

NATIONAL AERONAUTICS RESEARCH AND DEVELOPMENT POLICY

FOREWORD

Throughout the history of flight, the U.S. Government has played a leading role in advancing the fundamental scientific principles and technologies on which modern aviation is built. However, there has never been a unifying Federal policy to focus and guide its research and development (R&D) efforts. Entering the second century of flight, improved coordination, cooperation, and planning will be needed across the Federal Government to continue to meet new challenges through technology as aeronautics continues to become an ever more integral part of American life. A number of recent studies and reports have looked to address this issue, including the 2002 report from the Commission on the Future of the United States Aerospace Industry and several recent studies from the National Research Council, including its 2003 report, Securing the Future of U.S. Air Transportation and its 2006 Decadal Survey of Civil Aeronautics. In addition, focus on a national aeronautics R&D policy was magnified by the National Aeronautics and Space Administration Authorization Act of 2005 and the Science, State, Justice, Commerce, and Related Agencies Appropriations Act of 2006, which called for the development of a national policy to guide Federal aeronautics R&D programs through 2020. Accordingly, the National Science and Technology Council's Committee on Technology established an Aeronautics Science and Technology Subcommittee to undertake this effort. This policy reflects the result of that effort, and includes recommendations to clarify, focus, and coordinate Federal Government aeronautics R&D activities to help meet these challenges and advance aeronautics well into the century.

I. BACKGROUND

On December 17, 1903, the historic flight of Orville and Wilbur Wright at Kill Devil Hills, North Carolina, forever changed the American way of life. Today, aviation provides a broad range of services to the United States, including effective military flight operations and homeland defense, passenger travel, shipment of goods, law enforcement, traffic management, emergency services, and general aviation. Aviation has also become an integral part of the economy, posting strong manufacturing sales and a positive balance of trade, and along with related industries, supports several million skilled jobs in the United States. Flight is a mainstay of American life, supporting a

technologically advanced, robust, and growing economy, and helping protect American interests at home and abroad.

Throughout the first century of aviation, the U.S. Government played a vital role in facilitating the advancement of the fundamental scientific principles and technologies on which modern aviation is built. In the second century of flight, a continued strong U.S. Government role in aeronautics R&D is needed to meet U.S. military and security objectives, create an environment in which U.S. industry remains innovative and competitive, and enable safe, reliable, and efficient air transportation.

As the science and application of aeronautics progressed, an interdependence developed among the aircraft, the air transportation system, and the people who use these systems, resulting in a multi-dimensional, highly integrated aeronautics enterprise. This policy considers the aeronautics enterprise to be comprised of all elements of aviation, including civil and military aircraft and aircraft systems, the air transportation management system, aviation infrastructure, and the people involved in the design, development, operation, and use of these elements. Design or modification of any of these individual systems or parts, without consideration for the collective effect on the enterprise, may result in adverse unintended consequences. Treating the entire system as a whole is complex but necessary, and requires close coordination among multiple government departments and agencies as well as industry, academia, and other non-Federal stakeholders to ensure that the needs of all enterprise users are addressed.

II. PRINCIPLES

In order to maintain its technological leadership across the aeronautics enterprise, the United States should be guided by the following principles:

- ***Mobility through the air is vital to economic stability, growth, and security as a nation.***

Providing for mobility requires an aeronautics enterprise with sufficient capacity to meet increasing demand for air travel and transport and with sufficient flexibility and affordability to accommodate the full range of aircraft requirements and attributes. Possessing the capability to move goods and people, point-to-point, anywhere in the nation and around the world is essential to advance the local, state, and national economies of the United States. Furthermore,

the United States, in cooperation with international partners, should play a leading role in ensuring global interoperability.

- ***Aviation is vital to national security and homeland defense.***

Aviation is a central part of America's National Security Strategy, providing needed capabilities to project military power around the globe in defense of U.S. interests and overcome a wide range of national security challenges. At the same time, the military must possess the ability, at a moment's notice, to seamlessly use the national airspace system for defense anywhere within and approaching U.S. borders.

- ***Aviation safety is paramount.***

Every individual who enters an airport or boards an aircraft expects to be safe. To that end, continual improvement of safety of flight must remain at the forefront of the U.S. aeronautics agenda.

