracy of such CFD tools against available data from inlet/engine tests in order to identify any deficiencies in predictive capability that requires further improvement.

The Hypersonics Project will complete CFD predictions of ramjet-to-scramjet mode-transition and compare the predictions to available wind tunnel and/or flight data. The ability to accurately predict combustor performance under mode-transition fueling levels is a key enabler for the design of reliable high-speed propulsion systems. This CFD assessment activity will validate and verify the accuracy of two CFD codes (WIND and VULCAN) against available data from X-51 wind tunnel tests and an upcoming X-51 flight test.

Project Descriptions and Explanation of Changes

Subsonic Rotary Wing

Advanced rotorcraft can alleviate the capacity problems in the air transportation system by using simultaneous, non-interfering (SNI) approaches that includes non-primary runways, taxiways, and aprons. This approach would require a large, high-speed rotorcraft configuration with capability for 300+ knots cruise. The limiting factor for the cruise speed of tiltrotors has been propeller efficiency, as the designer trades cruise efficiency for hover performance, with a speed reduction of nominally 15 percent from hover to cruise. The Subsonic Rotary Wing Project has set aggressive goals to develop technologies for a variable/multi-speed propulsion system that will enable a 50 percent reduction in main rotor rotational speed from hover to forward flight, without adverse impact on the efficiency of the propulsion system and with minimal weight penalty. Other technical issues related to a variable-speed rotor, such as dynamics, aeroelastic stability, low-frequency noise effects, and flight control, are also being addressed in the Program. In order for the rotorcraft to be able to operate from smaller airports in a metroplex concept, significant reduction of external noise will be required.

The goal of the Subsonic Rotary Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic rotary wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline, and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions, and higher performance for rotary wing aircraft. Research in the Subsonic Rotary Wing Project includes the following goals:

- Enable variable-speed rotor concepts that incorporate the ability to change rotor rotational speed by 50% without performance or handling qualities penalties to enable optimum rotor aerodynamic performance in both hover and higher forward flight speeds than currently attainable, making rotorcraft competitive with fixed wing aircraft for short and medium-range missions within the NextGen.
- Contain the external noise within the landing area and reduce internal noise by 77 dB, and develop design capabilities for low-noise rotorcraft that include the accurate calculation of blade vortex interaction noise, high-speed impulsive noise, and blade/wake interaction noise.
- Develop acoustic propagation techniques that account for atmospheric effects, terrain, and shadowing so that rotary wing vehicles can be optimized for minimal noise impact while retaining performance and handling quality standards.

Subsonic Fixed Wing

The projected growth of the air transportation system by a factor of two or three over the next 20 years will increase emissions of greenhouse gases, such as carbon dioxide (CO2), nitrogen oxide (NOX), water vapor, and particulates, and the number of people exposed to airport noise. To meet the mobility needs of the future, the Next Generation Air Transportation System (NextGen) will also rely on the expanded use of secondary and reliever airports and employ a new class of vehicles that are capable of short take-off and landing (STOL). The goal of the Subsonic Fixed Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic fixed wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions (including NOx, CO2, water vapor, volatiles, unburned hydrocarbons, particulate matter, and soot), and higher performance for subsonic aircraft. Higher performance includes energy efficiency to reduce fuel burn and operability technologies that enable takeoff and landing on shorter runways. The 10-year strategy includes providing technologies, novel test methods, and validated prediction tools that can be used to improve system trades for advanced concepts capable of meeting longer-term noise, emissions, and performance targets. The following objectives address the overall project goals:

- Improvements in prediction tools and new experimental methods that provide fundamental properties and establish validation data;
- Noise prediction and reduction technologies for airframe and propulsion systems enabling -42 dB cumulative, below Stage IV (Stage IV refers to a limit imposed by the International Civil Aviation Organization on the maximum allowable noise levels for current aircraft.);
- Emissions reduction technologies and prediction tools enabling 80 percent reduction in landing and take-off NOx below the second state of regulation recommended by the Committee on Aviation Environmental Protection;
- Improved vehicle performance through design and development of lightweight, multifunctional and durable structural components, high-lift aerodynamics, and higher bypass ratio engines with efficient power plants, and advanced aircraft configurations enabling a 40 percent reduction in fuel burn as compared to the Boeing 737 with the CFM56 engine;
- Reduce field length by 50 %; and
- Multidisciplinary design and analysis tools and processes to enable design of advanced aircraft configurations with greater degree of confidence.

