THE FUTURE OF AERONAUTICS AT NASA

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

COMMITTEE ON SCIENCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

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THE FUTURE OF AERONAUTICS AT NASA

WEDNESDAY, MARCH 16, 2005

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ken Calvert [Chairman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

The Future of Aeronautics at NASA
March 16, 2005
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

PANEL I:

Hon. Jo Ann Davis
A Representative in Congress from the State of Virginia

Hon. Dennis Kucinich
A Representative in Congress from the State of Ohio

PANEL II:

Dr. J. Victor Lebacqz
Associate Administrator
Aeronautics Research Mission Directorate
NASA

Dr. John Klineberg
Chairman
National Research Council panel which authored the report,
"Review of NASA's Aerospace Technology Enterprise: An Assessment of
NASA's Aeronautics Technology Programs"

Dr. Philip Antón
Director
Center for Acquisition and Technology Policy
RAND

Dr. Mike Benzakein
Chairman
Department of Aerospace Engineering
Ohio State University

Dr. R. John Hansman
Director
International Center for Air Transportation
MIT

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HEARING CHARTER

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

The Future of Aeronautics at NASA

WEDNESDAY, MARCH 16, 2005
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Wednesday, March 16, at 10:00 a.m., the Subcommittee on Space and Aeronautics will hold a hearing on the proposed Fiscal Year (FY) 2006 budget for aeronautics at the National Aeronautics and Space Administration's (NASA).

The budget proposes significant changes in NASA's aeronautic programs, including, over the next five years, dramatic cuts in funding and staffing, closure of facilities, and redirection of research priorities. NASA argues that these proposed changes would enable NASA to focus on the highest priority areas in aeronautics while freeing up Agency funds for space exploration programs, the Agency's highest priority.

NASA has played a role in advancing aeronautics since its inception. Indeed, NASA was created by expanding the National Advisory Committee on Aeronautics (NACA), a federal agency created in 1917 to promote aeronautics. NASA's Langley Research Center in Virginia, one of its aeronautics centers, dates back to 1917.

Today, aeronautics programs are run by NASA's Aeronautics Research Mission Directorate (ARMD). No other federal agency supports research on civilian aircraft. NASA's aeronautics program also conducts most of the research on air traffic control systems, a responsibility it shares with the Federal Aviation Administration (FAA). The Aeronautics Directorate includes three NASA Centers: Glenn Research Center, Ohio; Dryden Research Center, California; and Langley Research Center, Virginia.

Overarching Questions

The Committee plans to explore the following overarching questions at the hearing:

1. What are the trends in civil aeronautics and what should the U.S. national strategy be for civil aeronautics research and development?
2. What is NASA's aeronautics research strategy and how well does it align with the Nation's strategic needs for civil aeronautics research?
3. Should NASA preserve its inventory of wind tunnels and propulsion test facilities until a new national strategy can be developed and funded?
4. How does NASA intend to achieve the workforce reductions it has proposed without losing essential skills and capabilities?

Witnesses

Dr. Vic Lebacqz is Associate Administrator of the Aeronautics Research Mission Directorate, National Aeronautics and Space Administration. He was named to his current position since January 2004, after serving about six months in an acting capacity.

Dr. John Klineberg led a 2004 National Academy of Sciences study entitled "Review of NASA's Aerospace Technology Enterprise: An Assessment of NASA's Aeronautics Technology Program." He is retired as President of Space Systems/Loral, and for 25 years worked at NASA, including as Director of the Goddard Space Flight Research Center and the Ames Research Center.

Dr. Philip Antón was the principal investigator of a 2004 report produced by the RAND Corporation entitled "Wind Tunnels and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Serve National Needs." The report was jointly sponsored by NASA and the Department of Defense. He is a senior scientist at

RAND, which is a federally funded research and development center sponsored by the Department of Defense.

Dr. Mike Benzakein was named Chairman of the Department of Aerospace Engineering at the Ohio State University in October 2004. From 1967 through 2004 he worked for GE Aircraft Engines and retired as General Manager of Advanced Technology and Military Engineering.

Dr. John Hansman is a Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology, and Director of the International Center for Air Transportation.

FY06 Aeronautics Budget Highlights

Over the last decade, funding for NASA's aeronautics research has declined by more than half, to about $900 million. For FY06, NASA proposes a relatively small decrease ($54 million, or about six percent) in aeronautics research and development compared to its FY05 Operating Plan. But the Agency's proposed five-year runout for aeronautics contemplates substantial funding reductions (20 percent) for aeronautics research, together with significant cutbacks in its civil service and contractor workforces.

Civil service personnel and infrastructure costs account for much of the Aeronautics Directorate's budget, largely because of the expenses involved in the operation and maintenance of NASA's 31 wind tunnels.

This is not the case for other portions of NASA, for which grants and contracts account for much of the cost. As a result, while the Aeronautics Directorate receives only six percent of NASA's total budget, it employs 23 percent of the entire NASA workforce and is responsible for 40 percent of all of NASA's infrastructure costs.

The Aeronautics Directorate comprises three programs—the Vehicle Systems Program, the Aviation Safety and Security Program, and the Airspace Systems Program. The Administration's proposed budget for the next five years for these three programmatic areas is shown below:

FY06 NASA Aeronautics Funding Request ($=millions)

	FY04 Actual	FY05 Actual	FY06 Request	FY07 Runout	FY08 Runout	FY09 Runout	FY10 Runout
Vehicle Systems Program	641.4	568.6	459.1	373.6	385.5	373.5	365.6
Airspace Systems	232.3	152.2	200.3	180.5	174.6	177.9	175.7
Aviation Safety and Security	183.1	185.4	192.9	173.5	170.5	176.2	176.3
TOTAL	**$1,056.8**	**$906.2**	**$852.3**	**$727.6**	**$730.6**	**$727.6**	**$717.6**

Vehicle Systems

Vehicle Systems emphasizes research in traditional air vehicle design concepts (examples being wing designs and high-speed aircraft), and for FY06, takes the biggest cut among the three programs (down $109 million compared to FY05, a 19 percent reduction). The proposed budget would make further reductions in the program in FY07, resulting in a cut of 33 percent (compared to FY05).

The cuts would be made by narrowing the program's focus beginning in FY06. The program would concentrate on projects designed to make significant leaps forward on technology and less on incremental changes. Specifically, the program would focus on four areas: (1) zero emissions aircraft—to demonstrate an aircraft powered by fuel cells; (2) subsonic noise reduction—to demonstrate a 50 percent reduction in noise compared to 1997 state-of-the-art; (3) high altitude long endurance (HALE)—to demonstrate a 14-day duration high altitude, remotely operated aircraft; and (4) sonic boom reduction—to demonstrate technology that could enable acceptable sonic boom levels.

Research activities proposed for termination in the FY06 Vehicle Systems program include hypersonics (higher-speed aircraft), rotorcraft (helicopters), and improvements in engine efficiency.

To conduct its research, Vehicle Systems relies heavily on wind tunnels and propulsion test facilities. The proposed budget appears to assume the closure of one or more of these facilities with associated cutbacks in staff (see below). However, NASA has not released any information on which facilities it would close or when, or the criteria on which closure decisions would be based.

In arguing for the proposed changes in the Vehicle Systems Program, NASA has cited a 2004 National Academy of Sciences report, "Review of NASA's Aerospace Technology Enterprise: An Assessment of NASA's Aeronautics Technology Program," led by Dr. John Klineberg. The report did recommend that NASA reduce the number of research projects it conducted, stating, "NASA is trying to do too much within the available budget and resists eliminating programs in the face of budget reductions." It also concluded that NASA's "aeronautics technology infrastructure exceeds its current needs, and the Agency should continue to dispose of underutilized assets and facilities." But while the Academy report listed individual projects it thought were a low priority, it did not recommend the elimination of whole categories of research as NASA has proposed. The report also did not elaborate on its recommendation concerning underutilized facilities. (A summary of the report is attached.)

Airspace Systems

Airspace Systems supports research to improve air traffic management. In conjunction with FAA, NASA is supporting the Joint Planning and Development Office, which is overseeing the effort to develop a next-generation air traffic management system. The Airspace Systems program would receive the largest increase of the programs within NASA's aeronautics portfolio in the FY06 budget, increasing by $48 million or about 32 percent. However, the program would still receive less than it did in FY04, and it would receive less in subsequent years. The increase in FY06 would be used to provide more funds for a number of software development projects, whose budgets would remain flat after that. A number of current projects would be completed during the out-years, resulting in the drop in overall funding for the program.

Aviation Safety and Security

The Aviation Safety and Security program conducts research to prevent the most common types of fatal accidents in aviation, such as planes colliding with mountainous terrain or other obstacles on the ground, and eliminating intrusions by other aircraft onto active runways. It also seeks to develop concepts and technologies to reduce the vulnerability of aircraft and the National Airspace System to criminal and terrorist attacks while improving the efficiency of security. For FY06, NASA proposes to increase funding for this program by $7.5 million, or about four percent. The program would receive less funding in the out years.

Personnel

The proposed cuts in the aeronautics budget would be achieved, in part, by reducing the workforce. NASA has not specified what skills would no longer be needed because of programmatic changes or how the personnel cuts might be linked to facilities cuts. It is unclear whether NASA decided how many employees would be cut based on budget targets, or whether the Agency decided how many employees would no longer be needed for programmatic reasons and then calculated how much money would be saved as a result, or some combination.

Acting Administrator Fred Gregory testified on February 17 that no one at NASA would be laid off involuntarily before FY07, raising the question of what NASA would do if buyout offers did not result in the expected reductions.

NASA FY06 Budget Request							
Proposed Aeronautics Workforce							
	FY05	FY06	FY07	FY08	FY09	FY10	Delta FY10 vs. FY05
Dryden Flight Research Center, CA							
Civil Service	424	408	293	295	285	264	-160
Contractor Workforce	299	255	228	243	242	242	-57
Total Workforce	723	663	521	538	527	506	-217
Langley Research Center, VA							
Civil Service	1327	1004	764	690	647	604	-723
Contractor Workforce	990	594	743	563	506	450	-540
Total Workforce	2317	1598	1507	1253	1153	1054	-1263
Glenn Research Center, OH							
Civil Service	790	647	429	404	385	362	-428
Contractor Workforce	295	267	235	233	230	216	-79
Total Workforce	1085	914	664	637	615	578	-507
					Total Civil Service		-1311
					Total Contractor		-676
					Total Reduction		-1987

Issues

The Committee plans to explore the following issues at the hearing:

- **What would the impact of the proposed cuts be on American civil aviation?**

This critical question is difficult to answer at this point because NASA has not made clear exactly what would be cut, particularly in terms of facilities and job categories.

What is clear is that the cuts would come at a critical time for the U.S. aviation industry. The sole surviving American manufacturer of large civil aircraft, Boeing, is facing ever stiffer competition from its European competitor, Airbus. The two U.S. turbine engine manufacturers, General Electric and Pratt and Whitney, also face tough competition. It is not clear what kind of research would be most helpful to U.S. industry and to U.S. aviation generally. Clearly, the air traffic control and environmental issues on which NASA intends to focus would be at the top of any research priority list.

In terms of vehicle systems research, NASA is looking at eliminating incremental research, but this is the research that companies are likely to be most interested in as they can quickly adopt its results. But some experts argue that industry should pay for shorter-term research on its own.

One example of shorter-term research that NASA is backing out of is rotorcraft research. This concerns helicopter manufacturers who argue that helicopters are still an "immature technology" for which many improvements are possible and that foreign competition is increasing.

But NASA has had a mixed record with the kind of far-ranging research it proposes to focus on. In the past, it has discontinued many revolutionary technology programs before they were completed. For example, in the FY06 budget, NASA proposes to end work on hypersonics (which included a high-profile test late last year of the X–43A scramjet, which set a new record for speed).

One reason for the uncertainty about what approach NASA should take is that NASA has no overarching plan for aeronautics, in contrast to the way the President's Exploration Vision is setting the agenda for the exploration programs and the way that National Academy of Sciences priority-setting exercises guide NASA's science programs. NASA is in the process of funding several efforts to develop an aeronautics agenda. This month, a study funded by the National Institute of Aeronautics, a university consortium, is due to make recommendations. This summer, an internal NASA "roadmapping" exercise (which includes outside advisory committees) is scheduled to lay out a plan for aeronautics. And in late 2006, the National Academy of Sciences is expected to complete a "decadal survey" for aeronautics (based on similar surveys done in space science) that would lay out a consensus on priorities in aeronautics over the next ten years.

- **What would be the impact of NASA closing wind tunnels?**

NASA currently operates 31 wind tunnels, with widely varying utilization rates. Wind tunnels are very expensive to build and operate, and their designs are carefully tailored to achieve precise flow conditions within a narrow range of speed and altitude. No single wind tunnel is suitable for replicating all flight conditions (e.g., high and fast as well as low and slow). Throughout the world, most wind tunnels are supported by governments. Over the past two decades NASA has reduced its number of wind tunnels and propulsion test facilities by one-third.

NASA commissioned a study last year from RAND, which concluded that NASA should continue to operate 29 of its 31 wind tunnels. RAND estimated the annual operating cost of all 31 tunnels to be $125–$130 million. RAND argued that while some of the tunnels were not well used now, they offered capabilities that could be needed in the future and that would be hard to replicate if the tunnels were shut down. RAND also argued that while some questions that once needed to be solved with wind tunnels could now be answered through computer simulation, many critical questions still required wind tunnels. It also said that wind tunnel data were sometimes needed to develop computer simulation software.

In addition to NASA itself, industry and the Department of Defense use NASA wind tunnels. NASA has increased the fees it charges industry to use its wind tunnels, now basing charges on the full cost of maintaining a wind tunnel rather than on the incremental cost of the specific work being done. Because of increased fees and because of the age and limitations of some of NASA's facilities, U.S. companies are more frequently using foreign wind tunnels. This has raised issues about whether the U.S. should be wary of becoming dependent on foreign facilities as well as concerns about whether trade secrets may be lost in using foreign tunnels.

Background

NASA's Aeronautics Research

Virtually every airplane flying today employs technological innovations developed by NASA. Examples include the high-bypass turbine engine that provides much greater fuel efficiency and lower noise emissions than original 1960's-era jet engines; "fly-by-wire" control systems that use computers and wires instead of heavy, maintenance-intensive hydraulics systems to control an airplane's rudder and wing flaps; flight management systems such as the "black boxes" that continuously monitor an aircraft's engines, speed, location, and other critical parameters; and advanced composites made out of materials such as graphite and epoxy that can be used to replace heavier and more maintenance-intensive aluminum alloy structures. The Boeing 787, now under development, will be the first large civil aircraft to use composite materials in its fuselage.

The U.S. Aircraft Industry

The domestic aeronautics industry has changed substantially over the last ten to fifteen years through consolidations. Today there is only one manufacturer of large civil aircraft, Boeing, and just two turbine engine manufacturers for large civil aircraft, General Electric and Pratt & Whitney. The U.S. has no domestic regional jet manufacturers, the fastest growing segment in civil aviation; most are made in Canada and Brazil. The business jet and general aviation aircraft industry has a much larger number of producers.

Boeing is this country's largest exporter of manufactured products (based on dollar value), and there are thousands of suppliers whose products are found in each jet. Airbus,[1] a European company and Boeing's only rival, has overtaken Boeing in terms of winning new aircraft orders. Parenthetically, earlier this year Airbus unveiled its new A380 aircraft, a "super jumbo" that will be the world's largest passenger-carrying aircraft (it can seat over 800 in a single-class layout). The A380's first flight is scheduled for later this spring.

Earlier this decade, the European Union (EU) identified aeronautics as part of a continent-wide industrial strategy. The EU produced a research program document, "Aeronautics 2020," that explicitly states its objective of becoming the world's leading supplier of aeronautics goods and services and achieving parity with Boeing. Arguably, it has met its goal. The EU also has set a goal of taking a leadership role in developing the design and production of next generation air traffic management services.

[1] Airbus began over 30 years ago as a government-created and owned entity with direct investment by the British, French, Spanish, and German governments. It has since been spun off as a private company owned by EADS and BAE systems, both European based conglomerates.

Witness Questions

In their letters of invitation, the witnesses were asked to address the following questions:

Dr. Vic Lebacqz, NASA—

Please briefly describe NASA's long-term national aeronautics strategy and goals of the Aeronautics Research Mission Directorate with particular emphasis on the following questions:

- How do the funding and programmatic changes in NASA's FY 2006 budget proposal affect the Aeronautics Mission Directorate's ability to achieve its goals?
- Which wind tunnels is NASA planning to close and when is it planning to close them? What criteria were used to select those tunnels? What effect will the Agency's decision to close wind tunnels and propulsion test facilities have on the ability of the Mission Directorate to meet its goals? How will NASA ensure that its workforce retains the skills that are critical to the Agency achieving its long-term goals?

Dr. John Klineberg, National Academy of Sciences—

Please briefly describe the findings and recommendations of the National Research Council's review of NASA's aeronautics technology programs with particular emphasis on the following questions:

- Over the next two decades, what are the main challenges facing the aeronautics industry and our aviation infrastructure? What are the Nation's most pressing strategic needs in civil aeronautics?
- What role do NASA's aeronautics programs and strategic plans have in fulfilling the Nation's strategic needs in civil aeronautics? How effective are NASA's programs in helping to ensure U.S. industrial competitiveness in civil aeronautics markets worldwide?
- What effect do you believe NASA's proposed budget (including proposed changes in funding, workforce, and operation of wind tunnels) will have on its ability to meet the Nation's strategic needs in civil aeronautics?
- What steps, if any, do you recommend NASA take to better meet the Nation's needs?

Dr. Philip Antón, RAND—

Briefly describe the findings and recommendations contained in your study and analysis of NASA's inventory of wind tunnels and propulsion facilities with particular emphasis on the following questions:

- What would be the consequence to American aviation of NASA closing one or more wind tunnels? Are there particular wind tunnels that it would be especially detrimental to close?
- Are there ways NASA could seek outside funding for its wind tunnels? Are there ways NASA could change its accounting practices regarding its wind tunnels?
- What are the disadvantages of relying on foreign wind tunnels and how serious are they?

Dr. John Hansman, MIT, and Dr. Mike Benzakein, Ohio State—

- Over the next two decades, what are the main challenges facing the aeronautics industry and our aviation infrastructure? What are the Nation's most pressing strategic needs in civil aeronautics?
- What role do NASA's aeronautics programs and strategic plans have in fulfilling the Nation's strategic needs in civil aeronautics? How effective are NASA's programs in helping to ensure U.S. industrial competitiveness in civil aeronautics markets worldwide?
- What effect do you believe NASA's proposed budget (including proposed changes in funding, workforce, and operation of wind tunnels) will have on its ability to meet the Nation's strategic needs in civil aeronautics?
- What steps should the government take to better address the Nation's strategic civil aeronautics needs? If continued research has an important role to play, what should be its priorities? How do you recommend NASA balance in-

vestment in evolutionary research against revolutionary, high-risk, high-pay-off research?

Attachment

An Assessment of NASA's Aeronautics Technology Programs

NATIONAL RESEARCH COUNCIL (2004)

Excerpts from the Executive Summary

The National Research Council Committee and its three subordinate panels conducted an independent peer assessment of the Vehicle Systems Program (VSP), the Airspace Systems Program (ASP), and the Aviation safety Program (AvSP), the three elements of NASA's Aeronautics Technology Programs. NASA specifically asked the Committee and panels to address four questions:

1. Is the array of activities about right?
2. Is there a good plan to carry out the program?
3. Is the program doing what it set out to do?
4. Is the entire effort connected to the users?

The Committee's simple answer to the four questions posed by NASA is that, in general, the Aeronautics Technology Programs are very good but could be greatly improved by following the Committee's 12 top-level recommendations.

Top-Level Recommendations:

1. The government should continue to support air transportation, which is vital to the U.S. economy and the well-being of its citizens.
2. NASA should provide world leadership in aeronautics research and development.
3. NASA has many excellent technical personnel and facilities to achieve its aeronautics technology objectives but should improve its processes for program management.
4. NASA should eliminate arbitrary time constraints on program completion and schedule key milestones based on task complexity and technology maturity.
5. NASA should reduce the number of tasks in its aeronautics technology portfolio.
6. NASA should pursue more high-risk, high-payoff technologies.
7. NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects.
8. NASA's aeronautics technology infrastructure exceeds its current needs, and the Agency should continue to dispose of under-utilized assets and facilities.
9. NASA should implement full-cost accounting in a way that avoids unintended consequences harmful to the long-term health of the aeronautics program.
10. NASA should develop a common understanding with the Federal Aviation Administration (FAA) of their respective roles and relationship.
11. NASA should seek better feedback from senior management in industry and other government organizations.
12. NASA should conduct research in selective areas relevant to rotorcraft.

Rudderless

NASA aeronautics chief hopes new administrator will push for clear policy to guide facility closings

FRANK MORRING, JR./WASHINGTON

NASA is attempting to absorb a 40% cut in its aircraft technology-development programs without a clear national aeronautics policy to guide it—leaving the door open to parochial logrolling as the agency mothballs wind tunnels to achieve the new deep-space focus ordered by President Bush.

With the drumbeat growing on Capitol Hill to save constituent jobs threatened by the shrinking aeronautics accounts, the official in charge of managing the shrinkage says he needs a little more guidance to do the job right.

"I think we need a dialogue leading to a national policy," says J. Victor Lebacqz, associate administrator for aeronautics.

Lebacqz says whoever Bush appoints to run NASA should try to generate a consensus on what should be the space agency's role inside the atmosphere. Such a consensus would be comparable to the one that has developed behind the White House space exploration vision coordinated by former Administrator Sean O'Keefe, who resigned and left the agency last month.

The Glenn Research Center in Cleveland and the Langley Research Center in Hampton, Va., both face sharp cutbacks growing out of reductions in aeronautics spending under the Bush administration's Fiscal 2006 budget request. Langley is bracing for the loss of 1,000 jobs, while Glenn managers estimate a reduction of 700 (*AW&ST* Feb. 14, p. 37).

"To cut these programs would seriously undermine America's ability to compete militarily and commercially as the next generation of aircraft is developed," said Sen. George Allen (R-Va.), in a fairly typical reaction to the budget request. House Science Committee members plan a hearing on NASA aeronautics issues this month that's likely to include the future of agency wind tunnels and other ground test facilities.

The Fiscal 2005 NASA appropriation forbids the agency from closing wind tunnels in the near term, and orders a plan for their future disposition. Even before the Fiscal 2006 budget request was released, NASA put a list of wind tunnels and other facilities at Langley and Glenn on the chopping block and asked for feedback from facility managers about the impact of closing them.

"A likely scenario is that we close ground test facilities and capabilities that are no longer necessary to support the aeronautics research program, including most of our large wind tunnels and engine test cells," stated Thomas B. Irvine, acting director of the mission support division in Lebacqz's office.

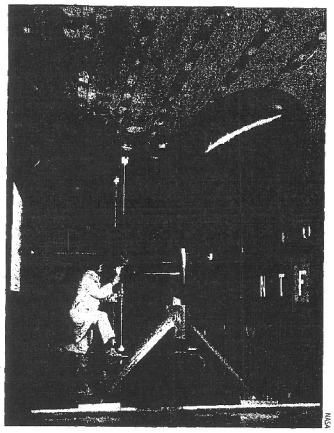
AMONG FACILITIES on the list at Glenn are the 10 X 10 Supersonic Wind Tunnel, Hypersonics Test Facility and the combustion and turbomachinery test cells in the Engine Research Building. At Langley, the list included the 14 X 22 Subsonic Tunnel, the National Transonic Facility and several high-Mach-number tunnels in the Aerothermodynamics Lab.

Irvine says the downsized aeronautics program outlined in the Fiscal 2006 budget would require "very few" of NASA's existing aeronautics ground test facilities. While the proposed aeronautics program would continue funding at previous levels for aviation safety and security and for increasing the capacity of the air transportation system, it would cut vehicle systems work by $100 million in Fiscal 2006 and by $200 million in 2007.

"There's roughly 40% less money to spend on vehicle-related activities," says Lebacqz.

The aeronautics mission directorate has narrowed its vehicle work to four programs, all of which are aimed at an eventual flight demonstration of technologies that in many cases will be tested on the ground first. For subsonic flight, the goal is redesigning engine inlets, landing gears and other airframe components to lower noise to the point that it stays within airport boundaries. For supersonic flight, NASA wants to continue sonic-boom reduction work that has already seen flight test on a modified F-5. The ultimate goal is reducing sonic booms to the point that the FAA could permit supersonic flight over land.

To eliminate hydrocarbon emissions from aircraft, the Fiscal 2006 budget includes work on advanced fuel cells and lightweight electric motors to support an eventual demonstration of a small electric aircraft. Finally, the proposed program calls for development of a prototype high-altitude, long-endurance unpiloted ve-



NASA

Although it was developed to test aircraft models, the Navy has also used Langley's National Transonic Facility to simulate the effects of flowing water on submarine models. The facility may be closed.

hicle that could carry scientific or other sensors for as much as two weeks. That same technology could be applied on Mars, where the low atmospheric pressure corresponds to the high-altitude environment on Earth.

"My personal view is that there are tremendous breakthroughs still to come in aeronautics," he said. "That's one reason we've focused in on the four that I talked about, but the facilities to support those breakthroughs or other breakthroughs are still required."

Lebacqz is far from alone in his call for a national aeronautics policy. Others making the call include the Rand National Defense Research Institute.

"For NASA leadership, the most critical issue is to develop a specific and clearly understood aeronautics test technology vision, to continue to support developing plans to very selectively consolidate and broadly modernize existing test facilities, and to prescribe common management and accounting directions for NASA's facilities," Rand stated in a report on NASA wind tunnels released last November. "This vision cannot be developed apart from other critical national decisions."

Within NASA, Lebacqz says he has tried to "corporatize" aeronautics planning instead of leaving it to the field centers. Irvine's letter to facility managers was part of an effort to collect the information needed for informed decisions at NASA headquarters. Those decisions will go into the wind tunnel plan Congress ordered NASA to produce by the end of September.

But the Rand study of 31 ground-test facilities recommended NASA close only two wind tunnels, and suggested that earlier facility shutdowns were poorly conceived. The Rand report recommended that NASA work with the Defense Dept. to rationalize the U.S. inventory of wind tunnels and other aeronautics test facilities, eliminating duplication where possible and finding ways to consolidate facility use (*AW&ST* Nov. 29, 2004, p. 20).

"It's a very complex problem," Lebacqz said. "There's not enough money to have them all open, particularly with this refocused approach. And the solution to the problem is not clear to me."

Also in the mix is the proper role in NASA planning for the U.S. aircraft industry, which has benefited from precommercial technology developed by NASA and its predecessor, the National Advisory Committee for Aeronautics, chartered in 1915. Harry C. Stonecipher has faulted the industry for its lack of guidance to government planners.

After Boeing and McDonnell Douglas lost interest in NASA's High-Speed Civil Transport effort, "the aeronautics industry let NASA down because we did not come forward with good aeronautics programs that we could work on together," Stonecipher said at the time (*AW&ST* Jan. 28, 2002, p. 27).

Rand also called for more investment in computational fluid dynamics (CFD), which uses computer models to predict the effects of design changes. SpaceShipOne, the private suborbital rocket that won the $10-million Ansari X prize last year, was largely developed with CFD, but when the models proved inadequate, engineers at SpaceShipOne builder Scaled Composites improvised a wind tunnel by mounting flight surfaces on a pickup truck and measuring the airflow effects as the truck drove along (*AW&ST* Nov. 17, 2003, p. 39).

"My personal view is that if we don't do adequate ground-based testing before we go to flight test, we'll make mistakes," says Lebacqz.

Chairman CALVERT. Good morning. I am here to call this meeting of the Space and Aeronautics Subcommittee to order. Without objection, the Chair will be granted the authority to recess the Committee at any time. Hearing no objection, so ordered.

Today, we are kicking off my first hearing as Chairman of the Space and Aeronautics Subcommittee. We are beginning our oversight of the fiscal year 2006 NASA budget, and we will focus today on the aeronautics research and development program.

There are a number of areas that I would like for us to examine through the hearing this year, including the Shuttle's return-to-flight, issues with the NASA workforce and infrastructure, NASA's financial management system, and issues concerning our commercial space industry. Just as important, I want to ensure that we get back to work on the authorization bill for NASA.

This is a critical time for the Agency, with a whole host of issues on its plate. It is important that the Congress offer guidance for the big decision facing NASA in the near future. I want to commend the President and his superb choice of Mike Griffin as the next NASA Administrator. I look forward to working with him, once he is confirmed, to begin addressing these issues.

Today, we will begin our oversight of the fiscal year 2006 budget proposed for NASA's aeronautics research and development program. The Europeans have thrown down the gauntlet, and said they will dominate aerospace in the world by 2020. The U.S. aerospace industry has expressed alarm at the reductions of NASA's aeronautics investment, pointing out that aerospace products are a huge source of export sales, and a major contributor to the United States international balance of trade.

Our nation's preeminence in commercial aircraft is being seriously challenged by Airbus, and many believe that reduced aeronautics R&D funding has directly played a role in the cause of the weakened position and the weakened aerospace industry. There is a lot of concern that the investment in aeronautics research and development by this nation has been limping along for several years, and there is a lack of a national strategy. Over the next five years, NASA is proposing to reduce its aeronautics workforce by approximately 2,000 people, and to shut down a number of its wind tunnels.

The questions that I have are, are these wise decisions for the Nation? Should NASA develop a national strategy for aeronautics before these valuable assets and skills are lost? Does NASA have a human capital strategy, or are these personnel cuts solely for budget purposes? Do we have a national strategy for civil aeronautics R&D, and if so, is NASA aligned to support a national strategy?

The current requested funding levels for the aeronautics program amount to a little over five percent of NASA's overall budget. The funding trend is declining at a rather precarious rate over the next several years. I am hoping that today's witnesses are able to guide the Subcommittee in addressing what this nation's aeronautics priorities should be, and how NASA should address these priorities.

In fiscal year 2006 budget request, NASA offers three programs in aeronautics R&D area. Of the three, Airspace Systems and Aviation and Security are funded at a flat level, and Vehicle Systems

received a 20 percent cut, approximately $100 million. This does not appear to bode well for the Nation investment in the future of the aerospace industry and our nation's competitiveness.

I look forward from hearing from our witnesses today on this important topic. I also want to welcome Mr. Udall in his new capacity as the Ranking Member on this subcommittee. I look forward to working with you and this Congress. We have worked together on other committees, and I look forward to working with you on this committee. In fact, I think we are on all the same committees, come to think of it. Yeah.

So, at this point, I would like to recognize Mr. Udall for his opening statement.

[The prepared statement of Mr. Calvert follows:]

PREPARED STATEMENT OF CHAIRMAN KEN CALVERT

Today, we are kicking off my first hearing as Chairman for the Space and Aeronautics Subcommittee. We are beginning our oversight of the FY 2006 NASA budget and will focus today on the Aeronautics research and development program. There are a number of areas that I would like for us to examine through hearings this year, including: the Shuttle's Return-to-Flight; issues with the NASA workforce and infrastructure; NASA's financial management system; and issues concerning our nascent commercial space industry.

Just as important, I want to ensure that we get to work on the authorization bill for NASA. This is a critical time for the Agency with a whole host of issues on its plate. It is important that the Congress offer guidance for the big decisions facing NASA in the near future.

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There is a lot of concern that the investment in aeronautics research and development by this nation has been limping along for several years, and that there is a lack of a national strategy. Over the next five years, NASA is proposing to reduce its aeronautics workforce by approximately 2,000 people and to shut down a number of its wind tunnels. The questions that I have are: Are these wise decisions for our nation? Should NASA develop a national strategy for aeronautics before these valuable assets and skills are lost? Does NASA have a Human Capital Strategy or are these personnel cuts solely for budget purposes? Should we have a national strategy for civil aeronautics R&D? If so, is NASA aligned to support a national strategy?

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I look forward to hearing from our witnesses today on this very important topic.

Mr. UDALL. I thank the Chairman. Good morning to everybody here.

I would like to join the Chairman in welcoming our witnesses, the first panel in particular, Representative Jo Ann Davis and Representative Dennis Kucinich, who I am sure will join us.

I would also like to take the opportunity to say how much I am looking forward to working with Chairman Calvert and the other Members of this subcommittee. We have a lot of important issues to deal with over the next two years, and I am confident that we will be able to work effectively across party lines to do the Nation's business.

One of the important issues that we need to address is topic of this morning's hearing, namely, the future of NASA's aeronautics program. This year marks the 90th anniversary of the establishment of the National Advisory Committee for Aeronautics, NACA, as it was known, the organization predecessor of NASA. During its existence, NACA undertook much of the R&D that made modern commercial and military aviation possible.

Congress recognized the value of federally sponsored R&D in aeronautics, and made it one of NASA's core missions when it established the Agency in 1958. It made good sense then, and it makes good sense now to have NASA involved in aeronautical R&D. NASA's R&D in aeronautics and aviation benefits not only—helps our international competitiveness, but also the quality of life of our citizens. Research on ways to drastically reduce aircraft noise and emissions, research into safer and more secure aircraft, research into new vehicle concepts that could revolutionize future air travel, and research into ways to modernize the Nation's air traffic management system, so that we don't face gridlock in the skies at some point in the coming decades. All of these are areas of research NASA has been pursuing.

Yet despite the clear value of such research, NASA aeronautics program has now reached a crisis point. Coming in the wake of years of declining budgets, the fiscal year 2006 request, if approved, would further erode the aeronautics program's capabilities over the next five years. In addition to the low priority being given to aeronautics in the budget, NASA's experiment with full cost recovery, an approach that DOD has tried and abandoned, has jeopardized the continued viability of an important segment of the Nation's aeronautical test facilities.

Moreover, while it has been difficult to get definitive answers concerning NASA's intentions for the workforce at the Aeronautics Research Centers, it is clear that NASA management envisions significant numbers of current employees leaving the program. As one of our witnesses, Dr. Hansman, observes in his testimony, the workforce actions appear to be motivated by budget pressures rather than strategic efforts at intellectual renewal. This, coupled with a perception of declining NASA priority in aeronautics, could create an atmosphere where it is difficult to retain and attract the best and the brightest.

All of this troubles me. We seem to be headed down a path that could result in the loss of a vital national capability if we aren't careful. The NASA witness at today's hearing will have the somewhat thankless task of trying to convince us that things aren't so bad, even though his programs are being cut year after year. In that regard, I bring an open mind to the hearing, and I am willing

to be convinced that the '06 budget request for aeronautics is healthy.

But in order to be convinced, I am first going to need to have a number of concerns addressed. For example, NASA's '06 budget request focuses the Vehicle Systems funding on research into breakthrough technologies, with the intent of achieving near-term flight demonstrations of revolutionary and barrier-breaking technology. That sounds good. However, flight demonstrations tend to be the most expensive part of the aeronautical R&D process. Yet, NASA's budget plan indicates that the Vehicle Systems budget will decline by 43 percent over the next five years. That doesn't strike me as a credible approach.

I could cite other examples, but I want to bring my remarks to a close, so we can hear from our witnesses. I would simply conclude by saying that I think we really have a straightforward question of priorities before us. The bleak outlook for aeronautics at NASA is not an inevitability. It is a result of policy decisions and prioritizations that Congress may or may not choose to endorse.

Mr. Chairman, as I close, I would like to ask unanimous consent that the written testimony submitted by Mr. Gregory Junemann, of the International Federation of Professional and Technical Engineers, be entered into the record.

Chairman CALVERT. Without objection, so ordered.

[The prepared statement of Mr. Junemann follows:]

PREPARED STATEMENT OF GREGORY J. JUNEMANN
PRESIDENT, INTERNATIONAL FEDERATION OF PROFESSIONAL & TECHNICAL ENGINEERS, AFL–CIO & CLC

Summary:

The International Federation of Professional and Technical Engineers, which represents more than 8,000 employees at five NASA Centers, is concerned that the dramatic cuts in NASA's aeronautical R&D proposed in the FY06 budget, together with the associated ill-conceived draconian workforce downsizing, will harm NASA's ability to live up to its responsibility to bolster U.S. global leadership in aeronautics, to its duty to maintain the safety and security of the air-traveling public, and to its obligation to help fuel U.S. economic growth and prosperity. We propose a few specific legislative solutions, appropriate for the FY06 Authorization bill, as well as an alternate revenue-neutral funding path better suited for delivering the President's Exploration Vision while maintaining NASA's intellectual assets and facilities necessary to meet America's critical future needs in aeronautics.

Statement:

The International Federation of Professional and Technical Engineers would like to thank Chairmen Boehlert and Calvert as well as Ranking Members Gordon and Udall for according us the privilege of submitting this testimony for the record. The Nation is looking to the House Science Committee and its Subcommittee on Space and Aeronautics to scrutinize carefully NASA's proposed FY06 budget and associated activities. In particular, in the context of today's hearing on the future of NASA's aeronautics programs, we ask that the Committee compel NASA to explain exactly how it expects to meet its responsibility to foster progress in aviation for the American people while imposing a nearly one-third cut in funding to the Aeronautics Research Mission Directorate. What increased risks are the American people being asked to accept? What constraints on economic growth? What loss in world leadership and national prestige?

NASA aeronautical R&D has an unquestioned track record of return on investment and, at less than $1billion dollars annually, is an amazing bargain; it continues to play a crucial role in the near flawless safety record in U.S. commercial aviation and in technology innovation for both civilian and military aeronautics. Unfortunately however, NASA aeronautics funds are being improperly pilfered to support a chaotic and hastily planned increase in the Exploration budget. The President's Vision for Space Exploration contains a budget chart (p. 19) showing a small

short-term decrease in aeronautical R&D of a magnitude far less than the one currently proposed, and the long-term costs of Exploration covered by the phase-out of funding to the Shuttle and ISS programs. NASA must explain to Congress and to the American people such a divergence from the President's initial plan, and why Aeronautics is being sacrificed for Exploration when the Vision clearly intended to use ISS and Shuttle funds for that purpose.

Much of the science and many of the currently implemented technologies and facilities funded by the Aeronautics budget have significant impacts on past space missions, and leveraging these existing assets and expertise will prove invaluable in any cost-effective yet accelerated Exploration plan. The proposed cutbacks jeopardize facilities, scientists, engineers, and technicians that should be available, for example, to test vehicle design and human-system integration for a Mars mission Entry, Descent and Landing, and to design airborne "flyers" for Mars surveying, to name just two. The proposed cuts in aeronautical R&D will have unintended consequences for Exploration in the out-years; such impacts must be evaluated and prevented before the damage is done.

Additionally, in NASA's Aeronautics blueprint (February, 2002), the Agency outlines a clear plan for NASA's aeronautical R&D as critical component of a bold vision of the future of America's civil and military aviation. This document states some simple facts:

1. Aviation is crucial to U.S. economic health, national security, and overall quality of life.
2. The Nation is facing continuing serious challenges in aviation.
3. New technologies are needed to create a new level of performance and capability.

These facts remain as true today as they were when Administrator O'Keefe signed off on the blueprint three years ago. Indeed, this view has been reasserted and extended by the Joint Planning and Development Office (JPDO)—an interagency task force created in 2003 under the *Century of Aviation Reauthorization Act* and charged with coordinating aeronautics efforts across NASA, FAA, DOD, Commerce, Transportation, and Homeland Security to "ensure that the Next Generation Air Transportation System meets air transportation safety, security, mobility, efficiency, and capacity needs." In their Integrated National Plan for the Next Generation Air Transportation System (December 2004), the JPDO lays out an urgent agenda to:

1. Retain U.S. Leadership in Global Aviation
2. Expand Capacity
3. Ensure Safety
4. Protect the Environment
5. Ensure Our National Defense
6. Secure the Nation

Clearly, NASA must play a prominent role in all six of these efforts (as it is the only Agency with the appropriate broad-based aeronautical R&D expertise and experience) and any reprogramming of NASA's aeronautical R&D programs must be evaluated to assure that cuts do not jeopardize the swift and effective implementation of this coordinated effort.

Just as clearly, industry and academia alone will not meet the Nation's needs in aeronautics. It is an inherently governmental responsibility to drive the long-term R&D needed to create the revolutionary (and, hence, risky and unprofitable even in the medium-term) changes needed for aviation in the 21st century. The profit motive will back the *status quo* until market conditions change so dramatically (e.g., the doubling of the number of commercial flights) that the *status quo* no longer functions safely and efficiently. Yet, revolutionary technology change does not occur overnight and hence the Nation can ill afford to wait until market forces can drive change, i.e., we cannot wait to act until planes are crashing because of an overburdened airspace system. Investing in NASA aeronautical R&D will bolster America's leadership in aeronautics as well as both our military might and our civilian competitiveness in aircraft design, production, and operations.

NASA also plays a unique role in responding to the Nation's need to develop and maintain critical, unique, and—yes—unprofitable test facilities; as well as the need for the independent, scientifically-based establishment of evolving standards for design requirements and safety certification. NASA plays a critical role in supporting the efforts of its sister aeronautics-related Agencies: the Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB). Using its facilities and in-house expertise, NASA assists the FAA establish and introduce new

safety standards and new operational capabilities and helps the NTSB identify the root causes of accidents. These key roles provide further justification for continuing a major governmental role in America's aeronautical R&D. Only NASA has the expertise, capability, and independence to perform this role properly and effectively without being compromised by external profit motives.

In a recent thorough external review of NASA's aeronautics program conducted by the National Research Council (NRC Review of NASA's Aerospace Technology Enterprise: An Assessment of NASA's Aeronautics Technology Programs, 2004), a panel of experts throughout the aeronautics industry and academia issued a dozen top-level recommendations. Among these, the first two are: "(t)he government should continue to support air transportation, which is vital to the U.S. economy and the well being of its citizens, and NASA should provide world leadership in aeronautics research and development." That said, in its third recommendation, the NRC gave NASA's rank-and-file employees a ringing endorsement while warning of problems with NASA management: "NASA has many excellent technical personnel and facilities to achieve its aeronautics technology objectives, but should improve its processes for program management." A large part of this management problem is the exploding population of technically-detached managers created by NASA management's inefficient matrixed structure and its insistence on excessive internal reporting, a permanent state of re-organization, and other unproductive, non-technical, and overall inefficient activities.

A full evaluation of all the NRC recommendations is beyond the scope of this statement, but it is important to note that another important recommendation was that "NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects." It is troubling that NASA management has rejected this recommendation and has turned instead in the opposite direction by implementing a demonstration project approach to its aeronautical R&D.

The NASA blueprint concludes with the blunt statement that "the cost of inaction is gridlock, constrained mobility, unrealized economic growth, and loss of U.S. aviation leadership." This must not be allowed to occur. NASA can continue to realign itself towards the President's Exploration Vision, but it must and can do so without dramatically reducing its aeronautical R&D capabilities. NASA management's plan to siphon off 30 percent of its aeronautics funds to support the Exploration Systems Mission Directorate (ESMD) will prevent NASA from living up to the promise of its own blueprint, to its responsibility in the JPDO's Next Generation Air Transportation Integrated Plan, to its duty to maintain the safety and security of the air-traveling public, and to its obligation to help fuel U.S. economic growth and prosperity.

The devastating impact of the FY06 budget on the Aeronautics Field Centers

NASA's FY06 budget proposal contemplates an overall 30 percent decrease in the aeronautics budget between FY05 and FY07. The immediate FY06 cuts focus nearly completely on redirecting the Vehicle Systems Program (VSP), despite the fact that the NRC review stated that "(t)he committee evaluated a total of 172 tasks in the VSP portfolio. The committee determined that more than 80 percent were of good quality or better, with 30 percent (51 tasks) rated as world-class." One has to wonder what will happen to all that world-class R&D and all those world-class scientists and engineers given that the proposed cuts far exceed the 20 percent that one might expect from the above numbers. However, even more troubling is the fact that, although the remaining programs (Airspace Systems, Aviation Safety and Security) appear stable in the overall FY06 budget projections, the current and projected funding picture is far different at all of the aeronautics performing Field Centers.