- ***Security of and within the aeronautics enterprise must be maintained.***

All elements of aircraft and the air transportation system must be secure to protect people and goods within the aeronautics enterprise as well as the general public.

- ***The United States should continue to possess, rely on, and develop its world-class aeronautics workforce.***

Advancement of the nation's aeronautics enterprise requires professionals within government, industry, and academia who possess the highest level of scientific, technical, acquisition, and operational education and experience.

- ***Assuring energy availability and efficiency is central to the growth of the aeronautics enterprise.***

Aviation must have reliable sources of energy and use that energy efficiently to enable aircraft and an air transportation system to meet growing demand in an economic fashion.

- ***The environment must be protected while sustaining growth in air transportation.***

Appropriate environmental protection measures must be part of strategies for continued growth in air transportation.

III. POLICY GOAL AND OBJECTIVES

The overarching goal of this policy is to advance U.S. technological leadership in aeronautics by fostering a vibrant and dynamic aeronautics R&D community that includes government, industry, and academia. To this end, in accordance with the above principles, as well as the President's Management Agenda and the Office of Management and Budget's R&D Investment Criteria, the U.S. Government should:

- Provide long-term stability and focus in innovative research that leads to ground-breaking ideas, concepts, approaches, technologies, and capabilities in order to provide a robust foundation for the advancement of U.S. technological leadership in aeronautics;
- Pursue and develop promising advanced aircraft concepts and technologies to enable new opportunities to provide unsurpassed military capability;
- Pursue and develop advanced concepts and technologies that enable increased air traffic capacity and new aircraft concepts in the national airspace;
- Pursue a coordinated approach to managing U.S. Government aeronautics research, development, test, and evaluation infrastructure identified as critical national assets required to maintain and advance world-class U.S. experimental and computational R&D capabilities;
- Identify the roles of the Federal Government in aeronautics R&D and the interrelationship between the Federal Government and the private sector in discovering and applying technological innovations;
- Cultivate an R&D environment that enables a globally competitive U.S. aeronautics enterprise, and encourages industry investment and academic participation;
- Enhance coordination and communication among executive departments and agencies to maximize the effectiveness of government R&D resources; and
- Strengthen mechanisms to engage partners in industry and academia concerning government R&D priorities, programs, and planning processes.

IV. GENERAL GUIDELINES

In order to achieve the goal of this policy, the executive departments and agencies of the U.S. Government should adhere to the following general guidelines:

Role of the Federal Government in Aeronautics R&D. The Federal Government should only undertake roles in supporting aeronautics R&D that are not more appropriately performed by the private sector. Specifically, the Federal Government plays a key role in the following three aspects of aeronautics R&D.

Investment in a full range of aeronautics R&D that supports national defense and homeland security, from basic research through advanced technology development and beyond, is a responsibility of executive departments and agencies and should remain a U.S. Government priority.

The U.S. Government plays a unique role in long-term, fundamental aeronautics research that provides the foundation for future technology development. Executive departments and agencies perform this role through direct Federal investment and indirectly through policies and regulations that stimulate academic or private sector R&D investment and innovation. In addition, executive departments and agencies should provide for the widest practical and appropriate dissemination of research results, consistent with national security, foreign policy, and the Office of Management and Budget's Information Quality Guidelines.

The Federal Government also has a role in more advanced civil aeronautics research. In these cases, the Federal Government's involvement in R&D must be based on well-defined goals with objective measures of efficacy. These goals must be scrutinized to ensure that the government is not stepping beyond its legitimate purpose by competing with or unfairly subsidizing commercial ventures. In such cases, the primary areas of government involvement are:

- *Public Interest Research:* Research that directly benefits the public by improving public safety and security, by promoting energy efficiency, or by protecting the environment.
- *Research and Development to Address Gaps:* In certain cases where risks or other market factors limit private sector investment in more advanced research, the Federal Government may decide investment is required. The appropriateness of Federal investment in such research

must be justified by an assessment indicating that the benefits of such R&D would occur far in the future or the risks would be too great for non-Federal participants, and the results from the research would not be appropriable to a single entity. In these cases, Federal R&D investment must be the best means to achieve the objectives as opposed to other means such as regulatory, policy or tax incentives.