Since NASA does not design or manufacture aircraft that can operationally show these improvements, we will use demonstrated component technologies and system-level assessments to show that our goals could be operationally achieved.

Supersonics

Supersonic air travel has been possible for decades, but has not been commercially viable because of the significant environmental and performance challenges inherent in this speed regime including overland sonic boom annoyance, high fuel consumption, and NOx emission at high altitudes. The goal of the Supersonics Project is to conduct long-term, cutting-edge research in the core competencies of the supersonic regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will address the technical challenges for supersonic vehicles.

The Supersonics Project is organized along the following major technical challenges: efficiency (supersonic cruise, light weight and durability at high temperature); environmental challenges (airport noise, sonic boom, high altitude emissions); performance challenges (aero-propulso-servo-elastic analysis and design, cruise lift/drag ratio); and multidisciplinary design, analysis and optimization challenges.

The Supersonics Project will develop technologies to enable overland supersonic cruise with civilian and military applications at acceptable environmental impacts (no greater than subsonic fixed wing aircraft). Research in the Supersonics Project includes the following 10-year goals:

- Cruise efficiency improvements in the airframe and propulsion system leading to approximately 30 percent improvement in aircraft range factor vs. the final NASA High-Speed Research (HSR) Program baseline;
- Approximately 15 EPNdB (effective perceived noise, in decibels) of jet noise reduction relative to an unsuppressed jet;
- A reduction of loudness on the order of 30 PLdB (perceived loudness, in decibels) relative to typical military aircraft sonic booms;
- Elimination or minimized impact from high-altitude missions.

Hypersonics

The Hypersonics Project is motivated by the fact that all access to Earth or planetary orbit, and all entry from orbit into Earth's atmosphere or any planet with an atmosphere, requires flight through the hypersonic regime. The goal of the project is to conduct long-term, cutting-edge research in the core competencies of the hypersonic regime, thereby producing knowledge, data, capabilities, and design tools at the foundational, discipline, multidiscipline, and system levels that will address the technical challenges for two high-payoff NASA-unique missions: Highly Reliable Reusable Launch Systems (HRRLS) and High-Mass Mars Entry Systems (HMMES).

Cutting-edge hypersonics research on HRRLS will enable sustained hypersonic flight through the atmosphere with space-access applications. The research focused on HMMES will result in the development of technologies and concepts that can enable the safe and accurate delivery of large payloads to the surface of Mars. This effort will facilitate the entry, descent, and landing (EDL) phase of both human and robotic planetary missions and is closely aligned with the long-term goals of NASA's space exploration activities.

The Hypersonics Project will focus its research on addressing some of the hardest challenges in hypersonics including:

- The development of materials for airframe and propulsion applications that can withstand the severe temperatures encountered in hypersonic flight for extended periods of time;
- The development of predictive models for compressible flow, turbulence, heating, ablation, combustion, and their interactions in order to reduce the uncertainty in predictions of aerodynamic heat loads during the design of hypersonic vehicles, with the benefit of lower vehicle weight resulting from reduced design margins for thermal structures and thermal protection systems;
- Realizable propulsion systems that operate efficiently over a very wide speed range by integrating high-speed turbine engines or rockets and scramjets; and
- Tying together all of the close interactions among the airframe, inlet, nozzle, and propulsion systems using a physics-based multidisciplinary design analysis and optimization approach.