From the data in Associate Administrator Lebacqz's February 16th briefing to committee staffers, one can generate the following clear picture of the magnitude of the impacts of the FY06 budget across all three Aeronautics Field Centers. (Similar impacts are evident at Ames Research Center but, because it is no longer an official Aeronautics Center, its detailed numbers were not available in his briefing.)

Aeronautics Funding	FY07 (in FY05 budget)	FY07 (in FY06 budget)	% change
Dryden	$173M	$130M	-24.8
Glenn	$263M	$200M	-24.0
Langley	$345M	$228M	-33.9

Aeronautics CS Workforce	FY07 (in FY05 budget)	FY07 (in FY06 budget)	% change
Dryden	434	293	-32.5
Glenn	833	429	-48.5
Langley	1198	764	-36.2

Aeronautics Contractor Workforce	FY07 (in FY05 budget)	FY07 (in FY06 budget)	% change
Dryden	277	228	-17.7
Glenn	410	235	-42.7
Langley	NA	NA	NA

The elimination over this 18-month period of more than a third of a Field Center's highly skilled and experienced technical aeronautics workforce would seem a bit imprudent, as well as contrary to NASA's own blueprint, the JPDO's Integrated Plan, and the NRC's recent NASA recommendations. The above numbers also do not address the adverse impacts on critical facilities (see below).

Legislative Proposals

IFPTE asks that the House Science Committee exercise its oversight authority by adding the following language into its FY06 Authorization bill to safeguard NASA's aeronautics capabilities:

1. NASA shall reserve at least six percent of its FY06 budget for the Aeronautical R&D activities and plan for seven percent in the FY07 rising to 10 percent in out-year budgets. Among other things, NASA shall use this increase in funding to implement the NRC review panel's recommendation to "reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects."
2. NASA shall decrease its management workforce (supervisors and management officials) by a third in FY06 and plan to reduce this workforce by a factor of two from the FY05 baseline by the end of FY07. NASA shall not decrease its technical workforce at any Field Center by more than 10 percent in any given year and shall explicitly include any planned technical workforce reductions of any kind in its annual Workforce Plan submitted to Congress.

An Alternate Approach to Funding the Exploration Vision and Aeronautics

The modest numbers in Proposal 1 will provide the Associate Administrator Dr. Lebacqz (or his successor) with adequate funding to preserve NASA's critical facility infrastructure and intellectual capital at Ames Research Center, Dryden Flight Research Center, Glenn Research Center, and Langley Research Center, and to enhance their ability to deliver to the American people what they need and expect from NASA—scientific discoveries and technology/operational breakthroughs.

Proposal 2 will not only allow NASA to re-vector internal funds for Exploration, Science, and Aeronautics R&D, it will put NASA more in line with the rest of the high-tech world as far as its management to technical employee ratio. Currently, the number of scientists and engineers across NASA for every non-clerical administrative employee is typically two to three, and this ratio does not even include corporate overhead from NASA HQ management. Our proposal will go a long way towards making this overhead ratio closer to a healthy 1:8, typical of private enterprise.

To generate the additional needed revenue to enable our first legislative proposal above and NASA's realignment toward the President's Exploration Vision, NASA should seriously consider reducing its role in completing the International Space Station (ISS). Administrator-nominee Dr. Griffin noted in his October 2003 testi-

mony to the House Science Committee that "in a human space flight program focused on 'settling the solar system,' construction of a LEO (low-Earth orbit) space station would not be an early priority." Furthermore, he states wisely that "we must not mortgage our future to ISS." We concur and ask that NASA funding decisions reflect this reality. Reducing NASA's ISS commitments would also allow it to make a better effort to meet its requirement not to exceed the cost ceiling of $25 billion in the *NASA Authorization Act of 2000.*

In this vein, NASA should admit now that it cannot conduct an additional 28 Shuttle flights before the end of 2010 and act accordingly. Significantly reducing the number of Shuttle flights would free up billions of dollars. NASA needs to wean itself as soon as possible of its dependence on the Shuttle, an intrinsically risky transportation system, and on Russian capabilities, a national security nightmare and a looming treaty violation. As Dr. Griffin stated to the House Science Committee, "(r)egarding the Space Shuttle, . . .we should move to replace this system with all deliberate speed. . .we must admit to ourselves that it is time to move on." NASA should focus a smaller number of remaining Shuttle flights to address core needs of the President's Vision: research on the impact of space flight on physiology and performance, and a manned Hubble repair mission. The released funds can then be redirected primarily for enhanced support of the development of the Crew Exploration Vehicle (CEV) and secondarily for enhanced support of Science and Aeronautics. This general scenario also puts these three core NASA efforts in a better position should Congress decide that it must cut NASA's overall budget in FY06 or later.

This alternate approach:

1. will expedite the Nation's real solution to its current space-related problems by reinforcing the development of new, safer, more flexible space transportation systems without consuming critical long-term R&D funds to meet near-term milestones;
2. will dramatically reduce the risk of another catastrophic failure of the Shuttle with its associated loss of life and national treasure;
3. will minimize U.S. dependence on Soyuz;
4. will minimize ISS cost overruns and NASA's need to extend ISS's cost ceiling.

The downside will be that this approach may harm NASA's relationship with its international partners. Of course, as Dr. Griffin stated with regard to ISS, "we should do what is necessary to bring the program to an orderly completion while respecting our international partnership agreements." IFPTE concurs that we must respect our international partners and must handle any reduced U.S. involvement in ISS diplomatically, however this respect cannot be allowed to supersede NASA's duty to protect the American taxpayer, to fulfill the President's Exploration Vision, and to defend the safety and security of the air-traveling public. Given that NASA has proposed only a tiny increase in funding associated with the Exploration Vision and that Congress appears poised to reduce this increase, Congress should heed Dr. Griffin's warning that "(i)f no additional funding can be made available, it will be very difficult to complete ISS and, at the same time, embark on the development of those other systems that are required for a truly valuable and exciting human space flight program."

IFPTE's legislative proposals above and the associated proposal to de-scope NASA's ISS commitments and to accelerate the retirement of Shuttle are sufficiently generic to allow NASA management considerable flexibility. They are meant to foster a serious discussion about the future of NASA and to propose an alternate path that allows NASA to better meet the challenge of the President's Exploration Vision without cannibalizing the other critical functions of the Agency.

Critical National Needs Impacted by NASA Aeronautics Cuts

The Nation is facing key aviation challenges: increasing capacity while maintaining or enhancing safety, reducing noise and emissions, establishing effective post-911 security, and holding off the serious challenge by Europe of the U.S. global leadership in aeronautics. Although the private sector will play an important role in addressing these challenges, as Mr. O'Keefe's aeronautics blueprint (p. 14) states "the need for a continuing government role in aeronautical R&T in support of civilian and military objectives is as strong today as ever" and that NASA's role is "strategic forward-looking breakthrough research combined with tactical problem resolution in response to priorities established through close partnerships (with aviation product developers and process owners)."

A complete evaluation of the programmatic impacts of NASA's proposed FY06 budget is beyond the scope of this statement. IPFTE urges the Committee to ask the Center Directors at each of the adversely affected Centers (Ames, Dryden, Glenn, Langley) to provide a report to them describing the impacts of the FY06 budget plan on their R&D activities, their facilities, and their contractor and Civil Service workforce. There is much more happening on the ground than is being shown to you in the FY06 budget numbers. The Committee will need this information to make an informed assessment of the wisdom of NASA FY06 budget plan.

Some make the argument that current technologies in aeronautics are mature and therefore should be transferred to the private sector. Current technologies are by definition mature and indeed have been transferred to the private sector. This argument is specious as it is future technologies that NASA is working on; these technologies are not mature and will require continued incubation in a government laboratory setting as part of a collaborative effort between NASA, industry, and academia prior to being ready for implementation in the real world. As Associate Administrator Lebacqz pointed out recently, "there are tremendous breakthroughs still to come in aeronautics" and "the facilities to support those breakthroughs or other breakthroughs are still required" (*Aviation Week & Space Technology,* March 7, 2005).

The critical point is that the Nation needs to go beyond current technologies. The U.S. once was the world leader in aviation. More civilian airplanes were once made in the U.S. than in the rest of the world combined. Aviation once played a major role in the Nation's trade balance. Now Airbus has a larger share of the global market than Boeing. The Europeans know that government support for Airbus is crucial and this has been a key reason for their success. Now more airplanes are being built in Canada and Brazil than in the U.S. The U.S. is clearly losing its leadership position and our trade deficit continues to grow. Simply redirecting taxpayer dollars directly to industry is unwise as it may trigger trade sanctions as an improper direct subsidy. While NASA in-house R&D activities have a special relationship with American aviation companies and preferentially benefit American business, these governmental activities do not cross the line imposed by the General Agreement on Tariff and Trade (GATT). If the U.S. has any chance of holding its ground, major government investment in aeronautical R&D is necessary. The U.S. needs to be as clever as Europe in providing assistance and support for their national industries without running afoul of the GATT. NASA is poised to lead that effort, representing the national interest as a whole. The government must take the lead.

Furthermore, even if current vehicle technologies are considered "mature," human error is still the major cause of aviation accidents. These accidents cost the Nation a huge amount even when they only happen in U.S. General Aviation, or to U.S.-made aircraft in other countries. No single manufacturer or operator will address this problem. It is a national issue, a national responsibility, a national priority. The government must take the lead.

The recent quiet on the airline safety and security front is misleading. As air traffic increases (e.g., potential tripling of commercial flights over the next 20 years, Unmanned Airborne Vehicles, micro-jets) and Air Traffic Control support dwindles (e.g., synchronized retirements, out-dated equipment), we are going to see greater delays and greater risks. Without sustained NASA aeronautical R&D funding, NASA technology innovations will not be there to keep our airline safety record second to none and to reduce flight delays and associated economic losses. Although we have not had a major aviation security failure since September 11th 2001, it is a complete surety that terrorists will try to strike our aviation system again. Without sustained NASA aeronautical R&D funding, NASA technology innovations will not be there to help American stay one step ahead of terrorists. These are serious national issues that cannot be solved by simplistic solutions such as privatizing ATC or limiting air traffic. Aviation is a major component of the U.S. economy and any economic growth will depend on a reliable transportation system that can scale up to meet new economic demands. This challenge will not be met by industry alone. The government must take the lead.

Irreparable Harm to Critical Government Assets

Prior to full-cost accounting, any ill-conceived budget cuts one year could be remedied the next by simply restoring the research funds. Unfortunately, full-cost accounting makes management blunders permanent by destroying laboratory infrastructure and intellectual capital. Once a facility is closed, it is gone. When the experts who run it are laid-off, they are gone. Decades of developing unique wind tunnel and simulator facilities and expertise can be lost in a heartbeat when a facility is killed or employees are laid-off by a program manager's shortsighted need to meet near-term milestones. Inadequate attention is being paid to the big picture and the

long-term health of the Agency and to its facilities and intellectual infrastructure. In a few years, when these very programs need these same facilities they once spurned, the facilities will no longer exist and the Nation will need to spend millions restoring capabilities inferior to the ones we previously had. As Associate Administrator Lebacqz warned recently, "if we don't do adequate ground-testing before we go to flight test, we'll make mistakes" (*Aviation Week & Space Technology,* March 7, 2005). These mistakes may kill military pilots or civilian passengers or lead to millions of dollars in expensive last minute design fixes, so this warning should not be taken lightly.

The serious concern about how NASA is implementing full-cost accounting is not just Union rhetoric; it is shared by the external industry and academic experts on the NRC panel that recently reviewed NASA's aeronautics programs. One of its top-level recommendations was that "NASA should implement full-cost accounting in a way that avoids unintended consequences harmful to the long-term health of the aeronautics program." Especially given the abysmal failure of NASA's full-cost accounting conversion to provide the accounting transparency promised Congress and the American taxpayer, we ask that Congress to use its authority to investigate this serious concern and to compel NASA to modify those accounting policies and practices that are adversely affecting NASA's ability to get its technical job done for the American people.

Thank you again for submitting these remarks into the hearing's official record.

Chairman CALVERT. I thank the gentleman for his opening statement. Without objection, the additional statements of other Members will be put in the written record, so we can get right to the testimony. Hearing no objection, so ordered.

[The prepared statement of Mr. Forbes follows:]

PREPARED STATEMENT OF REPRESENTATIVE J. RANDY FORBES

Mr. Chairman, thank you for holding this hearing on the proposed FY 2006 budget for aeronautics. This is an issue of great importance not only to the Hampton Roads area of Virginia, but also to our national security and economic security.

In only the last half century, space exploration and scientific discovery have brought an unquantifiable richness to human life. America's space program is a symbol of our success as a scientifically and technologically advanced nation. I am pleased that President Bush has devised a plan that seeks to advance human space exploration, however I am concerned that the FY 2006 Budget proposes cuts to vital programs that are not related to NASA's Vision for Space Exploration.

In particular, I remain concerned that reduced federal funding for aviation and aeronautics research and technology in FY 2006 will jeopardize the Nation's leadership in providing the technologies needed to develop the next generation aircraft, improve aviation safety and security, and attract the next generation of aerospace scientists and engineers. We are in danger of falling behind our competitors in Europe who have announced that their goal is to dominate commercial aviation sales by 2020.

In addition, cuts to the NASA Aeronautics budget will have a profound impact on the NASA Langley Research Center in Hampton, Virginia, which has a long and proud history of aeronautics research. NASA Langley's wind tunnels and laboratories, research aircraft and spacecraft and flight simulators have made significant contributions to our nation's advances in the aeronautics industry and have the promise of yielding many more in the future. Like the explorers of the past and the pioneers of flight in the last century, we cannot identify today all that we will gain from aviation and aeronautics research; however, we know from experience that the eventual return will be great. The greater the investments of today, the greater the rewards for generations to come.

I look forward to hearing from today's witnesses.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

Chairman Calvert and Ranking Member Udall, thank you for holding this important hearing today. I believe it is essential that, as NASA undertakes a "Transformation" to carry out the President's Vision for Space Exploration, we remember that NASA stands for the National Aeronautics and Space Administration and examine what is happening to the aeronautics programs within the Agency.

I am very concerned about the lack of Congressional oversight of this transformation and the fact that NASA has not provided us with timely information about changes that are taking place, including those being made as we speak to the aeronautics programs. Full Cost Accounting has been combined with broad discretionary authority granted to the Agency in the Fiscal Year 2005 Omnibus Appropriations bill to create a situation in which the salaries of vast numbers of Civil Service R&D employees are being moved out of project accounts and into general operations, which has created an artificial crisis at the centers and is being used as a reason to undertake large scale workforce reductions. To date, NASA has not provided us with a detailed Operations Plan outlining how these changes are being made, and NASA has not provided requested documentation outlining those "excess competencies" broken down by Center, so that it would be possible to see what areas NASA management considered to be no longer important to pursue. It seems that aeronautics programs have fallen in this group, with the FY06 Budget Request cutting aeronautics programs over 21 percent by FY10, not counting the loss in purchase power due to inflation. Although aeronautics accounts for only 1/17 of the NASA budget, it had to absorb close to 1/3 of the total cut made to the Agency's out-year budget plan.

These decisions seem to fly in the face of a number of recommendations made by expert panels. A RAND Corporation panel recommended that "of the 31 existing major NASA test facilities, 29 constitute the 'minimum set' of facilities important to retain and manage to serve national needs." A National Academies committee concluded that "although a strong national program of aeronautics research and technology [R&T] may not, by itself, ensure the competitiveness of the U.S. aviation industry, the Committee agrees with earlier studies that without it, the United States is likely to become less competitive in aeronautics relative to countries with stronger programs. Aviation is an R&T-intensive industry. . .. Some aeronautics R&T programs have produced 'breakthroughs' that are immediately usable. . .. More often, aeronautics R&T advances are evolutionary, and a substantial number of years can pass before the aviation systems making use of these advances enter service." This last statement is particularly interesting in light of the fact that NASA is currently saying that it is going to focus only on "breakthrough" technologies.

NASA seems to be following a course on aeronautics that has potentially grave consequences not only for its Research Centers and those who work there, but also for our nation. I have many questions that I hope the witnesses can answer, and I look forward to their testimony.

[The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Chairman Calvert, Ranking Member Udall,

I want to thank you for organizing this important Subcommittee hearing to discuss *The Future of Aeronautics at NASA*. I want to welcome our distinguished panel of witnesses to the Subcommittee on Space and Aeronautics. Being from Houston, I of course take a particular interest in the direction that NASA is taking. The truth is that any vision for NASA starts today, but will likely affect an entire generation of humanity in terms of its impact.

A number of our recent hearings in the Science Committee have dealt with the national budget and its impact on scientific research, development, and discovery. Sadly, the news is almost all bad because this Administration has put out a budget that puts a squeeze on most of our vital agencies and programs. NASA, is not an exception to this budget squeeze. While some would point to the fact that the total NASA budget of $16.5 billion actually increased by 1.6 percent, the fact is that despite this small increase many NASA programs have suffered deep cuts including vital aeronautics research, which suffered a six percent cut in this latest budget. In fact, over the last decade, funding for NASA's aeronautics research has declined by more than half, to about $900 million. Even more troubling is that the proposed five-year plan for aeronautics contemplates substantial funding reductions of 20 percent for aeronautics research, in addition with significant cutbacks in its civil service and contractor workforces. If our nation expects to stay on the cutting edge and leads the world's development of new technologies it can not afford to leave aeronautics research withering on the vine without proper funding.

I am also deeply concerned that the proposed budget cuts will hit NASA's workers the hardest. Downsizing the workforce may reduce the budget, but it will not succeed in moving NASA forward. The NASA workers are the heart and soul of the

Agency, the ones who put the vision into action and make discoveries happen. Not only do we lose these talented individuals by reducing the workforce, but I am certain that we will scare away potential NASA recruits. The fact that workforce is being reduced is a sign of instability and our best and brightest minds may decide to go another path if they feel NASA does not offer them the opportunity for real development. I hope NASA will soon provide figures as to how many facilities and workers they plan to release and the time frame for this downsizing. The uncertainty that is in the air can not be good for the Agency or for the future of our nation's aeronautics program.

I have been supportive of President Bush's *Vision for Space Exploration* because I firmly believe that the invest we make today in science and exploration will pay large dividends in the future. Similarly, I do not want to put a cap on the frontiers of our discovery, NASA should aim high and continue to push our nation at the forefront of space exploration and scientific discovery. However, I can not see how this is accomplished by cutting aeronautics research and planning for even deeper cuts in the future. The President has stated that the fundamental goal of his directive for the Nation's space exploration program is ". . .to advance U.S. scientific, security, and economic interests through a robust space exploration program." I could not agree more with that statement; unfortunately, this President's own budget does not meet the demands of his ambitious agenda. The United States can not cede our leadership in the area of aeronautics, especially considering all the practical applications it has for millions of Americans. While other nations, notably in Europe are strengthening their work in aeronautics research, we seem to be satisfied to stay stagnant and I find that unacceptable.

As Members of this committee know I have always been a strong advocate for NASA. My criticism of the President's budget is intended only to strengthen our efforts to move forward as we always have in the area of space exploration and discovery. NASA posses an exciting opportunity to charter a new path that can lead to untold discoveries. As always I look forward to working with the good men and women of NASA as we push the boundaries of our world once again.

Chairman CALVERT. I would like to ask unanimous consent to insert at the appropriate place in the record the background memorandum prepared by the majority staff for this hearing. Hearing no objection, so ordered.

Today, we will begin our hearing with testimony, beginning with Congresswoman Jo Ann Davis, and I think later, Congressman Dennis Kucinich will be joining us.

They will be followed by the distinguished panel of experts, led by Dr. J. Victor Lebacqz, NASA Associate Administrator for Aeronautics. At the table with Mr. Lebacqz will be Dr. John Klineberg, who led a 2004 Research Council study entitled "Review of NASA's Aerospace Technology Enterprise: An Assessment of NASA's Aeronautics Technology Program." He is retired as a President of Space Systems/Loral, and for 25 years, worked at NASA, including as Director of both the Goddard Space Flight Center and the Ames Research Center. Dr. Philip Antón, who was the principal investigator of the 2004 report produced by the RAND Corporation entitled "Wind Tunnels and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Serve the National Needs." The report was jointly sponsored by NASA and the Department of Defense. He is a senior scientist at RAND, which is a federally-funded research and development center sponsored by the Department of Defense. And Dr. Mike Benzakein, who was named Chairman of the Department of Aerospace Engineering at Ohio State University in October '04. From 1967 through 2004, he worked for GE Aircraft Engines, and retired as general manager of advanced technology and military engineering. And finally, Dr. John Hansman, who is the Professor of Aeronautics and Astronomics at the Massachusetts Institute of Technology, and Director of the International Center for Air

Transportation. His current research interests focus on advanced cockpit information system and flight crew situational awareness.

Keep in mind, I would like to keep the testimony, spoken testimony, to five minutes. Any written testimony can be made part of the hearing record. Once the testimony is received from all the witnesses, the Members of the Subcommittee will begin their questions to the witnesses, which we will also limit to five minutes.

We will start with Congresswoman Jo Ann Davis, who will lead off today, and hopefully, will be followed by Congressman Dennis Kucinich, who I am assured will be here shortly. And then, we will go right to our panel of experts, as soon as the two witnesses, Members of Congress, complete their testimony. If those witness could please come to the witness table. And here is Mr. Kucinich. Which will begin with NASA's Associate Administrator for Aeronautics, Dr. Vic Lebacqz.

And with that, Congresswoman Davis, you may begin.

Panel I:

STATEMENT OF HON. JO ANN DAVIS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF VIRGINIA

Ms. DAVIS. Thank you, Mr. Chairman, Ranking Member Udall, and other distinguished Members of the Committee. I want to thank you for the opportunity to speak before your subcommittee this morning on the future of aeronautics in this country.

I appreciate your holding a hearing on this important subject, which is truly becoming a matter of national security. I also appreciate Congressman Kucinich's appearance here this morning on behalf of NASA Glenn Research Center in Ohio.

I am proud to represent the engineers and technicians at NASA Langley Research Center, who made United States aeronautics research and testing the envy of the world for over 88 years. First established as the Langley Memorial Aeronautical Laboratory in 1917, it was the Nation's first civil aeronautics research laboratory under the charter of the National Advisory Committee for Aeronautics, the precursor to the modern-day NASA.

Mr. Chairman, there is no doubt that we have been pioneers in this highly specialized field for most of the last century. My concern is that recent and future cuts will simply make us unable to retain this advantage in the future.

In recent years, the National Aeronautics and Space Administration, the NASA budget, has seen modest increases. However, at the same time, the aeronautics programs within NASA have been dramatically reduced. Over the last decade, funding for NASA aeronautics research has declined by more than half, to about $900 million. In addition, the President's budget proposes to cut aeronautics research by an additional 20 percent over the next 20 years—over the next five years.

I have serious concerns that the United States is losing critical expertise in aeronautics research and development. This degradation will have a tragic impact on military and civilian aviation, which contributes significantly to our country's national defense and our economy.

The U.S. military has benefited tremendously from NASA aeronautics research. The single most important benefit of the Department of Defense and NASA Langley's partnership is in the application of new technologies to this nation's military aircraft. Every aviation asset in the military's inventory was designed with the help of NASA's experts, and NASA conducted wind tunnel tests for the Department of Defense or their contractors on the F–14, F–15, F–16, F–18, F–22, JSF, B–1, C–141, C–5, and the C–17, just to name a few.

I think we can all agree that the combined contributions of these aircraft have been significant in our achievement of military superiority in the skies. Not only have NASA researchers made U.S. military vehicles technologically superior, they have helped determine the capabilities of our enemies by testing and analyzing foreign warplanes for the defense and intelligence communities. Without proper funding, this capability will perish, and will be exceedingly difficult to restore.

In addition, the U.S. civil aviation industry, which plays an important role in the U.S. economy, has benefited from NASA research. This vital sector of our economy employs over two million Americans, and comprises roughly nine percent of our country's Gross National Product. This strength is a direct result of the investment in aeronautics research over the past several decades. Nonetheless, the industry has been declining over the past several years, and now, only holds 50 percent of the world market.

While U.S. aeronautics research and testing programs are declining, countries in Europe and elsewhere are investing heavily in aeronautics research. The health of the U.S. aviation industry depends on aeronautics research and development, especially long-term research that cannot—that they cannot and will not perform themselves, in order to compete on the world market. NASA is the only, and I repeat, the only federal agency that supports research on civilian aircraft. Their researchers are working to make our planes and our skies safer, and I believe that this is a worthwhile investment of the taxpayer's money.

Given the importance of NASA aeronautics research and testing, I am very concerned that NASA does not have a coherent vision for aeronautics programs. Past blueprints and other guiding documents seem to have been discarded, most likely because NASA did not have the aeronautics budget to support them.

As I briefly noted today, the importance of aeronautics research is obvious. We cannot afford to lose the aeronautical advantage that is vital to our national defense and to our economy.

Again, I want to thank you, Chairman Calvert, for holding a hearing on this important issue, and I am glad you thought it important enough to be your first hearing of the 109th Congress. I appreciate all of your work and your staff's work, and I thank you, also, to the witnesses for being here this morning.

[The prepared statement of Ms. Davis follows:]

PREPARED STATEMENT OF REPRESENTATIVE JO ANN DAVIS

Mr. Chairman:

Thank you for the opportunity to speak before your subcommittee this morning on the future of aeronautics in this country. I appreciate you holding a hearing on this important subject, which is truly becoming a national security concern. Also, I appreciate Congressman Kucinich's appearance here this morning on behalf of NASA Glenn Research Center in Ohio.

I am proud to represent the engineers and technicians at NASA Langley Research Center who have made United States aeronautics research and testing the envy of the world for over eighty-eight years. First established as the Langley Memorial Aeronautical Laboratory in 1917, it was the Nation's first civil aeronautics research laboratory under the charter of the National Advisory Committee for Aeronautics—the precursor to the modern-day NASA.

Mr. Chairman, there is no doubt that we have been pioneers in this highly specialized field for most of the last century.

My concern is that recent and future cuts will simply make us unable to retain this advantage in the future.

In recent years, the National Aeronautics and Space Administration (NASA) budget has seen modest increases. However, at the same time, aeronautics programs within NASA have been dramatically reduced. Over the last decade, funding for NASA's aeronautics research has declined by more than half, to about $900 million. In addition, the President's budget proposes to cut aeronautics research by 20 percent over the next five years.

I have serious concerns that the United States is losing critical expertise in aeronautics research and development. This degradation will have a tragic impact on military and civilian aviation, which contributes significantly to our country's national defense and economy.

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Every aviation asset in the military's inventory was designed with the help of NASA's experts, and NASA conducted wind tunnel tests for the Department of Defense or their contractors on the F–14, F–15, F–16, F–18, F–22, JSF, B–1, C–141, C–5, and the C–17, just to name a few. I think we can all agree that the combined contributions of these aircraft have been significant in our achievement of military superiority in the skies.

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While U.S. aeronautics research and testing programs are declining, countries in Europe and elsewhere are investing heavily in aeronautics research. The health of the U.S. aviation industry depends on aeronautics research and development—especially long-term research that they cannot and will not perform themselves—in order to compete in the world market. NASA is the ONLY federal agency that supports research on civilian aircraft. Their researchers are working to make our planes and our skies safer, and I believe this is a worthwhile investment of the taxpayers' money.

Given the importance of NASA aeronautics research and testing, I am very concerned that NASA does not have a coherent vision for aeronautics programs. Past blueprints and other guiding documents seem to have been discarded—most likely because NASA did not have the aeronautics budget to support them.

As I have briefly noted today, the importance of aeronautics research is obvious. We cannot afford to lose the aeronautical advantage that is vital to our national defense and economy.

Again, thank you Chairman Calvert for holding a hearing on this important issue. I appreciate all of your work and your staff's work, and thank you also to the witnesses for being here this morning.

Chairman CALVERT. I thank the gentlelady for her testimony. Mr. Kucinich, you are recognized.

STATEMENT OF HON. DENNIS J. KUCINICH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OHIO

Mr. KUCINICH. Thank you, Mr. Chairman, and Members of the Committee. I am privileged to be here with Representative Jo Ann Davis on this important matter relating to aeronautics in the United States.

She pointed out there is no vision for aeronautics. Sitting right behind you on the wall, come to this committee, are the words from Proverbs, which says: "Where there is no vision, the people perish." So, it is important that we are here talking about the future of aeronautics.

Today, I am going to make the case that aeronautics research is essential to America's national security, quality of life, economy, safety, and environment. NASA has played, and should continue to play, a crucial role in aeronautics. Yet, it is at grave risk of being undermined as a result of current efforts to eliminate jobs, facilities, and entire programs. We must not allow the erosion of aeronautics at NASA.

NASA's contribution to the field of aeronautics to the Nation and world are profound. A good starting point is aeronautics' contribution to national security. From further surveillance—from surveillance systems that monitor aircraft flight paths, to the development of secure communication systems, NASA's research has been instrumental in improving our national security. In addition, NASA's recent successful hypersonic flight, clocked at about 7,000 miles per hour, demonstrated that military or civilian aircraft might soon be able to fly anywhere in the world in less than two hours. Aeronautical vehicles are a substantial and key part of the national defense infrastructure.

NASA's aeronautics programs also contribute substantially to the Nation's economy. The NASA Glenn Research Center in Brook Park, Ohio, for example, is a cornerstone of Ohio's fragile economy, and a stronghold of aeronautics research. In fiscal year 2003, spending at Glenn on contracts and grants generated over $430 million of earnings for Ohio households. And studies have shown that it has over a billion dollar impact on the economy of northeast Ohio. Civil aeronautics is also a major contributor to this sector's positive balance of trade, more than any other industry. Aeronautics contributes to a stronger economy by lowering the cost of transportation, enabling a new generation of service-based industries like e-commerce to flourish, and by performing the research that leads to inexpensive and reliable flights.

Safety has advanced considerably because of NASA's elimination of wind shear as a cause of airline accidents, their improved detection of corrosion and cracks, their anti-icing and deicing research, advanced air traffic management technology, and others. Again, much of that research came from NASA Glenn. Other contributions include noise reduction and emissions eliminations, both of which will be limiting factors to expansion of air traffic in the future.

Finally, NASA's aeronautics research is important, because NASA is able to develop long-term, high-risk enabling technologies that the private sector is unwilling to perform, because it is too risky or too expensive. In fact, this has historically been the role of government-sponsored research. This is true not only with aero-

nautics, but with pharmaceutical research, defense research, energy research, environmental research, and much more. When the government-sponsored basic research yields information that could lead to a service or product with profit potential, the private sector transitions from research to development in order to bring it to market. While it is not always as simple as this, it is clear that where there is no basic research, there can be no development. Where there is no basic research, there could be no development, and what is happening with this new policy is we are getting out of basic research in aeronautics.

Yet aeronautics research in NASA is being attacked from multiple angles. The most recent and most potentially devastating threats come from the fiscal year 2006 budget proposal, which would result in major losses of key aeronautics proposals. The greatest cuts would be felt at NASA Glenn and at NASA Langley in Virginia, and that is why I am here with Representative Davis, on behalf of aeronautics. If this dark vision is realized, we are going to be ceding aeronautic superiority to Europe. The effects are exacerbated by a recent shift in the market share for aeronautics to the Europeans. For example, Boeing is now doing testing in Europe. The European company Airbus is also fast becoming the leader in aircraft design with its new A380 being touted as the most advanced, spacious, and efficient airliner ever conceived. Think about that when you think about America's traditional role as a leader in aerospace, and you realize why it is absolutely wrong for anything that would deter from our mission in basic research in aeronautics.

We already stand to lose valuable personnel. NASA aeronautics jobs are good paying jobs that attract people to areas hosting a center, and keeping them there. But the recent proposed cuts would eliminate 700 NASA jobs from Glenn, 1,100 NASA jobs from Langley, and those two centers are the cornerstones of aeronautics research in the United States. An undetermined number of contractor jobs are at risk. It is important to understand that threats to job stability posed by funding losses will encourage the Nation's most talented scientists and engineers, who now work for the United States of America, to look elsewhere for work. And some have already started to do so.

I want to submit the rest of the testimony for the record.

Chairman CALVERT. Without objection.

Mr. KUCINICH. And ask that the Committee, if they have any questions, please feel free to ask.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Kucinich follows:]

PREPARED STATEMENT OF REPRESENTATIVE DENNIS J. KUCINICH

Thank you, Chairman Calvert and Ranking Member Udall, for the opportunity to testify about *The Future of Aeronautics at NASA*. Today, I will make the case that aeronautics research is essential to America's national security, quality of life, economy, safety and environment. NASA has played and should continue to play a crucial role in aeronautics. Yet it is at grave risk of being undermined as a result of current efforts to eliminate jobs, facilities and entire programs. We must not allow the erosion of aeronautics at NASA.

NASA's contributions in the field of aeronautics to the Nation and the world are profound. A good starting point is aeronautics' contribution to national security. From surveillance systems that monitor aircraft flight paths, to the development of

secure communication systems NASA's research has been instrumental in improving our national security. In addition, NASA's recent successful hypersonic flight, clocked at about 7,000 miles per hour, demonstrated that military or civilian aircraft might soon be able to fly anywhere in the world in less than two hours. Aeronautical vehicles are a substantial and key part of the national defense infrastructure.

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Safety has advanced considerably because of NASA's elimination of wind shear as a cause of airline accidents, their improved detection of corrosion and cracks, their anti-icing and deicing research, advanced air traffic management technology, and others. Again, much of that research came from NASA Glenn. Other contributions include noise reduction, and emissions eliminations, both of which will be limiting factors to expansion of air travel in the future.

Finally, NASA's aeronautics research is important because NASA is able to develop long-term, high-risk enabling technologies that the private sector is unwilling to perform because it is too risky or too expensive. In fact, this is historically been the role of government sponsored research. This is true not only with aeronautics but also with pharmaceutical research, defense research, energy research, environmental research and much more. When the government sponsored basic research yields information that could lead to a service or product with profit potential, the private sector transitions from research to development in order to bring it to market. While it is not always as simple as this, it is clear that where there is no basic research, there can be no development.

Yet aeronautics research in the National Aeronautics and Space Administration is being attacked from multiple angles. The most recent and most potentially devastating threats came in the form of the Administration's FY06 budget proposal, which would result in major losses of key aeronautics programs. The greatest cuts would be felt at NASA Glenn and at NASA Langley in Virginia. If the Administration's vision for the weakening of aeronautics at NASA is realized, we cede aeronautics superiority to Europe. The effects are exacerbated by a recent shift in the market share for aeronautics to the Europeans. For example, Boeing is now doing its testing in Europe. The European company Airbus is also fast becoming the leader in aircraft design with its new A380, being touted as the most advanced, spacious and efficient airliner ever conceived.

We already stand to lose valuable personnel. NASA aeronautics jobs are well paying jobs that attract people to areas hosting a center and keep them there. But the recent proposed cuts could eliminate 700 NASA jobs from Glenn and 1100 NASA jobs from Langley, the two cornerstones of aeronautics research. An undetermined number of contractor job are also at risk. It is important to understand that threats to job stability posed by funding losses will encourage the Nation's most talented scientists and engineers to look elsewhere for work. And some have already started to do so.

The Agency is also considering shutting down several unique and expensive facilities, without consideration of their income generation potential through enhanced use leasing. The world-class wind tunnels at NASA Glenn are a classic example. Allowing private and university researchers to use them could result in significant income, which would increase the efficient use of the facilities, and would contribute to more scientific output. The wind tunnels alone would require tens of millions of dollars to replace.

We must not allow our dominance in aeronautics to atrophy. Clearly, NASA's role has historically been critical and can continue to be critical to our country's prosperity if we have the foresight to make it so. Make no mistake; it will require a long-term effort. But it will be worthwhile. In the meantime, it will be imperative that we stop the anti-aeronautics cuts to the budget.

First, we need to immediately restore and strengthen funding for NASA aeronautics research that is an economic engine for aeronautics and aerospace industries. Secondly, we must examine creative approaches to funding like enhanced use leasing in all NASA facilities. Before deciding which facilities to mothball, NASA should take into account the increase in assets enhanced use leasing would bring. Third, the facilities that require renovation must be funded as such, since it is cheaper to upgrade than to rebuild the facilities.

Of course, there is much more that needs to be done. I hope this important dialogue continues and intensifies. The future of aeronautics, not just at NASA, but in America, is at stake.

Mr. Chairman, I would also like to submit the following resolutions from various governmental entities as part of my testimony.

P/C
CA prior to 2/15/05
1st R 2/15/05
2nd R
3rd R
B/C

CITY OF BROOK PARK, OHIO

Resolution No. 3-2005

Introduced By: COUNCIL AS A WHOLE AND MAYOR ELLIOTT

A RESOLUTION
OPPOSING PRESIDENT BUSH'S
PROPOSED JOB CUTS AT NASA, AND
DECLARING AN EMERGENCY

WHEREAS, President Bush's proposed priorities, moving away from aeronautics and concentrating on space exploration, would negatively impact the NASA Glenn Research Center due to our historic specialties; and

WHEREAS, the President has proposed priorities, downplaying basic research and development, will result in our giving away the United States' historical dominance in aerospace; and

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS, many outstanding, highly educated and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutes would be stripped of education opportunities, grant funding and outlets for their graduating students; and

WHEREAS, the economic impact on the cities of Brook Park, Fairview Park and Cleveland, as well as cities throughout Northeast Ohio, would negatively affect our residents' quality of life; and

WHEREAS, the trickle down effect would impact businesses which interact with NASA locally, regionally and nationally; and

WHEREAS, Ohio must continue to demonstrate the vision, will and leadership to support NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW THEREFORE BE IT RESOLVED, by the Council of the City of Brook Park, State of Ohio that:

SECTION 1: That the City of Brook Park does hereby urge Ohio's Congressional Delegation to oppose President Bush's proposed job cuts at NASA Glenn Research Center and further take the necessary action to support Representative Dennis Kucinich and the Mayors and Managers Association's Coalition against job cuts at NASA.

SECTION 2: The Clerk of Council is hereby directed to forward certified copies of this Resolution immediately upon passage and approval to the President of the United States, NASA's Administrator, Glenn Research Center's Director, and each of the

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elected Senators and Congressmen in the State of Ohio, as well as all members of the Mayors and Managers Association of Cuyahoga County.

SECTION 3: It is found and determined that all formal actions of this Council concerning and relating to this Resolution were adopted in an open meeting of this Council, and that all deliberations of this Council and of any of its committees that resulted in such formal actions were in meetings open to the public in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

SECTION 4: This Resolution is hereby declared to be an emergency measure immediately necessary for the preservation of the public peace, health, safety and welfare of said City, and for the further reason so that it may be transmitted to the government officials mentioned above to make them aware of our concerns over NASA Glenn Research Center and its apparent continued downsizing; therefore, this Resolution shall take effect and be in force immediately from and after its passage and approval by the Mayor.

PASSED: February 15, 2005

PRESIDENT OF COUNCIL

ATTEST: Clerk of Council

APPROVED: MAYOR

2/16/05
DATE

CERTIFICATE

Roseann Armstrong, Clerk of Council, of The City of Brook Park, Ohio, do hereby certify that the foregoing is a true and accurate copy of Ordinance/Resolution No. 9-2005 passed on the 15 day of February 2005 by said council.

ROSEANN ARMSTRONG
Clerk of Council

I, Roseann Armstrong, Clerk of the City of Brook Park, State of Ohio, do hereby certify that there is no newspaper of general circulation in the municipality and that publication of the foregoing ordinances/resolutions was made by posting true copies thereof in six of the most public places in said municipality as determined by ordinance 4838-1975, passed on August 12, 1975, location City Hall, 6161 Engle Road Police Station, 17401 Holland Road, 01 Fire Station, 5550 Smith Road, #2 Fire Station, 22530 Ruple Road, #3 Fire Station, 17401 Holland Road, Brook Park Library, 6155 Engle Road, for a period of fifteen days.

commencing February 16, 2005

ROSEANN ARMSTRONG
Clerk of Council

CITY OF FAIRVIEW PARK
RESOLUTION NO. 05- 01

REQUESTED BY: MAYOR EILEEN ANN PATTON
SPONSORED BY: COUNCILMAN GAUTHIER
COSPONSORED BY: COUNCIL MEMBERS ROBATIN, MINEK, WESTFALL, THOMAS, SWEENEY, AND COUNCIL PRESIDENT BRINGMAN

A RESOLUTION OPPOSING PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA

WHEREAS, President George W. Bush's proposed priorities, moving away from aeronautics and focusing on space exploration, would negatively impact the NASA Glenn Research Center due to its historic specialties; and

WHEREAS, the President has proposed priorities, downplaying basic research and development, which will result in relinquishing the historical dominance of the United States in aerospace; and

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS, many outstanding, highly educated, and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutions would be stripped of education opportunities, grant funding, and sources of employment for their graduating students; and

WHEREAS, the economic impact on the cities of Cuyahoga County, as well as cities throughout northeast Ohio, would negatively affect the quality of life of our residents; and

WHEREAS, the trickle-down effect would impact businesses which interact with NASA locally, regionally and nationally; and

WHEREAS, Ohio must continue to demonstrate the vision, will, and leadership to support the NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF FAIRVIEW PARK, COUNTY OF CUYAHOGA, AND STATE OF OHIO:

SECTION 1. That the Council of the City of Fairview Park does hereby urge Ohio's Members of Congress, U.S. Senators, and Governor to oppose President Bush's job cuts at the NASA Glenn Research Center, to further take the necessary action to strike such language in the fiscal year 2006 budget moving through Congress, and to support the efforts of Congressman Dennis Kucinich via the 10th District NASA Summit, as well as the efforts of the entire Ohio Congressional Delegation in both the House and Senate.

RESOLUTION NO. 05- 01
PAGE 2

SECTION 2. That the Clerk of Council is hereby directed to forward this Resolution immediately upon passage and approval to the President of the United States, NASA's Administrator, the Glenn Research Center's Director, both U.S. Senators representing the State of Ohio, each o the Members of Congress representing districts in the State of Ohio, the Governor of Ohio, each of the members of the Ohio General Assembly, all mayors or trustees of municipalities in Cuyahoga County, and all clerks or presidents of city councils in Cuyahoga County.

SECTION 3. It is found and determined that all formal actions of this council concerning and relating to the adoption of this resolution were adopted in an open meeting of this council, and that all deliberations of this council and any of its committees that resulted in such formal action were in meetings open to the public in compliance with all legal requirements.

SECTION 4. That this Resolution shall take effect and be in force immediately from and after its passage.

PASSED: 2-22-05
APPROVED: 2-23-05

Norman A. Bringman, President of Council

Eileen Ann Patton, Mayor

Traci L. Waldron, Clerk of Council

1st read: 2-22-05
2nd read: Suspended
3rd read: Suspended

TRACI L. WALDRON, CLERK OF THE COUNCIL OF THE CITY OF FAIRVIEW PARK, OHIO, DOES HEREBY CERTIFY THAT THE ABOVE IS A TRUE COPY OF RESOLUTION ORDINANCE NO. 05-01 AT A MEETING OF THE COUNCIL OF THE CITY OF FAIRVIEW PARK, HELD 2-22-05

CLERK OF THE COUNCIL

RESOLUTION

Urging the United States Congress to support the NASA Glenn Research Center budget preserving local jobs and recognizing their contributions to civil aeronautics and its importance for commercial and military applications.

WHEREAS, the NASA Glenn Research Center employs over 1,900 fulltime employees.

WHEREAS, the NASA Glenn Research Center provides aeronautics research that aircraft companies cannot fund, due to cost and risk; local expertise helps design safer, quieter, higher-powered and more fuel-efficient aircraft for commercial and military applications.