- *Government Internal R&D*: Research in direct support of government infrastructure or services and the setting and enforcement of regulations.

Aeronautics Workforce. To further a robust U.S. aeronautics enterprise, the United States must have a workforce within government, industry, and academia that is well-educated and experienced in aeronautics science, technology, acquisition, and operations. Executive departments and agencies with responsibility for aeronautics-related activities should continue to invest in the educational development of the future aeronautics workforce as needed to further U.S. Government interests.

Academic Cooperation. To enable a robust, technologically advanced aeronautics R&D environment, the United States must cultivate human talent and creativity by fostering a vibrant, innovative academic community dedicated to aeronautical technical disciplines. To further advance a strong U.S. academic community dedicated to aeronautics, executive departments and agencies should continue to:

- Draw on the aeronautics research capabilities of academic institutions, especially in the conduct of focused, long-term research, though also in applied research and technology development as appropriate;
- Ensure that U.S. Government aeronautics activities, technology, and infrastructure are accessible for academic use through partnerships with academic institutions, consistent with national security and foreign policy considerations;
- Draw on expertise at academic institutions to provide independent scientific advice to help inform government R&D priorities, programs, and planning processes; and
- Provide a timely and responsive regulatory environment, consistent with national security and foreign policy considerations, to promote participation in U.S. aeronautics R&D activities by academic institutions.

Commercial Cooperation. The aeronautics enterprise is an integral part of the nation's economy. In order to foster a competitive domestic commercial aeronautics sector, executive departments and agencies should continue to:

- Engage the private sector in government activities related to the design and development of the U.S. aeronautics enterprise, including leveraging private sector resources as appropriate to further U.S. Government interests;
- Ensure that U.S. Government aeronautics activities, technology, and infrastructure are accessible for private use, consistent with national security;
- Draw on industry's expertise to help inform government R&D priorities, programs, and planning processes;
- Provide a timely and responsive regulatory environment, consistent with national security and foreign policy considerations, for civil and commercial aeronautical activities that supports the infusion of new technology into the U.S. aeronautics enterprise; and
- Refrain from activities that preclude, deter, or compete with U.S. commercial aeronautics activities, except as required by national security or public safety.

The Department of Commerce (DOC), in consultation with other executive departments and agencies as appropriate, should continue to provide industry perspectives, economic analyses, and competitiveness implications in relevant interagency policy committees.

International Relations. The U.S. Government should continue to pursue, as appropriate, international cooperation on aeronautics R&D activities through mutually beneficial cooperation with foreign nations and/or consortia to further the peaceful use of the sky and for other civil and scientific purposes. Such cooperation must be consistent with U.S. national security and foreign policy objectives. Federal aeronautics R&D investment and policies must also be consistent with U.S. international trade obligations. The United States should work to ensure that foreign governments abide by their international trade obligations and that aeronautics R&D policies do not place the U.S. aeronautics enterprise at a competitive disadvantage. The Office of the United States Trade Representative, with support from the International Trade Commission, should work with DOC, the Department of State, and other executive departments and agencies as appropriate through existing

interagency committees to evaluate the trade-related impacts of foreign government civil aeronautics R&D policies and, as necessary, formulate U.S. government responses to those policies.

V. STABLE AND LONG-TERM FOUNDATIONAL RESEARCH GUIDELINES

America's traditional aeronautics strength lies in its excellence and leadership in technology and innovation. A broad-based national foundational research program forms the underlying basis for new technological advances and breakthroughs needed to sustain U.S. leadership in aeronautics. For purposes of this policy, foundational research consists of basic research and many aspects of applied research that require continued long-term scientific study, focused on advancing a strong technology base in aeronautics, with basic research and applied research defined as in the Office of Management and Budget's Circular A-11. Foundational research includes the discovery of new ideas, concepts, and approaches leading to new technologies and capabilities, as well as focused, scientific research based on fundamental principles to solve difficult problems and overcome challenges that hamper technological progress.