The HRRLS mission class will provide new air-breathing launch vehicle architectures with increased reliability such as Two-Stage-to-Orbit Turbine-Based Combined-Cycle systems to eventually enable routine low-cost access to space. The HMMES mission research will push technology beyond the state of the art in hypersonic atmospheric entry to successfully land payloads on Mars with masses up to two orders of magnitude greater than is practically realizable today. The emphasis will be on concepts for reduced weight, atmospheric maneuverability, and safety.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010 finish suite of integrated multidisciplinary analysis tools to predict aircraft performance	Subsonics Fixed Wing	Same
By 2011 develop an integrated tool set to accurately predict performance of subsonic aircraft	Subsonics Fixed Wing	Same
In 2010 demonstrate through flight simulation a control optimization tool to control a variable speed engine & transmission	Subsonics Rotary Wing	Wording change to be consistent with current program plans.
In 2011 validate the ability to predict the effects of active rotor systems for level flight	Subsonics Rotary Wing	Same
By 2012 demonstrate a rotor concept incorporating the ability to change rotor speed without penalty	Subsonics Rotary Wing	Same
In 2010 develop computational models to predict integrated inlet and fan performance and operability	Supersonics	Same
In 2011 use a design optimization study to show a 2-week MDAO cycle time for cruise efficiency	Supersonics	Same
By 2013 develop framework for analysis and design of supersonic aircraft that are efficient with low noise and emissions	Supersonics	Added words for clarification. Commitment is the same.
In 2010 complete CFD predictions of ramjet-to-scramjet mode-transition, compare to test data from supersonic wind tunnel tests	Hypersonics	Same
In 2011 evaluate accuracy of models by comparing CFD prediction with test data from wind tunnel hardware	Hypersonics	Same
In 2011 validate combustor wall thermal-structural performance and critical failure modes	Hypersonics	Same
In 2012 develop simulation tool with accuracy to enable highly reliable reusable launch systems	Hypersonics	Same

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the FA Program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Subsonics Fixed Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Air Force Research Lab (AFRL), Boeing, Pratt & Whitney, Northrop Grumman, A.R. Associates, ENrG Inc., General Electric Aviation, Gulfstream Aerospace, and United Technologies Corporation
Subsonics Rotary Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, GRC, LaRC	U.S. Army, U.S. Air Force, U.S. Navy, Center for Rotorcraft Innovation (CRI), Bell Helicopter, Sikorsky, ZFL, Helowerks, Inc., Boeing, DARPA, FAA, Polyumac, Technocore, and Gulfstream Aerospace
Supersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Gulfstream Aerospace, Lockheed Martin, AFRL, Aerion Corporation and DARPA
Hypersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	AFRL, U.S. Air Force Office of Scientific Research (AFOSR), U. S. Navy, Deputy Undersecretary of Defense for Science and Technology, DARPA, ATK, and Dover ILC

Acquisition Strategy

Acquisitions within the program provide the basic elements for fundamental research, tools and methods development, enabling technologies, and validation and verification of research results. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Fundamental Aeronautics Program will award approximately $40.0 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	75.1	131.6	74.7	77.1	77.2	76.6	78.7
Aero Ground Test Facilities	50.0	100.0	48.6	50.1	50.2	49.8	51.2
Flight Operations and Test Infrastructure	25.1	31.6	26.1	27.0	27.0	26.8	27.5
FY 2009 President's Budget Request	75.1	73.9	75.8	78.0	78.2	78.2	--
Aero Ground Test Facilities	50.0	48.2	49.4	50.8	51.0	51.0	--
Flight Operations and Test Infrastructure	25.1	25.6	26.4	27.2	27.2	27.2	--
Changes from FY 2009 Request	0.0	57.7	-1.1	-0.9	-1.0	-1.6	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Program Overview

NASA's Aeronautics Test Program (ATP) was created to preserve and promote the testing capabilities of one of the largest, most versatile, and comprehensive set of research facilities in the world. Ames Research Center, Dryden Flight Research Center, Glenn Research Center and Langley Research Center operate ATP facilities that provide an extensive array of services in their respective areas of expertise.

ATP offers government agencies, corporations, and academic institutions unmatched basic and applied research and experimental opportunities that reflect four generations of accumulated aerospace skill and experience. ATP is built upon a nationwide team of highly trained and skilled staff whose backgrounds and education encompass every aspect of aerospace testing and engineering.