WHEREAS, the NASA Glenn Research Center also designs scientific experiments for the orbiting space station, including experiments for producing new drugs, increasing automobile gas mileage and reducing pollution.

WHEREAS, the European Union is proposing a $100 billion public-private partnership to make its aeronautic industry the world leader by 2020, further jeopardizing jobs in the United States.

WHEREAS, proposed changes to the International Space Station budget will negatively impact research at our local universities by reducing the size of the facility and the learning and employment opportunities for students.

NOW, THEREFORE, BE IT RESOLVED that the Board of Commissioners of Cuyahoga County, Ohio, urges the United States Congress to consider additional funding for the International Space Station and aeronautics and to provide adequate budget support for the NASA Glenn Research Center so as to preserve existing personnel levels.

BE IT FURTHER RESOLVED that the Clerk of the Board be, and she is, hereby instructed to transmit a copy of this resolution to President George W. Bush, U.S. Senators from Ohio Michael DeWine and George Voinovich, Subcommittee Chair Christopher Bond, U.S. Representatives Sherrod Brown, Stephanie Tubbs-Jones, Dennis Kucinich and Steven C. LaTourette, and County Commissioners Association of Ohio Executive Director, Larry Long and Paul Oyaski, Director, Department of Development.

On Motion of Commissioner Jones, seconded by Commissioner Dimora, the foregoing resolution was duly adopted.

Ayes: Jones, Dimora, Hagan.

Nays: None.

Resolution Adopted.

Penelope M. Hughes,
Clerk of the Board

Journal 285
February 17, 2005
050705
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RESOLUTION NO: 7968-05 BY: Corrigan, Dever, Dunn, FitzGerald, Madigan, Seelig.

A RESOLUTION opposing President Bush's proposed job cuts at NASA that would negatively impact the Glenn Research Center as well as cities throughout northeast Ohio.

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and,

WHEREAS, many outstanding, highly educated and extremely talented scientist and engineers would lose their jobs and be forced to relocate from our region; and,

WHEREAS, our academic institutes would be stripped of education opportunities, grant funding and outlets for their graduating students; and,

WHEREAS, the economic impact on the cities of Lakewood, Brook Park, Fairview Park and Cleveland, as well as cities throughout northeast Ohio, would negatively affect our residents' quality of life; and,

WHEREAS, an estimated 40 Lakewood residents are current employees at NASA, and an estimated 25 Lakewood residents are employed by contractors at NASA Glenn, all of these positions may be affected by these cuts; and,

WHEREAS, the trickle down effect would impact businesses which interact with NASA locally, regionally and nationally; and,

WHEREAS, Ohio must continue to demonstrate the vision, will and leadership to support NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration. Now therefore;

BE IT RESOLVED, BY THE CITY OF LAKEWOOD, STATE OF OHIO

Section 1 That the City of Lakewood does hereby urge Ohio's Congressional Delegation to oppose President Bush's proposed job cuts at NASA Glenn Research Center and further take the necessary action to support Representative Dennis Kucinich and the Mayors and Managers Association's Coalition against job cuts at NASA.

Section 2. The Clerk of Council is hereby directed to forward certified copies of this Resolution immediately upon passage and approval to the President of the United States, NASA's Administrator, Glenn Research Center's Director, and each of the elected Senators and Congressmen in the State of Ohio, as well as all members of the Mayors and Managers Association of Cuyahoga County.

Section 3 It is found and determined that all formal actions of this Council concerning and relating to this Resolution were adopted in an open meeting of this Council, and that all deliberations of this Council and of any of its committees that resulted in such formal actions were in meetings open to the public in compliance with all legal requirements.

Adopted: February 7th, 2005

President

Clerk

Approved: Dec 23, 2005

Mayor

CITY OF STRONGSVILLE, OHIO

RESOLUTION NO. 2005 – 42

By: Mayor Perciak and All Members of Council

A RESOLUTION OPPOSING THE REDUCTION IN FEDERAL FUNDS AVAILABLE TO SUPPORT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S JOHN GLENN RESEARCH CENTER IN THE CLEVELAND AREA.

WHEREAS, the Federal Government recently announced the reduction of some $88 Million Dollars in federal funding to the National Aeronautics and Space Administration (NASA) facility in the Cleveland, Ohio area, known as the John Glenn Research Center; and

WHEREAS, it is estimated that such substantial reductions will result in the loss of a number of jobs held by residents of the City of Strongsville; and

WHEREAS, such reductions will otherwise have a negative economic impact on the City of Strongsville and upon the entire region;

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF STRONGSVILLE, COUNTY OF CUYAHOGA, AND STATE OF OHIO:

Section 1. That this Council makes known its strong opposition to the Federal Government's substantial reduction in funding to NASA here in the Cleveland area, and urges the President and Congress to restore these funds on an immediate basis.

Section 2. That the Clerk of Council be, and she hereby is, directed to forward copies of this legislation to U.S. Senators Mike DeWine and George Voinovich, and to U.S. Congressmen Sherrod Brown, Dennis Kucinich, and Steve LaTourette.

Section 3. That it is found and determined that all formal actions of this Council concerning and relating to the adoption of this Resolution were adopted in an open meeting of this Council; and that all deliberations of the Council, and of any of its committees, that resulted in such formal actions were in meetings open to the public, in compliance with all legal requirements.

Section 4. That this Resolution shall take effect and be in force immediately upon its passage and approval by the Mayor.

CITY OF STRONGSVILLE, OHIO
RESOLUTION NO. 2005- 42
Page 2

Raymond L. Hasley Approved: Thomas R. Burns
President of Council Mayor

Date Passed: February 22, 2005 Date Approved: Feb. 23, 2005

Attest: Leslie A. Seefried
Clerk of Council

Res. ORD. No. 2005-42 Removed: _____
1st Rdg. 2/22/05 Ref: _____
2nd Rdg. Suspended Ref: _____
3rd Rdg. Suspended Rec'd: _____

Pub Hrg. _____ Ref: _____
Adopted: 2/22/05 Defeated: _____

CERTIFICATE OF POSTING

Clerk of Council of the City of Strongsville, Ohio, do hereby certify that Ordinance/Resolution No. 2005-42 was duly posted on 2-25-05, and remained posted for a period of fifteen days thereafter, in not less than five of the most public places in the city as determined by the Council of said City.

Leslie A. Seefried
Clerk of Council

Dated: 2/25/05

CITY OF WESTLAKE, OHIO
RESOLUTION NO. 2005-26

A RESOLUTION OPPOSING PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA.

WHEREAS, President Bush's proposed priorities, moving away from aeronautics and focusing on space exploration, would negatively impact the NASA Glenn Research Center due to its historic specialties; and

WHEREAS, the President has proposed priorities, downplaying basic research and development, which will result in relinquishing the historical dominance of the United States in aerospace; and

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contracts; and

WHEREAS, many outstanding, highly educated, and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutions would be stripped of educational opportunities, grant funding, and sources of employment for their graduating students; and

WHEREAS, the economic impact on the cities of Cuyahoga County, as well as cities throughout northeast Ohio, would negatively affect the quality of life of our residents; and

WHEREAS, the trickle-down effect would impact businesses which interact with NASA locally, regionally, and nationally; and

WHEREAS, Ohio must continue to demonstrate the vision, will, and leadership to support the NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF WESTLAKE, COUNTY OF CUYAHOGA AND STATE OF OHIO:

Section 1: That the Mayor and the Council of the City of Westlake urge Ohio's Members of Congress, U.S. Senators, and Governor to oppose President Bush's proposed job cuts at the NASA Glenn Research Center, to further take the necessary action to strike such language in the fiscal year of 2006 budget moving through Congress, and to support the efforts of Representative Dennis Kucinich via the 10th District NASA Summit, as well as the efforts of the entire Ohio Congressional Delegation in both the House and Senate.

Section 2: That the Clerk of Council be and she is hereby directed to forward this Resolution immediately upon passage and approval to the President of the United States,

CITY OF WESTLAKE, OHIO
RESOLUTION NO. 2005-26
PAGE 2

NASA's Administrator, the Glenn Research Center's Director, our U.S. Senator and Congress person, the Governor of Ohio, and our Ohio General Assembly Representative.

Section 3: That it is found and determined that all formal actions of this Council concerning and relating to this legislation were adopted in an open meeting of this Council and that all deliberations of this Council and of any of its committees that resulted in such formal action were in meetings open to the public in compliance with all legal requirements including Section 10, Article XI of the Charter of the City of Westlake.

Section 4: This Resolution shall take effect and be in force immediately from and after its passage.

Passed: 3/3/05

Michael F. Killeen
President of Council

Presented to Mayor: 3/4/05

Approved: 3/4/05

ATTEST:

Susan Prehoda, Clerk of Council

Dennis M. Clough, Mayor

2/22/05 L-38-05 vaz

RESOLUTION NO. 54-05

BY: MARY GALINAS, ANTHONY C. ZIELINSKI, MICHELLE J. STYS, LARRY NAPOLI, SEAN BRENNAN, STUART J. BOYDA, BRIAN DAY, ROY J. JECH

A RESOLUTION URGING THE PRESIDENT TO RECONSIDER THE REMOVAL OF 700 JOBS FROM NASA GLENN RESEARCH CENTER AND CUTTING BACK THE NASA PROGRAMS, AND DECLARING AN EMERGENCY

WHEREAS, NASA Glenn Research Center is one of the largest employers in Northeast Ohio; and,

WHEREAS, under the proposed budget proposal, the Glenn Research Center is set to eliminate more than a third of its work force and aircraft research programs by October, 2006; and,

WHEREAS, the economic impact of these cuts in the Northeast Ohio region will be devastating;

NOW, THEREFORE; BE IT RESOLVED BY THE COUNCIL OF THE CITY OF PARMA, STATE OF OHIO:

Section 1. That this Council hereby urges the President to reconsider the removal of 700 jobs from NASA Glenn Research Center and cutting back the NASA programs.

Section 2. That the Clerk of Council be, and he hereby is, directed to forward a certified copy of this Resolution to President George Bush; Senators Mike DeWine and George Voinovich, and Congressmen Steve Latourette, Dennis Kucinich and Sherrod Brown.

Section 3. That it is found and determined that all formal actions of this Council concerning and relating to the adoption of this Resolution were adopted in an open meeting of this Council, and that all deliberations of this Council and any of its committees that resulted in such formal action were in meetings open to the public in compliance with all legal requirements.

Section 4. That this Resolution is hereby declared to be an emergency measure necessary for the immediate preservation of the public health, safety and welfare of the City of Parma, and for the further reason that this measure is necessary due to upcoming discussions on this issue, and this Resolution shall become immediately effective upon receiving the affirmative vote of two-thirds of all members elected to Council and approval of the Mayor, otherwise from and after the earliest period allowed by law.

PASSED: February 22, 2005

/s/ Charles M. Germana
PRESIDENT OF COUNCIL

ATTEST: /s/ Michael F. Hughes
CLERK OF COUNCIL

APPROVED: February 23, 2005

FILED WITH THE MAYOR: February 23, 2005

/s/ Dean E. DeFiero
MAYOR, CITY OF PARMA, OHIO

CITY OF BROOKLYN, OHIO
RESOLUTION NO. 2005 – 1
INTRODUCED BY: Mayor Patton, Pucci, Baldwin, Gallagher, G. Frey, Coyne, J. Frey, Balsiger

TO JOIN IN SUPPORT OF THE CUYAHOGA COUNTY COMMISSIONERS, CONGRESSMAN DENNIS KUCINICH, STATE REP. TIM DEGEETER, SENATOR DAN BRADY, AND OTHERS IN REGARD TO SAVING JOBS AT NASA GLENN RESEARCH CENTER

WHEREAS, America has always been a country that prided itself on being first at achieving scientific breakthroughs; and

WHEREAS, America wishes to continue being a leader in all scientific fields, including, but not limited to aviation and space exploration; and

WHEREAS, President Bush's proposed priorities, moving away from aeronautics and concentrating on space exploration, would negatively impact the NASA Glenn Research Center due to our historic specialties; and

WHEREAS, the President has proposed priorities, downplaying basic research and development, which will result in our giving away the United States' historical dominance in aerospace; and

WHEREAS, many outstanding, highly educated and extremely exalted scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutes would be stripped of education opportunities, grant funding and outlets for their graduating students; and

WHEREAS, the City of Brooklyn recognizes the tangible and intangible benefits that approximately 1,900 technologically gifted people have contributed and should continue to contribute to Northern Ohio, all of Ohio, the United States, and the entire world; and

WHEREAS, the loss of these jobs would have an immediate negative effect on the economy of Northeast Ohio; and

WHEREAS, Ohio must continue to demonstrate the vision, will and leadership to support NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF BROOKLYN, COUNTY OF CUYAHOGA AND STATE OF OHIO:

SECTION 1. That this Council requests that any person in power should take all legal and equitable steps to ensure that NASA Glenn Research Center continues to perform at the standard and level that it has been operating at.

SECTION 2. This Council further requests every person in power should take all legal and equitable steps to ensure an adequate budget so that NASA Glenn Research Center is allocated the proper funds.

SECTION 3. That the Clerk of Council is hereby authorized and directed to forward a copy of this Resolution to the President of the United States, NASA's Administrator, Glenn Research Center's Director, each of the Senators and Congressmen in the State of Ohio, and all members of the Mayors and Managers Association of Cuyahoga County.

SECTION 4. That the Mayor and Brooklyn City Council thank the Cuyahoga County Commissioners, Congressman Dennis Kucinich, Representative Tim DeGeeter, Senator Dan Brady and the mayors and officials of Northern Ohio for their bi-partisan and continuing efforts regarding this important matter.

SECTION 5. That this Resolution is hereby declared an emergency measure necessary for the preservation of the public peace, health and safety; and for the further reason in order to make the federal government officials aware in a timely manner of the concerns of the City of Brooklyn pertaining to the proposed cuts to NASA Glenn Research Center, which will negatively impact Northeast Ohio, and provided it receives the affirmative vote of two-thirds (2/3) of all members elected to Council, it shall take effect and be in force immediately upon its passage and approval by the Mayor, otherwise it shall take effect and be in force from and after the earliest date allowed by law.

ADOPTED: 3/14/05

ATTESTED:

CLERK OF COUNCIL

APPROVED:

MAYOR

Filed with the Mayor: 3/15/05

CITY OF NORTH OLMSTED
RESOLUTION NO. 2005-20

BY: Council Member Miller

A RESOLUTION OPPOSING PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA, AND DECLARING AN EMERGENCY.

WHEREAS, President Bush's proposed priorities, moving away from aeronautics and concentrating on space exploration, would negatively impact the NASA Glenn Research Center due to our historic specialties; and

WHEREAS, the President's proposed priorities, downplaying basic research and development, will result in our giving away the United States' historical dominance in aerospace; and

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS, many outstanding, highly educated and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutes would be stripped of education opportunities, grant funding and outlets for their graduating students; and

WHEREAS, approximately 157 employees from the City of North Olmsted, about 8% of NASA Glenn Research Center, would lose their jobs reflecting in excess of $13 million in salary; and

WHEREAS, the economic impact on the cities of Brook Park, Fairview Park, Cleveland, and North Olmsted, would negatively affect our residents' quality of life; and

WHEREAS, the trickle down effect would impact businesses which interact with NASA locally, regionally and nationally; and

WHEREAS, Ohio must continue to demonstrate the vision, will and leadership to support NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF NORTH OLMSTED, CUYAHOGA COUNTY, AND STATE OF OHIO:

Resolution No. 2005-20
Page 2

SECTION 1: That the Mayor and Council of the City of North Olmsted hereby urge Ohio's Congressional delegation to oppose President Bush's proposed job cuts at NASA Glenn Research Center and further take the necessary action to support Representative Dennis Kucinich and the Mayors and Managers Association's Coalition against job cuts at NASA.

SECTION 2: That the Clerk of Council be, and hereby is, directed to forward a fully attested copy of this Resolution upon passage and approval to the President of the United States, NASA's Administrator, Glenn Research Center's Director, and each of the elected Senators and Congressmen in the State of Ohio, as well as all members of the Mayors and Managers Association of Cuyahoga County.

SECTION 3: That this Ordinance is hereby declared to be an emergency measure immediately necessary for the preservation of the public health, safety and welfare, and for the further reason that it is necessary for this Ordinance to go into effect immediately so it may be transmitted to the government officials mentioned above to make them aware of our concerns over NASA Glenn Research Center and its apparent continued downsizing, and further provided it receives the affirmative vote of two-thirds of all members of Council, it shall take effect and be in force upon its passage and approval by the Mayor.

PASSED: March 1, 2005

First Reading: 3/1/05
Second Reading: Suspended
Third Reading: Suspended
Committee: Suspended

ATTTEST:

BARBARA L. SEMAN
Clerk of Council

THOMAS E. O'GRADY
President of Council

APPROVED: 3/3/05

MAYOR NORMAN T. MUSIAL

APPROVED AS TO LEGAL FORM

/s/James M. Dubelko
JAMES M. DUBELKO
Director of Law

RESOLUTION NO. 05-13
INTRODUCED BY: Reese

A RESOLUTION

OPPOSING PROPOSED BUDGET CUTS AT NASA GLENN RESEARCH CENTER, AND DECLARING AN EMERGENCY.

WHEREAS, President Bush's focus and priorities include moving away from aeronautics and concentrating on space exploration; and

WHEREAS, the Bush Administration's proposed Fiscal Year 2006 budget would reduce NASA Glenn Research Center's 2,800 workers by over a third, eliminating 700 civil service positions and 390 contractors; and

WHEREAS, many outstanding, highly educated and extremely talented scientists and engineers, some of whom are Bay Village residents, would lose their jobs and be forced to relocate from our region, and local universities would likely lose research and grant opportunities and potential local employment for their graduates; and

WHEREAS, a Cleveland State University economic impact study showed that in the late 1990's the Glenn Research Center's total employment impact in Northeast Ohio included almost 9,400 jobs and total earnings impact was $315 million; and

WHEREAS, for a number of years the entire Cleveland metro area has experienced significant job losses, particularly in basic industry, and the region's local governments and private sector have undertaken substantial efforts to retain existing jobs and to attract new employers that represent knowledge-based sectors of the economy; and

WHEREAS, jobs at the Glenn Research Center and its associated suppliers have represented one of the remaining positive economic images for the entire region, but that image is seriously jeopardized by losses of this magnitude; and

WHEREAS, the Glenn Research Center's prominence and long history of successful projects make it the best choice for the home of NASA's new administrative Shared Services Center, and adding this designation there without reducing Glenn's technical research center budget would add to our region's economy and opportunities for professional employment;

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Bay Village Ohio:

SECTION 1. That this Council hereby states its opposition to President Bush's proposed budget cuts for the NASA Glenn Research Center which would result in subsequent job losses, and urge Ohio's Congressional Delegation to work toward the stabilizing of essential national technical resources such as the NASA Glenn Research Center.

SECTION 2. That this Council hereby urges the National Aeronautics and Space Administration to select Brook Park as the home for NASA's planned Shared Services Center.

SECTION 3. The Clark of Council is hereby directed to foward certified copies of this resolution immediately upon passage and approval by the Mayor to President George W. Bush, NASA's Administrator, Glenn Research Center's Director, Ohio's U. S. Senators, and Northeast Ohio's delegation to the U. S. House of Representatives.

SECTION 4. That this Council finds and determines that all formal actions of this Council concerning and relating to the passage of this resolution were taken in an open meeting of this Council; and that all deliberations of this Council, and of any committees, that resulted in those formal actions were in meetings open to the public in compliance with law.

SECTION 5. That this resolution is hereby declared to be an emergency measure immediately necessary for the preservation of the public peace, health, property and safety, and for the further reason that this information is forwarded to decision makers in a timely manner, wherefore this resolution shall be in full force and take effect immediately upon its passage and approval by the Mayor.

PASSED: March 7, 2005

/s/ T. Richard Martin
PRESIDENT OF COUNCIL

/s/ Joan T. Kemper
CLERK OF COUNCIL

APPROVED: March 8, 2005

/s/ Deborah L. Sutherland
MAYOR

hh

3/5/05

Cuyahoga County Mayors and City Managers Association

24 February 2005

Resolution No. _____

Introduced By:

Mayor Mark Elliott, City of Brook Park
Mayor Jane Campbell, City of Cleveland
Mayor Eileen Patton, City of Fairview Park
Mayor William Knoble, City of Rocky River
Mayor Thomas George, City of Lakewood
Mayor Kenneth Patton, City of Brooklyn

A RESOLUTION OPPOSING PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA

WHEREAS, President Bush's proposed priorities, moving away from aeronautics and focusing on space exploration, would negatively impact the NASA Glenn Research Center due to its historic specialties; and

WHEREAS, the President has proposed priorities, downplaying basic research and development, which will result in relinquishing the historical dominance of the United States in aerospace; and

WHEREAS, President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS, many outstanding, highly educated, and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS, our academic institutions would be stripped of education opportunities, grant funding, and sources of employment for their graduating students; and

WHEREAS, the economic impact on the cities of Cuyahoga County,

as well as cities throughout northeast Ohio, would negatively affect the quality of life of our residents; and

WHEREAS, the trickle-down effect would impact businesses which interact with NASA locally, regionally, and nationally; and

WHEREAS, Ohio must continue to demonstrate the vision, will, and leadership to support the NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW, THEREFORE, BE IT RESOLVED, that:

SECTION 1: The Mayors and City Managers Association of Cuyahoga County of Ohio does hereby urge Ohio's Members of Congress, U.S. Senators, and Governor to oppose President Bush's proposed job cuts at the NASA Glenn Research Center, to further take the necessary action to strike such language in the fiscal year 2006 budget moving through Congress, and to support the efforts of Representative Dennis Kucinich via the 10th District NASA Summit, as well as the efforts of the entire Ohio Congressional Delegation in both the House and Senate.

SECTION 2: The Executive Director of the Cuyahoga County Mayors and City Managers Association is hereby directed to forward this Resolution immediately upon passage and approval to the President of the United States, NASA's Administrator, the Glenn Research Center's Director, both U.S. Senators representing the State of Ohio, each of the Members of Congress representing districts in the State of Ohio, the Governor of Ohio, each of the members of the Ohio General Assembly, all mayors or trustees of municipalities in Cuyahoga County, and all clerks or presidents of city councils in Cuyahoga County.

SECTION 3: It is found and determined that all formal actions and deliberations of this Association concerning and relating to this Resolution were adopted in a meeting open to the public.

SECTION 4: This Resolution shall take effect and be in force immediately from and after its passage.

PASSED: Unanimous DATE: 2/24/05

President

Mayor Thomas Longo,
City of Garfield Heights

Executive Director

Lisa Barno
Cuyahoga County Mayors and City
Managers Association

CITY OF BRUNSWICK, OHIO

RESOLUTION NUMBER 38-05

By: Committee-of-the-Whole

AN EMERGENCY RESOLUTION OPPOSING PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA

WHEREAS: President Bush's proposed priorities, moving away from aeronautics and focusing on space exploration, would negatively impact the NASA Glenn Research Center due to its historic specialties; and

WHEREAS: The President has proposed priorities, downplaying basic research and development, which will result in relinquishing the historical dominance of the United States in aerospace; and

WHEREAS: President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS: Many outstanding, highly educated, and extremely talented scientists and engineers would lose their jobs and be forced to relocate from our region; and

WHEREAS: Our academic institutions would be stripped of education opportunities, grant funding, and sources of employment for their graduating students; and

WHEREAS: The economic impact on the cities throughout northeast Ohio would negatively affect the quality of life of our residents and the trickle-down effect would impact businesses which interact with NASA locally, regionally, and nationally; and

WHEREAS: Ohio must continue to demonstrate the vision, will, and leadership to support the NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center whereby targeting the goals for space exploration.

THE COUNCIL OF THE CITY OF BRUNSWICK HEREBY RESOLVES:

CITY OF BRUNSWICK, OHIO

RESOLUTION NUMBER 38-05

SECTION 1: That Council of the City of Brunswick does hereby urge Ohio's Members of Congress, U.S. Senators, and Governor to oppose President Bush's proposed job cuts at the NASA Glenn Research Center, to further take the necessary action to strike such language in the fiscal year 2006 budget moving through Congress, and to support the efforts of Representative Dennis Kucinich via the 10th District NASA Summit, as well as the efforts of the entire Ohio Congressional Delegation in both the House and Senate.

SECTION 2: The Council Clerk of the City of Brunswick is hereby directed to forward this Resolution immediately upon passage and approval to the President of the United States, NASA's Administrator, the Glenn Research Center's Director, both U.S. Senators representing the State of Ohio, each of the Members of Congress representing districts in the State of Ohio, the Governor of Ohio, each of the members of the Ohio General Assembly, all mayors or trustees of municipalities in Cuyahoga County, and all clerks or presidents of city councils in Cuyahoga County.

SECTION 3: That this Resolution is hereby declared to be an emergency measure necessary for the immediate preservation of the public peace, property, health, safety or welfare, and to provide for the usual daily operation of a municipality and for the additional reason that these job cuts would negatively impact the local economy. Therefore the same shall be in full force and effect from and after its passage by the required number of votes or from the earliest time allowed by law.

PASSED:	1st Reading February 28, 2005				
	Rules Suspended:	AYES	7	NAYS	0
ADOPTED:	February 28, 2005	AYES	7	NAYS	0

ATTEST: Barbara J. Ortiz CMC
Clerk of Council
Barbara J. Ortiz, CMC

C OF C 128-174 Passed 21-0 3/1/05

Resolution No.305-05

Council Members Sweeney, Gordon, Jackson, Cintron.

AN EMERGENCY RESOLUTION
Urging the United States Congress to consider additional funding and adequate budget to support the NASA Glenn Research Center so as to preserve it research capacity and personnel levels

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WHEREAS, the NASA Glenn Research Center employs over 3,300 fulltime employees; and

WHEREAS, the NASA Glenn Research Center provides valuable research in space power and propulsion; and

WHEREAS, the NASA Glenn Research Center provides aeronautics research that aircraft companies cannot fund, due to the cost and risk; and

WHEREAS, local expertise helps design safer, quieter, higher-powered and more fuel efficient aircraft for commercial and military applications; and

WHEREAS, the Glenn Research Center also designs scientific experiments for the orbiting space station, including experiments for producing new drugs, increasing automobile gas mileage and reducing pollution; and

WHEREAS, the European Union is proposing a $100 billion public-private partnership to make its aeronautic industry the world leader by 2020, further jeopardizing jobs in the United States; and

WHEREAS, proposed changes to the NASA Glenn Research Center budget will negatively impact research at our local universities by reducing the size of the facility and the learning and employment opportunities for students ; and

WHEREAS, the proposed changes to the NASA Glenn Research budget will cause the loss of approximately 1,100 civil and private sector jobs; and

WHEREAS, this resolution constitutes an emergency measure for the immediate preservation of public peace, property, health or safety, now, therefore,

BE IT RESOLVED BY THE COUNCIL OF THE CITY OF CLEVELAND:

Section 1. Urging the United States Congress to consider addition funding and adequate budget to support the NASA Glenn Research Center so as to preserve it research capacity and personnel levels

Section 2. That the Clerk of Council is hereby directed to transmit copies of this resolution to President George W. Bush, U.S. Senator Michael DeWine, U.S. Senator George Voinovich, Subcommittee Chair Christopher Bond, U.S. Representatives Sherrod Brown, Stephanie Tubbs-Jones, Dennis Kucinich and Steven C. LaTourette, and Governor Robert Taft.

Section 3. That this resolution is hereby declared to be an emergency measure and, provided it receives the affirmative vote of two-thirds of all the members elected to Council, it shall take effect and be in force immediately upon its adoption and approval by the Mayor; otherwise it shall take effect and be in force from and after the earliest period allowed by law.

RESOLUTION NO. 27-05

SECOND READING: _____
THIRD READING: _____

BY: MAYOR WILLIAM F. KNOBLE,
LAW DIRECTOR DAVID J. MATTY AND ALL MEMBERS OF COUNCIL

A RESOLUTION OPPOSING
PRESIDENT BUSH'S PROPOSED JOB CUTS AT NASA

WHEREAS: President Bush's proposed priorities, moving away from aeronautics and focusing on space exploration, would negatively impact the NASA Glenn Research Center due to its historic specialties; and

WHEREAS: the President has proposed priorities, downplaying basic research and development, which will result in relinquishing the historical dominance of the United States in aerospace; and

WHEREAS: President Bush's proposed budget would strip almost one-fifth of NASA Glenn's income, from $637 million to $519 million, eliminate over 700 civil service jobs and more than 440 contractors; and

WHEREAS: many of the approximately forty Rocky River residents who are employed at NASA are among the highly educated and extremely talented scientists and engineers who may lose their jobs and be forced to relocate from our region; and

WHEREAS: our academic institutions would be stripped of education opportunities, grant funding, and sources of employment for their graduating students; and

WHEREAS: the economic impact on the cities of Cuyahoga County as well as cities throughout northeast Ohio, would negatively affect the quality of life of our residents; and

WHEREAS: the trickle-down effect would impact businesses which interact with NASA locally, regionally and nationally; and

WHEREAS: Ohio must continue to demonstrate the vision, will, and leadership to support the NASA Glenn Research Center and urge President Bush to continue future aeronautics at the Center, whereby targeting the goals for space exploration.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF ROCKY RIVER, COUNTY OF CUYAHOGA, STATE OF OHIO:

Section 1. That the Council and the Administration of the City of Rocky River do hereby urge Ohio's Members of Congress, U.S. Senators and Governor to oppose President Bush's proposed job cuts at the NASA Glenn Research Center, to further take the necessary action to strike such language in the fiscal year 2006 budget moving through Congress, and to support the efforts of Representative Dennis Kucinich via the 10th District NASA Summit, as well as the efforts of the entire Ohio Congressional Delegation in both the House and Senate.

Section 2. That the Clerk of Council of the City of Rocky River is hereby directed to forward this Resolution immediately, upon passage and approval, to the President of the United States, NASA's Administrator, the Glenn Research Center's Director, both U.S. Senators representing the State of Ohio, each of the Members of Congress representing districts in the State of Ohio and the Governor of Ohio.

Section 3. That it is found and determined that all formal actions and deliberations of this Council concerning and relating to this Resolution were adopted in a meeting open to the public.

Section 4. That this Resolution shall take effect and be in force immediately from and after its passage.

PASSED: February 28, 2005

PAMELA E. BOBST
President of Council

PRESENTED TO MAYOR: Feb 28, 2005

APPROVED: February 28, 2005

MISAO KUROKAWA, Clerk of Council

WILLIAM F. KNOBBE, Mayor

LINDA BARTOLOZZI — At Large

ROBERT S. FROST — Ward 1

PAMELA E. BOBST — At Large

EARL W. POTTERFIELD — Ward 2

BRIAN A. HURTUK — At Large

FRANK B. GOLLINGER — Ward 3

DAVID J. MATTY — Director of Law

BRIAN A. HAGAN — Ward 4

I, the undersigned clerk of council of the city of Rocky River, State of Ohio, do hereby certify this publication of the foregoing ordinance was duly made by posting a true copy thereof in the lobby of the Rocky River Civil Hall, in accordance with the charter of Rocky River, commencing on the 1st day of March, 2005.

Misao Kurokawa
Clerk of Council of the City of Rocky River, Ohio

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/gb

DISCUSSION

Chairman CALVERT. I thank both of you for your excellent testimony. If there are no questions for the two Members. Questions? Mr. Rohrabacher.

Mr. ROHRABACHER. I would like to ask our two witnesses to tell me which part of the NASA budget that they would like to take the money from in order to bolster this part of the NASA budget that they are supporting today.

Ms. DAVIS. Mr. Rohrabacher, what I would like to see is that there be a separate line item for a national—for aeronautics, and a separate one for space. I think that right now, we have a vision for space. We have no vision for aeronautics. My concern is national security.

Mr. ROHRABACHER. Are there any programs in NASA that you feel are of less priority that we could take the money from, in order to fulfill the noble objectives that both of you have set out today?

Ms. DAVIS. Maybe not from NASA, but I believe the way the appropriations works, there are other projects within that pot of money that we can—I have an offset in mind, and I will be presenting that as an amendment, sir.

Mr. ROHRABACHER. You have a part of NASA that has less priority, that you think that the money could come from?

Mr. KUCINICH. Along with you, Representative Rohrabacher, I have been a strong supporter of the space program, as well as aeronautics, and I see the connection. Because for example, with the Shuttle, when the Shuttle goes up, it is a space vehicle. When it comes back, it relies on aeronautical technology in order to land. So you know, there always is a connection. That is why they call it the National Aeronautics and Space Administration, but we are going to take the A out of that, and it will just be the National Space Administration.

I don't want to see the NASA budget cut anywhere. But the fact of the matter is, Mr. Chairman, we are looking at more than a $500 billion budget deficit. This is kind of an odd time for us to be looking at the one area where we can grow our economy, and start cutting there. NASA is the path out of a budget deficit, with the kind of research and development which the system is capable of doing. So, we shouldn't be looking at any cuts in any way.

Mr. ROHRABACHER. It is very easy to advocate spending more money. It is very difficult to find prudent ways of trimming things from the budget. And that is not just for Members of Congress. I mean, we have witnesses after witnesses after witnesses, I think I have been here 16 years now, and I don't remember even one witness who was able to put the lowest priority. They are always able to say everything we got to spend the money on, but never can come up with some idea of where we could, things, perhaps, aren't being spent wisely, and could be better spent on the program they were advocating today.

Mr. KUCINICH. If I may, to my friend, Mr. Rohrabacher. What we are doing would be akin to asking a farmer to save money by throwing away some of his seed corn. Or—I mean, we——

Mr. ROHRABACHER. Or maybe, get rid of the whiskey allotment that he uses for holidays or something like that.

Mr. KUCINICH. Well, I think that—there is—NASA can hardly be accused of spending money like someone who is interested in self-enjoyment here, but I think——

Mr. ROHRABACHER. Mr. Kucinich, wouldn't you admit that NASA is just like every other organization? There has got to be things that are of less priority, and other things that are of higher priority.

Mr. KUCINICH. Well, we sure haven't found them in aeronautics. I can tell you that.

Mr. ROHRABACHER. All right.

Mr. KUCINICH. And that is why I am here. And I agree—listen, I am with you on space exploration, but why should space—why should one come at the expense of the other? Because the two are together.

Chairman CALVERT. I thank the gentleman for his question. Any other questions for this panel? Mr. Forbes.

Mr. FORBES. Thank you, Mr. Chairman. And Mr. Chairman, I think Mr. Rohrabacher is exactly right. This should be about looking at priorities. I just don't believe that aeronautical research is quite akin to whiskey allotment. And you know, as I look around this room, I am a strong supporter of the space program, but probably, I don't know, maybe there is somebody, but I don't know of anybody that has been in space sitting in this room, but I know just about everybody here has probably been on an airplane, and Congressman Davis, I appreciate the fact that you are here, because I know you serve on the Armed Services Committee, and I think the Intelligence Committee, and are you still on the Foreign Relations Committee, there——

Ms. DAVIS. Yes, sir.

Mr. FORBES. And you have traveled around the world, and there are two things that I want to ask you about. One is if you could elaborate a little bit more on the national security issue that you raised to us. But secondly, one of the things I hear over and over again, and Mr. Kucinich touched on this, so goes our research, so goes the industry. But I hear over and over again about the difficulties that we are having in attracting and retaining top flight engineers and researchers, and when I look at this budget, for Langley, in particular, it goes from $805 million in '04, $668 in '05, $557 in '06, $479 in '07. I know there is nobody that has been on the ground at Langley with the personnel more than you.

Can you elaborate a little bit more on, one, the national security concerns that you have, and secondly, the impact these budgets are having on the retention of top quality engineers and researchers?

Ms. DAVIS. Well, I will tackle the second part of the question first. And my concern is, with the jobs at Langley, but not major concern. My major concern is national security. As you well elaborated, I am on Armed Services and Intelligence, and International Relations as well. And yes, we stand to lose a lot of brainpower at NASA Langley and at Glenn.

I had someone in my office the other day telling me that we are now down to graduating, I think last year in the United States, 75,000 engineers, out of which 35,000 were Chinese, while China was graduating a million, Japan was graduating 750,000. That is worrisome to me. It is worrisome to me that we are turning over

our aeronautics and research to other countries other than the United States.

On a national security level, it bothers me that the JSF that I mentioned, that was tested at Langley, it is also being tested in Europe. It bothers me that we will be looking to other countries to give us the research and development for our military, for our military aircraft. Today's allies may be tomorrow's adversaries. I am not interested in the technology coming from the other countries. I think we need to retain that superiority here in the United States.

There is a reason NASA Langley is located next door to Langley Air Force Base, because there has been a partnership for many, many years, and I just would hate to see us lose that. And I think that the way we are going, we are heading down that path, and I think it would be a national tragedy.

Mr. KUCINICH. Mr. Forbes. Mr. Forbes. If I may, Representative Davis, you are absolutely right. I mean, we have to look to the future here, of America's defense capabilities, and if we cede the building of airplanes, to let us say, the Chinese market, we could be looking at a condition in the future where we don't have the technology we need to defend this country, and it is a very serious question.

I mean, one of the first things that happened when I came to Congress was that a representative of one of the largest aircraft manufacturers in the world came in our office, and asked me to vote for the China Trade Bill, which I didn't do. But they admitted, when I questioned them, that the price of their entry into the China market was to give China the prototypes of development aircraft. Now, we have to be concerned that we are giving up our position of superiority for the future, and so, I am totally supportive of what Representative Davis has said.

Mr. FORBES. Thank you, Mr. Kucinich, and I just want to add to what they said. There was an individual researcher that told me the other day, he was invited to China to give a talk to a group of engineers. He felt he would meet with 200 of them when he went there. There were 5,000 engineers in the room when he went there, so it is a big concern for us, and thank you both for being here today.

Ms. DAVIS. I might say, Mr. Forbes, there is a reason Marine One is not being totally built in the United States.

Chairman CALVERT. I thank the gentleman from Virginia. The gentleman from California, Mr. Honda.

Mr. HONDA. Thank you, Mr. Chairman, and I appreciate your putting this hearing together, and I appreciate Congresswoman Davis and Kucinich's comments, and Mr. Chairman, since I won't be here for the full length, I would like to submit some of my questions in writing.

Chairman CALVERT. Without objection, so ordered.

Mr. HONDA. And hopefully, expect a response in writing, some time definite point in the future. And I, too, support both Congresswoman Davis and Congressman Kucinich's position. And regarding the budget, I think what we did in the NASA budget is take all the money out of aeronautics and put it into space. And so, we are messing around with the budget within its own self, and so, some

people would call that a neutral budget action, but it is really not neutral. It is a deficit, in the sense that as they have quite well said, it is going to put us back, and it is not going to allow us to perform the mission that has been set out for us.

This budget has been set up as a full accounting process, and looking at FTEs and bottom line, and you force the budget that way, versus the mission that is stated. If this were a mission-driven budget, it would look different, and the people would be treated differently. And I think that that is the big question that we have before Congress. As to where would you get the money, well, the budget is not only NASA. The budget is, in its entirety, a little over $2.5 trillion, in terms of the President's budget, and I think there has been a lot of activities on the Floor as to how we look at our budget.

And you know, we had the issue of the Truman Commission, which looks for waste, and I am sure that we can find some moneys in that category. I think when Truman did it, they found over $15 billion. In those days, that was a lot of money. In today's count, that would be sufficient for what it is that you are looking for.

And we are looking at other items that won't even show up to our budget, and I think that that, if we looked at those supplementals, we might find sufficient funding there. So, the budget is not just NASA. It is in its entirety, and if our budget reflects our priorities, this certainly was thinned back, as Congresswoman Davis and Kucinich is asking, to look at that, and we analyze, before it is too late, our position on ASA. Thank you.

Chairman CALVERT. Thank you. I will recognize Mr. Bartlett, and then, we will get right to our panel. The gentleman from Maryland.

Mr. BARTLETT. Thank you very much.

I just wanted to note—I would like to comment on something that Congresswoman Davis said. The budget item that we are talking about today is simply a symptom of a very much larger problem. The numbers you gave about the number of engineers that are being trained in our country, and the percentage of those, nearly half of those, were Chinese, and then, the numbers being trained elsewhere, is a very alarming trend.

A society gets what it appreciates, and the truth is, in this country, we do not appreciate academic achievers, bright young men in our schools are called geeks and nerds, and pretty girls won't date them, and a really bright girl will play dumb, so that she can get a date. Now, what do you expect the result is going to be, when this is the kind of a culture that you have in your country. Yet, we need to be inviting academic achievers to the White House, and we need to be praising them and holding them up at least as much as football players, thank you.

I am concerned. I am concerned that for the short run, you are exactly right. Our economic superiority is at risk. We will not continue this blessed country, where one person out of 22 has 25 percent of all the good things in the world. We aren't going to continue to be here, unless we turn out scientists, mathematicians, and engineers of quality in large enough numbers, and we are not doing it.

Ultimately, you are exactly right. It is a threat to our military superiority. We will not continue to be the world's premier military

power if we are not turning out scientists, mathematicians, and engineers of quality in large enough numbers, and we are not doing it today.

So, thank you very much for bringing this to our attention. It is a whole lot bigger than aeronautics. That is just a system of a big problem our society has.

Mr. KUCINICH. Mr. Chairman, if I may, I want to thank Representative Bartlett for defending all those of us who had trouble getting dates in high school.

Chairman CALVERT. Something told me I knew that all along, Dennis. I thank the panel, and we will now have our——

Ms. DAVIS. Thank you, Mr. Chairman.

Chairman CALVERT.—full panel up. Thank you, Congresswoman Davis.

Thank you, gentlemen. I appreciate your coming out today, and Mr. Lebacqz, we will start with you. You are recognized for five minutes. You might turn your mike on, though.

Panel II:

STATEMENT OF DR. J. VICTOR LEBACQZ, ASSOCIATE ADMINISTRATOR, AERONAUTICS RESEARCH MISSION DIRECTORATE, NASA

Dr. LEBACQZ. There we go. Thank you, Mr. Chairman. It is a pleasure to see you again. Members of the Subcommittee, thank you. It is an honor for me to represent this fantastic agency to this panel today.

If I might take a moment. Personally, my father was an immigrant to this country from Belgium, after the first World War. Came on a scholarship as a geek, went out to Stanford to get a Ph.D. There, he met my mother, who was a daughter of Norwegian immigrants, who worked her way across the country teaching, and also, got a Ph.D. at Stanford in the 1930s. So, I think that is a function of the fact that this country does represent opportunity for all, and equality for all. And it is amazing that one generation after two immigrants can do that, that their son represents this fantastic agency in front of you, and I am grateful for the opportunity. I only wish they were here to share it with me still.

So, let me get on with my testimony. Mr. Chairman, I request that my full testimony be entered into the record.

Chairman CALVERT. Without objection, so ordered.

Dr. LEBACQZ. The NASA aeronautics research portfolio is a vital part of NASA's mission, to pursue the President's vision for space exploration, both in our continuing development of new technologies that improve aviation on this planet, and in our development of aeronautical science platforms to fly on this planet and those of other planets.

The research in the Aeronautics Research Mission Directorate supports the NASA strategic plan, and specifically, strategic objective #12 in our new document, the *New Age of Exploration,* and has been formulated with your input, and the input of federal agencies, industry, and academia, through our advisory committees.

The President's Fiscal Year 2006 budget fully supports the aeronautics program priority research in the areas of reducing aircraft

noise, increasing aviation safety and security, and increasing the capacity and efficiency of the national airspace system. Our budget request also supports the NASA contributions to the critical national planning activities that have been identified by the Interagency Joint Planning and Development Office.

NASA's Fiscal Year 2006 request for aeronautics research is $852.3 million, which supports three programs. The Aviation Safety and Security program protects air travelers and the public by developing technologies for both the national airspace system and the aircraft in it. We are focusing on technologies that can reduce air crash rates and reduce aviation injuries and fatalities, such as, for example, synthetic vision systems that allow us to see through fog and increase the safety of flying in bad weather. Additionally, the program produces technologies that can reduce the vulnerability of the national aviation system to terrorist attacks, such as integrated information technologies to predict trends.

