Report to the Congress

Impact of the Termination of
NASA's High Speed Research Program and
The Redirection of
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I. BACKGROUND

Request: Conference Report 106-379, to Accompany H.R. 2684, the VA-HUD-IA FY 2000 Appropriations Bill directed the Office of Science and Technology Policy (OSTP) to conduct a review which should address the overall impact of the termination of NASA's High Speed Research (HSR) program and the redirection of NASA's Advanced Subsonic Technology (AST) program on aviation safety, NASA Center core competencies, and on the United States aviation industry. Congress also asked that the review address the merits of NASA undertaking a program to improve aviation safety and reduce aircraft noise emissions. OSTP has completed its review and provides the following report.

Comprehensive Improvement of Civil Aviation: Before reviewing the HSR and AST decisions and their impact, it is important to first understand the overall approach the Administration has taken to improving the nation's civil aviation system. Air transportation has become an essential element to providing mobility for individuals, strengthening the health and vitality of the U.S. economy, and furthering U.S. interests around the world. The United States spans a continent and is the largest single participant in an increasingly global economy. Just as telecommunication technologies have enabled virtually instantaneous, low cost movement of information and convenient personal communications, the aviation system needs to provided dramatic advances in the movement of people and goods across great distances with speed, convenience and economy. Our accomplishments thus far have enabled rapid growth in global manufacturing, trade, and tourism. In addition to investments to research and develop new technologies, this Administration has taken a number of other steps to make our air system safer, securer, more efficient, more environmentally friendly and helped U.S. industry be more competitive.

Safety. Our skies are the highways of the world of the 21st century and the new millennium; spurred by the strongest economy in a generation, air travel has grown 36 percent during the past seven years. This is the equivalent of the dramatic effect the renaissance of our roads achieved for the country during the era of the Interstate Highway system construction. Even in the face of this dramatic growth, commercial aviation remains the safest form of transportation. Although the number of fatalities is very low, the public rightfully demands the highest standards of safety and security, and expects continued improvement. In 1997,the White House Commission on Aviation Safety and Security led by Vice President Gore set a goal of reducing the fatal aviation accident rate for U.S. commercial air carriers by 80 percent by 2007. We are working to achieve this aggressive goal. Since this commission NASA's spending on safety research has more than doubled. "AIR 21," the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century that President Clinton recently signed into law, gives us the resources and policy architecture necessary to make the strategic aviation investments that will assure continued improvements in our air traffic control system. Through FAA's "Safer Skies " initiative, we are focused on identifying and implementing corrective actions in the six categories found to contribute most to fatal commercial air crashes: controlled flight into terrain; loss of control; uncontained engine failure; runway incursions; approaches and landings; and weather. Identifying and implementing effective steps in these areas will have a positive impact on the fatal accident rate.

Security. In times of emergency, transportation is the vital link to mobilizing the nation. Although the number of terrorist incidents involving aviation has been relatively low, our nation remains at risk. In 1997,the White House Commission on Aviation Safety and Security led by Vice President Gore proposed steps to enhance the protection of the public by ensuring the safety and security of air travel. These steps include the establishment of effective aviation security measures and close cooperation among governments, airlines and airports. Additionally, explosive detection systems are an effective means for screening at airport security checkpoints. In response to the recommendations of the White House Commission, we have purchased a total of 136 such systems for screening checked baggage and 640 units for detecting traces of explosives in passenger carry-on luggage, and deployed them in 80 U.S. airports.

Efficiency. Commercial airline delays are estimated to cost the airlines more than $3 billion annually. The 20 most congested airports in the U.S. each have estimated average annual delays of more than 20,000 hours. With demand for aviation increasing annually, (air travel has grown by 36 percent since President Clinton and Vice President Gore took office) system wide delays are projected to jump as well. We are working to reduce delays by improving the National Airspace System, including better weather reporting and a comprehensive program to modernize air traffic control. Air Traffic modernization relies strongly on synergy with ongoing technology investments in NASA's Aviation Technology Program. We also have formed a partnership with industry to reduce delays and assure the flow of air traffic. We have fought for new laws to benefit airline travelers. The end of airport slot restrictions in Chicago and New York, and the increase in round trips in Washington, D.C., will enable new carriers to enter previously restricted markets. In cities dominated by one or two airlines, airports must lay out how other carriers are included in the airport's facility plans, a requirement that will encourage competition. Tough new fines for violations of their rights will protect air travelers, especially the disabled.