ATP was instituted in FY 2006, as an element of the Strategic Capabilities Assets Program (SCAP) but funded by and officially reporting through ARMD, to establish corporate management of NASA's aeronautics ground test facilities. The goals were to optimize the utilization of NASA's wind tunnels and air-breathing propulsion for efficiency and cost effectiveness, to sustain and improve NASA's core capabilities, and to ensure that a minimum core capability was maintained.

In FY 2007, the Western Aeronautical Test Range (WATR), Support Aircraft, Test Bed Aircraft, and the Simulation and Loads Laboratories at the Dryden Flight Research Center were added to ATP.

ATP is a long-term, funded commitment by NASA to retain and invest in test capabilities that are considered to be important to the agency and the Nation. Through ATP, NASA will adopt consistent processes and procedures across all agency research centers for operations and maintenance of the major wind tunnels/ground test facilities and flight operations/test infrastructure.

Looking to the future, ATP will move to the next phase of program maturity through the implementation of a new strategic plan that will have three thrusts: (1) provide vision and leadership for the use of ATP assets in meeting national goals; (2) provide sustained financial support for workforce, capability improvements, test technology development, maintenance, mothballing, and divestiture; and, (3) provide strategic planning, management, and coordination within NASA and between NASA and other government and industry stakeholders. This strategic plan will guide ATP investments and will provide the vision for how the ATP can fully support the current and long-term missions of NASA, the Department of Defense, and American aerospace industry.

For more information, see http://www.aeronautics.nasa.gov/atp.

Plans For FY 2010

As part of ATP's continuous efforts to improve facility operational efficiencies, the ATP-sponsored National Strain Gage Balance Team completed a technical review and concluded that NASA's capability to utilize strain gage balances in wind tunnel testing has severely eroded. These instruments are critical since they are required to measure model forces and moments while simultaneously holding the model in the wind tunnel. Implementation of the National Force Measurement Technology Capability (NFMTC), a multi-year project to address gaps and deficiencies in the Government and industry's state-of-the-art strain gage balance technology capability, began in FY 2009, and the NFMTC will achieve continuous, collaborative operations across NASA and the Air Force's Arnold Engineering and Development Center (AEDC) in FY 2010.

In FY 2009, ATP completed a comprehensive assessment of the current condition and reliability of ATP facilities and their ability to meet current and future (five-year horizon) ground test requirements. The assessment identified a set of facility projects that should be executed to ensure availability and operational status and, from this set, a five-year investment project schedule for each facility was developed. In FY 2010, ATP will start implementing these recommended recapitalization and maintenance projects.

In its first three years, ATP was intentionally tactical in nature, and investments were focused primarily on stabilizing aeronautics test facility condition, charge rates, and workforce competency. In FY 2009, ATP will complete and implement a new strategic plan that will have three main thrusts: (1) provide vision and leadership for the use of ATP assets in meeting national goals; (2) provide sustained financial support for workforce, capability improvements, test technology development, maintenance, mothballing, and divestiture; and, (3) provide strategic planning, management, and coordination within NASA and between NASA and other government and industry stakeholders. This strategic plan will also guide the recapitalization and maintenance investments, starting in FY 2010, identified through the comprehensive facility assessment.

In collaboration with the National Partnership for Aeronautical Testing (NPAT), ATP initiated an assessment of the Nation's hypersonic wind tunnel capabilities in FY09 and will initiate an assessment of the Nation's subsonic wind tunnel capabilities in FY10. These assessments will identify wind tunnels in both speed regimes that are critical to the Nation, and therefore will require continued investment. Wind tunnels that are not critical will become candidates for consolidation.

In 2010, the ATP will continue to implement its Flight Operations Test Infrastructure investment strategy. Usage rates for flight test assets will be established at the beginning of the fiscal year to recover the required infrastructure investment funds.

Also, ATP will conduct and participate in several significant meetings and collaborative activities, including quarterly reviews with the NASA Research Centers (ARC, DFRC, GRC, and LaRC) and the Air Force's AEDC and semi-annual meetings with the NPAT.