Our second important program is our Airspace Systems program, which works to enable major increases in the capacity and mobility of the U.S. air transportation system, through technology transfer and development. The NASA Airspace Systems Program has become an essential technology provider for the FAA's air traffic management long-term research requirements. We have already transitioned technologies to the FAA to support air traffic controllers, such as the Traffic Management Advisor, and we will be having a major demonstration of our small aircraft transportation system at Danville, Virginia, this spring, and you are all cordially invited to attend that.

Additionally, it is through our Airspace Systems program that we support the Interagency Joint Planning and Development Office that I mentioned earlier. We are honored to lead one of the eight integrated product teams that will be instantiating the new national transformed air transportation system for the JPDO.

Finally, the Vehicle Systems program develops and demonstrates barrier-breaking vehicle concepts and technologies, beyond the scope of conventional air vehicles, which protect the Earth's environment and enables science missions. To ensure maximum benefit to the taxpayer and to embrace the President's vision, this program will be undergoing a transformation in 2006, consistent with the review of the National Research Council a year ago. It has been refocused away from many interdisciplinary research and technology projects toward four specific revolutionary technology projects that are described in my written testimony.

Today, Mr. Chairman, the U.S. remains a global power in aviation. 10 years ago, I would have likely said, as did Representative Davis, the U.S. is the global leader in aviation. Over the past 15 years, it is true, global competition has slowly, but steadily, eroded our supremacy in aviation. 60 years ago, Vannevar Bush wrote in his insightful report, "Science, the Endless Frontier:" "A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade."

As I talk about our aeronautics program with our partners and stakeholders in academia, industry, and the government, and as you may hear from other members of this panel, and have, in fact,

already heard this morning, there are at least two distinct philosophies for this nation's investment in aeronautical research. On the one hand, there are those who think aeronautics and aviation is a mature industry and market, one in which government's research role is best scaled back and left to private industry. This view holds that market forces will decide the Nation's future as a commercial aeronautics power. On the other hand, there are those who think there are many breakthroughs in aeronautics ahead, and worry about the continuous large investments by foreign governments and competitors, and the apparent shrinking market share for U.S. industry. This view holds that federal aeronautical investments are important for the Nation's future military and economic security.

Many bipartisan reports, ranging from the President's Commission on the Future of the Aerospace Industry, to the National Academies Report, "Securing the Future of U.S. Air Transportation: A System in Peril," have called for a national aeronautics policy from both sides of this policy debate. Perhaps, Mr. Chairman, the time is, in fact, right for a vigorous national dialogue leading to such a policy.

I thank you again for your attention. I look forward to my fellow panelists, and I will be glad to answer questions from you.

[The prepared statement of Dr. Lebacqz follows:]

PREPARED STATEMENT OF J. VICTOR LEBACQZ

Mr. Chairman and Members of the Subcommittee:

Four months ago, on November 16, 2004, a B–52 that was designed in the early 1950's took-off from Edwards Air Force Base in Southern California and headed to a test range over the Pacific Ocean. Mounted underneath the starboard wing was a Pegasus rocket that was designed in the 1980's. Fitted onto the Pegasus in place of the nosecone was the X–43A, a small experimental scramjet (supersonic combustible ramjet)-powered vehicle designed at the Langley Research Center in the mid-1990's. Over the test range, the B–52 dropped the Pegasus, which propelled the X–43 into free flight. The X–43A scramjet ignited and flew at approximately Mach 10, nearly 7,000 mph, setting a new world record for an air-breathing vehicle, as it flew at an altitude of approximately 110,000 feet.

This breakthrough provides a promise for the future. The talent and vision of the people at our NASA Research Centers, joining forces with our industry team, made this breakthrough a reality, turning visionary possibilities into incredible realities. As the President said last January, we are engaged in exploration and discovery, and breakthroughs such as this are needed to enable the President's Vision for Space Exploration. Breakthroughs power the future. NASA's job is to envision the future and make it a reality. This is our history and it is our future.

I thank you for this opportunity to testify on aeronautics research at NASA. Our aeronautics research portfolio is a vital part of NASA's mission to pursue the President's Vision for Space Exploration, both in our continuing development of new technologies that improve aviation on this planet, and in our development of aeronautical science platforms to fly on this and other planets. We are developing technologies to improve safety, reduce environmental impact and improve the efficiency of aviation operations. We are developing technologies to permit long-endurance uninhabited aeronautical vehicles. It is an honor for me to explain how we are doing so.

The Importance of Aeronautics and Its Role at NASA

Aeronautics is critical to national military and economic security, transportation mobility and freedom, and quality of life. Air superiority and the ability to globally deploy our forces are vital to the national interest. Aviation is a unique, indispensable part of our nation's transportation system, providing unequaled speed and distance, mobility and freedom of movement for our nation. Air carriers enplane over 600 million passengers and fly over 600 billion passenger miles, accounting for 63 percent of individual one-way trips over 500 miles and 80 percent of trips over 1,000

miles. Airfreight carries 29 percent of the value of the Nation's exports and imports and is growing at over six percent annually. Global communications, commerce and tourism have driven international growth in aviation five to six percent annually, well beyond annual Gross Domestic Product (GDP) growth. In many ways, the U.S. has only begun to tap what is possible in air transportation. The U.S. has over 5,200 public-use airports, but the vast majority of passengers pass through a little more than one percent of those airports and only about 10 percent are used to any significant degree.

Aviation and the aerospace industry support over 15 million Americans in high-quality, high-paying jobs, second only to trucking in the transportation sector. Driven by technology, annual growth in aviation labor productivity over the past 40 years has averaged 3.6 percent, compared to two percent for U.S. industry as a whole. Aviation manufacturing is a consistent net exporter, adding $30 billion dollars annually to the Nation's balance of trade. Aviation produces and uses a broad base of technologies—from computing and simulation to advanced materials—supporting the high technology industrial base of the country. Defense aviation provides fast, flexible force projection for the U.S. Our military aircraft are unparalleled globally because they employ the most advanced technology.

Technological advances in aeronautics over the past 40 years, many of them first pioneered by NASA, have enabled a ten-fold improvement in aviation safety, a doubling of fuel efficiency with reductions in emissions per operation, a 50 percent reduction in cost to travelers, and an order of magnitude reduction in noise generation. In large part, the gains we have enjoyed have been due to the efficient transfer of the benefits of technology to consumers via competitive air transportation markets.

At NASA our aeronautics program is pioneering and validating high-value technologies that enable discovery and improve the quality of life through practical applications. We are investing in the revolutionary technologies that will ensure the success of our mission. To ensure maximum benefit to the taxpayer, and to embrace the Vision for Space Exploration, we are transforming our investment in Aeronautics Research in order to more sharply focus our investment on revolutionary, high-risk, "barrier breaking" technologies. Toward this end, the NASA Aeronautics Vehicle Systems Program (VSP) has been refocused away from research and technology development in multiple areas toward four specific revolutionary technology demonstration projects for which there is a clear government research role. These projects will address critical public needs related to reduction of aircraft noise and emissions, and enable new science missions. The revolutionary technologies developed by NASA within the next decade will form the basis for a new generation of environmentally friendly aircraft and will enhance U.S. competitiveness 20 years from now.

To fulfill our mission we must also identify the national facilities that are required to support our programs. Our transformed aeronautics program will rely on a more focused set of facilities than exists today. Over the past several years many reviews have been performed relative to our national aeronautical facilities. There have been closures and changes. However, more needs to be done to avoid the perpetuation of marginal facilities through small, evolutionary change. We are optimistic that looking to the future will provide the framework necessary to define the facilities, new and existing, that will enable success in aeronautics.

Roadmapping and the Strategic Plan

NASA is working toward the aeronautics R&D goals as published in *The New Age of Exploration: NASA's Direction for 2005 and Beyond.* In Strategic Objective 12 of this document, we commit to "provide advanced aeronautical technologies to meet the challenges of next generation systems in aviation, for civilian and scientific purposes, in our atmosphere and in atmospheres of other worlds." These aeronautics R&D goals are based on the *NASA Aeronautics Blueprint,* published in 2002. The Aeronautics Blueprint articulates goals for aeronautics that we believe can achieve the objectives set out in our Strategic Plan. As we looked forward and examined the issues facing aviation, we recognized a need for new concepts and new technologies to break through the current plateau facing aviation. Achieving big increases in capacity and mobility, while improving safety and reducing environmental impacts, was not feasible within today's construct and technology baseline. What we found was that emerging technologies, when combined with advances in traditional aerospace disciplines, can enable new system concepts that operate at levels of performance that eclipse current systems.

We use the Blueprint to help guide and prioritize our investments. The process we began in 2002 with the publication of the Blueprint—the framework and emphasis of the Blueprint—is reflected in our current program restructuring. Next steps

include more detailed systems analysis and technology roadmapping. We are also exploring a way to use the National Research Council to perform a decadal survey to help us better understand the Nation's future needs in aeronautics.

NASA has initiated a new roadmapping endeavor to better define all of our activities. One of these roadmaps is focused on aeronautics. To this end we have developed a Federal Advisory Committee Act (FACA) team, consisting of industry, academia, government, military, and local government planning representatives, to evaluate and draft strategic roadmaps that will help guide our long-range goals, capabilities, and enabling technologies. We intend to deliver the aeronautics roadmap this fall, and invite you to participate by providing input and comment. This interaction will help direct future investment decisions represented in the integrated NASA Strategic Roadmap.

As we begin this process, a broader national dialog on the aeronautics R&D goals for this roadmap may be appropriate as we enter the second century of aviation. These discussions should include a range of stakeholders and customers, including the Congress. This process could lead to a national consensus for aeronautics R&D goals.

Joint Planning and Development Office

Last year's FAA Reauthorization Bill, VISION–100 (P.L. 108–176), created the Next Generation Air Transportation System Joint Planning and Development Office (JPDO) with the goal to develop an integrated, multi-agency "National Plan" to transform the Nation's air transportation system to meet the needs of the year 2025 while providing substantial near-term benefits. The National Plan—in essence, a roadmap for the Next Generation Air Transportation System—has six overarching goals: (1) Promote economic growth and create jobs; (2) Expand system flexibility and deliver capacity to meet future demands; (3) Tailor services to customer needs; (4) Ensure national defense readiness; (5) Promote aviation safety and environmental stewardship; and (6) Retain and enhance U.S. leadership and economic competitiveness in global aviation.

The JPDO—composed of NASA, the FAA, the Office of Science and Technology Policy (OSTP), and the Departments of Transportation, Commerce, Defense, and Homeland Security—working in close collaboration with other public and private sector experts, created and published the National Plan, entitled *Next Generation Air Transportation System Integrated Plan,* referred to as NGATS, that was delivered to Congress in December 2004.

The NGATS goals and objectives broadly address eight major strategies. A series of eight Integrated Product Teams (IPT's) are developing executable roadmaps for each strategy to transform the National Airspace System. The eight IPT's are focused on such activities as developing alternative airport concepts and infrastructure to meet future demand, establishing a more effective and less intrusive airport security system without limiting mobility or infringing on civil liberties, creating a more responsive air traffic system that can accommodate new and changing aircraft vehicle classes and business models, reducing the impact of weather on air travel, and harmonizing equipage and operations globally.

NASA has a major role in the JPDO and the Next Generation Air Transportation System. While NASA is performing aeronautics research that provides the foundation to enable NGATS and the right strategies, we are also providing civil servants and direct support to the JPDO. NASA is providing civil service employees to serve as the JPDO Deputy Director (SES), Agile Air Traffic System IPT Lead (SES), and a Board member (SES), as well as 11 other full or part time civil servants. NASA financial support to the JPDO was $5.4M in FY 2004. This has increased to $5.6M in FY 2005 and will increase to $10M in FY 2006. We are also conducting a network-enabled operations (NEO) demonstration of security and capacity related technologies. This demonstration, jointly sponsored by NASA, DOD, DHS, and DOT, could prove to be valuable in integrating government-wide intelligence operations, providing significant aid to our national security.

In aviation there has never been a transformation effort similar to this one with as many stakeholders and as broad in scope. The objective of this plan is to provide the opportunity for creative solutions for the future of air transportation, our security, and our hope for a vibrant future. Its success is the first priority of our aeronautics portfolio.

Aeronautics Research Programs

The research in the Aeronautics Research Mission Directorate programs supports the NASA Strategic Plan, as formulated with your input and the input of federal agencies, industry and academia. The President's FY 2006 Budget fully supports the Aeronautics program's vital research, especially in the areas of reducing aircraft

noise, increasing the aviation safety and security and increasing the capacity and efficiency of the National Airspace System. The budget request also supports the activities that have been identified by the Joint Planning and Development Office. NASA's FY 2006 request for the Aeronautics Research Mission Directorate is $852.3 million, which is $54 million less than the FY 2005 budget.

Protecting air travelers and the public is the focus of the *Aviation Safety and Security Program (AvSSP)* which develops technologies for both the National Aviation System and aircraft that are aimed at preventing both intentional and unintentional events that could cause damage, harm, and loss of life; and minimizing the consequences when these types of events occur. Aviation safety focuses on technologies that can reduce aircraft accident rates and reduce aviation injuries and fatalities. Aviation security focuses on technologies that can reduce the vulnerability of the National Aviation System to terrorist attacks while improving the efficiency of security measures. The AvSSP Program also develops and integrates information technologies needed to assess situations and trends that might indicate unsafe or insecure conditions before they lead to fatalities or damage. The goal, in short, is to reduce the potential for loss of life in the National Aviation System. The President's FY 2006 Budget for AvSSP is $192.9 million, an increase of four percent over the FY 2005 program.

Last year AvSSP demonstrated aviation safety breakthrough technology that has enormous potential to eliminate the leading cause of world-wide commercial and general aviation fatalities, Controlled Flight Into Terrain (commonly referred to as CFIT). Synthetic Visions Systems performed simulation and flight-test evaluations of low-cost forward-fit and retrofit technologies for General Aviation aircraft. Synthetic Vision Systems create an artificial, "virtual view," of an area based on a detailed terrain database. Although the pilot may not be able to see the ground through the fog, a computer screen presents the landing site accurately based on map and terrain information. Evaluations included technical and operational performance assessments of improved pilot situational awareness with regard to terrain portrayal, loss of control prevention, and display symbology. Results from our demonstration show the efficacy of synthetic vision displays to eliminate CFIT and greatly improve pilot situational awareness.

Turbulence is a leading cause of in-flight injuries and costs the airlines at least $100 million per year. To address this issue, AvSSP has designed and is performing in-service evaluations of a turbulence prediction and warning system with a major airline that gives flight crews the advanced warning needed to avoid turbulence or advise passengers to sit down and buckle up to avoid injury. AvSSP is also developing safety design and maintenance tools to design safer aircraft that can, for example, operate more safely in icing conditions, and new techniques for industry to improve aviation maintenance procedures that can improve safety and reduce maintenance-related accidents.

Working in concert with other government agencies that have mission requirements in aviation safety and security, such as the Federal Aviation Administration and the Transportation Security Administration, as well as in cooperation with the U.S. aviation industry and universities, NASA actively pursues technology transfer with these partners by identifying and addressing user needs and by demonstrating key attributes of the technologies in relevant user environments, making use of both NASA and partner facilities and capabilities.

Last year at the Ft. Worth, Texas, and Washington, D.C., Air Traffic Control Centers, AvSSP demonstrated a prototype of the Rogue Evaluation And Coordination Tool (REACT), using a live traffic feed over eight hours. REACT demonstrated the ability to detect aircraft that are deviating from their expected flight paths using four detection algorithms. It also predicted incursions into restricted airspace, with countdown timers. These capabilities will enhance the public safety by mitigating the potential for catastrophic harm that might otherwise result from a rogue aircraft.

Transferring technology to enable major increases in the capacity and mobility of the U.S. air transportation system is the focus of the *Airspace Systems Program (ASP).* For example, the Small Aircraft Transportation System (SATS) has demonstrated the feasibility of pilots safely landing at non-radar equipped airports under low visibility conditions. Also, SATS has demonstrated the use of automation to increase flight-path accuracy and situational awareness, precluding the need for expensive, ground-based systems. In 2005, we are conducting a number of SATS demonstrations validating technologies that promote routine and easy access of general aviation aircraft to the Nation's under utilized small airports. SATS technologies can help to relieve the current excessive demands on the Nation's National Airspace System. We will conduct a public demonstration of our accomplishments in Danville, Virginia, during June 5–7, 2005. I extend a personal invitation to all

the Members on this committee to attend this SATS demonstration. The President's FY 2006 Budget for ASP is $200.3 million, an increase of 22 percent over the FY 2005 program.

The Airspace Systems Program has become an essential provider of the FAA's air traffic management long-term research. The FAA long-term forecast indicates a steady growth in air travel demand that will culminate in a doubling of that demand over roughly the next two decades. NASA's ASP research objectives are planned to meet the FAA's needs in 2025 though some priority is being given to meet the FAA's near-term operational support needs.

The Virtual Airspace Modeling and Simulation System, developed by the ASP, provides a unique and critical capability that is used to perform simulations and trade-off assessments of future air transportation system concepts, models, and technologies. This capability will allow an air traffic management tool concept to be tested in a non-operational environment before major development dollars are invested. The JPDO currently is using this capability to assess the impact of new technologies and to establish the requirements leading to a transformed national air transportation system.

Last year we successfully completed the Advanced Air Transportation Technologies (AATT) project that developed Air Traffic Management decision-making technologies and procedures to enable greater flexibility and efficiencies of the National Airspace System. In congested airspace with interdependent traffic flows, a delay at one center often creates a domino effect that spreads quickly to multiple centers. Over its five-year life, the AATT project developed and demonstrated several active decision support tools that would enable improvements in NAS throughput, user flexibility, predictability, and overall system efficiency while maintaining safety.

The *Vehicle Systems Program (VSP)* is developing and demonstrating barrier-breaking vehicle concepts and technologies, beyond the scope of conventional air vehicles that protect the Earth's environment and enable science missions. In FY 2005, the VSP was transformed into a goal-driven technology development program aimed at the maturation of technologies to flight. By developing well-defined technological metrics and goals, the diverse technology development effort was refocused in over seven different vehicle classes. Considering our current constrained budget environment, the program will be undergoing a second stage of transformation in 2006. Three basic tenets govern this transformation: barrier-breaking demonstrations, sharp focus on fewer goals, and fully competed awards. The 2004 record-breaking Hyper-X demonstrations, which I described at the beginning of my testimony, illustrated that many barriers remain in the second century of flight. The transformed Vehicle Systems investment will be focused on achieving these demonstrations through the use of increased competition through merit-based research selection. The President's FY 2006 Budget for VSP is $459.1 million.

As part of the transformation of the VSP, we have consolidated our research to four specific "barrier-breaking" technology demonstration projects:

- *Subsonic Noise Reduction:* Continues the barrier breaking research for reducing airport noise, a demonstration of noise reduction technologies for large transport aircraft will put us halfway to the goal of keeping objectionable noise within airport boundaries. This demonstration will include advanced engine and airframe noise reduction approaches as well as the innovative continuous descent approach to avoid the objectionable changes in engine speed as an aircraft approaches the airport.
- *Sonic Boom Reduction:* If nothing is done to break the barrier of supersonic flight over land, it will take just as long to fly across the country in the third century of flight as it did halfway through the first century. The barrier to high-speed flight is defining a sonic boom level that is acceptable to the general public, and designing an aircraft to reach that level. Building on our recent successful flight validation of the theory that by altering the contours of a supersonic aircraft, the shockwave and its accompanying sonic boom can be shaped resulting in a greatly reduced sonic boom signature on the ground, we plan to demonstrate an innovative air vehicle that will break the barrier of acceptable supersonic flight.
- *Zero Emissions Aircraft:* Conventional turbo machinery powered by fossil fuels can only incrementally address the need to reduce harmful NO_X and CO_2 emissions from aircraft. A breakthrough demonstration of an all-electric aircraft propulsion system will be the first step towards a truly emission-less aircraft.
- *High-Altitude, Long-Endurance, Remotely Operated Aircraft (HALE ROA):* NASA opened the door to high altitude flight when it successfully dem-

onstrated the Helios. This legacy will be extended through a series of high-altitude long-endurance aircraft that will extend duration, range, and payload capacity. The first breakthrough will be a 14-day duration aircraft that flies at over 50 thousand feet.

NASA Aeronautics Research Centers: Issues & Implications

Significant NASA organizational and programmatic transformation, based upon the recommendations of the President's Commission on the Implementation of United States Space Exploration Policy, is essential for NASA. As discussed above, the transformation of NASA's Aeronautics Research programs encompasses not only the technical content of those programs, but also the mechanisms by which those programs will be conducted. These changes are having major impacts on the people and facilities at NASA's four centers that perform aeronautics research for the Agency. NASA is taking proactive steps to manage the impact of these changes on our people and facilities. In particular, we are actively involved with several ongoing Agency initiatives, including the Core Competency Assessment and the Transformation Action Team, to ensure that we have identified the workforce skill sets that are critical to our future success. We have also established viable mechanisms for addressing areas where we anticipate having too many, or too few, of these skills. The NASA Organizational Model Assessment Team, established in response to a recommendation of the Aldridge Commission, identified potential alternate organizational models for NASA Centers. The Agency is evaluating the possible implementation of alternate organizational models including: Hybrid organizations, combining a Government component with an FFRDC, University Affiliated Research Center, Institute or Government Corporation.

Additionally, the Agency is examining a range of actions to address our workforce issues. These include: voluntary separations-buyouts; job fairs and perhaps directed inter-Center workforce rebalancing; acceleration of Center transformation strategies; preparation of requests for demonstration personnel authorities; and as a last resort, preparation for involuntary measures.

Regarding our facilities, we are instituting a "corporate approach" to the management of these key assets, beginning with our major wind tunnels. NASA, and its predecessor the National Advisory Committee for Aeronautics, has long used a variety of wind tunnels to support research, development, and related activities in both its aeronautics and space endeavors. External users, particularly DOD and the aerospace industry, have also used these facilities to meet their own research and development objectives. During the past decade, however, the level of demand for most, if not all, of these facilities has decreased substantially. The reduction in demand within NASA has been the result of a gradual change in programmatic direction toward areas such as airspace operations, aircraft safety, and aircraft security that by and large do not require significant wind tunnel usage. The reduction in demand external to NASA has paralleled the decreasing number of new aircraft development projects, both commercial and military.

As a result, NASA has considerably more wind tunnels than the Agency's programs require. In an effort to match program requirements with supporting infrastructure, NASA has, within the last ten years, closed about half of its wind tunnels. Decisions regarding the operation, and closure, of specific facilities were made primarily by the Research Center that operated each respective facility. Recently, however, the nature and pace of change within and external to the Agency has made it increasingly difficult for the Centers to manage and operate such facilities, particularly those with large fixed costs and uncertain levels of utilization.

Accordingly, on February 4, 2005, ARMD, operating as the Headquarters Center Executive responsible for the Dryden Flight Research Center, the Glenn Research Center, and the Langley Research Center, instituted a new "corporate management of facilities" approach, effective immediately. Under this approach, a new Headquarters office will be responsible for the integrated, strategic management of all the major wind tunnels within the Agency. Specifically, this office has been tasked with establishing an overall strategy for this suite of facilities; for setting cost, pricing, and top-level facility access policies; for coordinating overall marketing efforts; for approving test assignments; assessing program and facility performance; for sponsoring initiatives for improved operational effectiveness and efficiency; and—with respect to this set of facilities—for serving as the primary integrated interface with industry, DOD, and other customers and stakeholders.

In particular, this new approach will enable us to better address many of the challenges facing the management of these facilities, including those highlighted by the RAND Corporation in their recently concluded examination of NASA's wind tunnel and propulsion test facilities, such as the need for an aeronautics test technology vision, selective consolidation and modernization of existing facilities, common man-

agement and accounting practices, and a renewed reliance between NASA and the Department of Defense.

Summary

Thank you, Mr. Chairman and Members of the Subcommittee. I appreciate the opportunity to testify today to share our accomplishments and the actions we are taking for the future of this nation in aeronautics research. We are transforming aeronautics at NASA to emphasize innovations in addressing barriers through high-risk, high-payoff technologies. Our transformed aeronautics program will create challenges and opportunities as we pursue the Vision for Space Exploration. We are excited about this future, and we are anxious to get on with it.

BIOGRAPHY FOR J. VICTOR LEBACQZ

Dr. Lebacqz is the Associate Administrator for Aeronautics Research, one of four Mission Directorates within the National Aeronautics and Space Administration (NASA), a position he has held since July 2003. In this position, he has overall technical, programmatic, and personnel management responsibility for all aeronautics technology research and development within the Agency. The programmatic activities are funded by a $1.0 Billion/year budget that supports three major NASA programs, which are performed at the four Aeronautics research centers of Ames, Dryden, Glenn, and Langley. Personnel oversight of approximately 6,200 civil servants at the four Aeronautics centers is a concomitant responsibility.

Prior to this appointment, Dr. Lebacqz was the Associate Center Director for Aerospace Programs at the NASA Ames Research Center, a position he held since June 2002. In this position, he had overall management responsibility for the conduct of programs led by Ames for the Office of Aerospace Technology within NASA. These programs included Airspace Systems; Rotorcraft; Computing, Information, and Communications Technology; and Engineering for Complex Systems. They had a combined value of approximately $250M per year.

Between May 2000 and May 2002, Dr. Lebacqz was Deputy Director of the Office of Aerospace at the NASA Ames Research Center. The Aerospace Directorate's research and technology development efforts include advanced aerospace projects, space transportation and thermal protection systems, aviation operations systems, nanotechnology, acoustics, basic and applied aerodynamics, and rotorcraft. The work is performed in seven subordinate Divisions or Offices comprised of approximately 280 civil servant employees and 235 contractors, with an annual budget on the order of $75M. Dr. Lebacqz independently, or in partnership with the Director, was responsible for all personnel and financial management activities associated with the Directorate, as well as the development and transfer to industry and/or other government organizations of advanced air traffic management and flight systems technology, and of rotorcraft, low-speed aeromechanics, and hypersonic aerothermodynamic technologies.

Prior to this position, Dr. Lebacqz was Director of the Aviation System Capacity Program and the Aerospace Operations Systems Programs, for the National Aeronautics and Space Administration (NASA), a position he held since December 1997. He was responsible for the technical and programmatic conduct of three systems technology projects (Advanced Air Transportation Technologies, Terminal Area Productivity, and Short Haul Civil Tiltrotor) and one base research and technology program (Aerospace Operations Systems) for NASA. These programs have a combined value of approximately $725M over five years, and are conducted at three of the NASA Centers: Ames Research Center in California, Langley Research Center in Virginia, and Glenn Research Center in Ohio. They focus on developing technologies to increase the capacity and safety of the National Airspace System. In their conduct, he was also responsible for strategic alliances with the Federal Aviation Administration, and for developing formal relationships with the FAA's Technical Center and the DOT's Volpe Transportation Center.

Previous to that assignment, Dr. Lebacqz was Chief of the Flight Management and Human Factors Division at NASA Ames, a position he held between December 1996 and December 1997. As Division Chief, he had technical and personnel responsibility for 200 civil servant and contractor employees, with an annual budget of approximately $35M. He was specifically responsible for interdisciplinary Division programs in Air Traffic Management, Aeronautical Human Factors, and Aviation Safety research. Prior to this appointment, he was Deputy Chief of the same Division since 1994, during which time his specific responsibilities also included Rotorcraft Systems. Concurrently, he was Program Manager of NASA's Rotorcraft Base Research and Technology program from February 1996 until December 1996, with pro-

grammatic responsibilities for the entire NASA rotorcraft program at the same three NASA Aeronautics Centers.

Between 1991 and 1994, he was Chief of the Flight Human Factors Branch at NASA Ames. In this position, he was responsible for the development of human factors programs in crew resource management, fatigue countermeasures, and air-ground integration. Between 1985 and 1991 he was Chief of the Flight Dynamics and Controls Branch at Ames, where he was responsible for programs in rotorcraft and VSTOL stability, control, and handling qualities, and developed helicopter flight research activities cooperative with the U.S. Army, including the new RASCAL UH–60 helicopter. Concurrently, he was a lecturer at Stanford University between 1982 and 1992, teaching the graduate course *"Dynamics and Control of Rotary-Wing Aircraft."* From 1978 to 1985 he conducted flight and simulation research at Ames, and, prior to that, he was with the Calspan Corporation in Buffalo, NY, where he was Head, Flight Control Section.

His BSE (cum laude), MA, and Ph.D. degrees in Aeronautical Engineering are all from Princeton University. He is the author or co-author of over 50 technical reports, articles, or papers, was a member of the American Helicopter Society (AHS), and is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA). For the AHS, he has been Technical Director for the San Francisco Bay Region (1982–1983), as well as Technical Chairman for an International Conference on Flying Qualities and Human Factors in 1993. For the AIAA, he has been an Associate Editor for the *Journal of Guidance, Control, and Dynamics* (1982–1987), a member of the Technical Committee for Guidance and Control (1988–1991), and the Deputy Director, Aircraft Operations, for the Aircraft Technology Integration and Operations Technical Group. He was the Technical Chairperson for the first AIAA Aircraft Technology Integration and Operations Forum in November 2001.

Dr. Lebacqz has received two individual NASA Special Achievement Awards, five NASA Group Achievement Awards, six NASA "Turning Goals Into Reality" (TGIR) awards, two NASA Ames Honor Awards (for excellence in supervision and for mentoring), the U.S. Army Aeroflightdynamics Directorate Director's Award for Interagency Cooperation, the NASA Exceptional Service Medal, and has twice been awarded NASA's Outstanding Leadership Medal. He was named a Presidential Rank Award Meritorious Executive in 2003. He is listed in the *Lexington Who's Who Registry 2000–2001.*

Chairman CALVERT. I thank the gentleman. Next, Dr. Klineberg, you are recognized for five minutes.

STATEMENT OF DR. JOHN M. KLINEBERG, COMMITTEE CHAIRMAN, NATIONAL RESEARCH COUNCIL

Dr. KLINEBERG. Thank you, Mr. Chairman, and Members of the Committee. Thank you for the opportunity to testify before you today.

I have some prepared—get there on the screen. I am appearing today as the Chair of the Aeronautics and Space Engineering Board's Committee to Review the NASA Aeronautics Program. I have submitted a written report that covers that in—completely. I am going to try to hit some highlights here, and I will be as brief as I can.

Chairman CALVERT. Your full testimony will be entered into the record.

Mr. KLINEBERG. Thank you very much.

Particularly, the process I want to emphasize, we had a large number of very senior, very experienced people in the industry who reviewed, at length, the NASA aeronautics program during 2003, and the names of my fellow panel members are in the written submittal.

I would just highlight several of the recommendations we came up with. This first one is something that I am sure this committee could—will endorse. It says that air transportation is vital to this country. But behind this statement is—was a consternation my

committee found that NASA, the people in the NASA aeronautics program did not seem to have a good handle on why they were doing the work they were doing, and Mr. Kucinich touched on this earlier, the problem is the vision, the NASA Vision Statement says that their mission is to understand and protect the home planet, and that is the aegis, the vision under which aeronautics is contained in the NASA thinking, and frankly, that is completely wrong. That is not the vision for aeronautics. It is an issue of competitiveness, and the vitality of the air transportation system, and this has to be understood in NASA. And I will touch on that a little more later, if I may.

Another one, we said, we looked around, and we said NASA is the agency that must provide that leadership, and particularly, in research and development, and I don't think you will find arguments here, but we needed—we felt we needed to re-emphasize that, because that leadership role is not always exercised, and it needs to be exercised in having a strategic plan and a strategic vision that the rest of the players can unite behind.

We found NASA remarkably healthy, considering the tremendous pressures that they have been under, in budget pressures. And their facilities are world class national facilities. There are some very, very good people out there, that are working at it. They need a little focus in those focus programs, a little more focus, but we found the program still is salvageable.

They have absorbed, on this chart, they have absorbed a lot of cuts by decreasing the number of people they have in given areas. That is a natural tendency, but we felt that unless they can build up the budget, it is time, now, to look at dropping research in certain areas, because you simply don't have the people that can support that activity. At the same time that they need to focus their systems activities, we saw a real problem in that they backed away from long-term basic research, and NASA and NACA before it has traditionally been the home of a competence in aeronautics that we are worried has disappeared, as they have no line item and nowhere, place, to support basic research, unless it is focused on a given system, and that is not really what aeronautics is about. And that is my—that was recommendation 7.

This recommendation 8, we recognize that much of NASA facilities did grow up at a time when there was a very large industrial base in this country. That has consolidated, and NASA has to continue to look at consolidating facilities, but they need to do this carefully, and only close down those facilities that are truly not needed or redundant in some way.

And the last one I wanted to touch on this morning, is we felt there could be better, NASA could do a little bit better in dealing with their customers, the other agencies, the FAA, DOD, and others. And the second bullet down here is code a little bit, and I will touch on that in a second, we felt that we needed some way to involve the NASA Administrator in the aeronautics enterprise, and one way might be to have him recognize that aeronautics is, indeed, a very important, separate function of NASA, and needs to be supported that way.

And essentially, in this way of co-chairing a meeting with the FAA Administrator is a way to enforce that kind of feeling. Now,

if you will permit me just half a second, I would like to address the four specific questions I was asked verbally. I have no charts on that. And I will be as quickly as I can, Mr. Chairman.

The first question, now, I need to inform you that I have to take off my hat as the representative of the National Academies, and I am now speaking to you as a private citizen, a concerned private citizen, but one with over 45 years experience in this field. So, I hope what I say will be useful.

The first question was what are the main challenges facing us over the next two decades, and what are the Nation's most pressing strategic needs? I know my colleagues will address this in detail, so I am not going to go into that now, but in my mind, we are very close to letting the aeronautics infrastructure become a chokepoint for economic growth in this country. And not only exports of aeronautical systems and equipment and subsystems that we have talked about earlier, but the air traffic system itself in this country is becoming saturated. We had some relief after 9/11, when the growth in air traffic slowed temporarily. It is starting to pick up again, and we are going to get into a point very soon when you just can't—it will be unreliable. You won't be able to travel from point A to point B, and for those of us who live in California and use the Internet, for example, for commerce, and expect packages to appear at our door, that is going to be—that will just be a disaster, and this country has got to support that infrastructure, and we have to start to plan for the next generation of air traffic control systems, and the vehicles and systems that will fly in that. And I want to note here that the National Academies and the ASAB hopes to conduct a study that will help a bit in this area, by developing what we call a decadal strategy for aeronautics research, that will help identify the major issues and what is being done to address them.

The next question was what is NASA's role, and how effective are NASA's programs. I think I have touched on that, because that is what our study did. The mechanisms for NASA aeronautics have been in place since 1917. They grew a lot during the Second World War, and they are very effective. And I think that funding R&D is an effective way for the government to support this field, and it is much better than government subsidies, and as I say, we found a good program in place, in spite of the debilitating budget cuts that have been proposed.

The third question I was asked is what effect will the proposed budget have on NASA's ability to carry out this program. I think the budget is a disaster, unmitigated. And if you look at the aero budget, it has declined by more than half over the last several years. The five-year runout contemplates an additional 20 percent reduction in the budget. I think this program is on its way to becoming irrelevant to the future of aeronautics in this country, and perhaps—and in the world.

And what do I think NASA should do? I thought a lot about this. Representative Davis touched on this in her opening statements. I think somehow, I think NASA aeronautics belongs in NASA. NASA is an R&D agency, it is kind of special in the government. I don't believe we need a new organization that would involve the operational agencies like the FAA or DOD, but I think NASA itself has to pay attention to aeronautics, and one thought I have had is that

NASA needs two Deputy Administrators, one for aeronautics and for space, both of which would have advise and consent screening, and you would have an Administrator, a Deputy Administrator for NASA aeronautics, and I think—I approve of the notion of not allowing transfer across the budget line items. NASA aeronautics has a very different constituency——

Chairman CALVERT. Doctor, if you will summarize.

Dr. KLINEBERG. I am—the last second, sir.

The—NASA has a different constituency in aeronautics than space. It is very hard to trade the two off, and it shouldn't be—we should fix that somehow. So, that concludes my testimony, Mr. Chairman. I am sorry I ran a little bit long, but I appreciate your attention.

[The prepared statement of Dr. Klineberg follows:]

PREPARED STATEMENT OF JOHN M. KLINEBERG

An Assessment of NASA's Aeronautics Technology Program

Mr. Chairman, Mr. Udall, and Members of the Committee, thank you for the opportunity to testify before you today. My name is John Klineberg. I have recently retired from my position as the President of Space Systems/Loral and served for over 25 years in a variety of management and technical positions with NASA. I appear before you today in my capacity as Chair of the National Research Council's committee assessing NASA's aeronautics technology programs. The Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology.

In late 2002, the National Research Council was asked by NASA and the Office of Management and Budget to examine the technical quality of its aeronautics research and development. The National Research Council formed our committee under the auspices of the Aeronautics and Space Engineering Board to respond to this request. Our committee's report was released in November of 2003.

I am aware that NASA's program has been changing since our report was issued and that it will continue to change. However, the following material summarizes the findings and recommendations of our report as it was issued in November 2003.

OVERVIEW

The National Research Council (NRC) of the National Academies performed this detailed, independent assessment of NASA's Aeronautics Technology Programs by establishing three panels, one for each of the component programs within the Aeronautics Technology Programs. The NRC also established a parent committee, consisting of the Chairman and a subset of members from each panel. The committee and panels began their activities in early 2003.

The three subordinate panels conducted an independent peer assessment of the Vehicle Systems Program (VSP), the Airspace Systems Program (ASP), and the Aviation Safety Program (AvSP), the three elements of NASA's Aeronautics Technology Programs. The committee and panels were asked by NASA to address four questions:

1. Is the array of activities about right?
2. Is there a good plan to carry out the program?
3. Is the program doing what it set out to do?
4. Is the entire effort connected to the users?

The committee developed findings and recommendations at three different levels. At the top level, it created a list of 12 key crosscutting recommendations for the overall Aeronautics Technology Programs on issues that span the entire set of programs. These recommendations are appropriate for guiding Congress, NASA Headquarters, and the White House in prioritizing NASA's aeronautics research and development programs. At the second level of detail, the committee provided program-level recommendations appropriate for program and project managers at the NASA Research Centers. Finally, the committee developed findings and recommendations at the task level that are designed to assist the individual principal investigators in improving the quality of their research. These third-level recommendations are numerous and detailed and are not included in this document.

OVERALL ASSESSSMENT

The committee's simple answer to the four questions posed by NASA is that, in general, the Aeronautics Technology programs are very good but could be greatly improved by following the committee's 12 top-level recommendations. The array of research activities is about right, although a few additions and deletions are recommended in various areas. There are good plans to carry out the programs and they are accomplishing much of what they were established to do, but with some changes in the plans for execution results could improve results significantly. In addition, the programs are reasonably well connected to the users, but here again the committee recommends some improvements. These issues—scope, planning, achievement, and ties to users—are addressed more completely in the specific recommendations themselves:

Top-Level Recommendation 1. The government should continue to support air transportation, which is vital to the U.S. economy and the well-being of its citizens.

A strong national program of aeronautics research and technology contributes to the vitality of the U.S. aeronautics industry, the efficiency of the U.S. air transportation system, and the economic well-being and quality of life of people in the United States. The government has an important role in assuring the best possible air transportation system and the development of related technologies that enable products and services to compete effectively in the global marketplace. This is consistent with the legislative charter for NASA, the National Aeronautics and Space Act of 1958, as amended. The Act specifies that NASA's aeronautics research and technology development should "contribute to a national technology base that will enhance United States preeminence in civil and aeronautical aviation and improve the safety and efficiency of the United States air transportation system."

Top-Level Recommendation 2. NASA should provide world leadership in aeronautics research and development.

To provide leadership, NASA should develop consistent strategic and long-range plans to focus the aeronautics program in areas of national importance. NASA should have well-formulated, measurable, attainable goals at all program levels. To be meaningful, goals should be based on a sound evaluation of future needs, technological feasibility, and relevant economic and other non-technical factors.

Top-Level Recommendation 3. NASA has many excellent technical personnel and facilities to achieve its aeronautics technology objectives but should improve its processes for program management.

Many NASA facilities are world class national assets. In addition, the committee was impressed with the technical expertise of many program personnel. To maximize these assets, NASA needs to improve its program management and systems integration processes, including integration across programs. In particular, NASA should assure clear lines of responsibility and accountability. The use of matrix and line management reporting structures sometimes obscures lines of accountability, and subproject and task-level plans, funding, goals, metrics, staffing, and responsibility are often difficult to define or cannot be clearly traced back to a plan or vision for the program as a whole. Further, NASA should use independent quality assurance processes for program evaluation, and all projects should be evaluated on a regular basis to determine whether continued investment is warranted.

Top-Level Recommendation 4. NASA should eliminate arbitrary time constraints on program completion and schedule key milestones based on task complexity and technology maturity.

Research priorities, funding, and organizational structure change during the course of any research and development effort. However, NASA should resist constant changes and realignments designed to meet artificial five-year sunset requirements. Several long-term research efforts have been disguised as a series of five-year projects with different names so that it is not easy to trace the real progress of the research. In addition, the continuous reorganization and restructuring that occur in response to the five-year sunset rule create an unstable atmosphere that does not permit NASA researchers to pursue the best path to technology maturation. NASA programs need clear exit criteria at the task level that specify when research is complete or ready for transition to industry or other agencies.

Top-Level Recommendation 5. NASA should reduce the number of tasks in its aeronautics technology portfolio.

NASA is trying to do too much within the available budget and resists eliminating programs in the face of budget reductions. Often, there are too many tasks to achieve research objectives in key areas. This overload may be partly the result of including various research tasks within more focused efforts. The committee is concerned that breadth of activities is coming at the expense of depth.

Top-Level Recommendation 6. NASA should pursue more high-risk, high-payoff technologies.

Many innovative concepts that are critical to meeting aviation needs in the next decades will not be pursued by industry or the Federal Aviation Administration (FAA). NASA should fill this void. The committee applauds the inclusion of high-risk, revolutionary sub-projects in many areas and believes the program portfolio could benefit from additional far-reaching efforts with the potential for high payoff. This type of research is critical to investigating the feasibility of innovative concepts and reducing risk to the point where the concepts are suitable for advanced development and transfer to industry or the FAA.

Top-Level Recommendation 7. NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects.

The current research is mostly product-driven, with not enough fundamental work. Fundamental research is crucial for the development of future products. NASA needs to provide researchers the opportunity to conduct forward-looking, basic research that is unencumbered by short-term, highly specified goals and milestones. Historically, NASA has been a world leader in its core research areas; however, that base has eroded in recent years as the amount of in-house basic research diminishes. NASA needs to reassess its core competencies and assure their support through a base research program.

Top-Level Recommendation 8. NASA's aeronautics technology infrastructure exceeds its current needs, and the Agency should continue to dispose of under-utilized assets and facilities.

NASA test facilities create large fixed costs. Some of these facilities are not unique, and long-term fixed costs could be reduced through consolidation and deactivation. This should be an ongoing effort as the needs of the industry change and as validated computational tools reduce or eliminate the need for some experimental facilities.

Top-Level Recommendation 9. NASA should implement full-cost accounting in a way that avoids unintended consequences harmful to the long-term health of the aeronautics program.