Noise. Transportation is the tie that binds us together as a nation. But, transportation also can have the unwanted side effects of air and noise pollution. Aircraft noise has substantially decreased in recent years. Progress has been achieved through mandated replacement of older aircraft with newer, quieter models that rely on technology developed over the past decade. The phase-out to meet ICAO Stage 3 noise standards is now complete. Compared with 1993, about two-thirds fewer people are exposed to significant aircraft noise around our nation 's airports. In addition, the Presidents FY 2001 budget proposes a new Quiet Aircraft Technology Program at NASA.

International Competitiveness. We are opening international air travel to market forces and removing antiquated service restrictions dating back to the 1940s. We are doing this through “open skies ” agreements that permit unrestricted air service by authorized carriers to, from and beyond the territories of their partners. In 1999 we negotiated nine new agreements —with Pakistan, the United Arab Emirates, Bahrain, Argentina, Qatar, Tanzania, the Dominican Republic, Portugal and the Slovak Republic bringing to 46 the total number of nations that have agreed to “open skies ” with the U.S. We look forward to additional “open skies ” agreements in the future. We hosted the 1999 “Aviation in the 21st Century —Beyond Open Skies ” conference in Chicago, a successor to the famed 1944 Chicago conference that created today ’s international aviation policy architecture. This meeting brought together senior public and private sector representatives from 93 countries to chart a course for international aviation policy in the 21st century and the new millennium. We are moving from a reliance solely on bilateral aviation agreements to multilateral and other arrangements involving three or more countries or regions.

Civil Aviation R&D Policy Development: As a result of rapid technological advances, supported by continuous Federal investment in aeronautical research and development, the US has long led the world in aviation. The Federal role in this accomplishment has been a critical factor which allowed this success and is a remarkable tribute to all those in government who have contributed to research and technology infusion into the aviation transportation system in the United States and worldwide. However, the energy and creativity that characterized the first century of aviation will have to continue into the next century if the challenges that lie ahead are to be met.

The FAA has developed an operational concept and system architecture for a modernized National Airspace System (NAS) that will rest on a broad base of sophisticated technology, complex software and new procedures and standards. Congestion and associated delays are already of widespread concern, and the next-generation NAS will have to support a level of passenger traffic likely to grow almost threefold by 2025. Even with larger aircraft and higher load factors, that increased traffic will mean a large increase in the number of crashes and fatalities if the accident rate – which has remained relatively constant for two decades – is not substantially reduced. In addition, the forecast in traffic growth and congestion will further challenge the ability of the current hub-spoke system to meet travelers’ expectations for doorstep-to-destination speed. Events in recent years have intensified domestic and world sensitivity to the threat of many types of terrorist and other malicious attacks on the aviation system. Environmental concerns such as noise in the vicinity of airports, emission of air pollutants and gases linked to local air quality, global change, and petroleum usage are also major factors affecting the performance and health of the aviation industry.

In August 1996, in recognition of the seriousness of these issues, President Clinton established the White House Commission on Aviation Safety and Security, chaired by Vice President Gore. The Commission’s final report, issued February 12, 1997, set high goals to be met by the entire aviation community under the leadership of the Department of Transportation (DOT) and the FAA and made numerous recommendations addressing the safety and efficiency of the air traffic control system and the security of travelers.

Subsequently, the Assistant to the President for Science and Technology and the Director of the Office of Management and Budget requested that FAA, NASA and DOD work together and develop a joint plan to implement the Commission's recommendation to coordinate R&D investments and define the role of each agency. The plan was published in December 1999. It describes the substantial progress that has been achieved in shaping a truly integrated and coordinated array of aviation safety, security, efficiency and environmental compatibility programs. In addition, the plan provides a high level framework for meeting the ambitious goals of the White House Commission.

On October 9, 1998, FAA Administrator Jane Garvey and NASA Administrator Dan Goldin signed a formal agreement establishing a partnership between their agencies with the objective of articulating and achieving specific goals in aviation and future space transportation. This agreement, built on a long history of NASA-FAA joint efforts and cooperation, provides the leadership for defining, developing and deploying the technology necessary for the nation's aviation system to meet the difficult challenges of coming decades.

