Strategic Goal 4: Advance aeronautics research for societal benefit.

OUTCOME 4.1: DEVELOP INNOVATIVE SOLUTIONS AND ADVANCED TECHNOLOGIES THROUGH A BALANCED RESEARCH PORTFOLIO TO IMPROVE CURRENT AND FUTURE AIR TRANSPORTATION.

NASA, through the Aeronautics Research Mission Directorate (ARMD), plays a key role in the discovery and development of the innovative solutions and advanced technologies required for the Next Generation Air Transportation System (NextGen). This includes pursuing technologies that are in their infancy today, developing the knowledge necessary to design radically new aviation systems, and enabling efficient, high-confidence design and development of revolutionary vehicles. These improvements must take place without compromise to the current safety record of the aviation industry.

ARMD's Fundamental Aeronautics Program takes an integrated approach to address the critical long-term challenges of NextGen. This program ensures a long-term focus on both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. The Aviation Safety Program develops innovative algorithms, tools, concepts, and technologies that will improve the safety attributes of current and future aircraft operating in the National Airspace System, identify and control emerging hazards, and overcome aircraft safety-related barriers that could impede full realization of NextGen. Finally, the Airspace Systems Program addresses the fundamental air traffic management research needs of increasing capacity, improving efficiency, and reducing the environmental impact of aviation in NextGen in collaboration with ARMD's partners in government, industry, and academia.

Reported Multi-Year Performance

Multi-Year Performance Goal 4.1.1.1: Transfer knowledge to the aviation community to better manage safety in aviation.

FY11
Green
FY12
Green

NASA developed and tested an analysis tool that can automatically review large-scale software systems for errors without needing to run the software. This capability is part of an on-going NASA research effort to reduce the time and cost associated with ensuring the safety of complex, flight-critical systems. NASA's tool reduced the analysis time from the three to four hours typical of a currently available commercial product down to several minutes. The NASA tool also achieved a false positive rate of five percent or less.

NASA also advanced its data mining algorithms that look for anomalous events occurring across thousands of flights that can represent precursors to aviation safety incidents. In a validation test, the latest algorithm successfully predicted the occurrence of known safety events with at least 10 percent more lead time than prior methods. Earlier recognition can be a good indicator of an algorithm's ability to reliably identify a wide range of potential safety concerns. These tests were done on real flight datasets of at least 10 terabytes. NASA provided the capabilities to the Federal Aviation Administration (FAA), the Aviation Safety

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Information Analysis and Sharing System (ASIAS), and multiple airlines.

In addition, NASA completed a Concept of Operations for an Integrated Vehicle Health Assurance System. In this concept, NASA provides its research approach for monitoring the health of aircraft systems during in-flight and post-flight analyses and then using that knowledge to confidently predict system malfunctions before they occur. The concept integrates ground-based inspection and repair information with in-flight measurement data for airframe, propulsion, and avionics subsystems. This approach may eventually enable airline maintenance practices to rely more on the actual system health of an individual aircraft and less on fleet-wide reliability averages.

Finally, NASA completed a first generation engine icing simulation code that predicts the adverse effects on engine performance due to high ice water content icing. Aircraft flying through high altitude thunderstorms encounter high concentrations of ice crystals. Under certain conditions, these ice crystals may cause ice to form inside a jet engine in a way that can degrade its performance, potentially leading to engine power loss. To better understand the hazards of high altitude icing, NASA modeled the conditions an engine would encounter throughout a hypothetical flight. NASA's model incorporated the effects of ice accumulation, melting, and sublimation (conversion from solid to gaseous state) into a basic jet engine performance computer simulation. A study used the model to estimate the risk of engine icing in ice crystal conditions and the effect of the blockage on engine performance. Results showed that ice particle size is an important factor affecting engine icing. The distribution of ice particle sizes in clouds is currently unknown and is of high interest to NASA and its U.S. and international partners. Working with partners, NASA is conducting studies that further explore the atmospheric conditions leading to ice crystal icing and the effects of that icing on engine performance. Results from these studies will help aircraft remain clear of hazardous icing conditions and make aircraft engines more resilient if those conditions do occur.