Project Descriptions and Explanation of Changes

Aero Ground Test Facilities

The Aero Ground Test Facilities project is made up of different classes of facilities including low speed wind tunnels, transonic wind tunnels, supersonic wind tunnels, and hypersonic wind tunnels. The project includes four primary efforts to support the long term viability of the facilities and to continually improve on the efficiency and effectiveness of operations. These efforts include:

- Facility Operations Support which provides a portion of the facility fixed costs for ground test facilities to ensure facility and staff availability and user price stability;

- Facility Maintenance and Upgrades which provides funding for maintenance and upgrades that correct known deficiencies in facility safety, reliability, and productivity and enables the facilities to meet near-term and future testing requirements. These activities will result in improved facility productivity and reduced operational cost;

- Facility Test Technology which provides funding to develop and implement new technologies that increase test capability, improve productivity and efficiency, and improve data quality; and

- Facility Related Research whose activities are competed openly with a strong desire to involve universities with experimental work in major facilities. It is anticipated that one or more ATP assets will be utilized to develop technologies that will support either the facility operation or the other ARMD research programs.

Flight Operations and Test Infrastructure

The Flight Operations and Test Infrastructure Project is made up of an integrated set of elements consisting of the Western Aeronautical Test Range (WATR), support aircraft maintenance and operations, and testbed aircraft that provide the resources required for research flight and mission support projects. The goal is to provide up to 100 percent of the facility fixed costs for these flight facilities to ensure facility and staff availability and user price stability.

The project also includes the Simulation and Flight Loads Laboratories, a suite of ground based laboratories that support research flight and mission operations. The goal is to provide up to 20 percent of the fixed costs for labs to ensure facility and staff availability and user price stability.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010-2012, deliver at least 96% of on-time availability for operations and research facilities	Aero Ground Test Facilities Project	Same

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aero Ground Test Facilities	Senior managers of ATP facilities at ARC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, and LaRC	DoD and Boeing
Flight Operations and Test Infrastructure Project	Senior managers of ATP facilities at DFRC have key implementation responsibilities	DFRC	DoD

Acquisition Strategy

Acquisitions supporting ATP activity will be performed at each of the test sites consistent with the Federal Acquisition Regulation (FAR) and the NASA FAR Supplement (NFS). Each Center will be responsible for coordinating major acquisitions supporting ATP activities through the ATP Office as required by the ATP Director. Acquisitions that support the ATP facilities are usually less than $0.5 million and are initiated as early in the fiscal year as possible. This is inclusive of the annual NASA Research Announcement (NRA) activities within ARMD. These acquisitions are executed at the Center level, and the resulting contracts are subject to open competition and are typically fixed price, fixed fee. Larger ATP acquisitions are typically facility investments, and the funds are usually converted to Construction of Facilities (CoF) funds.

A full and open NASA Research Announcement (NRA) is used to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The ATP will award approximately $2.0 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia, and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Review	09/2008	Periodic reviews are carried out by the NASA Advisory Council (NAC) and the U.S. users of ATP facilities. The last ATP review was carried out by the Aeronautics Committee of the NAC in Feb. 2007; no major findings were reported. The last major community outreach meeting was held in September 2008 with NASA, DoD and U.S. aerospace industry users. The next meeting with the ATP users is planned for March 2010.	03/2010
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	0.0	0.0	62.4	64.4	67.1	64.4	60.5
Environmentally Responsible Aviation Project	0.0	0.0	62.4	64.4	67.1	64.4	60.5
Changes from FY 2009 Request	0.0	0.0	62.4	64.4	67.1	64.4	--

Program Overview

As the number of flight operations at many of the largest airports in the Nation continues to increase, environmental concerns over noise and emissions will limit the capacity of those airports, and therefore limit the capacity of the entire system. Recently, several recommendations have been issued to NASA by the National Research Council and the NASA Advisory Council. These recommendations cite the need for NASA to develop vehicle technologies to decrease the significant environmental impacts of the aviation system. These recommendations clearly point out the need for NASA to take the initiative to conduct system research and experiments of promising vehicle concepts and technologies that will simultaneously reduce fuel burn, noise and emissions.