An effective response to these challenges is needed to assure the continued viability and utility of the National Airspace System to all users. This response will require applying the relevant national scientific and technical resources, many of which reside in FAA and NASA, to a more comprehensive and coordinated program of research, development and implementation leading to improved operational systems, standards, procedures and/or regulations. Implementation of the results will rest largely with the FAA and the aviation community. However, NASA and DOD, on the basis of their technical strength and expertise, will play an essential role in this endeavor. It is particularly important that the efforts of FAA and NASA be fully integrated and directed towards well-defined civil aviation goals.

NASA and FAA researchers have long worked together on specific topics such as human factors, aging aircraft, aircraft icing, airworthiness of new classes of aircraft (e.g., tiltrotor, supersonic and vertical lift), crashworthiness, energy efficiency, and noise reduction. Interagency collaboration has been accomplished through a series of Memoranda of Understanding and an R&D coordinating committee since 1980. The Garvey-Goldin agreement now provides for a strategic alliance between FAA and NASA and a closer collaboration with DOD. It contains an explicit mandate to "maintain a close partnership in the pursuit of complementary goals for aviation and future space transportation and to coordinate their planning and tracking of accomplishments toward achievement of those goals." The agreement restructures the existing coordinating committee into a new "FAA/NASA Executive Committee," and charters it to oversee the success of the partnership to achieve the goals. One significant change resulting from this newly established joint committee is that, for the future, one council, representing the diverse interests of the two agencies at the executive level, will be responsible for adopting, executing and fostering the harmonization of civil aviation research efforts of the government.

This effort is being pursued within a broad context in which partnerships with DOD and other research organizations are recognized as critical mechanisms for achieving national objectives. The National Science and Technology Council (NSTC) has worked energetically to foster cooperation and joint programs among Federal agencies in general, and has particularly addressed aviation, as reflected in the 1995 NSTC document *Goals for a National Partnership in Aeronautics Research and Technology* and the establishment of an NSTC Aeronautics and Aviation Subcommittee. The NSTC *Transportation Science and Technology Strategic Plan* (September, 1997) includes specific partnership initiatives addressing aviation safety, security, efficiency and environmental compatibility that are embodied in this program plan.

Civil Aviation R&D Policy: On November 2, 1999, Dr. Neal Lane, Assistant to the President for Science and Technology, described the policy guiding investments in aeronautics research in the introduction of the National Science and Technology Council's (NSTC) *National Research and Development Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility*.

> " …it is important that the Nation have a set of clear and unambiguous goals to guide our civil aviation policy as we approach the new millennium. First and foremost, we will continue to place the highest priority on maintaining and strengthening public safety and security in our aviation system. We will also seek to continuously improve our airports and aviation system to increase their efficiency and capacity while fostering their environmental compatibility. Finally, we will maintain U.S. leadership in aviation science and technology to ensure the continued excellence of our aviation system, products and services."

The NSTC plan focuses on those areas of research for civil aviation that transcend individual agencies in the areas of safety, security, efficiency and environmental compatibility. However, it assumes continuing basic and vehicle research programs at NASA and DOD to maintain U.S. leadership in aviation science and technology. The plan states:

> "Important areas not specifically covered in the plan include development of advanced aerospace vehicles, commercial space transportation's effect on and integration into the goals for aviation, and operating concepts for commercial and general aviation that could substantially increase the mobility of the American people and the efficient utilization of the airspace.

NASA's Revolutionary Vehicle Concepts (REVCON) and Small Aircraft Transportation System (SATS) programs are examples of these efforts.

Policy Implementation Progress: NASA has made significant advancements towards the achievement of our national policy goals. Attached is an appendix that shows some of the highlights of NASA's progress over the past year.

II. HSR AND AST DECISIONS

HSR Program Termination: The High Speed Research (HSR) program was created to explore technologies necessary to enable an industry decision on development of a supersonic commercial aircraft, or “High Speed Civil Transport” (HSCT). The HSR program was dependent on an active partnership between the government and industry. Dramatic technology advances were made against the original HSR program goals. However, planned ramp-ups in industry cost sharing to bring an HSCT to market did not materialize as originally planned. NASA terminated HSR at the end of FY 1999, when the major industry partner in the program dramatically reduced support for the project, shrinking staff devoted to HSR from 300 to 50 and pushing the operational date for a high-speed commercial transport from 2010 to 2020. This industry action was the result of market analysis and technology requirement assessments indicating that the introduction of a commercial HSCT cannot reasonably occur prior to the year 2020 from an economically and environmentally sound perspective. Industry and NASA also questioned whether technologies being pursued today would appropriately address environmental standards and other challenges in 2020. In response, NASA reduced activity in the High Speed Research program to a level commensurate with industry interest.