For more information about NASA's Aviation Safety Program, go to http://www.aeronautics.nasa.gov/programs_avsafe.htm.

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
AR-12-1: Develop first generation engine icing performance degradation parametric simulation capability.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Aviation Safety			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**None**	**None**	**AR-12-1 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	AR-14-1: Conduct ground-based demonstration of a wireless sensor which provides lightning protection and can detect and diagnose damage in composite structures.				

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Comments	The next anticipated activity in this area was to conduct flight tests to characterize the ice crystal environment, which can adversely affect jet engine performance. This work was dependent on a contract that was discontinued due to unforeseen circumstances. As a result, NASA will not be able to complete a test flight in FY 2013 and has removed the associated FY 2013 APG from the performance plan. NASA and its partners are exploring opportunities for acquiring this important test data in the future.

Reported Annual Performance					
AR-12-2: Provide static code analysis techniques for certification.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Aviation Safety			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**10AT01 Green**	**AR-11-1 Green**	**AR-12-2 Green**
Planned Annual Performance					
FY13 Update	AR-13-2: Develop onboard capabilities that aid in-flight decision-making through instantaneous health assessment of aircraft systems.				
FY14	AR-14-2: Demonstrate use of an advanced software technique to verify the safety of a complex aircraft or ground automation software system.				

Reported Annual Performance					
AR-12-3: Develop concept of operations for an integrated vehicle health assurance system.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Aviation Safety			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7AT1 Green	**8AT02 Green**	**9AT1 Green**	**10AT03 Green**	**AR-11-2 Green**	**AR-12-3 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	AR-14-3: Provide integrated, high-fidelity simulator demonstration of an aerodynamic model that supports flight crew training requirements for assuring safe aircraft control.				

Reported Annual Performance					
AR-12-4: Demonstrate algorithm to predict at least three anomalies in massive datasets.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Aviation Safety			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**10AT01 Green**	**AR-11-1 Green**	**AR-12-4 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				

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Reported Multi-Year Performance

Multi-Year Performance Goal 4.1.2.1: HPPG: Increase efficiency and throughput of aircraft operations during arrival phase of flight.

FY11
Green
FY12
Green

Results of NASA's research to define and validate the Efficient Descent Advisor (EDA) concept were officially transferred in FY 2012 to FAA for further evaluation and potential operational use. The EDA concept helps air traffic controllers allow airliners of all sizes to more efficiently descend from cruising altitude to arrive at an airport using less engine power while maintaining a safe distance from other aircraft. As a result, airlines save money on fuel, fewer emissions are released into the atmosphere, and air traffic controller workload is reduced (since automation is added to the process). In fact, NASA simulations showed potential annual savings of $300 million in fuel.

NASA also successfully simulated airport operations using an integrated set of software that better manages scheduling and spacing of aircraft in congested terminal airspace. The technologies, which include Automatic Dependent Surveillance-Broadcast (ADS-B), a satellite based aircraft tracking technology, produced more precise aircraft spacing allowing for increased arrival rates and operational cost savings. The simulation was conducted with active FAA controllers, airline pilots, and data sets from Dallas/Fort Worth and Los Angeles airports. In addition, NASA successfully demonstrated safe interval management procedures to a single airport with dependent parallel runways utilizing NextGen flight-deck technologies. Benefits analysis indicates that these technologies have the potential to save several percent of total operational fuel costs due to more efficient arrivals. Although dependent on the level of aircraft equipage, annual system-wide savings are estimated at between $200 million to $300 million. Results from these simulations are being used to refine the plans for a future technology demonstration.