A strong foundational research program forms the technology base for the future of the U.S. aeronautics enterprise. It provides the fundamental understanding, tools, and future technologies to maintain and advance U.S. leadership in aeronautics. In addition, foundational research provides critical opportunities and resources to further the engineering, science, and mathematics education of the future aeronautics R&D workforce. The key to a successful foundational research program is long-term stability and focus, allowing researchers to take risks and innovate. To enable stability and focus, the Federal Government must take a strategic approach to foundational research and coordinate efforts across executive departments and agencies.

Roles and Responsibilities of the Executive Departments and Agencies

Executive departments and agencies that conduct such research should promote and plan for the long-term stability and vitality of their programs. In addition, executive departments and agencies should promote dissemination of their foundational research results to the widest practical and appropriate extent, consistent with national security, foreign policy, and the Office of Management and Budget's Information Quality Guidelines. Several departments and agencies should take responsibility for specific parts of the national foundational aeronautics research program:

- The National Aeronautics and Space Administration (NASA) should maintain a broad foundational research effort aimed at preserving the intellectual stewardship and mastery of aeronautics core competencies so that the nation's world-class aeronautics expertise is retained. These core competencies also include key aeronautical capabilities that support NASA's human and robotic space activities.
- The Department of Defense (DOD) should focus its foundational aeronautics research efforts on sustaining a robust technology base to support and advance the nation's military capabilities.
- The Federal Aviation Administration (FAA) should conduct foundational research, consisting predominantly of applied research, in areas that support safety, the environment, and air traffic management.
- The National Science Foundation should maintain a strong foundational research program through basic research to promote the progress of science and engineering in areas of interest to aeronautics.
- The Department of Homeland Security (DHS) should conduct foundational research to support homeland and aviation security applications.
- DOC should conduct foundational research in support of the aeronautics enterprise that advances measurement science and standards development that promotes the deployment of new technologies and improves the safety and reliability of existing technologies, as well as foundational research to advance the sensing and prediction of atmospheric and space processes that contribute to global weather impacts on the aeronautics enterprise.

VI. ADVANCED AIRCRAFT SYSTEMS DEVELOPMENT GUIDELINES

Advanced aircraft technologies and systems continue to be needed to meet the growing demand for moving people and goods and to provide superior military capability to the United States. Advances in aircraft capabilities, including speed and altitude, aircraft size, range and payload, environmental compatibility, efficiency, and the ability to safely operate in adverse conditions, could break technology barriers and lead to greater mobility to meet tomorrow's commercial, military, and general aviation needs. As demand for air transportation continues to increase, traditional approaches to meeting this demand will need to give way to more innovative multidisciplinary approaches that integrate traditional aircraft systems with air transportation management systems.

Roles and Responsibilities of the Executive Departments and Agencies:

- NASA should conduct research in key areas related to the development of advanced aircraft technologies and systems that support DOD, FAA, the Joint Planning and Development Office (JPDO), and other executive departments and agencies. NASA may also conduct such research to benefit the broad aeronautics community in its pursuit of advanced aircraft technologies and systems, in accordance with the guidelines presented in Section IV.
- DOD should develop advanced aircraft technologies and systems to provide future capabilities for national defense.
- FAA should conduct research as needed to support certification of the safety and environmental performance of aircraft systems.
- DHS should conduct R&D as needed to support the advancement of aviation security throughout the air transportation system.

Commercial development of civil aircraft, components, and technologies will remain in the private sector.

VII. AIR TRANSPORTATION MANAGEMENT SYSTEMS GUIDELINES

Meeting projected demand for increased passenger travel and cargo shipments over the next 25 to 50 years will require considerable increases in the capacity of the air transportation system. Moreover, the air transportation system must support new aircraft concepts, civil and military users, and uncrewed aerial systems, and must also provide for seamless and secure operation of aircraft across U.S. boundaries to other parts of the globe. The Federal Government, through the JPDO and in accordance with Public Law 108-176, has defined a vision for the Next Generation Air Transportation System (NGATS) that will guide system-wide transformation to meet these needs.

Roles and Responsibilities of the Executive Departments and Agencies:

- The JPDO, through its partner departments and agencies and in collaboration with the private sector, should be responsible for planning, coordination, and oversight of both research and implementation for the NGATS to meet the nation's civil, military, and homeland security

needs. The JPDO should encourage research, collaborative technology demonstrations, and other mechanisms that foster innovative uses of technology or policy approaches in support of NGATS.