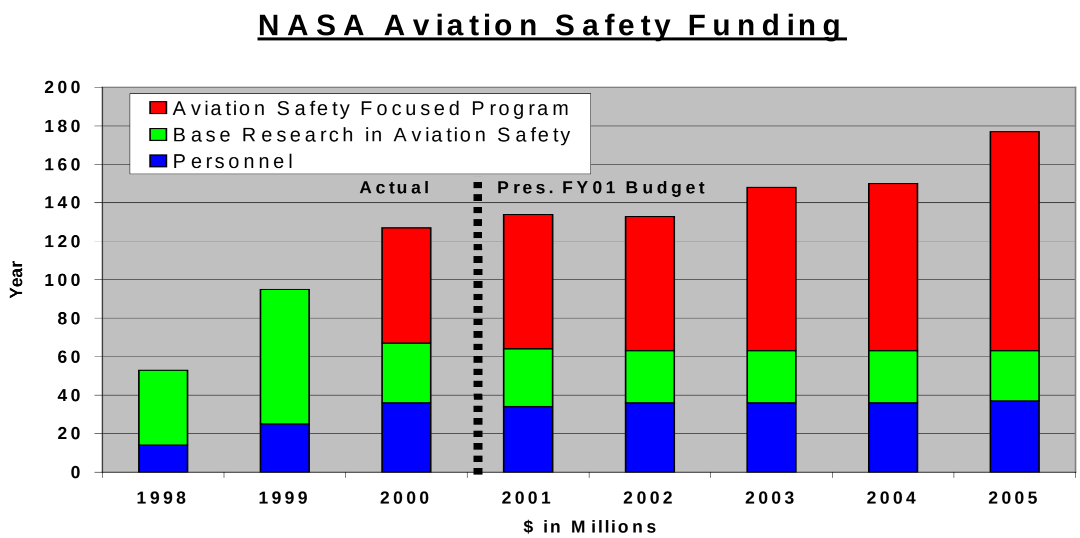
In addition, new national policy directions on overall aviation system efficiency, later expressed in the NSTC Aviation R&D Plan, brought into question whether HSR would significantly impact aviation efficiency issues. Reducing flight delays for domestic travel is the primary challenge to improving the efficiency of the U.S. air system. HSR, however, focused on improving transoceanic flight times. In response, NASA terminated most HSR activities. The External Vision System research area supported under HSR, has potential to improve flight safety for many airframes. It was expanded to include sensor integration and mapping and is now a project under NASA’s Aviation Safety Program. In addition, research in areas relevant to potential future supersonic jet aircraft continues on a smaller scale in NASA’s Aerospace Research and Technology Base Program and would provide a foundation for a technology development effort focused on the key enabling technologies for supersonic jet aircraft should industry interest revive.

Advanced Subsonic Technology Program Redirection: The goal of NASA’s Advanced Subsonic Technology program was to develop, in cooperation with the FAA and the U.S. aeronautics industry, high payoff technologies to enable a safe, highly productive global air transportation system that included a new generation of environmentally compatible, economical U.S. subsonic aircraft that were to be superior to foreign products. At the end of FY 1999, NASA redirected the majority of its AST work towards new programs to address the priority areas defined in the NSTC *National R&D Plan for Aviation*. These priorities continue AST work in areas like environmental compatibility but provide greater focus on public goods issues that threaten to constrain air system growth, such as aviation safety, airport delays, and aircraft emissions. To focus agency efforts on priority goals, NASA reorganized ongoing efforts in the AST program. The resulting new programs aim to improve aviation system efficiency by moving passengers and aircraft through airports more quickly (Aviation Systems Capacity, $322 million from FY 2000-04) and to develop environmentally cleaner jet engines (Ultra-Efficient Engine Technology, $243 million from

FY 2000-04). NASA also initiated a program to explore revolutionary x-plane concepts (RevCon, $100 million from FY 2000-04). The President's FY 2001 Budget builds on this framework by initiating a new program to reduce aircraft noise (Quiet Aircraft Technology, $100 million from FY 2001-05) and a program to bring the benefits of safe, economic air transportation to small communities (Small Aircraft Transportation System, $69 million from FY 2001-2005).