NASA is in the process of transitioning from a net accounting system to one that uses full-cost accounting. Under the former scheme, researchers managed only costs directly related to research and development. In full-cost accounting, all project costs are included in the project budget, including institutional infrastructure costs such as: research operations support; direct procurement; direct civil service workforce, benefits, and travel; service pools; center general and administrative; and corporate general and administrative. The committee is concerned that, if not carefully managed, full-cost accounting could result in (1) the closure of critical infrastructure and special-purpose facilities that will be needed for future program execution and (2) a disincentive to use large-scale facilities and flight tests to fully demonstrate technology readiness. This can easily occur if the responsibility for preserving institutional capabilities is delegated to lower level project managers. These project managers will also tend to avoid full-scale flight tests or wind tunnel tests in order to conserve their project budgets, since under full-cost accounting much of the cost of the testing infrastructure will be billed directly to their projects if they perform such tests. The testing infrastructure will be underutilized and will not generate the resources needed to sustain it. The committee recommends that basic research costs should be carried as a line item and not hidden in larger projects and. that large infrastructure costs, such as wind tunnels and full-scale flight testing, should be attributed to the total program and accounted for accordingly.

Top-Level Recommendation 10. NASA should develop a common understanding with the FAA of their respective roles and relationship.

NASA's airspace research ultimately benefits manly government, industry and private organizations with an interest in aviation, including the Department of Defense (DOD), airlines, manufacturers, system operators (air traffic controllers, managers, flight dispatchers and pilots), and the flying public. Practically speaking,

however, the most important customers are the senior managers at the FAA, at other government agencies, and in industry who decide whether they will take applied research products from NASA and continue their development to the point of incorporating them in operational systems. Although much of NASA's airspace research is applicable to systems acquired and operated by DOD, other government agencies, and industry, most of it is intended for application to civil aviation systems acquired, operated and/or certified by the FAA. In this sense, customers also include the many other organizations and officials who influence decisions by the government and industry regarding the advanced development of new systems for civil application.

NASA and the FAA often collaborate at the technical level but there is a real need for more effective management coordination. The need for continued improvement in NASA interactions with its customers is indicated, in part, by the committee's observation that NASA officials seem to perceive interactions with the FAA as more effective than do many FAA managers. NASA officials need to recognize that implementation decisions rest with FAA management (for systems to be implemented by the FAA) and advocacy by NASA, when it runs counter to FAA implementation plans, is not helpful. Problems in this area are exacerbated by (1) the view of many NASA personnel that the success of their research is measured only in terms of the extent to which customers incorporate NASA research in operational systems, and (2) competition that may arise between NASA and other organizations that conduct research on behalf of the FAA or other key customers. As as particular NASA research effort approaches the point where the value of continued development is contingent on operational implementation, the prospective user may decide that implementation is not feasible., NASA should be willing to close out the project that has no future and use the resources to support other research.

Top-Level Recommendation 11. NASA should seek better feedback from senior management in industry and other government organizations.

NASA's customers include aircraft manufacturers, operators, airlines and the FAA. NASA already involves customers in almost all of its research—for example, in the form of joint efforts with the FAA to take research products into the field for testing. Some projects, such as Small Aircraft Transportation Systems (SATS), also sponsor wide-ranging outreach efforts. Usually, however, customer involvement earlier in the process would be beneficial. Early involvement would (1) ensure that researchers understand and are able to respond to user requirements and concerns as early as possible, and (2) probably increase customer buy-in. Customers need not and should not be given veto authority over NASA research, but researchers should be aware of—and research plans should account for—objections or concerns that customers raise. This is especially important for research intended to provide operationally useful products capable of meeting specific functional requirements, but early consultations with user would also be beneficial in a base research program. NASA should improve its relationships with the FAA and other customers by involving them from the early stages of the research and development process through field implementation. One method for improving interaction would be for NASA to convene a yearly meeting, co-chaired by the FAA and NASA Administrators, with participation by industry executives at the chief operating officer level and senior managers from other federal agencies (e.g., Department of Transportation, Department of Homeland Security, and DOD). Topics should be limited to near-term issues and implementation plans, and such a meeting should not be held unless the NASA and FAA Administrators and industry chief operating officers will commit to personally attending.

Top-Level Recommendation 12. NASA should conduct research in selective areas relevant to rotorcraft.

Rotorcraft are an important constituent of air transportation. Many of the research projects currently under way in the Aeronautics Technology Programs, such as synthetic vision and human factors, would be directly relevant to rotorcraft, with only minimal additional investment. NASA could make a significant impact in under-researched areas of rotorcraft such as decision aids, synthetic vision, pilot workload, and situational awareness. Further, the existing U.S. Army programs in rotorcraft technologies and industry research and development in rotorcraft could be leveraged by NASA to meet civilian needs in the area. The committee believes that research in civil applications of rotorcraft will not be conducted elsewhere in government or industry and that NASA's decision to discontinue rotorcraft research has left critical civilian needs unaddressed. Therefore, NASA should consider potential applications to rotorcraft in its research programs in general aviation and transport aircraft.

SUMMARY

The first two top-level recommendations reiterate the importance of air transportation and of NASA's role in the research and development process. Top-level recommendations 3–7 suggest ways the content and/or structure of the programs could be improved, and 8 and 9 identify near-term important concerns that should be addressed. The final three top-level recommendations address the relationships between NASA and its customers. The committee believes that NASA can improve and strengthen its Aeronautics Technology Programs by following this advice.

SPECIFIC ASSESSMENT OF THE VEHICLE SYSTEMS PROGRAM

The Vehicle Systems Program contains seven projects:

- *Breakthrough Vehicle Technologies.* Develops high-risk, high-payoff technologies to dramatically and substantially improve vehicle efficiency and emissions.
- *Quiet Aircraft Technology.* Discovers, develops, and verifies, in the laboratory, technologies that improve quality of life by reducing society's exposure to aircraft noise.
- *Twenty-First Century Aircraft Technology Project.* Develops and validates, through ground-based experiments, the aerodynamic, structural, and electric power technologies that will reduce by 20 percent the fuel burn and carbon dioxide emissions from future subsonic transport aircraft.
- *Advanced Vehicle Concepts.* Develops advanced vehicle concepts and configurations to reduce travel time, expand commerce, and open new markets.
- *Flight Research.* Tests and validates technologies and tools developed by NASA in a realistic flight environment.
- *Ultra-Efficient Engine Technology.* Identifies, develops, and validates high-payoff turbine engine technologies that would reduce emissions.
- *Propulsion and Power.* Researches revolutionary turbine engine technologies, propulsion concepts, and fundamental propulsion and power technologies that would decrease emissions and increase mobility.

The committee noted that VSP has a clear mission statement with a set of fully linked goals and products, but it believes that NASA needs a better understanding of the core competencies required to meet these goals. The committee also believes that the current investment strategy of VSP appears to be ad hoc, with too many unprioritized projects and tasks and no apparent methodology to determine which areas will provide the greatest benefit. The committee recommends that NASA identify and prioritize technologies with respect to their potential benefit to aviation.

The committee was concerned that the recent transition to full-cost accounting will have an unintended effect on certain facilities and infrastructure that are national assets and will compromise the research program by reducing the number of full-scale tests for concept validation.

The committee was concerned that NASA does not always get the benefit of industry involvement at the appropriate management level and suggests that NASA reexamine the composition of its advisory groups.

The committee evaluated a total of 172 tasks in the VSP portfolio. The committee determined that more than 80 percent were of good quality or better, with 30 percent (51 tasks) rated as world-class. The committee identified 91 tasks that were good quality, 6 that were marginal, and 24 that were poor and should be redirected.

SPECIFIC ASSESSMENT OF THE AIRSPACE SYSTEMS PROGRAM

The ASP is organized into four projects:

- *Advanced Air Transportation Technologies.* Develops air traffic management tools to improve the capacity of transport aircraft operations at and between major airports.
- *Virtual Airspace Modeling and Simulation.* Develops models and simulations to conduct trade-off analyses of concepts and technologies for future air transportation systems.
- *Small Air Transportation Systems.* Develops and demonstrates technologies to improve public mobility through increased use of local and regional airports.
- *Airspace Operations Systems.* Develops better understanding, models, and tools to enhance the efficient and safe operation of aviation systems by human operators.

The committee was concerned that NASA's ASP research was generally too focused on short-term, incremental payoff work. NASA should plan ASP research

based on a top-down understanding of the air transportation system. Research should focus on areas of greatest payoff—that is, areas that relieve choke points and other constraints to a more efficient air transportation system.

The committee noted that many existing airspace research tasks will not be completed before the expiration of the projects under which they are currently funded. NASA is establishing a new project, NASA Exploratory Technologies for the National Airspace System (NAS)—NExTNAS—to continue some ongoing research tasks and start some new tasks. The committee recommends that NASA incorporate many ongoing tasks in the NExTNAS project so they can be completed.

The committee determined that the ASP also should support basic research relevant to long-term objectives and other research with a far-sighted vision. More specifically, the committee observed that the portfolio was primarily directed at improving ground-based air traffic management. The committee recommends that NASA continue distributed air-ground research for autonomous separation, with increased effort on the airborne side.

The committee developed a series of findings and recommendations regarding the FAA-NASA relationship. First, the committee noted that two different tools, Research Management Plans and Research Transition Plans, were being used to facilitate the transition of technology from NASA to the FAA.[1] The committee believes that there are worthwhile elements in the Research Transition Plans that could be included in Research Management Plans. In addition, NASA and FAA program directors should vigorously adhere to the Research Management Plan process, with reviews and updates at regular intervals. If either agency determines that the research results will not be implemented, the Research Management Plan should be canceled and NASA should formally reassess the merits of continuing to develop a product that will not improve the operation of the NAS.

The committee also had recommendations about how NASA should measure the success of its research. Currently, it tends to view success in terms of the ability to mature technology and get the FAA to implement it for operational use. Some FAA users, however, believe this view of success leads NASA to focus too much on implementation issues, which NASA may not be qualified to address given its limited operational experience. The committee recommends that NASA and the FAA develop a common definition of what constitutes the successful completion of an applied ASP research task. Success of NASA applied research tasks should not be defined solely in terms of implementation.

SPECIFIC ASSESSMENT OF THE AVIATION SAFETY PROGRAM

The AvSP consists of three projects:

- *Vehicle Safety Technology.* Strengthens aircraft to mitigate vehicle system and component failures, loss of control, loss of situational awareness, and post-crash or in-flight fires.
- *Weather Safety Technology.* Researches and develops technologies to reduce the frequency and severity of weather-related accidents and injuries.
- *System Safety Technology.* Reduces the frequency and severity of aviation accidents and incidents by proactively managing risk in a systemwide approach.

The committee found several examples of work of outstanding quality in AvSP, notably the Aircraft Icing subproject (Weather Safety), the Crew Training task (System Safety), the Structures Health Management subtask (Vehicle Safety), the Mode Confusion subtask (Vehicle Safety), and scale-model development and testing work (Vehicle Safety).

The committee was concerned about recent changes it observed in the quality of the human factors research in AvSP, partly because the number of in-house human factors personnel was decreasing and those who remained were primarily managing the work of contractors. In addition, the committee noted that human factors work did not appear to be well-integrated across the program. The committee recommends that AvSP strengthen in-house human factors research with federal employees who have outstanding human factors expertise. In addition, NASA should consider human factors requirements early in the design phase of all aeronautics technology research projects.

The committee believes AvSP health would be improved if five-year lifetimes were not imposed on every project. Instead, a project should endure for the natural lifetime of the research activity, which would allow basic research efforts to extend be-

[1] The FAA's Free Flight Phase II Office uses Research Transition Plans, which are similar to the Research Management Plans used by other FAA offices.

yond five years. In addition, the committee found the AvSP research portfolio to be too product-oriented and recommended that it include more basic research.

The committee also found that NASA's existing management structure obscures the lines of responsibility and accountability within the program, to the point that it is difficult to trace project, subproject, and task goals to the vision and goals of the program as a whole. The committee recommends that AvSP develop a hierarchy of goals and improve its management processes to create clearer accountability.

The committee believes that several products under development in AvSP duplicate similar products being developed in industry. The committee recommends that AvSP improve its user connections and benchmark its products against similar work performed elsewhere. NASA should not be working in a specific technical area unless it is leading the field. An outside advisory committee structure of some sort could assist AvSP in determining which technical areas it should address.

Finally, the committee noted a large gap in the program portfolio in the area of rotorcraft. NASA could significantly contribute to improving rotorcraft safety without substantial additional investment, particularly in the areas of decision aids, synthetic vision, pilot training, workload reduction, and situational awareness.

Thank you for the opportunity to testify. I would be happy to take any questions the Committee might have.

COMMITTEE FOR THE REVIEW OF NASA'S AERONAUTICS TECHNOLOGY PROGRAM

JOHN KLINEBERG, *Chair,* Space Systems/Loral (retired), Redwood City, California
RICHARD ABBOTT, Lockheed Martin, Palmdale, California
WALTER COLEMAN, Regional Airline Association (retired), McLean, Virginia
ROBERT HILB, United Parcel Service, Louisville, Kentucky
S. MICHAEL HUDSON, Rolls-Royce North America (retired), Indianapolis
RAYMOND LaFREY, MIT Lincoln Laboratory, Lexington, Massachusetts
LOURDES MAURICE, Federal Aviation Administration, Washington, D.C.
THEODORE OKIISHI, Iowa State University, Ames
TOD PALM, Northrop Grumman, El Segundo, California
EDUARDO SALAS, University of Central Florida, Orlando
THOMAS SHERIDAN (NAE), Massachusetts Institute of Technology (emeritus), Cambridge
EDMOND SOLIDAY, United Airlines (retired), Valparaiso, Indiana
ALFRED STRIZ, University of Oklahoma, Norman (from 01/03/2003 to 09/09/2003)
FRANK TUNG, Volpe National Transportation Systems Center (retired), Boston
THOMAS WILLIAMS, Northrop Grumman, Bethpage, New York
DEBRA WINCHESTER, Raytheon, Marlborough, Massachusetts

PANEL ON THE VEHICLE SYSTEMS PROGRAM (VSP)

THOMAS WILLIAMS, *Panel Chair,* Northrop Grumman, Bethpage, New York
MARK BALAS, University of Colorado, Boulder
ROBERT GOETZ, Lockheed Martin (retired), Friendswood, Texas
S. MICHAEL HUDSON, Rolls-Royce North America (retired), Indianapolis
STEVEN IDEN, Lockheed Martin, Fort Worth, Texas
SHEILA KIA, General Motors, Warren, Michigan
GARY KOOPMANN, Pennsylvania State University, University Park
HARRY LIPSITT, Wright State University (emeritus), Yellow Springs, Ohio
LOURDES MAURICE, Federal Aviation Administration, Washington, D.C.
DUANE McRUER (NAE), Systems Technology, Inc., Manhattan Beach, California
THEODORE OKIISHI, Iowa State University, Ames
TOD PALM, Northrop Grumman, El Segundo, California
ALFRED STRIZ, University of Oklahoma, Norman (from 01/01/2003 to 09/09/2003)
MAHLON WILSON, Los Alamos National Laboratory, Los Alamos, New Mexico
J. MITCHELL WOLFF, Wright State University, Dayton
MICHAEL ZYDA, Naval Postgraduate School, Monterey, California

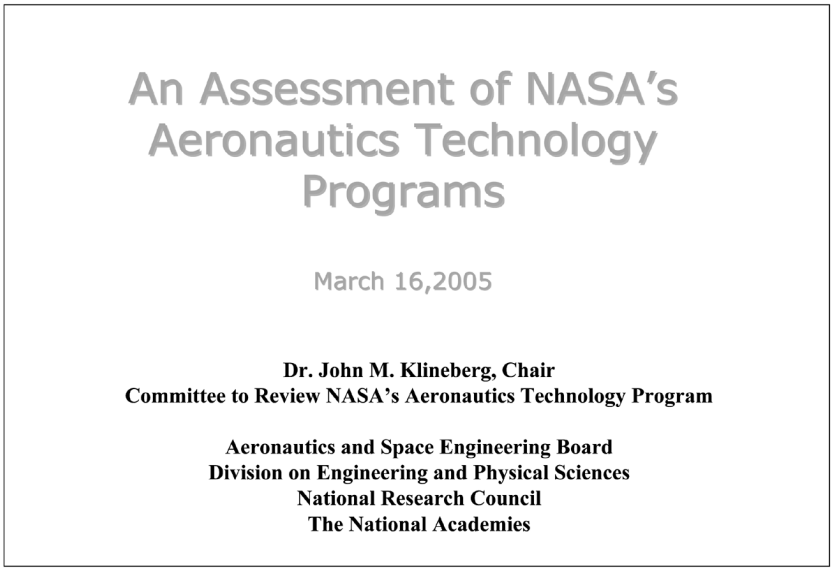
PANEL ON THE AIRSPACE SYSTEMS PROGRAM (ASP)

FRANK TUNG, *Panel Chair,* Volpe National Transportation Systems Center (retired), Boston
CHARLES AALFS, Federal Aviation Administration (retired), Menifee, California
YAAKOV BAR-SHALOM, University of Connecticut, Storrs
BARRY BERSON, Lockheed Martin, Palmdale, California
WALTER COLEMAN, Regional Airline Association (retired), McLean, Virginia
WILLIAM DUNLAY, Leigh Fisher Associates, Tiburon, California

ANGELA GITTENS, Miami-Dade International Airport, Miami, Florida
ROBERT HILB, United Parcel Service, Louisville, Kentucky
R. BOWEN LOFTIN, Old Dominion University, Suffolk, Virginia
J. DAVID POWELL, Stanford University (emeritus), Stanford, California
EDUARDO SALAS, University of Central Florida, Orlando
DEBRA WINCHESTER, Raytheon, Marlborough, Massachusetts

PANEL ON THE AVIATION SAFETY PROGRAM (AvSP)

THOMAS SHERIDAN (NAE), *Panel Chair,* Massachusetts Institute of Technology (emeritus), Cambridge
RICHARD ABBOTT, Lockheed Martin, Palmdale, California
JAMES DANAHER, National Transportation Safety Board (retired), Alexandria, Virginia
VALERIE GAWRON, Veridian Engineering, Buffalo
RONALD HESS, University of California, Davis
ADIB KANAFANI (NAE), University of California, Berkeley
DAVID KOHLMAN, Engineering Systems, Inc., Colorado Springs
RAYMOND LaFREY, MIT Lincoln Laboratory, Lexington, Massachusetts
JOHN McCARTHY, Naval Research Laboratory (retired), Palm Desert, California
EDMOND SOLIDAY, United Airlines (retired), Valparaiso, Indiana



The Study Process

- The NRC established three subject-specific panels* to support the committee in its assessment:
  - Vehicle Systems Panel: 16 members
  - Airspace Systems Panel: 12 members
  - Aviation Safety Panel: 10 members
- Committee: the chair and a subset of members from each of the panels
- Held series of program reviews, made site visits to all NASA Research Centers and evaluated ~ 240 documents submitted by principal investigators
- Assessed portfolio, program plan, technical performance, and user connections in all areas

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* Names and affiliations of panel members are provided with my written statement

Top Level Recommendations - 1

The government should continue to support air transportation, which is vital to the United States economy and the well-being of its citizens.

- A strong national program contributes to the vitality of the U.S. aeronautics industry, the efficiency of the U.S. air transportation system, and the economic well-being of the United States.
- The government has an important role in assuring the best possible air transportation system and in the development of related technologies that enable products and services to compete effectively in the global marketplace.

Top Level Recommendations - 2

NASA should provide world leadership in aeronautics research and development.

- To provide leadership, NASA should develop consistent strategic and long range plans to focus the aeronautics program in areas of national importance.
- NASA should have well formulated, measurable, attainable goals, at all program levels, based on a sound evaluation of future needs, technological feasibility, and relevant economic and other non-technical factors.

Top Level Recommendations - 3

NASA has many excellent technical personnel and facilities to achieve its aeronautics technology objectives but should improve its processes for program management.

- Many NASA facilities are world class national assets, and the committee was impressed with the technical expertise of many program personnel.
- NASA needs to improve its program management and systems integration processes and assure clear lines of responsibility and accountability.
- NASA should use independent quality assurance processes for program evaluation, and all projects should be evaluated regularly.

Top Level Recommendations - 5

NASA should reduce the number of tasks in its aeronautics technology portfolio.

- NASA is trying to do too much on the available budget. Often, there are too many tasks to achieve research objectives in key areas.
- The breadth of activities appears to come at the expense of depth.

Top Level Recommendations - 6

NASA should pursue more high-risk, high-payoff technologies.

- There are many innovative concepts that will not be pursued by industry or the FAA that are critical to meeting aviation needs in the next decades. NASA should fill this void.

Top Level Recommendations - 7

NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs.

- The current research is mostly product driven, with not enough fundamental work. NASA needs to provide researchers the opportunity to conduct forward looking, basic research unencumbered by short term, highly specified goals and milestones.
- NASA needs to reassess its core competencies and assure their support through a base research program.

Top Level Recommendations - 8

NASA's aeronautics technology infrastructure exceeds its current needs and the Agency should continue to dispose of underutilized assets and facilities.

- NASA test facilities create large fixed costs. Some of these facilities are not unique and long term fixed costs could be reduced through selected consolidation and deactivation.

Top Level Recommendations - 11

NASA should seek better feedback from industry and other government organizations.

- NASA should improve its relationships with the FAA and other customers by involving them from the early stages of the R & D process through field implementation.
- One method for improving interactions would be to convene a yearly meeting, co-chaired by the FAA and NASA Administrators, with COO-level industry executives. Topics should be limited to near-term issues and implementation plans.

BIOGRAPHY FOR JOHN M. KLINEBERG

Dr. Klineberg recently retired as President of Space Systems/Loral, a major provider of commercial communications satellite systems and services, and Vice President of Loral Space & Communications, of which SS/L is a wholly owned subsidiary. He continues his association with the company as a member of SS/L's Board of Directors. Before becoming the President of SS/L in 1999, Dr. Klineberg was Executive Vice President for Globalstar programs, where he led the successful development, production and deployment in orbit of the Globalstar satellite constellation for providing a new generation of telephone services. Before joining Loral in 1995, Dr. Klineberg spent 25 years with the National Aeronautics and Space Administration (NASA) in a variety of management and technical positions. He was the Director of the Goddard Space Flight Center; Director of the Lewis (now Glenn) Research Center; Deputy Director of the Lewis Research Center; Deputy Associate Administrator for Aeronautics and Space Technology at NASA Headquarters, and a research scientist at the Ames Research Center. Before beginning his career at NASA, he conducted fundamental studies in fluid dynamics at the California Institute of Technology and worked at the Douglas Aircraft Company and the Grumman Aircraft Company. Dr. Klineberg has received many awards for his outstanding service to NASA and his significant contributions to the fields of aeronautics and space systems, including: the NASA Distinguished Service Medal; the NASA Outstanding Leadership Medal; the NASA Goddard Award of Merit; the U.S. Government's ranks of Distinguished Executive and Meritorious Executive; the AIAA Barry M. Goldwater Education Award; and the Engineer of the Year Award from the University of Maryland. Among his other activities, he is a member of the Board of Directors of The Charles Stark Draper Laboratory Inc, Cambridge, MA; a member of the Board of Directors of Swales Aerospace, Beltsville, MD; a member of the National Research Council's Aeronautics and Space Engineering Board; an honorary Board member of the National Space Club; a member of the International Astronautical Federation; a fellow of the American Astronautical Society; and a fellow of the American Institute of Aeronautics and Astronautics (AIAA). He earned his Bachelor's degree in engineering from Princeton University and his Master's and doctoral degrees from the California Institute of Technology.

Chairman CALVERT. Thank you. Dr. Antón, you are recognized for five minutes.

STATEMENT OF DR. PHILIP S. ANTÓN, DIRECTOR, CENTER FOR ACQUISITION AND TECHNOLOGY POLICY, RAND

Dr. ANTÓN. Chairman Calvert, and distinguished Members of the Committee, thank you for inviting me to testify today on the roles and issues of NASA's wind tunnel and propulsion test facilities for American aeronautics. It is an honor and a pleasure to be here.

My comments today are informed by a recent RAND Corporation assessment of America's needs for wind tunnel and propulsion test facilities, and NASA's capabilities to serve those needs.

What would be the consequence to American aviation of NASA closing one or more wind tunnels? When NASA closes one or more strategically important wind tunnel propulsion test facilities, it eats away at our aeronautics future. Aeronautics maturity does not nullify the need for test facilities, but in fact, relies on the availability and effective use of test facilities to provide important capabilities.

Are there particular wind tunnels that would be especially detrimental to close? It would be detrimental to close any 29 of 31 NASA test facilities that serve national needs. Nine facilities would be especially detrimental to close. In an attempt to identify which facilities would be especially detrimental to close, I utilized the data from the RAND study using the following criteria. The facilities most detrimental to close are those that serve national needs that can not be met by any other U.S. facility, regardless of cost, moderate improvements, or access concerns. It is important to note the following. If the facilities that did not make this list are closed, then the testing costs to go to other U.S. facilities may be much higher, and relying on them may, in the long run, cost this country more money. Higher testing costs at alternative U.S. facilities may drive users to cheaper foreign facilities. The facilities most detrimental to close would affect any national strategic need from all sectors, NASA research, civil aviation, military, and space, not just NASA research needs.

There are nine such facilities meeting these criteria that would be especially detrimental to close. The Ames 12-Foot High-Reynolds number pressure wind tunnel, the Ames National Full-Scale Aerodynamics Complex, the Glenn Icing Research Tunnel, the Langley National Transonic Facility, the Langley Transonic Dynamics Tunnel, the Langley 8-Foot Hypersonic High-Temperature Tunnel, The Langley 20-Inch Mach 6 Tetrafluoromethane and Mach 6 Air, and finally, the Glenn Hypersonic Tunnel Facility.

Are there ways NASA could seek outside funding for its wind tunnels? There are outside funding options for NASA, but their viability is unclear. Possibilities include retainer or consortia fee from outside users from industry, or opening NASA's facilities to international users.

NASA could also explore shared funding mechanisms with the DOD, but that would not reduce the burden on the federal budget, and begs the question of who in the Federal Government is responsible for looking out for the long-term strategic aeronautic needs of the Nation.

Are there ways NASA could change its accounting practices regarding its wind tunnels? Elimination of full-cost recovery for test facilities and identifying shared financial support are recommended

options. The full-cost recovery currently imposed by NASA on centers discourages use and endangers strategic facilities by causing wide, unpredictable price fluctuations. Shared support would be relatively small. Even the total operating costs of about $130 million per year for these important facilities make up less than one percent of NASA's overall budget, and are infinitesimal related to the $32–58 billion the Nation invests annually in aerospace RDT&E.

RAND did identify a few accounting options. NASA Langley and Glenn tax the research resident programs to supplement user fees and ensure that test facilities are kept open. In addition, NASA headquarters could consider creating a line item in the budget to provide financial shared support for strategic facilities. The DOD's Major Range and Test Facility Base model, with direct financial support, is a mature model, and has served the DOD well.

What are the disadvantages of relying on foreign tunnels, and how serious are they? Relying on foreign facilities incurs serious security risks, and unclear access and availability risks. An assessment performed by the DOD Counterintelligence Field Activity on foreign test facilities indicated that there are real security risks to testing in foreign facilities.

In conclusion, the most critical issues are to develop an aeronautic test technology vision and plan, identify shared financial support, and stop applying full-cost recovery to wind tunnels. A national aeronautics policy would greatly inform and guide an aeronautics test technology plan.

While generally not redundant within NASA, a few of NASA facilities are redundant with those facilities maintained by the DOD, and others are redundant with commercial facilities. NASA should work with the DOD to analyze the viability of a national reliance plan. Unless NASA, in collaboration with the DOD, addresses specific deficiencies, investment needs, budgetary difficulties, and collaborative possibilities, the Nation risks losing the competitive aeronautics advantage it has enjoyed for decades.

Thank you for the opportunity to contribute to the debate regarding this important issue area in aeronautics. I am happy to answer any questions from the Committee, and I would like to request that my full testimony be entered into the record.

Chairman CALVERT. Without objection, so ordered.

[The prepared statement of Dr. Antón follows:]

PREPARED STATEMENT OF PHILIP S. ANTÓN

Chairman Calvert, and distinguished Members of the Committee, thank you for inviting me to testify today on the roles and issues of NASA's wind tunnel and propulsion test facilities for American aeronautics. It is an honor and pleasure to be here.

INTRODUCTION

My comments[1] today are informed by a recent RAND Corporation assessment of America's needs for wind tunnel and propulsion test (WT/PT) facilities,[2] and NASA's capabilities to serve those needs. We focused on the needs for, and capabilities of, the large (and, thus, more expensive to build and operate) test facilities in six types of WT/PT facilities—subsonic, transonic, supersonic, hypersonic, hypersonic propulsion integration, and direct-connect propulsion—as well as any management issues they face. RAND conducted this research from June 2002 through July 2003, followed by refinement of our findings, peer review, and the generation of study reports. The results of the RAND study were published in 2004.[3] The study methodology involved a systematic review and analysis of national research, development, test, and evaluation (RDT&E) and sustainment needs, utilization trends (historical and projected), test facility capabilities, and management issues.

While some things have changed since our study concluded (particularly declines of NASA's research programs and aeronautics budget and closure of three facilities), our technical assessments and much of our strategic assessments remain valid.

In addition to leading this study, I have also remained active in supporting government assessments of issues and options related to WT/PT facilities. My statements below also reflect analysis and experiences related to those activities.

Study Activities

To answer these study questions, RAND conducted intensive and extensive interviews with personnel from NASA headquarters; personnel from NASA research centers at Ames (Moffett Field, Calif.), Glenn (Cleveland, Ohio), and Langley (Hampton, Va.), which own and manage NASA's WT/PT facilities; the staff of the Department of Defense's (DOD's) WT/PT facilities at the U.S. Air Force's Arnold Engineering and Development Center (AEDC, at Arnold AFB, Tenn.); selected domestic and foreign test facility owners and operators; U.S. Government and service project officers with aeronautic programs; and officials in a number of leading aerospace companies with commercial, military, and space access interests and products.

In addition to RAND research staff, the study employed a number of distinguished senior advisers and consultants to help analyze the data received and to augment the information based on their own expertise with aeronautic testing needs and various national and international facilities.

Finally, the study reviewed and benefited from numerous related studies conducted over the past several years.

Perspectives on the Study Approach Used by RAND

The analytic method used in the study to define needs did not rely on an explicit national policy and strategy document for aeronautics in general or for WT/PT facilities in particular because they do not exist. Lacking such explicit needs documents, we examined what categories of aeronautic vehicles the United States is currently

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[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of RAND or any of the sponsors of its research. This product is part of the RAND Corporation testimony series. RAND testimonies record testimony presented by RAND associates to federal, State, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

[2] Throughout this testimony, I use the term "WT/PT facilities" to mean wind tunnel facilities and propulsion test facilities. Since individual facilities within this designation can be either wind tunnel facilities, propulsion test facilities, or both, "WT/PT facilities" serves as a generic term to encompass them all. That being said, when a specific facility is talked about, for clarity, I refer to it using its owner/operator, size, and type. As well, the term "test facilities" and "facilities" can be substituted to mean "WT/PT facilities." Of course, NASA owns and operates other types of test facilities, but my conclusions and recommendations do not apply to them unless explicitly stated doing so.

[3] See Antón, Philip S., Richard Mesic, Eugene C. Gritton, and Paul Steinberg, with Dana J. Johnson, Michael Block, Michael Brown, Jeffrey Drezner, James Dryden, Tom Hamilton, Thor Hogan, Deborah Peetz, Raj Raman, Joe Strong, and William Trimble, *Wind Tunnel and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Meet National Needs,* Santa Monica, Calif.: RAND Corporation, MG–178–NASA/OSD, 2004, available at *www.rand.org/publications/MG/MG178/*; and Antón, Philip S., Dana J. Johnson, Michael Block, Michael Brown, Jeffrey Drezner, James Dryden, Eugene C. Gritton, Tom Hamilton, Thor Hogan, Richard Mesic, Deborah Peetz, Raj Raman, Paul Steinberg, Joe Strong, and William Trimble, *Wind Tunnels and Propulsion Test Facilities: Supporting Analyses to an Assessment of NASA's Capabilities to Serve National Needs, Santa Monica, Calif.: RAND Corporation, TR–134–NASA/OSD, 2004, available at www.rand.org/publications/TR/TR134/.*

pursuing, plans to pursue, and will likely pursue based on strategic objectives and current vehicles in use.

Also, as *enabling infrastructures,* WT/PT facility operations are not funded directly by specific line items in the NASA budget.[4] The study's determination of WT/PT facility needs and the resulting conclusions and recommendations are therefore not based on the federal budget process as a direct indicator of policy dictates of facility need. We determined WT/PT facility need by identifying what testing capabilities and facilities are required given current engineering needs, alternative approaches, and engineering cost/benefit trade-offs. This, of course, can lead to a bias in the findings in that these assessments may be overly reflective of what the engineering field determines is important rather than what specific program managers are willing to spend on testing because of program budget constraints. Thus, when a needed facility is closed because of a lack of funding, there is a disconnect between current funding and prudent engineering need. This indicates that the commercial and federal budget processes may be out of step with the full cost associated with research and design of a particular vehicle class, indicating a lack of addressing long-term costs and benefits.

Finally, while the study's focus was on national needs and NASA's WT/PT facility infrastructure, national needs are not dictated or met solely by NASA's test infrastructure; DOD, U.S. industry, and foreign facilities also serve many national needs. Our study did look at *technical* capabilities of alternate facilities. However, the study was *not* chartered or resourced to examine the entire sets of cost and other data for these alternative facilities to fully understand consolidation opportunities *between NASA and non-NASA WT infrastructures.* Based on our findings, however, such a broader study is important and warranted.

WHAT WOULD BE THE CONSEQUENCE TO AMERICAN AVIATION OF NASA CLOSING ONE OR MORE WIND TUNNELS?

When NASA closes one or more strategically important wind tunnel and propulsion test facilities, it eats away at our aeronautic future.

Closing facilities needed for strategic reasons cuts off the country's options for research and development of current and future concepts and vehicles. Even if current budgetary priorities limit on-going aeronautic research, we should not "eat our seed corn" given that it often takes a decade to build these kinds of major facilities, more years to fund them; and replacing all these facilities would cost billions. Does the country want to have a future in advanced aeronautics, or will it decide to relegate future aeronautic leadership to foreign countries who are aggressively pursuing our position and its economic fruits?

To understand why this is so, let me review why this country needs wind tunnel and propulsion test facilities. In particular, I would emphasize that this concern applies to strategically important facilities, not simply all facilities regardless of current need.

Background

Wind tunnel and propulsion test facilities continue to play important roles in the research and development (R&D) of new or modified aeronautic systems and in the test and evaluation (T&E) and sustainment of developmental systems. The Nation has invested about a billion dollars (an unadjusted total) in NASA's existing large, complex WT/PT facilities[5] (some dating from the World War II era), which has created a testing infrastructure that has helped secure the country's national security and prosperity through advances in commercial and military aeronautics and space systems. Replacing these facilities would cost billions in today's dollars.[6]

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[4] The *construction* of government WT/PT facilities are, however, very large expenditures that require explicit congressional funding, and certain facilities such as the National and Unitary facilities have associated congressional directives regarding operation and intent.

[5] The Book Value of 26 of the 31 NASA facilities that fell within the scope of RAND's study amounted to about $0.9 billion dollars based on data identified in the NASA Real Property Database. The book value is the simple sum of unadjusted dollars invested in past years in facility construction or modernization. Because, in many cases, decades have passed since construction, the book value is significantly lower than the cost it would take to build these facilities today.

[6] The current replacement value (CRV) of 26 of the 31 NASA facilities that fell within the scope of RAND's study totaled about $2.5 billion dollars based on data identified in the NASA Real Property Database. The CRV is derived by looking at similar types of buildings (e.g., usage, size) within the Engineering News Magazine's section on construction economics. The magazine uses a 20-city average to come up with rough estimates of how much a building would cost to replace. Most NASA finance and facilities people believe that this average underestimates the actual cost of replacing WT/PT facilities, since they are more complex buildings than the "simi-

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Many of these test facilities were built when the United States was researching and producing aircraft at a higher rate than it does today and before advances in modeling and simulation occurred. This situation raises the question of whether NASA needs all the WT/PT facilities it has and whether the ones NASA does have serve future needs. In fact, over the past two decades, NASA has reduced its number of WT/PT facilities by one-third. More recently, the Agency has closed additional facilities. In addition, some of the remaining facilities are experiencing patterns of declining use that suggest they too may face closure.

Despite Aeronautic Maturity, Test Facilities Are Still Critical

Some argue that the facility testing capabilities that have been built up over the years are no longer needed. They assert that the aeronautics industry has matured and that any test capability needs can be met through computer simulation or other means.

Our research generally confirms industry maturity, but that maturity *relies on* the test facility infrastructure. No vehicle classes have gone away, and for each new design in a class, it will still be necessary to predict airflow behavior across a range of design considerations.

Although applied aeronautics encompasses relatively mature science and engineering disciplines, there is still significant art and empirical testing involved in predicting and assessing the implications of the interactions between aeronautic vehicles and the environments through which they fly. Designers are often surprised by what they find in testing their concepts despite decades of design experience and dramatic advances in computer modeling and simulation known as computational fluid dynamics (CFD). This is, of course, especially true for complex new concepts that are not extensions of established systems with which engineers have extensive practical design and flight experience. But even improving the performance at the margin of well-established and refined designs—for example, commercial jet liners in areas such as reduced drag, fuel efficiency, emissions, noise, and safety (e.g., in adverse weather)—depends on appropriate and sufficient WT/PT facility testing.

Insufficient testing or testing in inappropriate facilities can lead to erroneous estimations of performance. Missed performance guarantees can impose extremely costly penalties or redesign efforts on airframe manufacturers, overly conservative designs from low estimations prevent trade-offs such as range for payload, and even a seemingly small one-percent reduction in drag equates to several million dollars in savings per year for a typical aircraft fleet operator.

For engineers to predict with sufficient accuracy the performance of their vehicles during design and retrofit, they need a range of capabilities during testing, including high Reynolds number (Rn),[7] flow quality, size, speed, and propulsion simulation and integration. These capabilities cannot be met by a single test facility but rather require a suite of facilities.

While CFD has made inroads in reducing some empirical test requirements capabilities, this technology will not replace the need for test facilities for the foreseeable future. Flight testing complements but does not replace WT/PT facilities because of its high costs and instrumentation limitations. The aeronautic engineering community does not have well-accepted handbooks of facility testing "best practices" or even rules of thumb from which to deduce testing requirements, nor is it possible from historical data to accurately predict returns on specific facility testing in terms of programmatic cost savings or risk reduction.

Thus, *aeronautic maturity does not nullify the need for test facilities but in fact relies on the availability and effective use of test facilities to provide important capabilities.* The Nation continues to need general-purpose WT/PT facilities across all speed regimes, as well as for specialty tests facilities. These facilities advance aerospace research, facilitate vehicle design and development, and reduce design and performance risks in aeronautic vehicles.

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lar" building types available through engineering economics. Unfortunately, NASA has not found a better metric to compare buildings across the various field centers.

[7] The Reynolds number is a nondimensional parameter describing the ratio of momentum forces to viscous forces in a fluid. The Mach number is a more familiar nondimensional parameter, describing the ratio of velocity to the sound speed in the fluid. When the flows around similarly shaped objects share the same nondimensional Rn and Mach parameters, the topology of the flow for each will be identical (e.g., laminar and turbulent flow distribution, location of separation points, wake structure), and the same aerodynamic coefficients will apply. Airflow behavior changes nonlinearly and unpredictably with changes in Rn. Thus, it is important to test the flow conditions at flight (or near-flight) Rn to ensure that the flows behave as expected and that conditions such as undesired turbulence, separations, and buffeting do not occur.

ARE THERE PARTICULAR WIND TUNNELS THAT IT WOULD BE ESPECIALLY DETRIMENTAL TO CLOSE?

It would be detrimental to close any 29 of the 31 NASA test facilities that serve national needs. Nine facilities—for which no alternatives exist within the U.S. regardless of cost—would be especially detrimental to close.

Identifying Facilities Detrimental to Close: A "Minimum Set"

RAND used four factors to assess which NASA facilities constitute the minimum set of strategically important facilities: alignment with national needs, technical competitiveness, redundancy, and usage.

First, facilities in the minimum set must serve national needs. Thus, facilities that no longer meet national needs are discarded from consideration out of hand.

Next, the *primary* NASA facilities that serve national needs are included in the set. These are the primary facilities that NASA has to serve each national need. Until the need disappears or analysis can determine that it is better served outside NASA (see the discussion on collaboration and reliance below), the Agency should include it in the minimum set.

Finally, facilities that are redundant to the primary facilities may or may not be included in the set depending on their technical competitiveness and utilization.

Nearly All of NASA Facilities Serve Strategic National Needs

We examined how well NASA's portfolio of 31 test facilities aligns against national strategic needs in each of six categories—subsonic, transonic, supersonic, hypersonic, hypersonic propulsion integration, and direct—connect propulsion. Nearly all existing NASA facilities serve at least one strategic need category important to the Nation's continuing ability to design aeronautic vehicles. We found very little overlap and very few gaps in coverage.

NASA's WT/PT facilities have been generally consistent with the testing needs of NASA's research programs, as well as with those of the broader national research and development programs. Currently, redundancy is minimal across NASA. Facility closures in the past decade have eliminated almost a third of the Agency's test facilities in the categories under review in this study. In nearly all test categories, NASA has a single facility that serves the general- or special-purpose testing needs, although some primary facilities also provide secondary capabilities in other test categories. We found two noncritical WTs: (1) the Langley 12-Foot Subsonic Atmospheric WT Lab, which is redundant to the Langley 14x22-Foot Subsonic Atmospheric WT, and (2) the Langley 16-Foot Transonic Atmospheric WT, which is generally redundant to the Ames 11-Foot Transonic High-Rn and Langley National Transonic Facility WTs run in low-Rn conditions.

There are gaps in NASA's ability to serve all national needs. In most of these cases, though, DOD or commercial facilities step in to serve the gaps.

Finally, some of NASA's facilities that serve national needs have been mothballed or closed. While mothballing an important facility is preferred to abandonment, mothballing involves the loss of workforce expertise required to safely and effectively operate the facility. Thus, mothballing is not an effective solution for dealing with long periods of low utilization, and it puts capabilities at risk.

29 of 31 Facilities Should Be in NASA's "Minimum Set"

Based on RAND's assessment of national needs, survey data of test users' strategic needs to produce the kinds of vehicles they research or develop, technical capabilities within NASA, and usage data, RAND's study concluded that 29 of the 31 existing major NASA test facilities constitute the "minimum set" of facilities important to retain and manage to serve national needs. Thus, the test complex within NASA is both responsive to serving national needs and mostly "right sized" to the range of national aeronautic engineering needs. Closing any of the 29 would be detrimental.

It is important to bear in mind that, while not the case within NASA, a few of NASA's facilities are redundant when considering the technical capabilities of the larger set of facilities maintained by commercial entities and by the DOD's AEDC. All such NASA facilities had strategic advocacy resulting from unique features such as cost effectiveness (e.g., due to their smaller size), technical capabilities, and proximity to researchers. Whether these redundancies amount to the "unnecessary duplication" of facilities prohibited by the National Aeronautics and Space Act of 1958 was beyond the scope of RAND's study. Further analysis of technical, cost, and availability issues is required to determine whether WT/PT facility consolidation and right-sizing across NASA and AEDC to establish a national reliance test facility plan would provide a *net savings* to the government and result in a smaller minimum set of WT/PT facilities at NASA.

Congress has expressed interest in collaboration between NASA and the DOD.[8] NASA and the DOD (through the National Aeronautics Test Alliance—NATA) have made some progress in their partnership,[9] but NASA's recent unilateral decision to close two facilities at Ames without high-level DOD review shows that progress has been spotty. Some in industry have expressed an interest in exploring collaborative arrangements with NASA and hope that RAND's study will reveal to others in industry the risks to NASA's facilities and the need for industry to coordinate its consolidations with those of NASA and the DOD. Our study provides insights into the problem but offers only glimpses into the wider possibilities and issues surrounding broader collaboration.