- FAA, DOD, DHS, and DOC should work with the JPDO to integrate their operational mission-specific requirements into the NGATS plan.
- Executive departments and agencies conducting R&D related to the air transportation system should align their efforts in this area with the NGATS objectives to the maximum extent practicable.

VIII. NATIONAL RESEARCH, DEVELOPMENT, TEST, AND EVALUATION INFRASTRUCTURE GUIDELINES

The nation's research, development, test, and evaluation (RDT&E) infrastructure must provide the capability and flexibility to test and evaluate a broad range of new aircraft and air transportation management systems, from component-level to full-scale, and to the extent practicable, to evaluate these at an enterprise level. For purposes of this policy, RDT&E infrastructure and assets refer to both experimental facilities and computational resources. Since many of these assets are used by multiple departments and agencies, industry, academia, and other non-Federal stakeholders, consistent cost and usage policies are needed to support the requirements of the broad user community in both the government and the private sector.

Roles and Responsibilities of the Executive Departments and Agencies:

- NASA, DOD, FAA, and other executive departments and agencies as appropriate, should, in accordance with applicable laws and regulations, develop cost and usage policies that facilitate interagency cooperation and utilization in the management of their respective RDT&E assets, as well as appropriate access by non-Federal users.
- NASA, DOD, FAA, and other executive departments and agencies as appropriate, should assess current and future needs for constructing, maintaining, modifying, or terminating RDT&E assets and should develop and implement measures to improve coordination of those needs both among executive departments and agencies and across the broader community of users.

IX. IMPLEMENTATION GUIDELINES

This national aeronautics R&D policy delineates responsibilities among executive departments and agencies for various aspects of the national aeronautics R&D enterprise. Pursuant to Executive Order 12881, the National Science and Technology Council (NSTC) should serve as the coordinating agent for all implementation actions for this policy, as follows:

- NASA, DOD, FAA, JPDO, and other executive departments and agencies as appropriate, should develop a national aeronautics R&D plan comprising national research priorities and objectives, roadmaps to achieve the identified objectives, and timelines. The plan should include foundational research as described in Section V of this policy as well as applied research and technology development for advanced aircraft systems and air transportation management systems. This plan should be coordinated through and published by the NSTC within one year of the signature of this policy and updated every two years thereafter. The NSTC, working with the Office of Management and Budget, should review Federal investment in aeronautics R&D to ensure that it meets the needs outlined in the plan.
- NASA, DOD, FAA, and other executive departments and agencies as appropriate, should develop an infrastructure plan, aligned with the aeronautics R&D plan, for managing critical Federal RDT&E assets. The infrastructure plan should identify which assets are considered critical from a national perspective and define an approach for constructing, maintaining, modifying, or terminating these assets based on the needs of the broad user community. This infrastructure plan should be coordinated through and published by the NSTC within one year of the signature of this policy and updated every two years thereafter.
- Executive departments and agencies conducting aeronautics R&D should engage industry, academia, and other non-Federal stakeholders in support of government planning and performance of aeronautics R&D, and should report to the NSTC within one year of the signature of this policy and every two years thereafter on the results of these interactions.
- Executive departments and agencies should develop and implement, as appropriate, measures for improving dissemination of R&D results and lowering the barriers that would prevent technology transition from R&D to applications, reporting within two years of the signature of this policy and every two years thereafter any specific actions to the NSTC.

- Executive departments and agencies should identify and promote innovative policies and approaches that complement and enhance Federal aeronautics R&D investment, reporting within two years of the signature of this policy and every two years thereafter any specific actions to the NSTC.
- The NSTC should develop and implement measures to improve coordination and cooperation among executive departments and agencies and to promote and facilitate the exchange of technologies between departments and agencies to maximize the effectiveness of Federal aeronautics R&D investments.

Based upon the above actions and inputs, the NSTC should assess the efficacy of these implementation actions as appropriate and should recommend further measures to the executive departments and agencies as necessary to ameliorate any weaknesses found.