III. IMPACTS

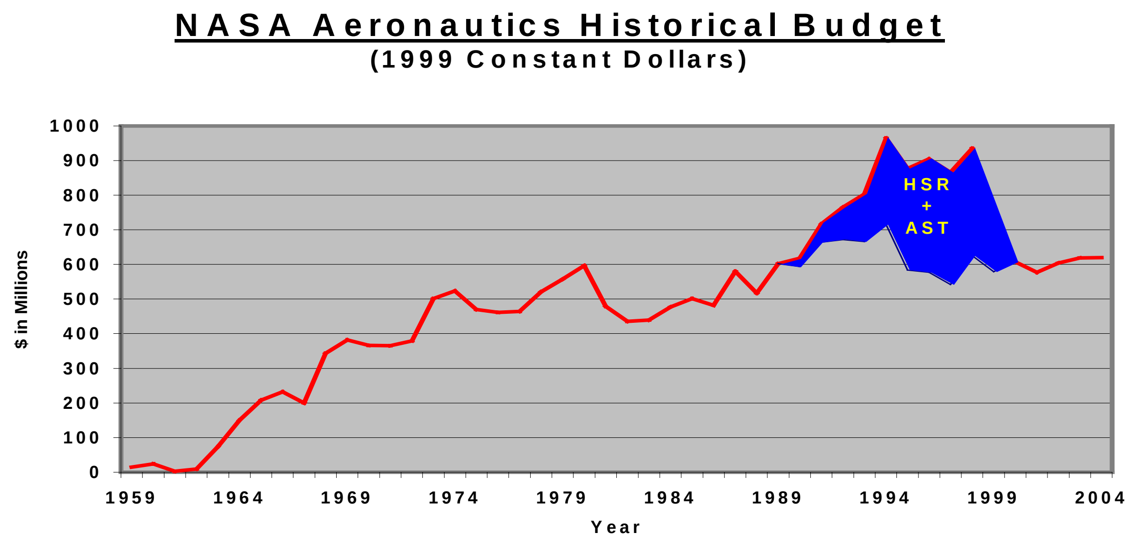
Impact on Aviation Safety: Based on the work of the White House Commission on Aviation Safety and Security, the Administration started an Aviation Safety Initiative in FY 1998 to which NASA committed to spend $500 million over the next five years. In addition, the external vision system research supported under HSR, was expanded to include sensor research to form the basis for the Synthetic Vision project in NASA's Aviation Safety Program ($50 million, FY 2000-2004). This research has the potential to improve pilot situational awareness and flight safety in both commercial transports and general aviation



aircraft. The President's FY 2001 Budget request for NASA continues the Administration's commitment to improving aviation safety (see chart above).

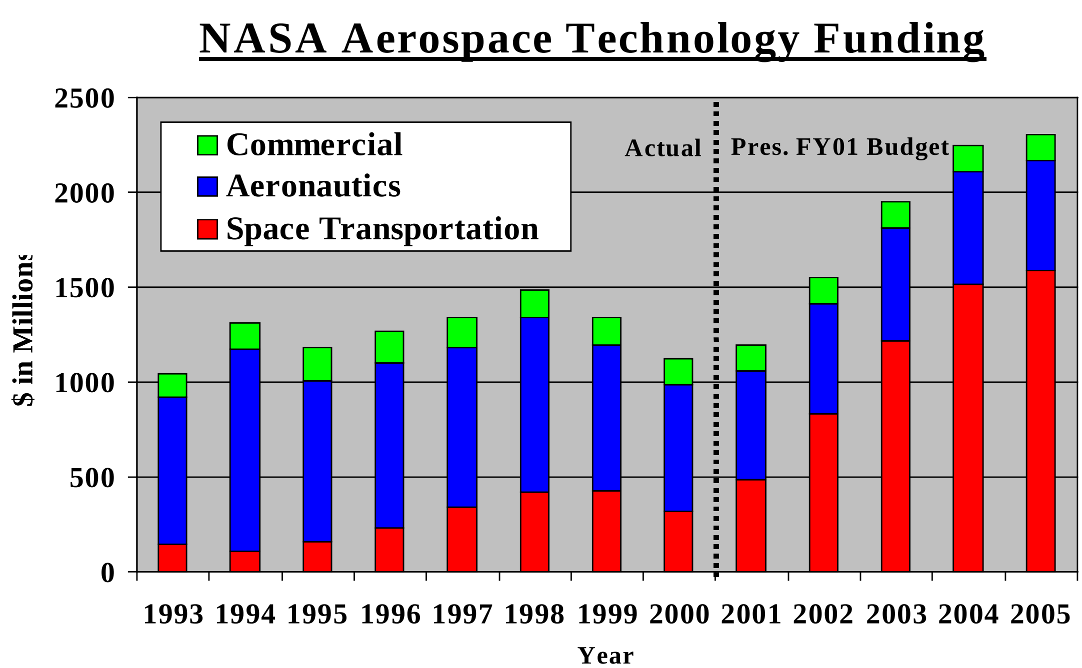
Because the program was focused on developing faster air transport, the termination of the HSR program has no direct impact on the safety of the U.S. aviation system.