In addition, NASA developed weather translation models that provided an estimate of the weather's impact (e.g., high surface winds, low visibility, etc.) on an airport's capacity for 1 to 8 hours in the future over a 15 minute interval. These models incorporated forecasts from three state-of-the-art, airport-centric weather forecasts from the National Weather Service. Two of the models on average were able to predict the weather-impacted Airport Arrival Rate (AAR) at two representative airports over a 1 to 8 hour look-ahead time horizon within 10-15 percent of the actual weather impacted AAR. The third model was able to estimate the weather impacted AAR over a one-hour look-ahead time horizon within five percent of the actual weather impacted AAR at three representative airports. This improvement in use of weather predictions will provide substantial increase in airport arrival throughput.

For more information about NASA's Airspace Systems Program, go to http://www.aeronautics.nasa.gov/programs_asp.htm.

Update to Multi-Year Performance Goal	
FY13 Update	Demonstrate advanced technologies and solutions to achieve fuel efficient increases in operational performance of the Next Generation Air Transportation System (NextGen) while reducing noise and emissions.
FY14	Demonstrate advanced technologies and solutions to achieve fuel efficient increases in operational performance of the Next Generation Air Transportation System (NextGen) while reducing noise and emissions.

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Comments	During FY 2012, NASA completed this Priority Goal and, with approval from the Office of Management and Budget, closed it out. Because ARMD is continuing work to increase operational performance of NextGen, NASA has retained 4.1.2.1 as a standard performance goal and revised the description to reflect current activities.

Reported Annual Performance					
AR-12-5: Develop Initial Weather Translation Models.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Airspace Systems			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7AT3 Green	**8AT05 Green**	**9AT5 Green**	**10AT05 Green**	**AR-11-3 Green**	**AR-12-5 Green**
Planned Annual Performance					
FY13 Update	AR-13-3: Conduct human-in-the-loop simulations for taxi operations conformance, which will reduce fuel consumption during movement on the airport surface.				
FY14	No annual performance goal in FY14.				

Reported Annual Performance					
AR-12-6: Demonstrate safe Interval Management Procedures to a Single Airport with dependent parallel runways.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Airspace Systems			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7AT2 White	**None**	**None**	**10AT14 Green**	**AR-11-5 Green**	**AR-12-6 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	AR-14-4: Develop a scheduling tool to enable efficient aircraft departure and merging into open slots in the congested overhead traffic stream reducing departure delays.				

Reported Annual Performance					
AR-12-7: NASA will provide the results of the human-in-the-loop (HITL) simulations and the field trial to the Federal Aviation Administration (FAA) as they are completed, with the final report being provided in September 2012. (HPPG milestone)					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Airspace Systems			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7AT2 White	**None**	**None**	**10AT14 Green**	**AR-11-5 Green**	**AR-12-7 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				

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Reported Multi-Year Performance

Multi-Year Performance Goal 4.1.3.1: Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components to overcome national performance and capability challenges.

FY11
Green
FY12
Green

NASA completed analyses of ground-based tests that characterized the emissions of hydro-treated renewable jet (HRJ) fuel, which is an alternative aviation fuel. The results showed that HRJ fuels and their blends had substantially reduced particulate emissions (characterized by small particles of solids and liquids), minor effects on gaseous emissions, and no measureable adverse effect on engine performance. These data are important to industry and other government agencies such as the FAA and Environmental Protection Agency (EPA) to help ensure that aircraft can safely and efficiently utilize alternative fuels.

In order to realize significant improvements in efficiency and reductions in the environmental impact of aviation, it may be necessary to develop new aircraft designs that have little resemblance to today's tube-and-wing aircraft. NASA completed wind tunnel testing of a new concept that was very different from a tube-and-wing and demonstrated its reduced noise potential and improved short take-off and landing performance. Results from this test will be used to improve computational tools for a number of advanced aircraft configurations.