Which Are Especially Detrimental to Close?

In an attempt to identify which of those 29 facilities would be especially detrimental to close, I utilized the data from the RAND study using the following criteria:

> *The facilities most detrimental to close are those that serve national needs that cannot be met by any other U.S. facility regardless of cost, moderate improvements, or access concerns.*

In using these criteria to form a list of those facilities especially detrimental to close, it is important to note the following:

1. If the facilities that did not make this list are closed, then the testing costs to go to other U.S. facilities may be much higher, and relying on them may, in the long run, cost this country more money, especially in future research programs that would probably have to spend more on testing in alternative facilities than they would otherwise. In many cases, alternative facilities are more sophisticated and have more capabilities than needed (e.g., they are larger or have additional technical features that cost more). An analogy would be to eliminate the ability of a consumer to use a compact pickup truck, leaving them the only alternative of driving a semi truck to work despite the fact that the added capabilities of the semi were not needed in all cases.
2. Higher testing costs at alternative U.S. facilities may drive users to cheaper foreign facilities, reducing the amount of domestic facility business and incurring risks discussed later related to foreign facility testing.
3. Each test facility is unique in some way, so this list does not consider all technical differences.
4. The facilities most detrimental to close would affect any strategic national need from all sectors—NASA research, civil aviation, military, and space—not just NASA research needs. Therefore, this list in some way assumes that NASA, as a "National" agency, still has a role in supporting not just NASA's own research needs but the Nation's aeronautic needs. With a lack of a recent national aeronautics policy, it is difficult to see if there has been an objective, long-term policy shift away from NASA having a role as a national steward of government infrastructure, or whether there has been just a *short-term* budgetary prioritization forcing NASA to focus on infrastructure needed for its own current research.

There are nine facilities meeting these criteria based on the data available from the RAND study that would be especially detrimental to close:

- *Subsonic*
  - — Ames 12-Foot High-Reynolds number pressure wind tunnel, needed, for example, for high-lift vehicle research and development such as super-short take-off and landing commercial and military passenger, cargo, and tanker transports,[10]

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[8] See, for example, the GAO report on NASA and DOD cooperation entitled *Aerospace Testing: Promise of Closer NASA/DOD Cooperation Remains Largely Unfulfilled,* 1998.

[9] For example, NATA has produced a number of joint NASA and DOD consolidation studies.

[10] This facility is currently closed but is the only U.S. capability in this category and has been historically important for civil, space, and military vehicle RDT&E. Currently, however, the facility has some undesirable features and limitations that render it unacceptable for both commercial transport and tactical aircraft development when compared with the two superior facilities in Europe: the QinetiQ 5-Metre in the United Kingdom and the ONERA F1 in France. Users are currently using facilities in Europe, particularly the QinetiQ 5-Metre.

— Ames National Full-Scale Aerodynamics Complex (NFAC), needed, for example, for rotorcraft and noise reduction research and development, and

— Glenn Icing Research Tunnel, needed for icing research and certification testing, for example, to prevent accidents from flying in icing conditions.

- *Transonic*

  — Langley National Transonic Facility (NTF), needed, for example, to validate computational models and test data from lower Reynolds number facilities for transports and high-dynamic fighters,

  — Langley Transonic Dynamics Tunnel (TDT), needed, for example, to test for noise problems and dynamic effects such as the tail buffeting problem not discovered by the F/A–18A program until flight testing.

- *Hypersonic* (needed to pursue future concepts of hypersonic transport or space access vehicles and missiles)[11]

  — Langley 8–Foot High-Temperature Tunnel (HTT), needed for a broad range of moderately high Mach numbers, is the most important hypersonic facility in this list,

  — Langley 20-Inch Mach 6 Tetraflouromethane (M6 CF4) and the companion Langley 20-Inch Mach 6 Air, needed, for example, to understand real-gas effects,

  — Glenn Hypersonic Tunnel Facility (HTF), needed, for example, to understand whether combustion byproducts in other facilities is preventing advances in air-breathing Ramjet and Scramjet that don't require carrying oxygen for combustion.

Note that most of these facilities could not be operated as a commercial venture without shared financial support (as evidence by their low current utilization and financial difficulties). Nearly all would be too expensive for industry to build on their own. Thus, emphasizing the significance of losing them.

ARE THERE WAYS NASA COULD SEEK OUTSIDE FUNDING FOR ITS WIND TUNNELS?

There are outside funding options for NASA, but their viability is unclear.

The RAND study did not explore in depth the question of outside funding mechanisms, but there are some obvious candidates for consideration. Possibilities to explore include retainer or consortia fees from outside users from industry, or opening NASA's facilities to international users (assuming we want to make our national capabilities available to potential economic competitors). NASA is already exploring some of these options with U.S. industry.

NASA could also explore shared funding mechanisms with the DOD, but that, of course, would not reduce the burden on the federal budget and begs the question of who in the Federal Government is responsible for looking out for the long-term strategic aeronautic needs of the Nation.

ARE THERE WAYS NASA COULD CHANGE ITS ACCOUNTING PRACTICES REGARDING ITS WIND TUNNELS?

Elimination of full-cost recovery for test facilities and identifying shared financial support are recommended options.

Why Are Financial Accounting and Shared Support So Important?

The current full-cost recovery (FCR) accounting policy imposed by NASA on the centers discourages use and endanger strategic facilities by causing wide, unpredictable price fluctuations in a world where government and commercial testing budgets are under pressure and are set years in advance. It appears reasonable to ask users to pay for the costs *associated with their tests* (i.e., to pay for the short-term benefits), but forcing them to pay all operating costs (including long-term priorities such as the costs for facility time they are not using) through FCR *direct test pricing* (as is done at Ames) is ill advised.

[11] Note that users in our surveys rated nearly all of NASA's hypersonic facilities as essential for continued progress. Thus, it is particularly difficult to identify those that are especially detrimental to lose given that each facility offers important capabilities. Because hypersonics is still relatively immature, those differences are important in resolving the wide variety of challenges facing the research, development, and production communities. Nevertheless, the Langley 8–Foot HTT is definitely the most advocated facility, and the two Langley Mach 6 tunnels and the Glenn HTF offer significant capabilities not available elsewhere in the U.S.

FCR has especially serious implications for the financial health of those facilities that are underutilized (about one-third of the facilities in general, with variation across the test facility category types). Average-cost-based pricing, decentralized budgeting, poor strategic coordination between buyers and providers of NASA WT/PT facility services, and poor balancing of short- and long-term priorities inside and outside NASA are creating unnecessary financial problems that leave elements of the U.S. WT/PT facility capacity underfunded. With declining usage and FCR accounting, these facilities run the risk of financial collapse. Identifying shared financial support will keep NASA's minimum set of facilities from financial collapse given the long-term need for these facilities.

In the extreme case at Ames, the lack of resident aeronautics research programs, combined with the center management's strategic focus toward information technology and away from ground test facilities, has left Ames WT/PT facilities without support beyond user testing fees. Thus, Ames WT/PT facilities are vulnerable to budgetary shortfalls given low utilization. Two Ames facilities are unique and needed in the United States, yet they have already been closed. One (the Ames NFAC) is in the process of being transferred to DOD operation, but the other remains abandoned.

Shared support would be relatively small. Even the total operating costs of about $130 million per year for these important facilities make up less than one percent of NASA's overall budget and are infinitesimal relative to the $32–58 billion the Nation invests annually in aerospace research, development, test, and evaluation (RDT&E).

If NASA management is not proactive in providing financial support for such facilities beyond what is likely to be available from FCR pricing, then the facilities are in danger of financial collapse. In the near-term, this market-driven result may allow NASA to reallocate its resources to serve more pressing near-term needs at the expense of long-term needs for WT/PT facilities. Given the continuing need for the capabilities offered by these facilities for the RDT&E of aeronautic and space vehicles related to the general welfare and security of the United States, the right-sizing NASA has accomplished to date, the indeterminate costs to decommission or eliminate these facilities, the significant time and money that would be required to develop new replacement WT/PT facilities, and the relatively modest resources required to sustain these facilities, care should be taken to balance near-term benefits against long-term risks. Collaboration, reliance, and ownership transferal options for obtaining alternative capabilities in lieu of certain facilities are possible, but even if these options are exercised, many NASA facilities will remain unique and critical to serving national needs. Key to subsequent analysis of these options is the collection and availability of the full costs of operating these facilities as well as the full costs associated with relying on alternative facilities.

Accounting Options

RAND identified a few accounting options to recovering full operating costs through user fees.

Taxing Research Programs. NASA Langley and Glenn tax the resident research programs to supplement user fees and ensure that test facilities are kept open. However, the ability to keep current facilities open through those taxing mechanisms are at risk as the aeronautics research program budgets continue to decline. Also, NASA Ames currently does not have a resident aeronautics research program to tax.

Line Item and MRTFB-Like Model. NASA Headquarters could consider creating a line item in the budget to provide financial shared support for strategic facilities. The DOD's Major Range and Test Facility Base (MRTFB) model, with direct financial support, is the most mature and has served the DOD well. This support has allowed the DOD to keep its strategic facilities open through times of low utilization. The DOD Financial Management Regulation provide lessons learned through its user accounting and management guidelines, essentially charging users for the direct costs associated with their tests but not the full costs to keep the facility open for the year.

UK MOD Outsourcing Model. Finally, another accounting and management option is the facility operations outsourcing model recently enacted by the UK Ministry of Defence (MOD) for its T&E facilities.

Under this model, the MOD identified the T&E facilities it needed for the future and then privatized the operation of those facilities. Ownership of the fixed equipment and land were retained by the MOD for indemnity reasons, but ownership of the movable items was transferred to a private company, QinetiQ.

Under the model, QinetiQ has a 25-year contract for operating the facilities. The contract is structured to encourage the company to implement efficiencies while retaining the long-term health and availability of the facilities. QinetiQ gets to keep the efficiency savings realized during the then-current five-year period of the contract. When the next five-year period is negotiated, the MOD receives the benefits of the efficiencies by adjusting the period funding amount to the new efficiency level.

The key to this model was the MOD's access to all facility costs to ensure that support levels in the contract guarantee the success of QinetiQ and the facilities. In U.S. parlance, this would require open full-cost accounting not only of the facilities but also of the acquisition programs that rely on the facilities.

The model employs shared support for the facilities. In the current five-year period, the MOD centrally funds 84 percent of facility costs to keep the facilities' doors open. Sixteen percent of the funding comes from programs to support direct costs of specific program test activities. In the past, the MOD had to query programs for how much they would put in first. Now, the health of the facilities are ensured and planned for, regardless of the realized utilization in the known-variable environment.

The MOD implemented the model in 2003, so the long-term success of it has yet to be established. Nevertheless, some important observations can be made. The MOD made a conscious, objective decision about which facilities are strategically important in the long term (25 years, in this case). The ministry ensured that it accounted for all the costs to inform its decision. It provided shared support for the facilities to ensure their long-term health, independent of the yearly utilization. While not having to perform the actual operation of the facilities, the MOD provided controls and incentives to realize efficiency and cost savings while ensuring quality and availability of needed facilities. NASA could learn from these observations.

Full-Cost Accounting. Finally, while our study recommended that NASA should change its policy of Full-Cost *Recovery* (where operators must recover the full annual costs of operating facilities from the users regardless of the actual utilization of those facilities), we applaud NASA's implementation of Full-Cost *Accounting* (that ensures we know the full costs of operating activities). It is important to know the full costs of operations to inform management analysis and decision-making.

WHAT ARE THE DISADVANTAGES OF RELYING ON FOREIGN WIND TUNNELS, AND HOW SERIOUS ARE THEY?

Relying on foreign facilities incurs serious security risks, and unclear access and availability risks.

The RAND study did not explore in depth the policy issues of relying on foreign wind tunnel, but some observations and references can be made. It appears that the main disadvantages are security, access, and availability risks.

As a continuation of my involvement in this area, I have been briefed on an assessment performed by the DOD Counterintelligence Field Activity (CIFA) on foreign test facilities.[12] That report indicated that there are real security risks to testing in foreign facilities. "Without tight controls on access and data management, critical technology is at significant risk for compromise at most, if not all, of the [foreign facilities that CIFA considered], or in transit to and from them. Despite contractual security specifications, the designs or data deployed to these sites is in a virtual sea of potential collectors whether representing national, commercial or private interests." I commend that report to the committee for its classified details.

While the RAND study did not analyze them in detail, access and availability are also of concern, especially given an international competitive environment in aeronautics and tensions that arise occasionally (even with allies) and the unstable global business of wind tunnel facility operation. In general, if we rely on foreign facilities for strategically important capabilities, then we put our strategic needs at risk. At the very least, the government should explore reliance agreements to help reduce security risks and establish long-term agreements to ensure access as well as the long-term financial and technical stability of those facility operations.

In the course of our study, RAND did find that there is some reliance on foreign test facilities, particularly on the QinetiQ 5–Metre subsonic high-Reynolds number wind tunnel. If additional NASA facilities are closed, the country will be forced to rely more on foreign facilities for capabilities it cannot find domestically, including those that are inexpensive alternatives to larger, remaining U.S. facilities.

[12] "Technology Risk Assessment for European Test Facilities (U)," DOD Counterintelligence Field Activity Report, SECRET, CIFA/DA–218–04, 12 July 2004.

CONCLUSIONS

For NASA leadership, the most critical issues are to:

- develop a specific and clearly understood *aeronautics test technology vision and plan;*
- *identify shared financial support and stop applying full-cost recovery to WT/PT facilities;*
- continue to support developing plans to *very selectively consolidate* and *broadly modernize* existing test facilities; and
- prescribe *common management and accounting directions* for NASA's facilities.

This vision cannot be developed apart from other critical national decisions. It must be informed by the long-term aeronautic needs, visions, and capabilities of both the commercial and military sectors supported by NASA's aeronautical RDT&E complexes. A *national aerospace policy* would greatly inform and guide an aeronautics test technology plan.

Given the inherent inability to reliably and quantitatively predict all needs for RDT&E to support existing programs much beyond a few months out, the tendency of multi-year surges in aeronautic programs, and the trends indicating a continuing decline in needed capacity to support these needs for the foreseeable future, *long-term strategic considerations must dominate.* If this view is accepted, then NASA must find a way to sustain indefinitely and, in a few cases, enhance its important facilities (or seek to ensure reliable and cost-effective alternatives to its facilities) as identified in the RAND study.

While generally not redundant within NASA, a few of NASA's facilities are redundant with those of facilities maintained by the DOD, and others are redundant with commercial facilities. *NASA should work with the DOD to analyze the viability of such a national reliance plan* because it could affect the determination of the future minimum set of facilities NASA must continue to support.

NASA should pursue all three testing approaches—facility, CFD, and flight—to meeting national testing needs; establish the minimum set of facilities important to retain and manage to serve national needs; reassess poorly utilized facilities for strategic, long-term needs rather than eliminate them out of hand; identify financial support concepts to keep its current minimum set of facilities healthy for the good of the country; continue to invest in CFD; eliminate the backlog of maintenance and repair at its facilities; and address hypersonic air-breathing research challenges.

Unless NASA, in collaboration with the DOD, addresses specific deficiencies, investment needs, budgetary difficulties, and collaborative possibilities, the Nation risks losing the competitive aeronautics advantage it has enjoyed for decades.

Thank you for the opportunity to contribute to the debate regarding this important issue area in aeronautics. I am happy to answer any questions from the Committee.

BIOGRAPHY FOR PHILIP S. ANTÓN

Dr. Antón directs the Acquisition and Technology Policy Center in RAND's National Security Research Division (*http://www.rand.org/nsrd/atp.html*). This center addresses how accelerating technological change and modernization efforts will transform the U.S. national security establishment. It also explores new acquisition and management strategies and explores ways to maintain core defense technology and production bases.

Dr. Antón also conducts a wide range of research, including policy and application research in information technology, cyber security, information operations, nanotechnology, biotechnology, applied neuroscience, aeronautics, science and technology trends and effects, acquisition, and venture capital. His projects include a major study of wind tunnel and propulsion test facilities for NASA; development of a methodology for finding and fixing vulnerabilities in information systems; and an assessment of the global technology revolution through 2015.

Dr. Antón earned his Ph.D. in information and computer science from the University of California, Irvine, and his B.S. in engineering from the University of California, Los Angeles.

Chairman CALVERT. Dr. Benzakein, we are going to recognize you for five minutes, and we need to stay on that five-minute schedule, because we have a vote that is going to be present, and

we are going to recess right after your testimony. So, you are recognized for five minutes.

STATEMENT OF DR. MIKE J. BENZAKEIN, CHAIRMAN, DEPARTMENT OF AEROSPACE ENGINEERING, OHIO STATE UNIVERSITY

Dr. BENZAKEIN. Thank you, Mr. Chairman. Thank you, Members of the Committee.

I think we need aeronautics technology to create a civil aviation industry that will bring safe, clean, affordable jet service to every community. To do that, it will take research and a new generation of highly trained Americans to create the vehicles, airports, air traffic management systems to make this possible. The national needs can be summarized as follows. U.S. competitiveness, freedom of air travel, flight safety, security and defense of our nation, protection of the environment, education of the future workforce.

The U.S. has enjoyed a favorable balance of trade in aeronautics since—every year since 1970. This is based on the fact that we own the right technologies, which permits us to adopt the right market and product strategies. This could change in the next 10 years. The European Union, as well as others, have decided to make the necessary investment to threaten our leadership position in the industry. Europe is also developing a strong partnership between industry, government, and academia. It is led by industry and focused on their needs.

Technology breakthroughs are required for emission, acoustic, fuel efficiency. We are at the point of diminishing returns with current technology, and the United States needs to fund R&D for quantum improvement as we move forward. There is also a need to triple the current airspace capacity. Last, but not least, we must address the need for a first-rate aerospace engineering workforce, as they hold the key to the future.

So, what is NASA's role in the aeronautics agenda? Let me start by saying that technology developed by NASA has been key to the success of jet engines, which is the industry I am coming from. The Energy Efficient program, the Quiet Engine Program, sponsored by NASA in '80s and the—in the '70s and the '80s, did identify technologies that found themselves in product lines, like the GE90 family that powers the Boeing 777 today, and who spawned products like the GEnx, which will power the 787 at Boeing tomorrow.

Why NASA? The answer is simple. There is no other agency that can do it. DOD, of course, has the technical expertise in airframe and engine systems, but their focus is on weapon systems, as it needs to be. While FAA's mission is similar, it has neither the expertise nor the infrastructures required.

How effective are NASA programs? They have been effective in the '70s and '80s. Unfortunately, the critical link to industry began to break down in the late '90s. The curtailment of budget dictated by the funding needs of the International Space Station and other space projects have left the Agency struggling to identify its mission and agenda in aeronautics. So NASA's effectiveness in help, ensuring the U.S. industrial competitiveness in civil aeronautics is unfortunately diminishing. The intellectual power is there. The facilities are still there. And so is the will to do it, but the budget

is not. So, this is creating a serious void for this nation as we look forward.

That brings me to the next subject, the impact of the 2006 budget cuts. I am sorry to say that these cuts are having and will have serious implications on the ability of NASA to continue to play a relevant role in aeronautics in the future. The cuts that were made affect not only the programs that the industry needs, but cuts into the core of NASA competency and facilities at centers like Glenn and Langley. These centers have some unique competencies to the Nation and the world, and we are going to lose them. In the years ahead, both people and facilities will be gone, with little chance for recovery.

That takes us back to what is NASA's mission? The technology that NASA develops in civil aviation will be used by industry and the FAA. It is therefore paramount that a very strong partnership exists between NASA and its stakeholders. This kind of strong partnership exists in Europe, where industry shapes most of the technology program. The U.S. needs to learn from this relationship. The end user has to be part of the process. Is this corporate welfare? The answer is no. The industry is not looking for NASA to fund the development of their products, but they do need NASA's help to do the fundamental research and screening of high-risk concepts before industry picks it up. The alliance works. It has gotten the U.S. aeronautics industry its leadership position, and we need to ensure that it stays there.

So where do we go from here? I believe that aeronautics needs a national vision and an agenda to move forward. I believe, also, that the vision and strategy must be developed in partnership by industry, academia, and the Federal Government. Aeronautics must have a vision and goals, like those that NASA has set for returning to the Moon and going to Mars. So, how do we get this started? Well, we already have.

In response to the Aerospace Commission Report and other national studies, Congress asked the National Institute of Aerospace to work with the aeronautics industry and academia to develop a research plan and budget for the next five years that would substantially augment ongoing NASA programs. More than 250 of the Nation's aeronautics aviation experts from industry and academic have developed an integrated budget plan that contains roadmaps, milestones, and funding requirements for aeronautics technology to address the Nation's needs in the years ahead.

The result of this intense effort that has taken place over the last five months is being summarized in a report to Congress, which is targeted to be available at the end of the month.

Chairman CALVERT. And Doctor, if you could summarize your statement, we have to recess very shortly.

Dr. BENZAKEIN. Thank you, Mr. Chairman, Members of the Subcommittee. I appreciate the opportunity to testify today, and to share my views on aeronautics and the roles that NASA plays. I believe that the opportunities are there, the needs are there, and the strong partnership between industry, let me repeat that, I think it needs a partnership to move ahead. And we need a partnership in industry, academia, and NASA, but we need a strong,

stable support from Congress and the Administration, and that is the answer.

Thank you very much.

[The prepared statement of Dr. Benzakein follows:]

PREPARED STATEMENT OF STATEMENT OF MIKE J. BENZAKEIN

Mr. Chairman and Members of the Subcommittee:

The *National Authorization Act for FY 2001* created "The Commission on the Future of the United States Aerospace Industry" as a bipartisan effort to address Congress's concern for America's economic and national security. The Commission issued an urgent call to the White House and Congress to increase and sustain significant and stable funding in long-term research and associated Research, Development and Technology infrastructure. Some of us have been working to help Congress respond to that call.

The Importance of Aeronautics

From building the strongest economy in the world to winning the war on terror, we need aeronautics technology to create a civil aviation industry that will bring affordable jet service to every community. Moving people and goods faster, safer, more cost effectively and more securely to any place in the world in a more environmentally friendly way will benefit the American public and the American economy. To do so will take research and a new generation of highly trained Americans to create the vehicles, airports and air traffic management systems to make this possible. The national needs can be summarized as follows:

- U.S. economic competitiveness
- Freedom of air travel
- Flight safety
- Secure and defend the Nation
- Protect the environment
- Educate the future workforce

In all partnerships around the world, the U.S. industry must maintain a leadership position. The U.S. has enjoyed a favorable balance of trade in aeronautics every year since 1970. In 2003, this was $27 billion—not an insignificant number. Aeronautics research is key to maintaining our leadership.

Leadership is based on the fact that we own the right technologies, which permit us to adopt the right market and product strategies. This could change in the next 10 years. The European Union, as well as a number of Asian governments and, most recently, the Canadian government, are making the necessary investments to threaten our leadership position in this industry. The European 2020 Vision unequivocally states that the E.U. wants to be #1 in aeronautics by the year 2020. They have increased their funding in aeronautics by a factor of 20 over the last 10 years. To this one can add the individual European governments' funding (United Kingdom, France, Germany, etc.). Europe is also developing a strong partnership between industry, government and academia. In fact, it is led by industry and focused on their near-term and mid-term needs.

Meanwhile, U.S aeronautics research is focused primarily on more revolutionary, long term research instead of the need to maintain our economic competitiveness. We need a balance between long-term and shorter-term research. In addition as we move forward, aeronautics research must develop the tools and technologies to provide the comfort, performance, fuel economy, and reduced emissions and noise expected by the traveling public. These advanced tools and technologies require research on airframe and propulsion for both large and small vehicle systems.

We need to facilitate the ease of travel from point to point with small vehicles as well as meet the requirement to travel faster around the globe. Technology breakthroughs are critically needed for acoustics and fuel efficiency. We are at the point of diminishing returns with current technologies, and the United States needs to fund R&D for quantum improvements as we move forward.

There is also a necessity to triple the current airspace capacity in the U.S. To accomplish this will take close cooperation between the different agencies of the Federal Government, industry and academia. The freedom of air transportation and America's ability to advance economically are lost if the aviation system is not safe, secure and capable of handling the increasing demand for airspace. It is critical that

the research agenda recognizes current and future system vulnerabilities based on changing transportation concepts and designs.

Last but not least, we need to educate our workforce. There is an increased demand for students in Aeronautical Engineering. We need to interest young people in science and engineering. We have to start at K through 12, continue through college. We must prepare undergraduate and graduate students—B.S., M.S., and Ph.D. candidates—for what should be very exciting careers in aeronautics. We need more U.S. students pursuing advanced degrees. These young people will be key if the United States is to maintain its aeronautics leadership in the world.

NASA's Role

So what role should NASA play in the aeronautics agenda? Let me start by saying that technologies developed by NASA have been key to the success of jet engines, which is the industry where I have spent most of my life. The Energy Efficient Engine Program, the Quiet Engine Program, etc., sponsored by NASA in the 1970's and 1980's identified technologies that eventually found themselves in product lines like the GE90 family of engines that powers the Boeing 777 today. They have also spawned products like the GEnx which will power the Boeing 787 tomorrow. Without this research, GE could not have had the composite fan blades, the high pressure-ratio core, or the low emission double annular combustor that put them in a leading position in the industry today.

Why NASA? The answer is simple: There is no other agency that can take that role in the United States today. In 1915 Congress created the National Advisory Committee for Aeronautics (NACA); this organization was reconstituted as NASA in 1958 as the United States entered the race for space. From 1915 onward, NACA/NASA has invested in aeronautics research and technology—an investment in the future of this nation. Over the years, Industry and Academia have come to depend on NASA's support to invest in longer-term research—but always with an eye to providing a benefit to the American public. This investment has been small compared to the infrastructure it supports and the balance of trade benefits it brings. DOD, of course, has the technical expertise in airframe and engine systems, but their focus is on weapon systems as it should be, and DOD does not have the same priorities as civil aviation. In fact, DOD has traditionally relied on NASA to provide noise and emissions breakthroughs that could be adopted by the military. While FAA's research mission is similar, they have neither the expertise nor infrastructure required.

How effective are NASA's programs? They have been very effective in the 1970's and 1980's as I previously said. Unfortunately, the critical link to industry began to break down in the late 1990's. The termination of the High Speed Research Program and the Advanced Subsonic Technology Program marked the beginning of a downslide that continues today. The curtailment of budgets dictated by the funding needs of the International Space Station and other space projects has left the Agency struggling to identify its mission and agenda in aeronautics. It has valiantly tried. The NASA Aeronautics Blueprint published in 2002 articulated very well the correct goals of the Agency. Unfortunately, adequate funding was never there to fulfill these goals. More important, the funding was never stable enough to launch and sustain any significant initiatives. So NASA's effectiveness in helping to ensure the U.S. industrial competitiveness in civil aeronautics is unfortunately diminishing. The intellectual power is still there, the facilities are still there, and so is the will to do it; but the funding is not. This is creating a serious void for this nation as we look ahead.

Budget Cuts

That brings me to the next subject—the impact of budget cuts. I am sorry to say that these cuts are having and will have serious implications on the ability of NASA to continue to play a relevant role in aeronautics in the future. The cuts have occurred primarily in the Vehicle Systems Program, which defined technologies for the airframe and propulsion systems of the future. These technologies are aimed at ensuring U.S. competitiveness in the years ahead. The cuts that were made unfortunately affect not only the programs that industry needs, but cut into the core of NASA competency and facilities at centers like Glenn and Langley. These centers have some competencies unique to the Nation and the world, and we are going to lose them. In a few years, both people and facilities will be gone with little chance for recovery.

NASA has refocused the Vehicle Systems Program to address four revolutionary high risk "barrier breaking" technologies. They represent a valiant effort to salvage what is remaining of the vehicle system programs. However, the funding constraints make even these programs highly inadequate. Let me take for example the super-

sonic airplane program which focuses on the need to reduce the sonic boom. We need to do it and it is the right thing to do, but it currently focuses only on changes in airframe configuration. At the same time there are a flock of technologies dealing with materials, engine emissions and engine noise, airplane systems, etc., that must be addressed if we want to have a supersonic airplane program in the future.

That takes us back to what is NASA's aeronautics mission? Before I speak to this, let me discuss the role of the industry. When DOD develops technology, it does so for its own use, its own vehicles, its own weapons systems. The technologies that NASA develops for civil aviation will be used primarily by industry and the FAA. It is therefore paramount that a very strong partnership exists between NASA and its stakeholders. This kind of strong partnership exists in Europe where industry shapes most of the technology programs. The U.S. needs to learn from this relationship. The end user has to be part of the process. Is this "corporate welfare"? The answer is no. Industry looks to NASA to screen technologies and help define the key game changers that are worth pursuing.

Let's take, for example, the NASA Clean Combustor Program. Under this 1970's NASA program, GE looked at different combustor concepts to reduce nitric oxides (NO_X). GE identified a double annular configuration as a leading candidate, ran it in an engine and declared victory. But it wasn't until the mid 1980's that the pressure for low NO_X was such that GE decided to put the double annular combustor into some of their products. It cost GE over $100 million to make it service ready for the CFM and GE90 families. I use this example to show that industry is not looking for NASA to fund the development of their products, but they do need NASA's help to do the fundamental research and screening of high-risk concepts before industry picks them up. This alliance works. It has gotten the U.S. aeronautics industry its leadership position, and we need to ensure that it stays intact.

The Go Forward Plan

So where do we go from here? I believe that aeronautics needs a national vision and an agenda to move forward. I believe also that the vision and strategy must be developed in partnership by industry, academia and the Federal Government. It should be focused on aeronautics priorities based in future commercial regulatory challenges. Challenging aeronautical goals for 2015/2020 need to be established targeting 85 percent lower emissions, 50 percent lower noise, 30 percent lower fuel consumption, 3 × thruput, etc. Aeronautics must have a vision and specific goals like those that NASA has for returning to the Moon and going to Mars. So, how do we get this started? Well, we already have.

In response to the Aerospace Commission Report and other National studies, Congress asked the National Institute of Aerospace to work with the aeronautics industry and academia to develop an aeronautics research plan and budget for the next five years that would substantially augment ongoing NASA programs. More than 250 of the Nation's aeronautics/aviation experts from industry and academia have developed an integrated budget plan that contains roadmaps, milestones and funding requirements for aeronautics technology to address the Nation's needs in the years ahead. It addresses the requirements for:

- airspace systems
- aviation safety and security
- hypersonics
- rotor craft
- subsonic vehicles
- supersonic vehicles
- workforce and education

The result of this intense effort that has taken place over the last five months is being summarized in a report to Congress that is targeted to be available by the end of this month. The team has worked hard to balance the short and long-range needs of the Nation. The short-range needs address technologies for systems and vehicles to be ready in the years 2015–2020. The long-range needs address requirements for systems required in the years 2040–2050. In addition to research requirements, we addressed the need for a strong aerospace workforce, suggesting coalitions to revamp the way we prepare students for careers in industry. The proposal is to transform aeronautical engineering programs to meet industry needs and will require a paradigm shift in emphasis on the way we educate B.S. students, and will require a collaboration of all elements that make up the educational system.

As said earlier, this report should be available to Congress and to NASA by the end of this month. We look to Congress and the Administration to call for a national

vision for aeronautics and hope that this report will serve as a baseline upon which to build the aeronautics strategy for the future.

Summary

Thank you, Mr. Chairman and Members of the Subcommittee. I appreciate the opportunity to testify today and to share my views on aeronautics and the role that NASA plays in aeronautics research. The partnership between NASA and industry has meant success to the United States in aeronautics in the past. The budget pressures on NASA are at the point of potentially creating a technology void in the future. It is important that this be turned around. The opportunities are there, the needs are there and a strong partnership between industry, academia and NASA with strong, stable support from Congress and the Administration is the answer.

Chairman CALVERT. Thank you, Doctor, and Dr. Hansman, we will have your testimony as soon as we return from this recess. We will recess until approximately five minutes after the last vote.

[Recess.]

Chairman CALVERT. Our last witness on the panel is Dr. Hansman. You are recognized for five minutes.

STATEMENT OF DR. R. JOHN HANSMAN, JR., DIRECTOR, INTERNATIONAL CENTER FOR AIR TRANSPORTATION, MIT

Dr. HANSMAN. Thank you, Mr. Chairman, for the opportunity to speak on the future of aeronautics and NASA. I have some slides, because a university professor these days should have to have slides to talk.

[Slide.]

This is a picture that shows the U.S. air traffic density over the U.S., which shows the dependence of the U.S. economy on air transportation. This is a little macro scale conceptual model we use that show the dependence of the economy on the air transportation system, both the capability of the national airspace system, our infrastructure, and also, the capability of the vehicles that are in there.

As people have mentioned today, the U.S. aviation impact is estimated at about eight percent of the Gross Domestic Product, roughly 100 million, correction, 10 million jobs, and about $900 billion per year to the U.S. economy. This shows you the growth of passenger traffic by region, showing the U.S. is—has been growing exponentially in passenger traffic as well as Europe and Asia Pacific. You can see the latent demand, which hasn't emerged yet, in other parts of the world. This shows you the freight demand, and shows you that the freight out of Asia actually exceeded the freight out of the U.S., starting in the 1990s. So, you can see that dependence on the economy.

Talking about challenges and opportunities, I will just quickly go through one—a few of them. Let me start with flight delays and the capacity of the air traffic—air transportation system. Before the attacks of September 11, in the years 2000, 2001, air traffic control delays were an emergent and critical problem. Even in this body, people were very upset, concerned about it. The system was close to saturation. The attacks of September 11 pulled down demand on the system for a few years. Demand has come back into the system, and you can see, starting in late 2003 and through 2004, the delays in the system have actually exceeded historical levels.

The capacity of the system is limited by the—fundamentally in the U.S., the capacity of the airports and runways, although it is also the airspace system, the complexity, the people to run the system, and the technical elements of the system. These are going to be urgent issues in the future, and we actually project that the system will go into gridlock, probably in the summer either of 2007 or 2008, and we will see issues emerging next summer.

Another factor is the economic instability in the industry. This shows you the net U.S. airline profits, as a function of time, starting with deregulation in 1978. You can see that the industry is cyclic, with about an 11 year cycle. And the amplitude of the cycle has been growing with time. This is actually—appears to be a fundamental effect, not directly attributable to September 11, which exacerbated the situation.

Another clear and emergent issue will be fuel availability and price of fuel. As you know, fuel at the crude level has gone over $50 a barrel. This appears to reflect a secular trend. As fuel prices go up, this will be actually a technical opportunity to look for more efficient means, more efficient aircraft, will actually provide an opportunity to renew aircraft in the system, and also, the aerospace industry, because of its nature, worrying about efficiency, will provide a technical conduit for technologies to come out of aviation into other modes, such as ground vehicles.

Environmental limitations are going to be critical. We already know the noises are a critical issue which limits our ability to add airports and runways to the system. Emissions are becoming a more important problem, both in local emissions, but also global emissions. Also, interestingly, effects such as contrails are now starting to be looked at as significant factors on influencing the global radiative balance and global warning.

International—this industry is clearly an international industry, and that is both an opportunity, in terms of future markets, but it is also, as has been said earlier today, an issue in terms of challengers. People mention the Airbus A380. This is the rollout of the A380, expected to fly later this year. It is an interesting airplane, and again, it is enabled by some of the technical investments in Europe, but it is not just Europe. It is—we have significant growth in midsized jets and regional jets. These are the new airplanes coming out of Brazil, the Embraer 190 and 170 series. Out of Canada, the CRJ–900 series, and actually, out of China, on a midlevel, regional jets, and this is expected to be one of the big growth markets. We do have innovation in the U.S., in a number of ways, this is a picture of the Boeing 77. I just note it, because it is in the Japanese livery, which were the—one of the launch customers. So, again, points to the issue as this being an international industry and international markets, which we have to compete in.

The biggest challenge and my biggest concern is actually in our intellectual capital, not just in NASA, which was talked about today, but really, in the country at large. In my business, you know, we look at students flowing into the system, go—you know, I actually teach a lot of those what were called nerds this morning. Okay. And they are not really nerds. The concern I have is that the talent and experience really isn't being replaced. Right now, we are getting competition from other fields, information technology,

biotechnology, bioengineering, and we are also getting, as we know, international competition, so you know, one has to ask, why would a young person go into aeronautics, except for their love of flying or flight?

Another issue that we deal with is changing skill requirements, so that the skills that we are going to need for aeronautics in the future are not the same skills that we have needed in the past. In terms of NASA's role, they have a critical role in developing the knowledge base, technologies, and people, and stimulating innovation, fostering growth of talent, and their critical role in reducing the technical risk in the systems.

They have been historically invaluable. I actually took off my bookshelf a book that one of my mentors gave me, which is Abbott and van Doenhoff, all these guys will know this book, okay. These were the original work out at NACA, these were the wind tunnel data of airfoil geometry which are still used today, and sort of represent the fundamental type of knowledge we should be generating out at NASA. There currently is, people have said, sub-critical. The programs are aligned with some of the future needs, but are inadequate from the core standpoint. The budget and the trend in the budget is inadequate to maintain a vital national aeronautics capability that we must have. The working budget, the amount of money that is really available for innovation, creativity, and excitement, just isn't there. Okay. And this will have an adverse impact on the intellectual capital to meet future challenges. Again, why would you recommend that your son or daughter go into the industry?

What can the government do? The government should invest in aeronautics, for the future, and not coast on the prior momentum. NASA should take more risks, and should increase investment in developing opportunities that will attract excitement and talent to aeronautics. We need a fundamental research core in the portfolio, and this is going to require additional investment and collaboration with government agencies and industry, and there are some efforts, such as the JPDO, that are a good start.

Chairman CALVERT. If the gentleman would summarize his remarks, we——

Dr. HANSMAN. That is it.

Chairman CALVERT. That is it.

Dr. HANSMAN. And my written remarks are—hopefully will go in the record.

Chairman CALVERT. Your full written remarks will be entered into the record, without objection.

[The prepared statement of Dr. Hansman follows:]

PREPARED STATEMENT OF R. JOHN HANSMAN, JR.

Chairman Calvert and Members of the Subcommittee:

Thank you for the opportunity to comment on *The Future of Aeronautics at NASA*. For most of the past century, the U.S. has led the world in "pushing the edge of the aeronautics envelope" based, in part, on a strong national aeronautics research strategy. This has resulted in a vibrant aerospace industry and an unsurpassed air transportation system which has contributed materially to the Nation's economic development, geographic structure and quality of life. The social and economic connectivity provided by our air transportation system can bee seen in the density of aircraft trajectories over the U.S. (Fig 1.).

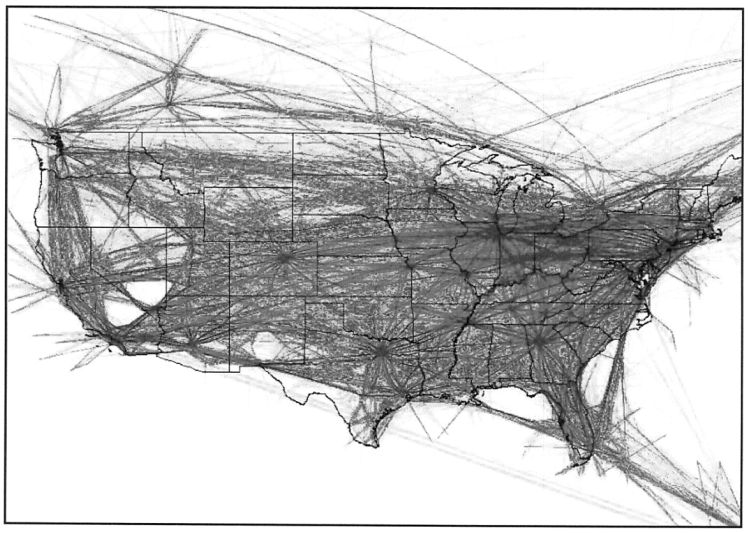


Figure 1. U.S. Air Traffic Density (Source: FAA ETMS Data)

There are, however, indications that the U.S. preeminence in aerospace has declined. In part this is due to strategic investments other nations have made, and continue to make, in aeronautics research. These investments in programs and, more importantly, in people, have created a strong international civil aeronautics capability. In contrast the U.S. has systematically decreased it's investment in civil aeronautics research over the past decade and has underinvested in fundamental and high risk research to develop the excitement knowledge and people to shape aeronautics in the future.

I will comment below on the specific questions which you have asked me to address.

Over the next two decades, what are the main challenges facing the aeronautics industry and our aviation infrastructure? What are the Nation's most pressing strategic needs in civil aeronautics?

National Airspace System Capacity—Indications of the capacity problem can be seen in the delay data of Figure 2. Prior to September 11, 2001, the system was approaching capacity limits at key airports and other points in the system. Nominal interruptions resulted due to weather or traffic congestion in non-linear propagation of delays and loss of reliability in the system. Delays were reduced after September 11 due primarily to reduced traffic. However traffic has returned and delays in late 2004 have exceed historic levels. This pattern is expected to continue and it is likely that delays will reach crisis proportions within the ext few years. It is important to note that key airports in the system (e.g., LGA and ORD) have had a disproportional impact on national delays illustrating the importance of getting maximum capacity from our airports and reducing local environmental impacts to reduce local community opposition to airport capacity expansion.

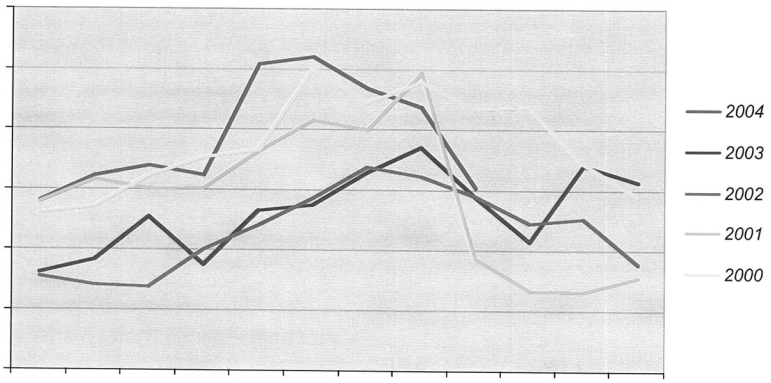


Figure 2. Flight delays by month (Source: FAA OPSNET data)

Economic Stability—The economic instability of the aeronautics industry can been seen in the aggregate profitability of the U.S. airlines (Fig. 3). The cyclic nature of the industry can be seen with the cycle period being approximately 11 years. Prior to deregulation of the industry in 1978 the Airline Industry was cyclic but profitable. After de-regulation the amplitude of the oscillation has increased. This pattern is also seen globally. It is unclear what will limit the growth of this instability, however the implications are significant both for the industry, the Nation and the world.

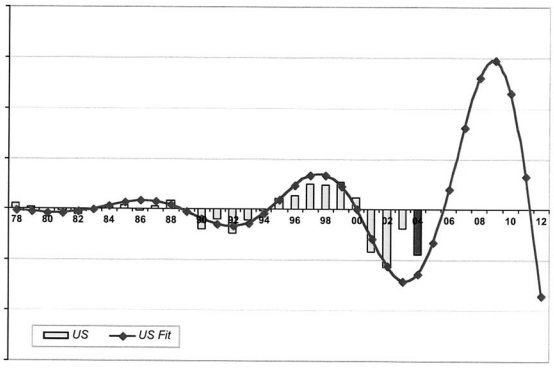


Figure 3. Net Profit of U.S Airline Industry and Best Fit of Undamped Oscillation Model

Fuel—Another challenge will be the price and availability of fuel. As can be seen in Fig. 4, the price of fuel recently exceed $50 per barrel. While this is partly due to short term issues it is expected that fuel prices will continue to rise as the rate of discovery of new fossil fuel sources slows. While this is a challenge, it is also a technical opportunity as it shifts the design criteria to value fuel efficiency.