Impact on the Core Competencies of NASA Centers: NASA defines core competencies as world-class technological expertise, supported by key human resources, critical facilities and relationships with outside organizations. There were no personnel reductions at NASA's field centers and no facility closures resulting from the termination of the HSR program or the redirection of the AST program. NASA R&D funding for aeronautics has remained at or



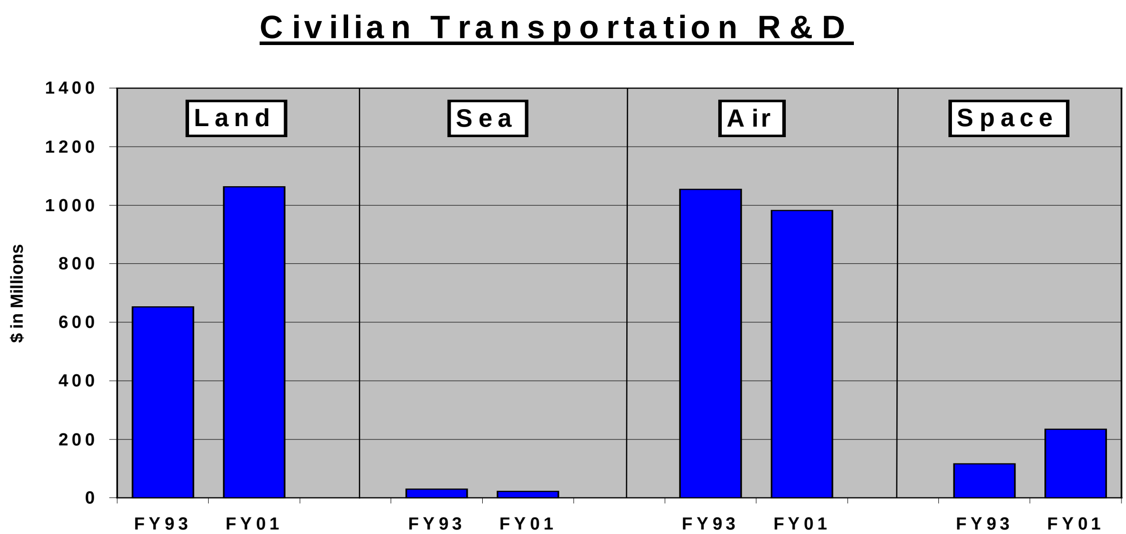
above historical levels prior to the HSR program on a constant dollar basis (see chart above). NASA personnel budgets reside in a separate account from the program dollars shown in this chart and were not reduced. Technology developed during the HSR program has been carefully preserved. Where products could not be easily used in other programs, NASA has archived technology development details and written summary documents of technology development including lessons learned.

In addition, aeronautics and space transportation research requires expertise in many of the



same skill areas such as high-temperature materials and turbomachinery. To take advantage of these synergies, NASA integrated its separate aeronautics and space base research and technology efforts into a single aerospace research and technology base. NASA has retained core competencies in key aerospace technology areas by refocusing critical personnel from aeronautics to space transportation. The President's FY 2001 Budget request greatly augments the total amount of funding going to NASA aerospace technology research through increased spending in space transportation technologies under NASA's Space Launch Initiative (see chart above). NASA aeronautics research personnel in these skill areas are expected to make valuable contributions to space transportation research.