NASA also made advances in making air travel even more flexible and convenient. It is highly desirable to make modern helicopters quieter and more efficient so that they can safely carry more people and cargo and be more effective in conducting current missions and new missions such as increased delivery and transportation. To support these improved capabilities, NASA made significant advances in rotary wing propulsion systems that included new types of engine compressors and new transmissions. Also, to make rotorcraft more efficient, NASA demonstrated advances in computational modeling for rotorcraft fuselage drag reduction systems. People are always looking to spend less time traveling and more time at their destination. One way to help achieve this desire is faster air transportation. Although the noise associated with sonic booms has always been a limiting factor, this may change due to NASA research. NASA successfully completed wind tunnel tests that validated the computational tools developed for designing and shaping supersonic aircraft to produce quieter sonic booms. As part of its efforts to understand how much sonic boom noise must be reduced to allow unrestricted overland flight, NASA conducted the first tests in a new facility for simulating sonic boom noise as heard indoors.

The new computational design tools under development can greatly decrease the time needed for designing air vehicles and allow industry to explore new configurations. NASA completed the first generation of the Integrated Design and Engineering Analysis (IDEA) software, which enables the rapid and automated conceptual design of a hypersonic air-breathing vehicle. Because of this new tool, the time to conduct a vehicle design and analysis was reduced from 3 months (with today's methods) to less than 24 hours with the fully automated IDEA software tool. Another software tool was used to calculate the airflow through the scramjet engine of a hypersonic airbreathing vehicle, which was then compared with real flight data obtained from an Air Force flight. This comparison helps refine and improve the software, which is used to design scramjet engines.

NASA studied hypersonic planetary physics by obtaining unique Martian atmospheric pressures, heat shield temperatures and heat shield recession data (loss of mass due to the ablation of the heat shield) from the instrumentation installed on the Mars Science Laboratory carrying the Curiosity rover. This highly unique data is being analyzed by

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	researchers at NASA and universities in order to inform all future Mars landing missions to enable reduced vehicle mass or a larger, more capable scientific payload. For more information about NASA's Fundamental Aeronautics Program, go to http://www.aeronautics.nasa.gov/fap/index.html.

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components to overcome national challenges, especially in fuel efficiency, noise, and emissions.

Reported Annual Performance					
AR-12-8: Characterize gaseous and particulate emissions of hydro treated renewable jet fuel as a potential carbon dioxide (CO2) neutral aviation fuel.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Fundamental Aeronautics			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**8AT07 Green**	**9AT7 Green**	**10AT07 Green**	**AR-11-6 Green**	**AR-12-8 Green**
Planned Annual Performance					
FY13 Update	AR-13-4: Develop, improve, and validate a multi-fidelity toolset to assess the noise characteristics of future subsonic aircraft.				
FY14	AR-14-5: Determine the viability and performance benefits of a truss-braced-wing aircraft configuration through wind tunnel tests and high-fidelity computer simulations.				

Reported Annual Performance					
AR-12-9: Demonstrate drag reduction benefits of active flow control for a representative rotorcraft fuselage configuration.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Fundamental Aeronautics			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7AT6 Green	**8AT09 Green**	**9AT8 Green**	**10AT08 Green**	**AR-11-7 Green**	**AR-12-9 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	AR-14-6: Demonstrate the noise reduction and performance benefits of active twist concepts for rotor control for rotary wing aircraft through wind tunnel testing.				

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Reported Annual Performance					
AR-12-10: Validate the effectiveness of Micro-array Flow Control devices for improving performance and flow quality in low-boom supersonic propulsion inlets.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Fundamental Aeronautics			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**8AT11 Yellow**	**9AT9 Green**	**10AT09 Green**	**AR-11-8 Green**	**AR-12-10 Green**
Planned Annual Performance					
FY13 Update	AR-13-5: Validate high fidelity tools for sonic boom and drag prediction to enable the design of future supersonic air vehicles.				
FY14	No annual performance goal in FY14.				

Reported Annual Performance					
AR-12-11: Demonstrate First Generation Integrated Multi-Disciplinary Simulation Tool for Analysis and Design of Reusable Air-Breathing Launch Vehicles.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Fundamental Aeronautics			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**8AT13 Green**	**9AT10 Yellow**	**10AT10 Yellow**	**AR-11-9 Yellow**	**AR-12-11 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				

OUTCOME 4.2: CONDUCT SYSTEMS-LEVEL RESEARCH ON INNOVATIVE AND PROMISING AERONAUTICS CONCEPTS AND TECHNOLOGIES TO DEMONSTRATE INTEGRATED CAPABILITIES AND BENEFITS IN A RELEVANT FLIGHT AND/OR GROUND ENVIRONMENT.