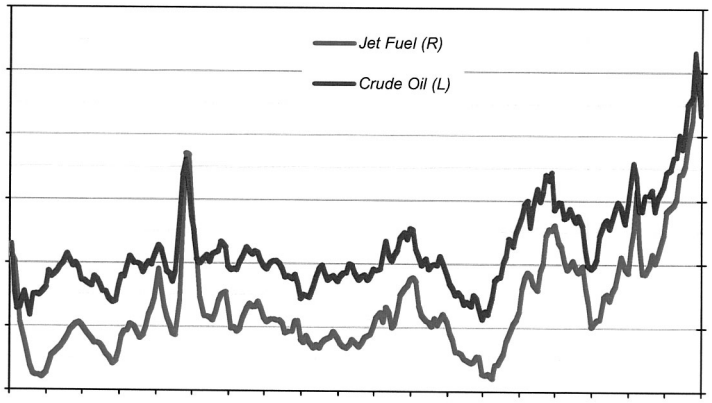


Figure 4. Oil and Jet Fuel Price Trends (Source: ATA)

International Competition and Markets—International competition will also be a key challenge over the next few years. As noted above, international competition to U.S. manufactured aircraft and aeronautics technologies have increased and the historical U.S. leadership has diminished. However, the international markets represent the largest future opportunities for civil aeronautics products and systems. This can bee seen in Figures 5 and 6 which show the rapid growth in passenger and freight traffic in North America, Europe, and Asia and the emergent potential of developing regions such as the Middle East, Latin America, and Africa.

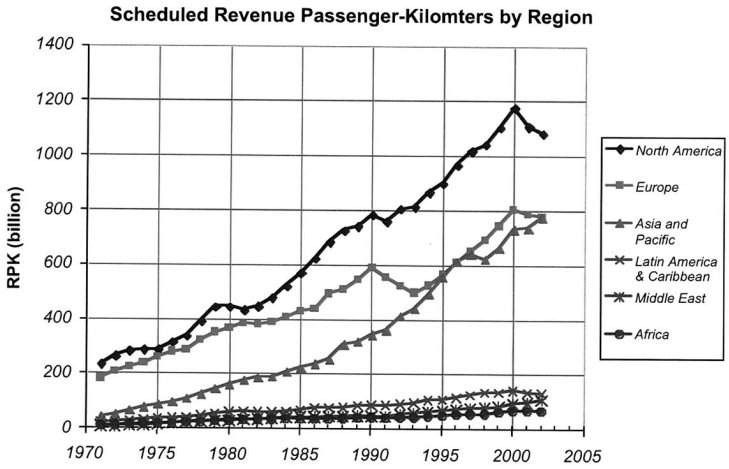


Figure 5. Civil Passenger Traffic by Region (Source: ICAO)

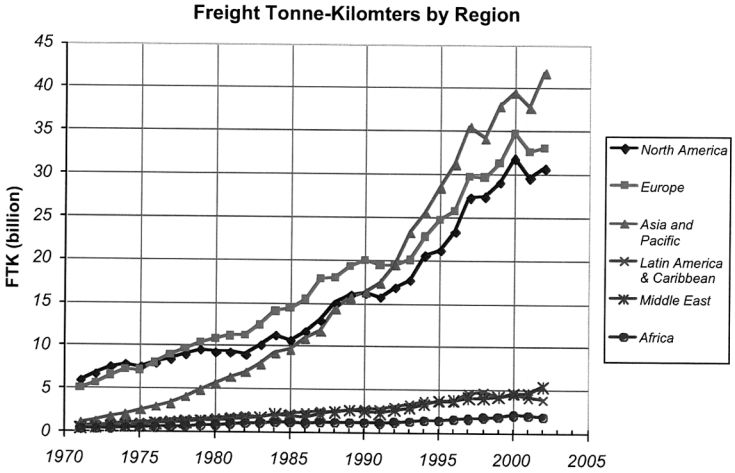


Figure 6. Civil Freight Traffic by Region (Source: ICAO)

Environmental Impact—Environmental issues will become increasingly important challenges to aviation as well as other segments of society. At the local level, noise and emissions make it difficult to add runway capacity to meet the traffic demand. On a global scale, increasing concerns regarding global warming will impose limits on high altitude emissions and aircraft contrails which impact the earth's radiative energy balance.

Security and Public Health Threats—The perception as aviation as a potential social threat mechanism could significantly constrain the potential benefits from aviation and the aeronautics industry. As important as the well publicized security concerns is the bio-propagation of natural health threats as illustrated by the reaction to the SARs virus in Asia. While these concerns are real the potential to overreact are significant.

Information Technology and Complexity—On the technology side, one of the key challenges will be dealing with complexity and criticality in Information Technology and software systems which are an increasingly important part of all aerospace systems.

Human Roles—Defining the limits of automation and the role of the human will be a challenge for civil aviation. Unmanned Air Vehicles have demonstrated their capability in military applications and are emerging in civil aviation. The future role of humans both as operators and controllers will change and become an emergent issue.

Loss of Intellectual Capital—Perhaps the most important challenge is the potential decline of intellectual capital in the U.S. Aeronautics enterprise. Much of the historical strength in aeronautics was due to the knowledge and expertise in our people. Currently we are not stimulating intellectual renewal at a pace which will maintain or increase the national capability to deal with the challenges ahead.

What role do NASA's aeronautics programs and strategic plans have in fulfilling the Nation's strategic needs in civil aeronautics? How effective are NASA's programs in helping to ensure U.S. industrial competitiveness in civil aeronautics markets worldwide?

There is clearly an urgent strategic need to invigorate aeronautics research in the U.S. to meet the challenges of the future. As the national agency for civil aeronautics research NASA should have a key role. However the lack of prioritization of aeronautics within NASA puts this at risk.

Given the limited budget for aeronautics, the aeronautics programs are generally aligned with a subset of the strategic needs but are unlikely to be as innovative or as effective as necessary to have a major impact on U.S industrial competitiveness in civil aeronautics.

I am somewhat concerned that budget pressure and internal evaluation metrics have created an environment where the aeronautics research efforts are too short-term focused on products and programs and not enough on knowledge and capability which are the critical enablers for the long-term competitiveness.

Regarding the three specific NASA Aeronautics Programs:

The *Airspace Systems Program* is well aligned with the future capacity challenges to the National Airspace System (NAS) although somewhat too focused on developing specific solutions rather than general capabilities which can be used to address future challenges as they emerge. It is important to recognize that NASA does not implement airspace systems and must work collaboratively with the FAA and other government agencies as well as industry and international agencies in order to be effective. To this end, I am encouraged by NASA's strong involvement with the Joint Program and Development Office (JPDO).

The *Aviation Safety and Security Program* supports the noble goal of increasing aviation safety. The safety element of the program is based on a well developed identification of key safety issues. The program appears to be open to innovation. The one area which appears under-represented are issues related to critical software and complexity related emergent safety issues. I am less clear what the appropriate NASA role is in aviation security and am therefore concerned that the security element of the program may be diverting scarce resources from other efforts. Again, I am encouraged that the JPDO will be a mechanism to clarify the NASA role in aviation security.

The *Vehicle Systems Program* has been refocused around four technology demonstration projects (Subsonic Noise Reduction, Sonic Boom Reduction, Zero Emissions Aircraft, and High Altitude Long Duration Remotely Operated Aircraft). Each of these programs address expected future challenges and their priority has emerged from a collaborative interaction with industry. There is, however, a general concern that the focus on technology demonstrations comes at the expense of more fundamental research and core technology development in vehicle systems and that the national competitiveness in aircraft technologies may atrophy as a result.

What effect do you believe NASA's proposed budget (including proposed changes in funding, workforce, and operation of wind tunnels) will have on its ability to meet the Nation's strategic needs in civil aeronautics?

I am generally dismayed by the magnitude and trend of the proposed NASA aeronautics budget. It appears to reflect a lack of commitment of the Agency to the future of aeronautics.

Given the reduced level of investment in the Aeronautics Theme, NASA has done a reasonable job at prioritizing facilities and has recognized the need to align it's workforce to the challenges of the future. While there is clearly a need to reduce the number of NASA facilities, this must be done carefully and with a strategic national perspective. If done correctly the Nation's future strategic needs will be met.

I am more concerned regarding the ability of NASA to maintain a talented and enthusiastic workforce with the skills and interest to meet the challenges in civil aeronautics. The workforce actions, appear to motivated by budget pressures rather than strategic efforts at intellectual renewal. This coupled with a perception of declining NASA priority in aeronautics, can create an atmosphere where it is difficult to retain and attract the best and the brightest.

I am also concerned that the declining aeronautics budget coupled with fixed obligations and congressionally mandated earmarks have reduced the ability of the NASA aeronautics program to pursue innovative new ideas and emergent research needs.

What steps should the government take to better address the Nation's strategic civil aeronautics needs? If continued research has an important role to play, what should be its priorities? How do you recommend NASA balance investment in evolutionary research against revolutionary, high-risk, high-payoff research?

I believe that the Nation must recognize the civil and military importance of aeronautics and commit to maintaining the health and vitality of the national capability in aeronautics. A vital element of this capability is a healthy research program which builds core knowledge, stimulates innovation, builds intellectual capital, creates opportunity and solves emergent problems in the civil air transportation system.

I believe that NASA is most effective when it focuses on fundamental issues and longer-term innovative research and hands of the results to industry or the operating agencies such as FAA to implement. To this end NASA must continue to build close ties to industry and other government agencies. The JPDO has the potential to be a conduit for this collaboration.

In terms of priority, I would focus on building the knowledge base and national workforce to address the challenges to civil aeronautics identified above.

To this end, I would urge NASA to take more risks and to actively stimulate innovation.

I would also urge NASA to increase the opportunity space in aeronautics for new faculty and students through an increased focus on small single investigator, projects or grants. The investment is not large but the potential for innovation and growth of the Nation's capability is huge.

BIOGRAPHY FOR R. JOHN HANSMAN, JR.

Dr. Hansman is currently a Professor of Aeronautics and Astronautics at MIT, where he is Head of the Humans and Automation Division. He is also the Director of the MIT International Center for Air Transportation. He conducts research in several areas related to Air Transportation including air transportation systems, flight vehicle operations, safety, information technology, human factors and Air Traffic Control. Dr. Hansman holds six patents and has authored over 200 technical publications. He has over 5,000 hours of pilot in-command time in airplanes, helicopters and sailplanes, including meteorological, production and engineering flight test experience. He holds a Type Rating for Lear Jet 20, 30 and 55 series aircraft. He is a Fellow of the American Institute of Aeronautics and Astronautics. Professor Hansman received the 1996 FAA Excellence in Aviation Award, the 1994 Losey Atmospheric Sciences Award from the American Institute of Aeronautics and Astronautics, the 1990 OSTIV Diploma for Technical Contributions.

DISCUSSION

AERONAUTICS PLANNING: BUDGET VS. PRIORITIES

Chairman CALVERT. Let's get into the question part of the hearing. When I was in business, years ago, we would obviously put together a business plan, and that would drive our number of jobs, our capital outlays, and our budget.

We would make a determination at that point what would occur. It seems, sometimes, as I listen through this, that the job level and the budget is driving the business plan here some, to some degree. And that the budget right now is the determining factor.

Dr. Lebacqz, how would you evaluate the '06 aeronautics budget? Does it match the priorities of the Nation, in your opinion?

Dr. LEBACQZ. Sir, let me start by talking about the way that NASA develops a business plan, which of course, is different than you would have done, but is consistent with the way we developed the budget. We are, in fact, engaged in a road mapping activity, across the entire Agency. We have developed 18, I believe the number is, strategic objectives for the Agency, and there are 13 roadmaps that are intended to be long-term guideposts to achieve those 13—those objectives.

One of those roadmaps is in aeronautics. It is co-chaired by my Deputy for Technology, who is here behind me, Mr. Terry Hertz, as well as the Chief Technology Officer of the Boeing Company, Mr. Jim Jamieson. We use that, in conjunction with a lot of other guidance that we get from the aerospace, the President's Commission on the Future of Aerospace, from the National Research Council, both their prospective studies, such as "Securing the Future of U.S. Air Transportation," as well as the reviews of our program that my

friend and colleague, Dr. Klineberg, talked about, to develop the aspects of the roadmap. From that, in principle, we then derive budgetary requirements to achieve the goals of the roadmap.

Chairman CALVERT. Well, what—before I get into that, why don't we allow the other panel to answer that question also. I—Dr. Klineberg, I think you probably answered that question in your opening remarks, but you can do it again.

Does the aeronautics budget, in your opinion, match the priorities of the Nation?

Dr. KLINEBERG. I think you are right, Mr. Chairman, that the budget is driving the strategic plan, and not the other way, and I don't think that is right. So, my answer would be no, that it is not satisfying the needs of the country, because we haven't really looked hard at what those aeronautics needs are, separately from the budget, and I think my colleagues have talked to what some of those needs are, and need to be addressed.

Chairman CALVERT. Dr. Antón.

Dr. ANTÓN. I am probably the most qualified to talk about the infrastructure needs, and from that perspective, no, there has not been an identification, as of yet, of assured support for those facilities that are needed from a national perspective.

Chairman CALVERT. Dr. Benzakein.

Dr. BENZAKEIN. Mr. Chairman, I think we—some of us are agreed that it looks like the budget is driving the agenda, which is really, in our opinion, the wrong way to go.

There is unfortunately, and I think some of our colleagues said the same thing, we do need an aeronautics mission, an agenda, agreed to. And then, after that, you can put a budget around it. Here, it seems to say there are that many, that much funding available, and then, a mission gets wrapped around it. That is really, in our opinion, in my opinion, the wrong way to go.

Chairman CALVERT. Dr. Hansman.

Dr. HANSMAN. The simple answer is no.

ZERO BASE REVIEW

Chairman CALVERT. The Navy has just gone through a zero base review on their operations, the United States Navy, and they have done quite, for the Navy, quite a radical change, where how they utilize their personnel, how they utilize their fixed assets, how they utilize ships, equipment, et cetera. Dr. Lebacqz, do you see NASA going through that same type of exercise, in order to get as much efficiency and economy and productivity out of its working force?

Dr. LEBACQZ. Yes, sir. Thank you for the question. What we have done this year, effective the beginning of February, is focusing on one set of—one part of our infrastructure, which is our set of wind tunnels. We have corporatized, so to speak, management of them. I noticed earlier in speech, in some of the other testimony today, that people would talk about the Langley such and such tunnel, or the Glenn such and such tunnel. They are NASA tunnels, and so, we have brought the management of them back to headquarters, under a program manager, who is responsible across all of the wind tunnels, for assessing the pricing policy, assessing the demand, because these are, after all, demand-driven facilities.

Somewhat similar to other zero base reviews, we are trying to understand what the demand will be for them from our own programs, what the demand will be for them from other programs within NASA, and what the demand for them will be from the industry, and our colleagues in other agencies. The folks, good folks at the RAND Corporation, in the study that Dr. Antón mentioned, talked, provided sort of a process to go through, in which one can prioritize against a set of criteria the need for some of these facilities, and as Dr. Antón mentioned, they came up with roughly 31, or 29, I can't quite get the number straight in my head, of the NASA facilities that has some need, and nine of them, in their view, are critical, based on this process.

We will be doing that again, given the fact that the environment is different now than it was three years ago, when the study was initiated. But using the same process, but at a corporate level, rather than at an individual center level, because in those cases, one tends to sub-optimize. There are a number of ways, if I could go on briefly, a number of ways here that these facilities can be operated differently than they are now.

One of them is through some kind of shared ownership, shared pricing. One of them is through transfer of some of them to other entities that need them. We are investigating that currently, with one of the big tunnels at the Ames Research Center, with the DOD, as a matter of fact. Another of them is to, if we can corporatize how we operate them, operate them differently than we have. For example, take an idea from the Navy, of having a cadre of people who are capable of operating all the facilities, and move them physically, as needed, to the facility that is required.

So, all of these things are in play, and that is the purpose of this corporatizing of the program this year. We are going to identify some money that we will pull out into a separate program, to give this program manager some leverage. It is the government. You have got to follow the money, so you need some leverage.

NUMBER OF WIND TUNNELS NEEDED

Chairman CALVERT. I want to turn it over to Mr. Udall for his question, but while we are on the subject of wind tunnels, and how many wind tunnels we need, and how many tunnels need to be closed, is that decision based upon utilization, or is that decision based upon—maybe Dr. Antón, you could answer that briefly, and how did you arrive at the 28 versus 30 or 29 or whatever?

Dr. ANTÓN. We found in our research that utilization data was very difficult to project into the future, and so, we took a much more strategic look at trying to understand the kinds of vehicles that——

Chairman CALVERT. So, if you have a tunnel that has zero utilization.

Dr. ANTÓN. Yes.

Chairman CALVERT. It still has value in your mind?

Dr. ANTÓN. Yes. The question is what kinds of future vehicles might need that kind of capability. So, for example, the hypersonics program in the country has gone down, but——

Chairman CALVERT. I understand that from the manager's point of view, Dr. Lebacqz's point of view, if—going back to the old busi-

ness model. If you have zero utilization, but you have an asset that may have potentiality——

Dr. ANTÓN. Yes.

Chairman CALVERT.—how do you manage that asset? And I guess that is something that has to be worked out, but I am going to—but I just—trying to understand how you are determining what has future value to hold, and what should be closed, or what shouldn't be closed. With that, Mr. Udall.

CREDIBILITY OF NASA'S AERONAUTICS PLAN

Mr. UDALL. Thank you, Mr. Chairman. I think this line of questioning is important to pursue later. I want to just start. First, I want to thank the panel, and also, ask your forgiveness for the break in the action, but I appreciate you being willing to stay with us, because this is a very crucial area that we are discussing today.

Dr. Lebacqz, your testimony, along with that provided with other witnesses, makes a persuasive case for the importance of aeronautics research. I enjoyed looking at your bio. You have a long and distinguished career in aeronautics research. And as I mentioned in my opening remarks, you are obligated to put the best face on what I think is a bleak situation that NASA's aeronautics program faces.

I have to tell you, I find a real disconnect between the NASA testimony and the actual situation. The paragraphs of your—initial paragraphs of your written statement talk about the great promise of hypersonics, yet the '06 budget eliminates funding for hypersonics. The testimony talks about the importance of the Aviation Safety and Security Program, yet that budget for that program will be lower in 2010 than it was in Fiscal Year 2004. The testimony makes a strong case for the critical need to modernize the Nation's air transportation system, yet funding for Airspace Systems would decline by 22 percent from fiscal '04 levels. Finally, your testimony makes a case for pursuing flight demonstrations of breakthrough technologies in four areas, and yet, the funding for the Vehicle Systems will be 43 percent lower in 2010 than it was in '04. That is even though, and my understanding, the flight demonstrations are the most expensive part of the R&D cycle.

I have to confess, the plan doesn't appear credible to me, and I know what your official position has to be, but speaking as an experienced professional in aeronautics research, do you consider it to be a credible and sustainable plan for the long term? That is my first question.

I want to ask two more. What will the consequences for the future of NASA's aeronautics program be if the funding and workforce and infrastructure reductions contained in the five-year budget plan actually come to pass? And then I would like to ask the other witnesses if they would like to make any comments, Doctor, after you make yours.

Dr. LEBACQZ. There is a lot of points in your question there, so maybe I can kind of get at it from the back end toward the front.

Mr. UDALL. I apologize for throwing all that at you.

Dr. LEBACQZ. No, that is all right. I am supposed to be a rocket scientist. I ought to be able to remember it. I just can't. So, let me start, I think a critical point of your question has to do with wheth-

er the Vehicle Systems program being shrunk by 40 percent, with these four demonstrations, is a credible program, in my estimation.

The Vehicle Systems program has been refocused from a program that was based on a number of disciplinary activities, and sort of the classic disciplines of aerodynamics, avionics, materials and structures, propulsion, that were applicable to a wide range of vehicles, which the four that we have selected were some. There were, I believe, seven concept vehicles that we were doing this research for.

So, I believe that, particularly—let me pick the—I didn't really have a chance to talk about them, one of the demonstrations is a flight demonstration of reducing subsonic noise. That actually is a continuation and completion of work that we had initiated, and I don't think there is any question but that we will accomplish that in roughly fiscal '08. Another one of them is the development of high altitude, long endurance, remotely operated or autonomous vehicles for science platforms. We have research underway currently, and in fact, we have built vehicles that are the beginnings of this type of thing, with the Helios vehicle. I think that one is also doable within the amount of money that we are talking about.

Because we are not doing research that is applicable to more than just it, as well as a number of other things, we are focusing the research on just it. So, I think in general, that the—that program is credible. I suspect my colleagues won't agree with me, but I believe that program is credible. But the concerns that you raised about the Safety and Security program and the Airspace Systems program, I think are good concerns. We believe strongly, and in fact, it is interesting, the NASA aeronautics portfolio, percentagewise now, compared now to 10 years ago, is almost 50 percent on these systems kinds of research, airspace systems, systems that provide more security, more safety in the airplane, and only 50 percent on sort of our classic vehicle research.

We believe that what we have planned out in those areas is, will make a significant contribution. We support entirely the Joint Planning and Development Office, which—the NASA, the FAA, the DOT, the DOD, the Department of Homeland Security, Department of Commerce, Interagency Working Group, that has been our highest priority all along, and will continue to be, to make sure that the national plan for a transformation of the national airspace system will occur, and that we have research to support that.

Maybe I over-answered a long question.

Mr. UDALL. I created the problem by asking a long question, and you did a very nice job of responding to me, the questions I asked, and the points I made.

Mr. Chairman, I see my time has expired. Perhaps the other panelists could—if we don't have a second round, you could respond in writing to my question. But let us see how the questioning goes from this point on. I think, because Mr. Forbes is here, I don't want to take from this time.

Chairman CALVERT. We are going to have a lot of time for another round of questions, so—Mr. Forbes, you are recognized.

Mr. FORBES. Thank you, Mr. Chairman, and thank all of the members of the panel, and the toughest thing, for me, in going through these budgets, is it is so hard for us to get somebody to

just walk in here and say that building costs $10 million. We need it, but we can't afford it. So, what we see in the budget is that we are going to put up a tent, and then, we have to figure out whether the tent is really going to suffice, or whether you are just trying to not tell us you are not going to build the building.

U.S. COMPETITIVENESS AND THE AERONAUTIC BUDGET

And when I look at your five-year budget runout for aeronautics in fiscal year 2006, and I compare that with the one submitted last year, it looks like we got a $738 million shortfall from fiscal year 2005 to fiscal year 2009 timeframe. Now, when I look at our market share dropping in aeronautics, as we have talked about. 25 years ago, we were at 90 percent. 10 years ago, 70 percent. Today, we are at 47 percent, and we hear what our friends in Europe are saying, they want to dominate aviation sales by 2020. Are we just retreating, and just saying okay, we understand we are going to lose that battle, and we are not going to go after it? How do these numbers tell us we are really making a stab to stay competitive?

Dr. LEBACQZ. If I could answer that the way that I did in my opening statement, I believe we need a national dialogue on that very issue. We need to decide whether we will have a policy in aeronautics that is consistent with either side of the discussion.

Mr. FORBES. But does this budget do that? Does this budget——

Dr. LEBACQZ. This budget is——

Mr. FORBES.—not the dialogue, but does it——

Dr. LEBACQZ. This budget is consistent with one side of the policy issue that I raised.

Mr. FORBES. Which is what side?

Dr. LEBACQZ. The side that says that the marketplace will, in fact, provide the best outcome.

Mr. FORBES. But the marketplace has not done that for the last 25 years, has it?

Dr. LEBACQZ. That would not be up to me answer, sir.

WORKFORCE AT LANGLEY RESEARCH CENTER

Mr. FORBES. The other question I would have for you is, has NASA decided internally that the Langley Research Center in Hampton is going to be closed?

Dr. LEBACQZ. No, sir.

Mr. FORBES. If they haven't, then how do we explain to the workers there and the people there, when you get these cuts from 804, $105 million, fiscal year 2005, $668, fiscal year 2006, $557, and fiscal year 2007, $479. How do we communicate to the engineers and the workforce that we are not trying to gut the program there, and force these engineers out? Because that is at least the impression that has come across when you just look at the raw numbers of the budget.

Dr. LEBACQZ. Congressman, as you know, there are four mission directorates within NASA, of which Aeronautics is one. Space Operations, there is Exploration Systems, and there is Science. We have, in Aeronautics, $100 million less in fiscal '06, and $200 million, roughly, less, starting in fiscal '07 and out. That is less funding for work in aeronautics, and so, the centers have made an esti-

mate of what that means to people who work, were working in aeronautics at the centers. But that does not necessarily mean that those people won't be doing other parts of the NASA mission. They just won't be working on this part.

Mr. FORBES. And one last question. As you know, the detailed NASA budget justification for each program has a section entitled risk management, which describes the possible factors that could impede the progress on each project, and I am concerned by the fact that the following two risks are cited only for aeronautics programs and no other NASA programs in this budget. The first one is, it says risk: "Given the loss of critical workforce skills, facilities, there is the possibility that costs and schedule may be impeached." The second one, it says risk: "Given the possibility that competing funding requirements draw funding away from research and development, there is a high probability that project activities may be de-scoped or eliminated." In the first case, there seems to indicate that NASA believes the centers that perform this work, which are mostly in Langley and Glenn, will lose workforce, skills, and facilities, because of these budget cuts. And the second case, I was hoping you could maybe enlighten me on what it means when it says competing funding requirements that draw funding away. What does that refer to? Does that—I assume it must mean the Space Exploration Initiative, but——

Dr. LEBACQZ. No, sir. I think what that is referring to, and I am embarrassed that I don't actually know by heart what you are reading from. I believe what that is referring to is within our programs, we will use more full and open competition, collaboratively, among the centers and the industry than we have in the past. We have tended to use so-called directed research, that goes to a center, and then, the center decides to do with it. We will be doing that in a different fashion, similar to the way that our Science Mission Directorate, and our Exploration Systems Mission Directorate operates.

Mr. FORBES. Mr. Chairman.

Dr. LEBACQZ. That is what they are talking about.

Mr. FORBES. My time is up, but maybe, we could submit some written questions, if Mr. Lebacqz would be kind enough to answer those for us.

Dr. LEBACQZ. Glad to do that, sir.

Mr. FORBES. Thank you.

PLANS FOR WIND TUNNEL CLOSURES

Chairman CALVERT. I would like to go back to the subject we were talking about, and let me preface this by saying that I am a restaurant operator, so I know zero about operating a wind tunnel, so you are going to have to help me with this, Dr. Lebacqz, and the others on the panel. But it would seem to me that, as we talked about a business plan, as you mentioned, a strategy, a national strategy on aeronautics, should that—shouldn't we arrive at that first, prior to making a determination of which tunnel should stay open and which tunnel should close, or have you already made a determination which tunnels should close?

Dr. LEBACQZ. We certainly have not made a determination of which tunnels should close. We are, as I mentioned, trying to un-

derstand the requirements this year, but you are also exactly correct, sir. That should be best done in the context of a national policy.

Chairman CALVERT. The—going back to the—and the reason, I guess, that we spend some time on these tunnels is that, obviously, a significant part of your employee load is to operate the tunnels. And I suspect that the—it is like an infrastructure at any major company, depending on your utilization rate, how many employees do you have, and how much utilization do you have out of these tunnels?

And that goes back, you know, to laypeople like myself, who look at this and say, well, you know, you are not getting the great utilization of this, you are not getting the productivity out of your employees, but on the other hand, you may have science of national importance that doesn't meet a traditional business plan. So, I suspect that that may be the case. But is there ways that we can operate these tunnels more effectively, with employees being able to be shifted from one location to another, as you mentioned? And are you looking into that type of thing, where you can maximize the number of tunnels that you are operating, and maximizing the effectiveness, and the, you know, the productivity of your employee base?

Dr. LEBACQZ. Yes, sir. I think, as I mentioned earlier, I think that is a very interesting model, that it is an analog of ways that other organizations operate some infrastructure. That is a reason, again, that we have corporatized the management of the tunnels, so that we can look at this from an agency point of view, rather than a center-centric point of view.

U.S. COMPETITION

Chairman CALVERT. Maybe some of the others can answer this question for me. The tunnels that are competing with us, the Europeans, in this case, how many tunnels do they have? Does anybody know the answer to that question? I mean, how many—what are we talking about here, as far as our——

Dr. ANTÓN. Internationally, I don't have a number off the top of my head. It is probably in the 50 to 100, I would have to go back and count them.

Chairman CALVERT. Internationally, that is worldwide.

Dr. ANTÓN. Worldwide. The larger size.

Chairman CALVERT. Now, the primary competition at this—at the present moment is coming from Europe, I assume. And these tunnels are operated by the European Union?

Dr. ANTÓN. They are operated by private companies. Some of them have some relationships with European governments.

Chairman CALVERT. Are they subsidized?

Dr. ANTÓN. I don't know the answer to the——

Chairman CALVERT. Know the answer to that?

Dr. HANSMAN. There is a mix of tunnels. Some of them are actually run by government agencies, such as the French ONERA, the National——

Chairman CALVERT. Which one is Boeing using?

Dr. HANSMAN. I think that Boeing is doing some tests in ONERA, and then in the—they are also testing the—I think there is a Dutch, Netherlands——

Chairman CALVERT. Question. Is the Europeans subsidizing the tunnel that Boeing is using?

Dr. ANTÓN. The 5 Meter is not subsidized. It is a private entity, and Boeing is doing their subsonic——

Chairman CALVERT. It was all private money that went into building it, all private money that is operating it? All private money——

Dr. ANTÓN. Only the operation, it used to belong to the UK MOD.

Chairman CALVERT. Was it sold at a less than market price to the private operation that utilizes it?

Dr. ANTÓN. I don't know the details on that.

Chairman CALVERT. Dr. Klineberg, you seem to know the answer to that question.

Dr. KLINEBERG. I do, sir, but I am not an expert in that arena. But I—in the space business, I spent quite a bit in time in Europe, in consortia, and there are many, many ways that the governments, the European governments support their aeronautics and space industry, and you have touched on several of those, and I think it is a good supposition that—support them.

Chairman CALVERT. I find it—if, in fact, it is the case, ironic that an American company would be in Europe using a competitor's technology in order to compete with the same people. That is just——

Dr. HANSMAN. Well, I would just like to point out that there are—sometimes, there are critical tests that you need to do to get the airplane off the ground, and so, you may be using that facility because it is the only one available in the world, and you are reducing your risk. I know——

Chairman CALVERT. Is that the case?

Dr. HANSMAN. That has happened in the past, yes.

Chairman CALVERT. Is that the case in the instance that we are using for comparison, in case of Boeing? Is that why they are there? Or are they there because of the cost?

Dr. ANTÓN. In terms of the 5-meter, they were driven there when the Ames facility was rebuilt, and there was no alternative. Right now, the facility there—they like the technical capabilities better there than the Ames 12-foot.

Chairman CALVERT. They like it better because it is a better tunnel?

Dr. ANTÓN. They like the shape better, and some other technical differences. It is——

Chairman CALVERT. Again—but I think these are important—as we move toward a strategy, because at this point, we don't have one, apparently. And as we make a determination of how many employees we are going to have, or not have, it seems to me that these are the kind of questions we are going to need to get more in depth on, and some answers on, and I know we can't do that in a hearing context. But it is certainly something I would like to get more involved in.

Representative Green, you are recognized for five minutes.

WORKFORCE RETENTION

Mr. GREEN. Thank you, Mr. Chairman, and thank you, members of the panel.

I have a special affinity and a kinship with NASA and for NASA, I suppose. I used to work for NASA. I had the very good fortune of working for NASA as a co-op student, and it was very helpful to be there, and to work with some of the scientists and engineers as they were performing stellar services for our country, and in fact, for the world. So, I salute you, and I thank you for coming in, and giving us this very important information.

We all agree, I am sure, that space travel is inherently hazardous. A concern that I would want someone to address, and I am not to sure to whom I should pose the question, but a concern that I have has to do with the R&D and the exemplary technical standards that we have adhered to. Are we going to lose something in the quality of our exemplary work by losing so many valuable and talented minds?

Dr. LEBACQZ. Well, sir, I will have a shot at that. I think the answer is no. NASA has, as a result of the *Columbia* tragedy two plus years ago, instituted a couple of new entities to ensure, in fact, that we maintain the highest standards of safety and engineering discipline, and ensure that they remain within NASA. Excuse me. One of those is the NASA Engineering and Safety Center, which is, in fact, located at, in NASA Langley, but is an Agency-wide activity that provides independent, as-required, engineering and safety analyses of aspects of, specifically, right now, our return to flight endeavors.

Additionally, we have, only within the last two months or so, initiated under our new Chief Engineer, Rex Geveden, something called the Independent Technical Authority, which will be the best people at our various centers, who are given, so to speak, warrants to go and check independently that safety and engineering standards are, in fact, at the highest quality. And those people will be retained and maintained throughout any activities that we do, as long as we are going to be flying either the Shuttle of any of my airplanes, for that matter.

So, I understand the concern. When people leave, you always worry about what is leaving, but in those particular—in that particular area, both of these entities are in place to do our best to ensure that doesn't happen.

Mr. GREEN. I greatly appreciate the assurance, and I thank you, Mr. Chairman, for the time.

Chairman CALVERT. If you would like, if any of the other panel would like to address that issue also. It looked like Dr. Hansman——

Dr. HANSMAN. I would just say that I think that we can manage through loss of some people. My concern is whether new people are going to be coming in. So, in the future, will there be opportunities for co-ops, like you had, in aeronautics. Will we have opportunity path to bring our people in, to have them, potential for the future? Because my concern is not next year or two years, my concern is 10 years.

Mr. GREEN. Thank you very much. Mr. Chairman.

Chairman CALVERT. I thank the gentleman. The gentlelady from Texas.

Ms. JACKSON LEE. First of all, let me welcome the new chairman and Ranking Member of the Committee, and we are in the middle of marking up the bankruptcy bill in Judiciary, so I appreciate the witnesses understanding that two important proceedings are going on at once, and if the bells ring, that means they are saying that my amendments are before the Committee, and I am not there.

But it emphasizes the importance of this hearing. I have been a Member of this committee now for a decade. And I believe my advocacy has been consistent in what I believe is a key element of the aeronautics industry, the aeronautics opportunity, which would include, of course, my commitment to the human Space Shuttle, which is a little distinctive, but also, my view of the industry, compared to how it is treated in Europe, which is that it is an industry that is clearly one that is protected and provided for. I am—want to share some thoughts with you, and then, allow you to comment on this thrust that we are in.

In the course of supporting NASA, I have offered several commentaries that don't pertain directly to its operations, but it, hopefully, contains—pertains to its embrace. One, if there is no science with aeronautics or human spaceflight, then what? I think the two must go hand in hand, and that means that the International Space Station should be a place of scientific research and study. Whether it means that we create the next generation of machines, the next generation of bioresearch, medical research, homeland security. I think you are well aware of the reports, although late, about the possibility of having detected the tsunami after the fact. We understood there might have been that capability. How tragic and sad, if it was, and we were not aware.

I remember the debates of saving NASA right after I came to Congress. The preceding term, NASA's budget passed by one vote. We turned the corner in 1995, and begin to show that NASA and its spaceflight meant something to the average citizen, that there was HIV research, that there was heart disease, there was—or research dealing with heart disease and stroke and cancer. In fact, we had a partnership with the Texas Medical Center. We are not going to continue even with the excitement of a vision, to find stakeholders, if we do not add R&D, or make sure that we are combining those efforts. That is my first point. The second is that we cannot have a good, strong program without safety.

I hope the Chairman of this committee will read some of the materials that I will be providing to him. I know that he has heard me comment on this, and I hope that we will have a hearing, either in the Full Committee, or in this subcommittee, simply on the question of safety. Safety cannot be judged or regulated by the recent newspaper articles, or the lack of oxygen, or lack of quality of air, or lack of water, or lack of this or that at ISS. That is how we get our information. There should be a Gehman's Report similar to what happened in Columbia VII. In addition, as Columbia VII becomes a backdrop to safety, have we really answered all of those questions, and have we truly vetted the space program as it proceeds?

The other aspect of it is generally looking at aeronautics in general, and to not lose the competitive edge to our European colleagues on this question of producing the next state of technology in aeronautics. And under that particular concept, I would just simply say this. This industry should begin to look in diversity. Historically black colleges, Hispanic-serving colleges, minority businesses, to embrace those entities, so that we can expand the stakeholders, those who are understanding the industry, and those who can possibly move it into the 21st Century.

So I would welcome, in my short time that I have, I am not going to pose questions. I will review your testimony. But in the short time that I have, I would be interested in, Dr. Hansman and others, if you would just comment briefly on this—these concepts that I have offered to you.

Dr. HANSMAN. Well—thanks. I agree 100 percent. We really need to maintain the core research and development capability. That is going to be the heart of our ability to respond to the problems in the future. I think that safety is clearly a key issue, and in fact, you can point to contributions NASA has made to safety issues, such as responding to wind shear and other aviation weather hazards. I think we need to keep that going.

And I agree with you 100 percent that investing in our people, and going to nontraditional sources, to build up the strength in places like the historically black colleges, in the aeronautics is a real opportunity that we should take advantage of.

Ms. JACKSON LEE. Doctor, if I may just get the NASA representatives to comment on the issue. I thank you for indulging me, Mr. Chairman.

Dr. LEBACQZ. Yes, ma'am. Let me start with the maintaining the competitive edge. Competitive edge is a policy issue. If we have a national policy in aeronautics that says we will, as a country, invest in this arena as one of our niche areas, to maintain a competitive edge, then we will be able to do that more clearly than we are now.

I agree entirely with your concern about where the ideas come from. In my Mission Directorate, we have put in place this year something called a Council of Deans, which has deans from 15 engineering schools throughout the country, big ones, little ones, historically black ones—Tuskegee is one—who are supposed to help inform me of what our programs need to do to encourage education in aeronautics in the universities, and vice versa, I will be informing them of the kinds of curricula changes they should have to reengage students in aeronautics. So, I think that is a critical thing, a fundamental thing, I did that as soon as I became the Associate Administrator a year and a half ago.

You asked about *Columbia,* and whether we are, in fact, following through, we as an agency are following through on the *Columbia* Accident Investigation Board. As I know you have been told and heard in other hearings, we believe, and are working assiduously to ensure that we meet every single recommendation and requirement from the *Columbia* Accident Investigation Board, and we will not fly the Shuttle again until we do.

There are a whole host of discussions one can get into relative to that, but the fact is we are not flying that machine until we all

believe that it is safe. We have gone through a culture change activity. I think that may have been breached at a previous hearing, to ensure that people who think there is an issue with safety are able to raise it without fear of reprisal. And I believe that that, and that activity has, in fact, been quite successful. God knows I am getting more emails than I used to get. So, I think the answer to that question is pretty clear. As John mentioned, in my programs, in the aeronautics research programs, our work in aviation safety has led to assessing wind shear. It has led to these synthetic vision systems, that will allow us to fly in bad weather, and be able to see better. It has led to putting turbulence detectors on commercial aircraft, so that we can sense ahead whether the airplane is going to be upset, and somebody will be hurt. That is a fundamental part of what we are doing.

Chairman CALVERT. I thank the gentlelady. Appreciate it.

Ms. JACKSON LEE. Thank you very much.

Chairman CALVERT. Let us see. I think I am next. Or is it the gentleman from—Mr. Udall, yeah, I think he did the second round, and——

Mr. UDALL. Thank you, Mr. Chairman. I asked, my initial round, Dr. Lebacqz, his impressions, and I want to turn to the four of you, I think start with Dr. Hansman, I will restate the question. We will come across, and—if I get done quickly, you each should have about a minute, within a five-minute context.

EFFECTS OF THE BUDGET PROPOSAL

I had asked what would the consequences be for the future of NASA's aeronautics program if the funding and workforce and infrastructure reductions contained in this five-year budget plan actually come to pass?

Dr. HANSMAN. I think it is clear, because of the cutbacks, that the national capability represented by NASA will be reduced, and I think that—I personally have concerns as to whether we will be able to meet challenges that are going to emerge in the future, some of which we can't predict right now.

Mr. UDALL. Dr. Benzakein.

Dr. BENZAKEIN. I would agree with that statement. I do think, in addition to that, I am not sure this is a second question, but the competency is going down in Vehicle Systems. You did mention a serious reduction in Vehicle Systems. This is exactly where Europe is going to give us a very, very strong competition. But I do think this reduction really drives to the heart of the problem we have. In addition to that, Europe, in addition to putting more money on these programs, really has put together a consortium of university and academia, to really address that. And the universities is leading this effort in defining those programs. And that, really, has driven the right balance between short and long range, which I don't see happening in this country.

Mr. UDALL. You would say that, I was reading the comments of the EC, the European Commission's multiyear initiative, and they not only have put words on paper, but they are putting resources behind their efforts.

Dr. BENZAKEIN. Absolutely.

Mr. UDALL. Dr. Antón.

Dr. ANTÓN. I would just like to add that the management and—efforts that NASA is pursuing, I think make a lot of sense, and go a long way to helping out. The only question I guess I would raise with—relative to workforce and infrastructure is to emphasize the fact that capabilities for test facilities isn't just a hardware issue. It is also the workforce issue, and so, there—if we do lose workforce capabilities, that—there is a degradation in that capability. You can't just simply just mothball and preserve it in that level.

So, the question ultimately comes down to how long a range does NASA, is NASA resourced so that they can look out, and try to preserve things that maybe not—may not necessarily fit and support current research programs, but would allow them options later on to add new programs, as opportunities arise.

Mr. UDALL. Dr. Klineberg.

Dr. KLINEBERG. Yeah. Thank you. I am concerned, also, about this—the consequences of the infrastructure, but I believe NASA aeronautics is doing what they can within the budget. If you will, I would just like to quickly remember an anecdote from my career in NASA.

Some time in the mid-80s, there was a very clever guy down at Langley, Richard Whitcomb, who was working in the 7 by 10 tunnel, I believe, which he was responsible for, and he was filing away the wings, and trying different concepts, and he came up with the idea that if, instead of having a wing be one plane, if you put aerodynamic devices at the wingtip, he called them winglets, you could improve the lift of the commercial airplanes. The industry was pretty negative about that, gosh, we can't do that, and we have problems, you know, there were a lot of reasons not to do that, and you now go to any commercial airplane in the world, and they have winglets. They have these things on the tips that vastly improve the efficiency of the transportation system, reduce the amount of fuel import, all sorts of public goods, come from that invention that was made in a tunnel, that was used only for in-house work, was not used in the way we are talking here, to support industry or specific programs, and resulted in a breakthrough that was very important.

And there are many other like that. The problem you are asking us now, and I think Mr. Antón and John Hansman said it, is you try to project from the future, make decisions now to project from the future, is very difficult. Thank you for your indulgence.

AERONAUTICS FUNDING CUTS

Mr. UDALL. I see my time is beginning to expire, and I didn't want to leave Dr. Lebacqz alone in this next round. I am going to make a comment, and we will see if there is a chance for you to respond.

As I understand, part of the budgetary problem is that aeronautics had a sort of almost a third of the cut that the White House made to NASA's budget plans from—for fiscal year 2006 through 2009, and it is a puzzling allocation, because aeronautics, as I do the numbers, only represents about one-seventeenth of the NASA budget. Would you care to comment on why aeronautics took such a large share of the overall cut?

Dr. LEBACQZ. The change in the budget from the fiscal '05 runout to the fiscal '06 request is a difference of a projected increase of 5.8 percent from '05 to '06 in the '05 runout, and an actual 2.4 percent. The Agency believed that we should try to contribute, also, to the reduction in the deficit of the country, and so, what we asked for was actually less than in our previous runout. Within that, three Mission Directorates actually received less money than they had in the runout of the '05 budget, of which I am one. In our case, our runout was flat, so receiving less means that we ended up getting less. In the case of the other two, receiving less was just less than the request would have been, but was still an increase.