Impact on Industry: Compared to other transportation modes, federal research and development activities for civilian air transport remain on par with ground transport and greatly outweigh investments in sea or civil space transportation modes, even with the termination of the HSR program (see chart below).



Although there is parity in civil research, a National Research Council (NRC) report on *Recent Trends in U.S. Aeronautics Research and Technology* has found "evidence that the aeronautics segment of the economy is becoming less competitive." It notes that the "U.S. share of world aerospace markets fell from over 70 percent in the mid-1980s to 55 percent in 1997." Aviation industry organizations carry similar figures. Although the U.S. aerospace industry is enjoying record sales, the Aerospace Industries Association states that the U.S. share of global sales has fallen from 72 percent to 56 percent since 1985. The NRC report finally concludes that:

> "….The continuing decline in the U.S. market share for commercial jet transport aircraft, recent regional conflicts and the Air Force's decision to devote more of its assets to space developments and operations in an era of declining overall budgets have made the needs for strong support for aeronautics R&T more urgent."

Despite the downward trend in market share, the National Research Council report goes on to endorse the three key aeronautics goals identified by the National Science and Technology Council:

- Maintain the superiority of U.S. aircraft and engines.
- Improve the safety, efficiency, and cost effectiveness of the global air transportation system.
- Ensure the long-term environmental compatibility of the aviation system

NASA's aeronautics programs are aligned with these three goals and the National Research Council Report endorses NASA's response to these challenges.

IV. MERITS OF NEW RESEARCH

Merits of Aviation Safety Research: NASA has a robust Aviation Safety program in place and has increased budget requests in areas where research shows promising technological breakthroughs such as synthetic vision as discussed previously. NASA Aviation Safety research funding request for FY 2001 including base research, the focused Aviation Safety program, and personnel is $134 million, growing to $177 million by FY 2005. OSTP considers investment in aviation safety research a national priority and has set forth an aggressive safety research roadmap to achieve our safety goal in the National Science and Technology Council's *National Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility*. This National Plan shows how NASA, FAA and DOD programs combine to achieve the National Safety Goal to reduce the fatal accident rate by 80% by 2007. This goal was established by the President in response to the White House Commission on Aviation Safety and Security and was supported by the congressionally mandated National Civil Aviation Review Commission.

Merits of Aircraft Noise Research: NASA has had an active aircraft noise program for many years and has requested $64.9 million in program funding in the Presidents 2001 budget. OSTP considers investment in aircraft noise research a national priority and has set forth an aggressive research roadmap to achieve our noise goals in the National Science and Technology Council's *National Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility*.

Appendix

NASA FY 1999 PROGRESS TOWARDS *NATIONAL PLAN FOR AVIATION SAFETY, SECURITY, EFFICIENCY AND ENVIRONMENTAL COMPATIBILITY* GOALS

Safety

Aviation Safety*: *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years.

Controlled Flight into Terrain (CFIT): Over 30 percent of all fatal accidents worldwide are categorized as CFIT accidents, in which a functioning aircraft impacts terrain or obstacles that the flight crew was unable to see. As part of the Airframe Systems Program, several underlying causes of CFIT were identified, and thirteen 2- to 3-year contracts were awarded to develop and demonstrate approaches for fully operational and certifiable synthetic vision (7 awards) and health management (6 awards) systems. Preparation for flight evaluation of a crew-centered synthetic vision display was also completed, as was a study of synthetic vision applicability to General Aviation aircraft.

Figure 1: Synthetic Vision Displays

Supercooled Large Droplet Icing Flight Test: Under the Aviation Operations Systems Program, the NASA Glenn Research Center's Twin Otter Icing Research Aircraft completed flight tests for the 98-99 winter icing season with high-fidelity icing cloud instrumentation mounted underside its wing. In combination with instrumentation comparison testing from the NASA Glenn Icing Research Tunnel conducted in November 1998, this database provides new knowledge of ice formation processes. Due to the wealth of data gathered, reduction and analysis was 70 percent complete at the end of the fiscal year with the remainder completed by the end of the calendar year. Both activities were a cooperative effort with Atmospheric Environmental Services (AES), Canada and the Federal Aviation Administration to improve understanding of severe icing hazard, and thus improve aviation safety.