As NextGen evolves to meet the projected growth in air traffic, researchers and technology developers must address the national challenges in the areas of mobility, capacity, safety, security, energy and the environment. In addition, researchers and technology developers must also address increasingly stringent aviation regulations, many of which are being imposed at the local levels. The Integrated Systems Research Program (ISRP) conducts research and technology development at an integrated system-level on promising aeronautical concepts and technologies and explores, assesses, and demonstrates their benefits in a relevant environment. By focusing on technologies that have already proven their merit at the fundamental research level, this program helps transition them more quickly to the aviation community, as well as inform future fundamental research needs. The integrated system-level research in this program is coordinated with on-going long-term, research within ARMD's three fundamental research programs, with the research being conducted in partnership with other government agencies and industry. In addition, the research will focus specifically on maturing and integrating technologies into major vehicle, ground and operational systems and subsystems for accelerated transition to practical application.

Currently the ISRP has two projects, the Environmentally Responsible Aviation (ERA) project and the Unmanned Aircraft Systems Integration in the National Airspace Systems (UAS/NAS) project. The ERA project is exploring and documenting 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. Throughout its existence, NASA has invested in technologies aimed at improving fuel efficiency and reducing noise and emissions of current and future aircraft. Many of these technologies have directly impacted the advancement of capability present in today's fleet, but are also applicable to the continued evolution of conventional configurations and to the realization of alternate airframe, propulsion and vehicle system concepts. The ERA project is currently developing promising vehicle configurations, airframe and propulsion concepts and technologies that were selected through aircraft system level assessments based on their potential to simultaneously reduce fuel burn, noise and emissions. These game-changing concepts and technologies will then be matured, and their performance will be evaluated at the sub-system and system level in relevant environments. The UAS/NAS project will contribute capabilities that reduce technical barriers related to the safety and operational challenges associated with enabling routine UAS access to the NAS. The desire and ability to fly Unmanned Aircraft Systems in the NAS is of increasing urgency. The application of unmanned aircraft to perform national security, defense, scientific, and emergency management is driving the critical need for less restrictive access by UAS to the NAS. This goal will be accomplished through a two-phased approach based on development of system-level integration of key concepts, technologies and/or procedures, and demonstrations of integrated capabilities in an operationally relevant environment. Solutions will advance the state of the art for UAS access. The timeframe for impact of this project will be 2015 to 2025. Each technical area will transfer technologies to relevant stakeholders, including the Federal Aviation Administration, Department of Defense (DoD), and industry, through research transition teams, technology forums, or other collaborative means.

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Reported Multi-Year Performance

Multi-Year Performance Goal 4.2.1.1: Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.

FY11
Green
FY12
Green

Throughout the initial phase (FY 2010–FY 2012) of the ERA project, a variety of tests and associated analyses were conducted with the goal of maturing promising technologies that will simultaneously reduce transport aircraft fuel burn, noise and emissions. Through these tests, environmentally friendly aircraft technologies were validated for performance and matured to the point that they can be tested together and in relevant environments. Through a series of reviews and assessments conducted in FY 2012, NASA selected eight, large-scale integrated technology demonstrations to advance ERA research based on the potential benefit of the technologies to meet project goals, and the associated costs and risks. The integrated technology demonstrations build on work performed during the initial phase of the project and will focus on five areas: aircraft drag reduction through innovative flow control concepts; weight reduction from advanced composite materials; fuel and noise reduction from advanced Ultra High Bypass (UHB) engines; emissions reduction from advanced engine combustors; and fuel consumption and community noise reduction through innovative airframe and engine integration designs. This integrated, relevant-environment testing is the focus of the second phase of the ERA project, which began in FY 2013.