The Integrated Systems Research Program (ISRP), a new program effort beginning in FY10, has been organized to support the Environmentally Responsible Aviation (ERA) Project and will take an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, local and global emissions, and local air quality) in the area of air vehicle technologies. As the NextGen evolves to meet the projected growth in demand for air transportation, the environmental impacts of noise and emissions are a growing concern and could limit the ability of the system to accommodate growth. The integrated system-level research in this program will be coordinated with on-going long-term, foundational research within the three other research programs, and will focus specifically on maturing and integrating technologies in major vehicle systems and subsystems for accelerated transition to practical application.

Plans For FY 2010

The Integrated Systems Research Program will use enhanced measurement capability in the Langley 14x22 Low Speed Wind Tunnel to investigate the ability of a Hybrid Wing Body (HWB) aircraft architecture to shield aircraft engine noise during simulated takeoff and approach conditions. The program will develop combustor concepts that offer the potential of reducing NOx emissions levels below those attainable with current technologies. Propulsion and airframe integration issues and the trade-off between acoustic and fuel burn performance of ultra-high bypass and open-rotor propulsion systems will be explored in the 9x15 Propulsion Wind Tunnel at Glenn by mounting Ultra-High Bypass (UHB) and open-rotor models in close proximity to simulated pylons and aircraft surfaces. Natural laminar flow wind tunnel models and hybrid laminar flow flight test articles will be fabricated for use in exploring the ability to maintain laminar flow at flight Reynolds number as a means of reducing aircraft drag and thereby improving fuel burn. The program will also award a NASA Research Announcement (NRA) in FY 2010 to conduct N + 2 (the generation beyond the next generation aircraft) vehicle systems-studies in order to assess the potential benefits that technologies within the existing research programs can contribute toward simultaneously reducing aircraft noise, emissions, and fuel burn. The NRA will also identify additional technologies that should be considered for further maturation and develop enabling technology roadmaps to further inform ISRP investment decisions.

Project Descriptions and Explanation of Changes

Environmentally Responsible Aviation (ERA)

The goal of the ERA project is to explore and document the feasibility, benefits, and technical risks of vehicle concepts and enabling technologies identified to have the potential to mitigate the impact of aviation on the environment. Through system-level analysis, promising N+2 vehicle and propulsion concepts and technologies will be down-selected based on their potential benefit towards simultaneously reducing fuel burn, noise and emissions. These concepts and technologies will then be matured and their performance will be evaluated at the system and sub-system level in relevant environments. Among the technologies to be explored are the following:

- Non-conventional aircraft architectures that enable reduced drag and shielding of propulsion system noise
- Drag reduction through laminar flow
- Advanced composite structural concepts for weight reduction
- Low NOx combustors
- Propulsion and airframe integration for noise reduction and fuel burn improvements

The ERA project will expand the well-informed design trade space for these types of technologies. The project will transfer knowledge outward to the aeronautics community so that aircraft and propulsion system manufacturers can confidently transition these technologies into new products. The project will transfer knowledge inward to the Fundamental Aeronautics Program so that concepts and technologies which do not yield predicted performance benefits can be further investigated and developed at a foundational level in order to mature to their full potential benefit.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In FY 2010, award a NRA to conduct N+2 vehicle systems-studies.	Environmentally Responsible Aviation Project	New

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other NASA or ARMD programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Environmentally Responsible Aviation	Project Manager and Resources Manager, who report to the Program Director	ARC, DFRC, GRC, and LaRC	None

Acquisition Strategy

The Integrated Systems Research Program will develop and further mature promising technologies to the integrated system-level. This necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Integrated Systems Research Program will award approximately $10 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Subject Matter Experts	N/A	The National Research Council of the National Academies is convening a meeting of experts to review NASA's plans for system-level research in Environmentally Responsible Aviation. The purpose of the review is for NASA to collect comments and observations from subject matter experts in the areas of aviation operations, vehicles and environmental impact. NASA will consider the comments and observations it receives in future refinement of its plans.	05/2009
Performance	Expert Review	N/A	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2010