Figure 2: Twin-Otter and Droplet Particle Measuring Probes (on aircraft and in tunnel)

Efficiency

Aviation System Capacity*: *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.

Advanced Vortex Sensing System (AVOSS): Under the Aviation System Capacity Program, NASA is developing AVOSS, a system to better predict, identify and measure air turbulence created in the wake of jet aircraft. By better characterizing jet turbulence, aircraft will be able to fly closer together while maintaining safety, which will increase the capacity of the nation's aviation system. This year, development of the core code for Build 1, Version 2 of AVOSS was completed and integrated with the real-time shell. New features include improved wake prediction (decay and ground effect); improved wake sensor tracking algorithms and sensor-derived wake residence time in corridor; improvements to observational weather system; and Weather Nowcast for several hours forecast of runway throughput. AVOSS Build 1, version 2 is now operational in the AVOSS laboratory at Langley Research Center with live data feeds from the Dallas-Fort Worth airport.

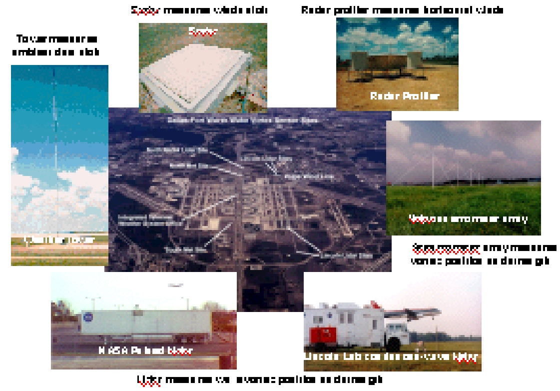


Figure 3: Sensor Elements of AVOSS Build 1 at Dallas-Fort Worth Airport

Environmental Compatibility

***Emissions Reduction*:** *Reduce emissions of future aircraft by a factor of 3 within 10 years and by a factor of 5 within 25 years.*

<u>50 Percent NOx Reduction Low-Emission Combustor</u>**:** As part of the Advanced Subsonic Technology (AST) Program, a low-emission combustor was demonstrated on a Pratt and Whitney 4000 development engine. The engine was operated over the normal operating envelope with both conventional and low-sulfur fuel, and included limited combustor operability and durability assessment. Results included reductions in oxides of nitrogen (NOx) levels during landing and take-off cycle (below the 50 percent 1996 ICAO regulation); reductions in CO and unburned hydrocarbon levels (below regulation); and comparable reductions in cruise NOx emissions (40 percent).

Figure 4: Pratt and Whitney 4000 Engine with AST Low Emission Combustor

***Noise Reduction*:** *Reduce the perceived noise levels of future aircraft by a factor of 2 from today's subsonic aircraft within 10 years and by a factor of 4 within 25 years.*

<u>Prediction and Minimization Methodology for Community Noise Impact</u>**:** Advanced prediction methods and operational procedures to reduce community noise are required to meet the 10 and 25-year Enterprise noise reduction goals. The Advanced Subsonic Technology Program's Aircraft Noise Impact Model combines airport noise prediction, census data, and satellite imagery in a Geographic Information System. The model optimizes ground tracks and trajectories to minimize noise impact. Improved high-lift systems, in combination with advanced operational procedures, have the potential to reduce community source noise impact by 2-4 decibels.

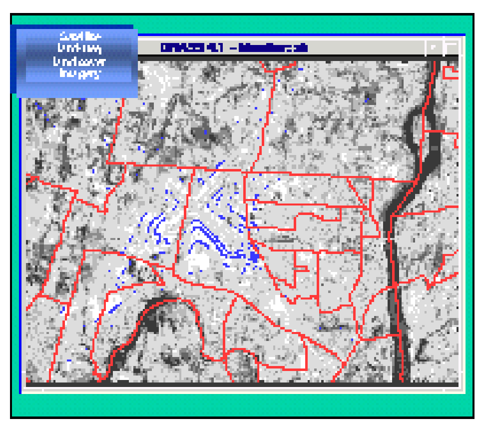


Figure 5: Airport Noise Impact Graphic Showing Noise Contours and Census Tracts Superimposed on Satellite Image