Based on data obtained during extensive ground test campaigns, NASA completed an assessment of two types of highly fuel-efficient jet engine concepts by comparing their performance in reducing the rate of fuel consumption and noise. One of the systems, referred to as "Open Rotor," does not encase the engine fan blades in an engine housing as is typical in traditional jet engine designs. The second system, referred to as a "UHB Turbofan" is a much more fuel-efficient version of the aircraft engine commonly used by airliners today. Research has validated that both engine concepts have the potential to dramatically reduce fuel burn. The Open Rotor shows greater potential for fuel burn reduction (-36 percent vs. -27 percent) but at the price of a reduced noise reduction benefit when compared to the UHB concept (-13 dB vs. -24 dB). These results provide data to the aviation industry and regulatory community to make informed decisions on future aircraft propulsion systems, with a continual emphasis on reducing their impact on the environment.

NASA also conducted final analysis of test data (in partnership with FAA and The Boeing Company) for a Pultruded Rod Stitched Efficient Unitized Structure (PRSEUS) curved panel, which successfully demonstrated the viability of this integrally stitched composite technology concept for conventional commercial aircraft fuselage structures. The excellent performance of this concept shows promise in enhancing the structural integrity of aircraft while reducing overall structural weight.

As part of a collaborative effort with the FAA Technical Center, NASA conducted a flight test of a large (Ikhana MQ-9) unmanned aircraft equipped with ADS-B. This demonstration was a critical step in the development of a Live Virtual Constructive-Distributive Environment (LVC-DE), an innovative way to safely immerse a flying unmanned aircraft in the NAS through virtual techniques. The LVC-DE will provide the backbone for future flight tests (scheduled in FY 2015 and FY 2016) to validate the concepts and procedures developed by the project.

In support of these flight tests, a comprehensive plan was developed that addresses, in an integrated manner, a number of the challenges vital for safe UAS operations in the NAS. This plan also outlined the specific test objectives and concepts of operations for the LVC-

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	DE flight tests that will integrate remotely operated unmanned aircraft with simulated air traffic to evaluate these technologies in a relevant environment. For more information about NASA's Integrated Systems Research Program, go to http://www.aeronautics.nasa.gov/programs_isrp.htm.

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
AR-12-12: Demonstrate low-weight, damage-tolerant stitched composite structural concept on curved panel subjected to combined tension and internal pressure loads.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Integrated Systems Research			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**10AT12 Yellow**	**AR-11-10 Green**	**AR-12-12 Green**
Planned Annual Performance					
FY13 Update	AR-13-6: Conduct tests to validate low-noise characteristics of a hybrid wing body aircraft concept.				
FY14	AR-14-7: Demonstrate Ultra High Bypass (UHB) propulsion systems can be integrated with Hybrid Wing Body (HWB) concepts to meet fuel burn and noise goals.				

Reported Annual Performance					
AR-12-13: Develop integrated Human Systems Integration, Communications, and Separation Assurance subproject test concept and Phase 2 test objectives necessary to achieve human-in-the-loop simulation and flight test series milestones supporting the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project.					
Contributing Theme:		Aeronautics			
Contributing Program(s):		Integrated Systems Research			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**None**	**None**	**AR-12-13 Green**
Planned Annual Performance					
FY13 Update	AR-13-7: Complete flight evaluations to assess the capabilities of the Live, Virtual, Constructive (LVC) distributed simulation environment.				
FY14	AR-14-8: Conduct a human-in-the-loop (HiTL) simulation where unmanned aircraft are mixed with manned aircraft and subjected to a range of test conditions.				

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Reported Annual Performance	
No annual performance goal in FY12 or trended performance.	
Contributing Theme:	Aeronautics
Contributing Program(s):	Integrated Systems Research
Planned Annual Performance	
FY13 Update	No annual performance goal in FY13.
FY14	AR-14-9: Conduct successful Project Formulation Review to enable the goal of accelerating the development and certification process for advanced composite structures thus improving the competitiveness of U.S. Industry.