That is about as far as I want to go with answering that question.

Mr. UDALL. Yeah. I——

Dr. LEBACQZ. In fact, what I just told you——

Mr. UDALL. I appreciate, in conclusion, the hard work you do, and I still would stick by my statement that you have a thankless task to come up here to the Hill and justify what I think are worrisome cuts in a—the sort of endeavors that I think are equal in importance to the space exploration programs that we all support, and we have heard, I think, very eloquently, why. It is national security. It is economic opportunity. It is maintaining our workforce, exciting young people to stay in engineering and math and technology fields, and for all those reasons, I just want to again say I am very concerned about the direction in which we are heading. I thank the panel.

Dr. LEBACQZ. Thank you, sir, and again, that is why I am open, we in the Agency are open to a policy dialogue, across the country. There are certainly a number of areas in which breakthroughs in aeronautics are still waiting to be found, including hypersonics, which was one of your original parts of your question that I never got to, including rapid demonstrations of transforming the national airspace system through far more airborne autonomy, and a variety of other things. So, that is why we need this policy dialogue.

Chairman CALVERT. I thank the gentleman. Just a couple of quick questions before we wrap this up. Dr. Klineberg, in your study, the National Academy of Sciences, what did they have in mind when they said "disposing of underutilized facilities?" Mothballing, shutting down completely, or what do you mean by that?

Dr. KLINEBERG. We were just recognizing budget realities, and realized those are a very—they are really expensive, some facilities. And where there were facilities which were truly duplicative, either of air force capability, or within NASA, we thought, obviously, those needed to be shut down. But we didn't look in detail. We urged NASA to do a study, and I know the RAND Corporation, and my colleague here, Dr. Antón, in fact, did that study, to take a look at those facilities.

HYPERSONICS

Chairman CALVERT. Dr. Lebacqz, you mentioned hypersonics just a second ago, and had I ever had him on the Armed Services Committee, and obviously, this has some—obviously some defense capability, potentially. How is DOD reacting to this, these potential

cuts? Have you heard from their compadres over there? What do they have to say about that?

Dr. LEBACQZ. I have a meeting this Friday, sir, with Dr. Sega, DDR&E, on this subject. As you may have read in the Post this morning, the—DARPA is moving forward with the Falcon program, which is taking some of the things that we learned from the X-43, and trying to take them to the next step. But we will be having discussions with Dr. Sega on this subject.

Chairman CALVERT. And how would you describe your coordination with the Department of Defense, as of late?

Dr. LEBACQZ. It is not as good as I would like it to be.

Chairman CALVERT. Is NASA still involved, to any significant degree, in some of the black operations that the Department of Defense is involved in?

Dr. LEBACQZ. I probably can't answer that.

Chairman CALVERT. I mean, we are not asking you to describe the program, just whether or not—is there——

Dr. LEBACQZ. Yes. We have. Yes.

Chairman CALVERT.—still—okay. Okay. Dr. Griffin, I know, our new Administrator, is coming on, has very much been involved in all of this, and we are certainly looking forward to his involvement in this. Wrapping this up, I am looking forward to us working toward a vision on aeronautics, as we move toward these budget cuts. If that is what we are going to do. And before, I think you are right, we have got to get the—we can't have the tail wagging the dog here. We are going to have to work out something that makes more sense, I think.

I certainly appreciate this panel. I certainly appreciate your spending the time with us today. And with that, we are adjourned.

[Whereupon, at 1:00 p.m., the Subcommittee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by J. Victor Lebacqz, Associate Administrator, Aeronautics Research Mission Directorate, NASA

Questions submitted by Chairman Sherwood L. Boehlert

Q1. On May 3, 2005, you provided the Committee with a White Paper on the Aeronautics Test Program that outlines your plans for NASA wind tunnels in Fiscal Year (FY) 06 and beyond. What steps need to be taken for this plan to be formally approved and put into effect? When do you expect that process to be completed?

A1. As part of our FY 2007 budget formulation process, NASA is considering initiation of the Aeronautics Test Program. The deliberations within the Administration will culminate in the FY 2007 budget submission to Congress in February 2006.

Q2. The White Paper describes NASA as "in general, concur[ring]" with the recommendations of the RAND study of wind tunnels. Yet clearly, the White Paper plan prioritizes wind tunnels quite differently than RAND did, as the White Paper apparently considers the rate of use of a tunnel as the primary classification criteria. Why did you decide to reject RAND's notion that NASA needed to take into consideration the uniqueness of facilities and potential future national needs?

A2. The Aeronautics Research Mission Directorate (ARMD) has, or is attempting to respond to the RAND study's eight conclusions and six recommendations, including the development of an aeronautics test facility plan, providing institutional (shared) funding to alleviate the full-cost recovery burden from individual customers, maintaining and investing in a minimum set of test facilities, etc. We diverge from the RAND study with regards to our current selection of the "minimum set" of ground test facilities that we believe to be important to sustain for the future of NASA and the Nation's aeronautics needs. RAND assessed 31 ground test facilities. NASA currently considers six of the 31 to be critical to sustain in full operational status. Ten of the 31 are to be kept in standby and used as needed, two are to be mothballed because while we agree with RAND regarding their criticality, there is simply no present or projected future work, four are to be closed, and the other nine facilities that RAND assessed are to be maintained by the field centers, without direct financial support from the ARMD. These nine are mainly small, lab-type, hypersonics and engine test facilities. During the current hiatus in hypersonics and turbomachinery research by NASA, the Centers are most likely to not use these facilities. At the same time, we do not anticipate that anything irreversible will be done to these facilities which would preclude the Agency from operating them future.

We assessed and then categorized the facilities based on utilization, facility uniqueness and future national need. Assessing both utilization and national need allowed us to consider the needs of NASA Aeronautics, other NASA mission directorates, DOD, other government agencies and the U.S. industry. Keeping the National Transonic Facility in an operational status is an explicit acknowledgement that the Nation's only flight Reynolds Number wind tunnel, while not currently utilized by NASA Research Programs, is of critical national importance. Similarly, many of the facilities that we will put into standby have unique performance characteristics which make them indispensable from a national perspective. So while NASA does not currently need these facilities to meet Aeronautics Research program requirements, we are committing NASA Aeronautics funding to sustain these facilities, for the very reasons that RAND recommended. Lastly, it should be noted that RAND defined nine NASA test facilities that they deem to be "detrimental to close." All of these nine facilities are being maintained by NASA in either operational, stand-by, or mothball conditions.

Q3. The White Paper states that NASA will be running a University Research Project funded "at one percent of the 'after tax'." Please describe what this means and what level of funding is anticipated for the University Research Project in FY06. Would you expect the University Research Project and the $1 million in university funds in the Aeronautics Test Program to be all the money available for universities from the Aeronautics Research Mission Directorate (ARMD)?

A3. The tax referred to are the Agency Corporate General and Administrative (G&A) costs and the Mission Directorate budget required to fund Mission Directorate operations. Approximately 10 percent of the FY 2004 aeronautics budget

($106M of the $1,056M aeronautics budget) went to universities. The estimate for FY 2005 is also projected to be about 10 percent. For FY 2006, NASA anticipates that approximately 10 percent of $852M (or about $85M) will be with universities. The University Research Project that NASA is considering would enable NASA to seek from the university community revolutionary ideas for aeronautics research that would not otherwise be possible if the research were tied directly to the individual programs. If implemented, this project would be part of the $85M.

Q4. How did NASA determine how many employees it would cut from the ARMD in FY06? Were these cuts made pursuant to any strategy or were they just a budgetary calculation? How will NASA determine which employees to cut?

A4. Future ARMD workforce requirements at the NASA Centers were derived as an integral part of the overall strategy for realigning the Aeronautics Research program. As in any fiscal year, the process of projecting future aeronautics-related workforce levels (and facility needs) at the Centers began with the programmatic requirements established by the Agency through the annual programming and budget development process, culminating with the preparation of the FY 2006 President's budget as submitted to Congress. The FY 2006 NASA budget reflects a major transformation in both the content and conduct of the Aeronautics Research Mission Directorate's programs. With respect to content, the ARMD program, in particular the Vehicle Systems Program, has been transformed to focus on four "barrier-breaking" technology demonstrations, emphasizing higher-risk research where the private sector will not optimally invest due to risk and anticipated rate of return (as opposed to more near-term development programs that are typically the purview of the private sector). With respect to conduct, ARMD will be placing a renewed emphasis on realizing best value for the taxpayer's investment through a combination of competition models. One aspect of the increased use of competition is expected to be a greater contribution by the private sector to the conduct of NASA's aeronautics research.

Both of the changes in strategic direction (i.e., content and conduct) have the potential for a substantial impact on the NASA workforce. Having established the transformed programmatic requirements, ARMD—working with the Centers and the Agency's human capital planning community—quantified the impact on workforce requirements of the combination of a more focused research effort and an increased private sector role. This impact was defined both in terms of numbers of employees and in terms of specific skill mixes required to implement anticipated programs. Workforce numbers and skills that did not fall within the revised set of Aeronautics-related program requirements then became the basis for future human capital actions including buyouts and reassignments.

Q5. The proposed budget for FY06 reflects a decision to move away from incremental subsonic research. Has NASA assessed the impact that would have on the U.S. aircraft manufacturing industry? What is the evidence that this work would be funded or carried out elsewhere?

A5. To ensure maximum benefit to the taxpayer, we are transforming part of our investment in Aeronautics Research investment in order to more sharply focus the investment on revolutionary, high-risk, "barrier breaking" technologies. Toward this end, the NASA Aeronautics Vehicle Systems Program (VSP) has been refocused away from evolutionary research and technology development and toward more key revolutionary, "barrier-breaking" technology demonstration projects that address critical public needs related to reduction of aircraft noise and emissions, and enable new science missions. NASA's assessment is that the revolutionary technologies developed within the next decade will form the basis for a new generation of environmentally friendly aircraft and will enhance U.S. competitiveness 20 years from now. The work that was terminated to refocus the program is carried out elsewhere. One example is the recent General Electric Aircraft Engines announcement regarding the capability of their GEnx aircraft engine. The following is extracted from GEAE brochures:

> "The GEnx engine will achieve dramatic gains in fuel efficiency and performance with significantly lower emissions than other engines in its class. And the GEnx is the quietest large commercial engine we have ever produced.
>
> "And by incorporating our most advanced combustion technology ever, the result will be an engine that will produce fewer smog-causing emissions than the maximum allowed by 2008 international standards (94 percent fewer hydrocarbon emissions and 57 percent nitrogen emissions), while consuming at least 15 percent less fuel than the engines they replace.

"With the use of our unique, super high bypass composite fan design, these same aircraft are expected to be 30 percent quieter than today's GE-powered aircraft."

Q6. You have stated that hypersonics would be one of your top priorities if money were restored to the ARMD budget. Why is that a top priority? Are hypersonic aircraft likely to be used for commercial as well as military purposes? What is the basis for your answer?

A6. A hypersonic technology demonstration is one of several candidates that would be considered following completion of the current set of demonstrations identified in the FY 2006 President's Budget Request for aeronautics research. Examined for many years, hypersonic vehicles provide the potential for low-cost, reliable access to low-Earth orbit. NASA's interest is for long-term civilian purposes, however, the military may find applicability for this type of vehicle. NASA's recent success with the Hyper-X, in which a scramjet was flight demonstrated at Mach 7 and 10, is the culmination of this work. However, many breakthroughs are required before routine hypersonic access to space is realized. Low-cost reliability means that these vehicles would accomplish many take-offs and landings; NASA's success to date is limited to two 10-second flights. Much research and technology work remains to develop engines and airframes, particularly in high-temperature materials and propulsion. Due to these challenges, a hypersonic demonstrator is of potential interest.

Questions submitted by Representative Bart Gordon

Q1. Administrator Gregory's recent testimony to the Science Committee indicated that NASA has established "core competencies" at each of the NASA Centers that "must be maintained in order for the Agency's mission to be achieved." *I understand that NASA headquarters has had each of the Centers do an assessment of the "health" of their core competencies, that is, an assessment of whether any core competencies are at risk of being lost or degraded.*

Q1a. What have the aeronautical research Centers—Glenn, Langley, Ames, and Dryden—reported regarding the health of their core competencies?

Q1b. Have any of those Centers reported that their core competencies are at risk? If so, where, and what competencies have they identified as being at risk?

Q1c. What will NASA Headquarters do in response to those assessments? Is NASA prepared to request additional funding to deal with the problem?

A1a,b,c. Of the thirteen approved NASA core competencies located at the four Research Centers (ARC, DFRC, GRC and LARC), six are associated with the Aeronautics Research Mission Directorate. These are Air Transportation Management Systems (ARC), Atmospheric Flight Research and Test (DFRC), Aeropropulsion (GRC) and Aerosciences, Aerospace Materials and Structures, and Systems Analysis/Engineering and Safety (LARC). It should be noted that the three Langley core competencies also provide substantial support to all of the other NASA Mission Directorates.

Following the identification and assignment of these core competencies, each Center completed an initial assessment of the health of each competency. This assessment consisted of an initial estimation of the minimal investment (in people and facilities) required to sustain the competency, coupled with programmatic guidance from the four Mission Directorates regarding anticipated requirements for each competency. Based on this initial assessment, the Centers reported that all but one of the six aeronautics-related competencies faced potential challenges beginning in FY 2005 (the exception being the Systems Analysis/Engineering and Safety Competency at LARC). In FY 2005, the primary factor behind a less than fully healthy assessment was the accommodation of Congressional interest items (necessitating reductions at the Centers to create funds for out-of-house contract awards); in FY 2006 and out the primary factors were changes in Mission Directorate requirements.

There are still three important steps remaining in the first round of the NASA Core Competency activity. First, each of the Mission Directorates (including ARMD) is engaged in a dialogue with each Center that has a related performing competency regarding the sizing of the minimal sustainment level. Second, each of the Mission Directorates continues, as part of the FY 2007 budget development process, to update and clarify its anticipated programmatic requirements. Once these first two steps are completed, the Agency will be able to complete a final assessment of the projected health of each competency. As the third step, strategies for dealing with any identified shortfalls in the suite of NASA core competencies, for example addi-

tional Mission Directorate or Agency investment, will be developed and dispositioned.

Q2. The NASA FY 2006 budget book discussion of NASA's Aviation Safety and Security program states that "Given the loss of critical workforce/skills/facilities, there is the possibility that cost and schedule may be impacted."

Q2a. What is the reason for the loss of those critical workforce/skills/facilities?

Q2b. Are they considered "excess competencies" by NASA? If so, why?

A2a,b. The section that is quoted is identifying the risks that the program *may* encounter throughout its life cycle. As part of a risk management plan, the program develops a mitigation strategy for each of these potential events even though they are not currently an issue that needs to be actively worked.

Loss of critical capabilities can occur for a myriad of reasons including personnel turnover and skill mix, which is a normal process for any long term program, (e.g., retirement, illness, new job opportunities, etc.) whereas facility issues are normally unique, such as breakdowns, multiple users vying for the same time, etc.

While the in-house skills and facilities are not excess, it may be possible to accomplish the mission in an alternative manner if one is lost or not available.

As an example, the LARC 757 research aircraft is a one of a kind facility that is used to flight test aeronautical technologies. When this aircraft encountered an extended safety stand down, the Aviation Safety Program worked with airlines, aircraft manufacturers, etc. to install and test NASA technologies on their vehicles. This resulted in NASA technologies being flight tested without noticeable impact to the original schedule even though a critical capability was not available. As a bonus, these technologies were tested in an actual operational environment, which enhanced the technology transfer process.

Similarly while personnel turnover is a normal activity, outside forces may result in a significant local loss of personnel that will have to be mitigated by use of other NASA, academia, or industry assets. This may result in financial and cost impacts for the program.

Q3. Your budget shows a five-year funding plan for Vehicle Systems with a focus on four breakthrough technology flight demonstration projects. Please provide the funding profile for each of the four Vehicle Systems demonstration projects over the five-year period, as well as over the life of each project that extends beyond the five-year period covered in the FY06 request. Please provide the specific milestones for each project, as well as the specific accomplishments anticipated at the end of the five-year period and at the completion of each project.

A3. The Vehicle Systems program will demonstrate revolutionary technology concepts through flight demonstrators that are beyond the scope of conventional air vehicles. Preliminary plans are to focus on the four specific projects that are described. Over the next year, the program will work with the aeronautics community to define the scope of the overall program. To initiate this discussion, preliminary milestones have been developed for planning purposes. These preliminary estimates are detailed below for each of the four projects.

Estimated budget:

	FY 06	FY 07	FY 08	FY 09	FY 10
Subsonic Noise Reduction	103.9	84.5	88.0	46.7	46.7
Sonic Boom Reduction	66.5	57.3	66.2	74.6	76.8
High Altitude Long Endurance (HALE)	150.2	113.7	108.4	130.7	120.8
Zero Emissions Aircraft	114.0	98.5	101.4	101.4	101.9
Corp G&A	24.6	19.6	21.5	20.1	19.4
Total:	459.1	373.6	385.5	373.5	365.6

Subsonic Noise Reduction: Continues the barrier breaking research for reducing airport noise. A demonstration of noise reduction technologies for large transport aircraft will establish a significant milestone toward keeping objectionable noise within airport boundaries. The demonstration will include advanced engine and airframe noise reduction approaches as well as innovative continuous descent ap-

proaches to avoid the objectionable changes in engine speed as an aircraft approaches the airport.

Subsonic Noise Reduction will by the end of FY 2008 identify those technologies that will contribute to a validated 10dB reduction, and by the end of FY 2009, identify those technologies that will extend that validated noise reduction to 15dB.

Sonic Boom Reduction: If nothing is done to break the barrier of supersonic flight overland, it will take just as long to fly across the country in the third century of flight as it did halfway through the first century. The barrier to high-speed flight is defining a sonic boom level that is acceptable to the general public, and designing an aircraft top reach that level. On recent successful flight validation of the theory that by altering the contours of a supersonic aircraft, the shockwave and its accompanying sonic boom can be shaped resulting in a greatly reduced sonic boom signature on the ground. Work will investigate the formation of shaped waves and the human response to shaped waves to allow developing an acceptable regulatory standard. The Sonic Boom Reduction will culminate with a flight demonstration of a low boom vehicle by the end of FY 2010.

HALE: NASA opened the doors to high altitude flight when it successfully demonstrated the Helios. NASA will extend this accomplishment through a series of high altitude long endurance aircraft that will extend duration, range and payload capacity. The first breakthrough will be a 14-day duration aircraft that flies at over 50 thousand feet prior to the end of FY 2008, followed by a flight demonstration that will achieve a 30-day endurance flight demonstration by the end of FY 2010.

Zero Emissions Aircraft: Conventional turbo machinery powered by fossil fuels can only incrementally address the need to reduce harmful NO_X and CO_2 emissions from aircraft. A breakthrough demonstration of an all-electric aircraft propulsion system will be the first step towards an emissionless aircraft. NASA intends to conduct zero emissions flight demonstrations mid-FY 2010.

Questions submitted by Representative Mark Udall

Q1. Why did NASA decide to discontinue rotorcraft research, despite the National Research Council's recommendation that "NASA should conduct research in selected areas related to rotorcraft"?

A1. NASA has transformed the Vehicle Systems Program to focus on key barrier-breaking demonstrations. While none of the initial set is a rotorcraft follow-on, the mission directorate continues to monitor advances in rotorcraft technology and maintains communication with the industry (through the American Helicopter Society) and the Army in the event that similar barrier-breaking opportunities arise.

More specifically, the Aviation Safety & Security Program continues to examine ways to extend fixed-wing aircraft technology development, such as synthetic vision and weather information systems, to rotorcraft. This was the specific recommendation of the NRC.

Q2. Please provide the five-year NASA funding profile required to meet the objectives of the JPDO Integrated Plan. How does that compare to the five-year funding plan for NASA's Airspace Systems program?

A2. The JPDO is still in the process of developing the integrated roadmap for the Next Generation Air Transportation System (NGATS). The integrated roadmap should be completed by the end of the calendar year. Until such time, the specific funding profile required to meet the NGATS plan is unknown. Once the funding requirements are known, NASA will review its Airspace Systems Program to ensure appropriate alignment.

Q3. In 2001 NASA and DOD entered into a joint National Aerospace Initiative (NAI) that identified hypersonic research as an important focus for both near-term and long-term efforts. Furthermore, your testimony at the March 16th hearing showcased NASA's initial accomplishments in this area of research. Given that, why didn't NASA request any funding for hypersonic research in FY 2006? Was the reason budgetary?

A3. The NASA investment in hypersonic research culminated in successful flight demonstrations at nearly Mach 7 and Mach 10 in FY 2004. In FY 2005, NASA, under an item of special Congressional interest, is focusing on analyzing and transferring technical information to assist the Air Force with their X–43C activities. In FY 2006, NASA has no requirement for a hypersonic vehicle to meet its launch requirements for the new Exploration Vision and therefore, the Agency terminated its Next Generation Launch Technology program. With other aeronautics programmatic

priorities in FY 2006, it was not possible to propose additional hypersonic research in the President's Budget Request. However, we will continue to assess the Nation's hypersonic requirements and options for the future.

Q4. NASA apparently is considering closing down additional "underutilized" facilities in part to free up funds for the exploration initiative. Aeronautical test facilities and the technicians that operate them have been identified as likely targets. However, a recent RAND Corporation assessment prepared for NASA concluded that: "NASA should maintain nearly all of its 31 major wind tunnel and propulsion test facilities to support research, development, production, and sustainment by the Nation's aeronautic industry."

Q4a. Have you reviewed the RAND assessment?

Q4b. Do you agree with it?

Q4c. What is NASA planning to do about the 31 test facilities and associated workforce cited in the RAND assessment?

A4a,b,c. The RAND project team briefed NASA management at multiple points during the conduct of the RAND study, including a final briefing summarizing their findings.

We believe that the RAND team did a commendable job of not only assessing the current state of, and environment surrounding, NASA's major aerodynamic and propulsion ground test facilities, but also of developing and using an assessment method that can be applied as national and programmatic requirements continue to evolve. In general, we concur with the RAND team on the basic substance of all of their findings and recommendations. In particular, we agree with their findings that ground test facilities (along with computational tools and flight assets) are still critical components of a research and technology program; that nearly all of the facilities studied can serve strategic national needs (but not necessarily NASA needs, a point to which we will return below); that NASA's portfolio of facilities is in mixed health; and that NASA should provide some type of shared financial support to a minimum set of test facilities.

With respect to their specific recommendations, we agree that it is important to develop an aeronautics test technology vision (although we would stress that such a vision should be driven by, and an integral part of, and overall national aeronautics policy); that NASA should continue to develop plans to modernize facilities; that NASA should prescribe common management and accounting guidance for these facilities; and that NASA should work with the Department of Defense to address the viability of a "national reliance plan" for major ground test facilities. In fact, NASA's Aeronautics Research Mission Directorate is pursuing implementation of all of these recommendations as part of the FY 2006 and FY 2007 budget processes.

As mentioned above, however, RAND developed and used a methodology that can be applied as national and programmatic requirements continue to evolve. As does any such study of this type, the RAND study began with, and was grounded in, an assessment of future national aeronautics-related research and technology requirements, as well as in an assessment of the total available suite (government, industry, and academia) of major ground test facilities. As either national and programmatic requirements or the suite of available facilities changes, so does the minimum set of facilities that NASA may need to retain. In particular, NASA's projected programmatic requirements have evolved substantially since the RAND team evaluated those requirements almost three years ago. In addition, RAND stated that nearly all of the existing NASA facilities served *national needs, not necessarily NASA needs.* As requirements change, it may be more appropriate to have operators other than NASA (for example, the DOD) operate specific facilities that they require, but that NASA may not. Finally, from the perspective of efficient facility operation, it may make more sense to operate a somewhat smaller set of facilities at a higher rate of utilization than it does to operate a larger suite of facilities at lower utilization rates (assuming, of course, that technical requirements can be satisfied with either approach). Given these three factors (i.e., evolving NASA requirements, related national requirements, and efficient facility operation), an updated application of the RAND process coupled with these other considerations may well result in a different optimum set of minimum facilities for NASA than that recommend by RAND at the conclusion of their study.

Q5. The National Academies panel led by Dr. Klineberg recommended that "NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects."

Q5a. Do you agree or disagree with that recommendation?

Q5b. If you agree with it, what level of funding is provided for that base research program for each of the years FY06–10, where is the funding located, and what is the content of the base research program?

A5a,b. NASA agrees with the intent of the recommendations to ensure adequate level of funding for long-term research. Each of ARMD's three programs has approximately 20 percent of the funding in long-term research. In the outyears, we plan to consolidate this funding into a new Foundational Technology Program that captures long-term cross-cutting base research & technology activities as well as those providing support of ARMD core competencies.

Questions submitted by Representative Michael M. Honda

Q1. How has the percentage of NASA's budget for aeronautics research changed over the past decade and, in particular, over the last three years? Your budget presentation numbers to Committee staffers in February only presented total program dollars. Under Full-Cost Accounting, how have direct expenditures for each of the NASA aeronautics programs (i.e., the procurement dollars, civil servant salary dollars, and contractor salary dollars) at each of the four centers (Ames, Dryden, Glenn, Langley) changed over the past three years and how is NASA proposing to change those numbers in FY06 and outyears?

A1. Please see data in the following graphs and tables:

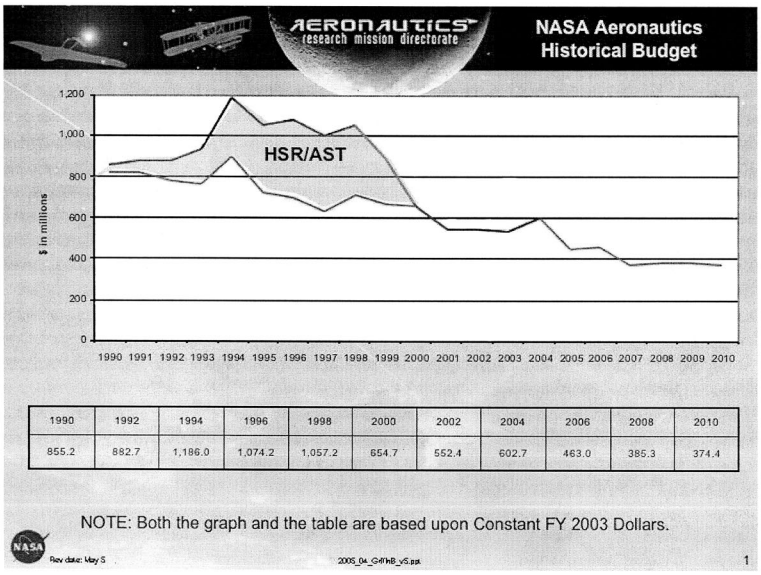
1. Overall aeronautics funding level history
2. Percentage of NASA budget over the past two decades
3. Overall budget request
4. Four NASA Center breakdown according to preliminary planning

(Note: HSR and AST in the chart below refer to the High Speed Research and Advanced Subsonic Technology programs.)

As a percentage of the NASA budget, the Aeronautics budget peaked during the FY 1993 through FY 1999 time period when the High Speed Research (HSR) and the Advanced Subsonic Technology (AST) Programs existed. Both of these focused programs terminated at the end of FY 1999 which resulted in a reduced funding level for Aeronautics.

Note: The Aeronautics budget numbers are not full cost; they do not include personnel costs, such as salaries and travel and Institutional CoF

The table below reflects FY 2003 Constant-year dollars (inflated).



1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010
855.2	882.7	1,186.0	1,074.2	1,057.2	654.7	552.4	602.7	463.0	385.3	374.4

Comparison of Aero Budget to NASA Budget

($, Millions)

(Real Year $) 4/20/05
NOT FULL COST

Fiscal Year	Total Federal Budget	NASA Budget	NASA Percentage of Fed Budget	NASA BAU Budget *	AERO Budget	AERO Percentage of Total NASA Budget
1980	870,062	5,350	0.8	4,212	300.3	7.1
1981	740,300	5,634	0.8	4,463	275.3	6.2
1982	806,522	6,200	0.8	4,974	264.8	5.3
1983	869,841	7,065	0.8	5,774	262.0	4.5
1984	923,432	7,458	0.8	6,061	302.3	5.0
1985	1,028,304	7,573	0.7	6,114	342.4	5.6
1986	1,013,994	7,807	0.8	6,367	354.0	5.6
1987	1,003,974	10,923	1.1	9,303	421.0	4.5
1988	1,081,374	9,062	0.8	7,141	441.0	6.2
1989	1,196,003	10,969	0.9	8,769	498.6	5.7
1990	1,286,176	12,324	1.0	9,950	589.8	5.9
1991	1,386,119	14,016	1.0	11,265	631.0	5.6
1992	1,467,459	14,317	1.0	11,385	683.2	5.8
1993	1,474,400	14,310	1.0	12,331	727.0	5.9
1994	1,529,266	14,570	1.0	12,355	957.2	7.7
1995	1,539,693	13,854	0.9	11,306	876.5	7.8
1996	1,580,920	13,886	0.9	11,399	911.9	8.0
1997	1,642,838	13,711	0.8	11,147	857.8	7.7
1998	1,692,222	13,649	0.8	11,269	920.1	8.2
1999	1,776,662	13,655	0.8	11,156	786.0	7.0
2000	1,824,897	13,602	0.7	11,070	600.1	5.4
2001	1,958,985	14,257	0.7	11,981	517.3	4.3
2002	2,090,958	14,893	0.7	12,309	536.8	4.4
2003	2,266,092	15,391	0.7	12,752	541.4	4.2
2004	2,407,446	15,379	0.6	12,486	534.0 **	4.3
2005 Est.	2,477,354	16,197	0.7	12,906	503.9 **	3.9
2006 Reqst	2,547,549	16,457	0.6	13,012	333.7 **	2.6

Source: Data from President's Budget "Historical Tables" Table 5.2 Budget Authority by Agency
* NASA BAU Budget excludes Personnel Costs (Salaries/Travel), ROS and Instit. CoF (Cars GAA in FY04 and beyond)
** Note that beginning with FY 2004, the agency implemented full-cost budgeting. Budget amounts beginning in FY 2004 and beyond are estimated BAU which includes *Procurement* and *Service Pool* dollars

FY 2006 President's Budget Request
Aeronautics Total
($ in millions)

	2003*	2004	2005	2006	2007	2008	2009	2010
Direct Civil Servant Salaries/Travel	190.8	207.2	222.2	186.0	130.7	127.7	127.1	123.8
Service Pools	205.5	145.5	160.6	135.0	119.8	129.3	126.0	124.8
Center G&A	181.4	192.1	194.6	287.0	167.9	152.2	151.5	147.7
Remaining Direct Procurement	416.5	421.7	228.2	169.3	240.0	249.1	241.3	255.2
	994.2	966.5	805.6	777.3	658.3	658.3	645.9	651.5

*FY 2003 are Full Cost Estimates

Other Includes Corporate & Center G&A

FY 2006 President's Budget Request
ARC Total
($ in millions)

	2003*	2004	2005	2006	2007	2008	2009	2010
Direct Civil Servant Salaries/Travel	20.3	30.5	33.4	27.0	26.0	24.6	26.2	22.1
Service Pools	55.2	15.9	13.4	12.1	11.9	10.4	10.4	9.1
Center G&A	30.6	36.2	34.2	57.7	26.3	24.3	26.0	23.4
Remaining Direct Procurement	55.5	101.6	42.3	62.9	70.2	62.0	58.1	69.7
	161.6	184.3	123.3	159.8	134.4	121.3	120.7	124.3

*FY 2003 are Full Cost Estimates

FY 2006 President's Budget Request
LARC Total
($ in millions)

	2003*	2004	2005	2006	2007	2008	2009	2010
Direct Civil Servant Salaries/Travel	75.9	81.8	83.0	69.0	44.3	42.2	42.2	40.9
Service Pools	79.3	71.8	78.4	64.9	50.7	60.9	60.6	61.1
Center G&A	76.4	71.5	77.6	119.7	73.3	67.1	67.0	66.5
Remaining Direct Procurement	130.4	170.8	96.7	42.3	59.9	67.2	62.0	64.3
	362.0	395.9	335.7	295.8	228.2	237.4	231.8	232.7

*FY 2003 are Full Cost Estimates

FY 2006 President's Budget Request
GRC Total
($ in millions)

	2003*	2004	2005	2006	2007	2008	2009	2010
Direct Civil Servant Salaries/Travel	72.2	67.8	72.9	60.4	39.7	39.6	37.8	39.2
Service Pools	46.5	44.2	43.5	35.5	34.3	34.6	30.4	29.7
Center G&A	49.1	51.3	53.9	78.4	42.1	34.6	32.6	31.3
Remaining Direct Procurement	140.6	94.9	68.9	39.5	83.7	94.3	86.9	88.6
	261.9	258.3	239.1	213.8	199.8	203.1	187.7	188.8

*FY 2003 are Full Cost Estimates

FY 2006 President's Budget Request

DFRC Total
($ in millions)

	2003*	2004	2005	2006	2007	2008	2009	2010
Direct Civil Servant Salaries/Travel	22.4	27.0	32.9	29.6	20.6	21.2	20.9	21.7
Service Pools	24.5	13.6	25.3	22.5	22.9	23.5	24.6	24.8
Center G&A	25.3	33.1	28.9	31.3	26.1	26.2	25.9	26.5
Remaining Direct Procurement	66.0	54.4	20.3	24.5	26.2	25.6	34.3	32.6
	137.7	**128.0**	**107.5**	**107.8**	**95.9**	**96.5**	**105.7**	**105.7**

*FY 2003 are Full Cost Estimates

Q2. How extensively has NASA consulted with the airlines and with pilots' organizations on what types of R&D are most crucial to aviation safety and to the efficiency of operations? How are the airlines' perspectives represented in the priorities of the Aeronautics Research Mission Directorate (ARMD)?

A2. From its inception as the Aviation Safety Program in 2000, the management team of the Aviation Safety and Security Program (AvSSP) has proactively reached out to the airlines in defining and assessing its research and development portfolio.

In program and project formulation phases, AvSSP has conducted well-attended planning workshops that have included all sectors of the aviation community, including representatives from airlines and the Air Transport Association, as well as airline pilot unions.

In many of the Program's research activities, project managers conduct User Needs studies. Through these studies, project managers and principal investigators conduct focused interviews with product user representatives to identify user-specific issues and capability gaps. The product user representatives usually target airline and pilot representatives. This information is used to formulate specific research issues and guide and focus research and development activities.

For program relevance reviews, airline representatives have always been members of the AvSSP review teams. Currently, the AvSSP relevance reviews are conducted under the Federal Advisory Committee framework, with a subcommittee specifically to review the AvSSP.

The AvSSP is a voting member of the Commercial Aviation Strategy Team (CAST), which is the entity within the U.S. that is defining and implementing commercial aviation safety enhancements that are projected to decrease the U.S. fatal accident rate by 73 percent. CAST is chaired by both an FAA official and an airline representative. Manufacturers and pilot organizations are also represented on CAST. The AvSSP Program Manager is a member of the CAST Executive Committee, which manages the CAST processes and defines the strategic direction of the group.

AvSSP has been successful in achieving airline participation in its research and development efforts. Through NASA Research Announcements, research teams were selected that have included airline members. Currently, NASA technologies are being flown on revenue flights with two airline partners, Delta and Mesaba (a regional airline).

Q3. In your opinion, what are the aeronautical R&D activities for which a government laboratory is required or best suited for the job? For example, how can the private sector analyze flight safety issues across the industry free of conflicts of interests or promote expensive long-range developments that cannot be profitable for at least a decade?

A3. Problems with the environment and other elements of the aviation infrastructure, such as air system capacity and air traffic control are not easily addressed by the private sector. The resulting delays, noise and emissions pollution are not even priced in the marketplace. Economists term these problems "externalities" because, unlike other costs, no market participant pays for them directly. As a result, the private sector has inadequate incentive for addressing the very real challenges associated with aviation. This is the situation at work in the example of expecting the private sector to analyze flight safety, or the promotion of long-range activities-neither will be profitable in the near-term, and there is no obvious single or shared point of responsibility among the competitors in the marketplace.

Developing, maintaining, and regulating national transportation infrastructures, as well as other significant areas such as national security, are the responsibilities of the government. The civil R&D activities required in this task include air system capacity (which is a complex "system of systems," including human performance elements, cockpit design and communications), noise and emissions reduction, aviation safety, and elements of security. Many NASA stakeholders and customers believe the government also has responsibility for maintaining a strong technology base for air and space transportation to ensure competitiveness of the U.S. economy. New technologies as well as technology advances in traditional and emerging study areas of aeronautics, such as power and propulsion, materials and structures, aerodynamics, etc., will enable the private sector to develop new capabilities and operating paradigms into products and services that will compete globally.

This is a multifaceted issue that government can affect as a direct or indirect result of policy. The aerospace industry remains critically dependent on technology. Even as NASA's priorities change to meet the changing needs of society, it still pursues long-term efforts in aerospace science and technology; efforts that would not be made otherwise, by the private sector or other government agencies. NASA continues to play a unique role by connecting research infrastructure in both the private and public sectors. In this regard, partnerships remain a critical element in disseminating and applying NASA-developed technologies.

Q4. How will the proposed reductions in NASA's aeronautics budget help bolster American's global leadership in aviation? How will the budget cuts impact NASA's ability to support the Joint Planning and Development Office's Integrated Plan? In your best judgment, do you believe the proposed cuts will be good for NASA aeronautics, the Agency, the JPDO, and the Nation?

A4. NASA's Aeronautics research is vital to the Nation in our work for the public good to increase safety, reduce adverse environmental impacts, and transform air transportation. This budget supports NASA's emphasis to address basic aeronautical barriers confronting our national aviation system and supports research to pioneer and validate high-value technologies that enable new exploration and discovery, and improve the quality of life though practical applications. The President's FY 2006 Budget supports the Aeronautics program's vital research in Aviation Safety and Security and Airspace Systems. To ensure maximum benefit to the taxpayer, we are transforming part of our investment in Aeronautics Research investment in order to more sharply focus the investment on revolutionary, high-risk, "barrier breaking" technologies. Toward this end, the NASA Aeronautics Vehicle Systems Program (VSP) has been refocused away from evolutionary research and technology development and toward more revolutionary, "barrier-breaking" technology demonstration projects that address critical public needs related to reduction of aircraft noise and emissions, and enable new science missions. The revolutionary technologies developed by NASA within the next decade will form the basis for a new generation of environmentally friendly aircraft and will enhance U.S. competitiveness in 20 years from now.

NASA has a major role in the JPDO and the Next Generation Air Transportation System (NGATS). While NASA is performing aeronautics research that provides the foundation to enable NGATS and the right strategies, we are also providing civil servants and direct support to the JPDO. NASA is providing civil service employees to serve as the JPDO Deputy Director (SES), Agile Air Traffic System IPT Lead (SES), and a Board member (SES), as well as 11 other full or part time civil servants. NASA financial support to the JPDO was $5.4M in FY 2004. This has increased to $5.6M in FY 2005 and is currently planned to increase to $10M in FY 2006. We are also conducting a network-enabled operations (NEO) demonstration of security and capacity related technologies. This demonstration, jointly sponsored by NASA, DOD, DHS, and DOT, could prove to be valuable in integrating government-wide intelligence operations, providing significant aid to our national security.

Q5. With a large portion of the aeronautics budget being set aside for competition among industry, universities, NASA centers, and others for very large technology demonstrations, how can ARMD assure that the remaining budget for "seed corn" be large enough to sustain a critical mass of scientists and engineers and to address the Nation's long-range critical needs?

A5. Approximately 20 percent of each of our current aeronautics programs is targeted toward basic research that provides the foundation for the next generation of technology advancements required by NASA's aeronautics' goals.

Q6. Why is ARMD ignoring the National Research Council's recommendation to set up a new base long-term R&D program?

A6. NASA agrees with the intent of the NRC's recommendations for long-term basic research. Each of ARMD's three programs has approximately 20 percent of the funding in long-term research. In the outyears, we are considering the consolidation of this funding into a new Foundational Technology Program that captures long-term cross-cutting base research & technology activities as well as those providing support of ARMD core competencies.

Q7. How did ARMD participate in NASA's Human Capital planning effort to target more than 2,000 civil service jobs for elimination by the beginning of FY07? How was it determined that Dryden, Glenn, and Langley were to lose more than a third of their aeronautics technical employees? With such substantial reductions in the number of scientists and engineers at NASA centers conducting aeronautics R&D projected in your budget plans, will your programs be able to maintain their current exemplary technical quality? Will it be possible to reacquire these lost skills, if this move were to prove unwise?

A7. The process of projecting future aeronautics-related workforce levels and facility needs at the Research Centers begins with the programmatic requirements established by the Agency through the annual programming and budget development process, culminating with the preparation of (in this case) the FY 2006 President's budget as submitted to Congress. The FY 2006 NASA budget reflects a major transformation in both the content and conduct of the Aeronautics Research Mission Directorate's programs. With respect to content, the ARMD program, in particular the Vehicle Systems Program, has been transformed to focus on four "barrier-breaking" technology demonstrations, emphasizing higher-risk research where the private sector will not optimally invest due to risk and anticipated rate of return (as opposed to more near-term development programs that are typically the purview of the private sector). With respect to conduct, ARMD will be placing a renewed emphasis on realizing best value for the taxpayer's investment through a combination of competition models. One aspect of the increased use of competition is expected to be a greater contribution by the private sector to the conduct of NASA's aeronautics research. ARMD, working with the Research Centers and the Agency's human capital planning community, then quantified the impact on workforce (and facility) requirements of this combination of a more focused research effort and an increased private sector role. At the same time, changing requirements from other Mission Directorates either added to or reduced the total workforce projection, resulting in the final numbers inherent in the FY 2006 budget submit.

Although there are numerous human capital management changes associated with implementing a change of this magnitude, including some near-term issues associated with buyouts and other workforce transition mechanisms, we believe that the Research Centers will retain the quality technical workforce required by ARMD for successful execution of its future programs. As part of the final phase of the ongoing NASA Core Competency exercise, NASA will address any issues of potential loss of skills that may be required by other Agency programs in the future.

Q8. How are you planning on safeguarding your critical aeronautics facilities (wind tunnels, simulators, virtual control tower, etc.. . .)? In particular, how are you coordinating with Admiral Steidle to save "dual-use" facilities that support both aeronautics and space exploration efforts? For example, recently, at Ames, dozens of contract employees who have worked at the Vertical Motion Simulator were let go (some had extremely specific valuable expertise and experience having worked there for decades) leaving the facility all but shutdown. Why is this being allowed to happen given the historical support of this unique facility for aeronautics testing of human-system control interactions, for shuttle pilot training, and the likely future critical need for CEV development work?

A8. Recognizing the importance of major test facilities to both NASA and the Nation, the Aeronautics Research Mission Directorate is considering a new approach to the management of major ground test facilities. Through an Aeronautics Test Program (ATP), ARMD would plan to make a strategic investment in such facilities—in some cases to ensure continued operational availability and in some cases to ensure that a minimal level of funds are available until future users require those facilities. Discussions with other current and potential users, including but not limited to the Exploration Systems Mission Directorate, have been an integral part of the investment process. Through the ATP, NASA would be able to ensure that critical facilities are available for an additional period of time while future requirements develop. With respect to the Vertical Motion Simulator (VMS) at Ames, contract layoffs during FY 2005 have been required in order to accommodate decisions made regarding Congressional earmarks. Future requirements for the VMS are being defined as part of the ongoing budget process.

Q9. Is NASA able to provide the stable, predictable funding of individual long-range R&D studies necessary for success? What percentage of time are NASA scientists and engineers expected to devote to conducting R&D versus program planning, reporting, advocacy, and proposal writing? Under this environment, how do you foresee NASA's ability to continue despite the GS wage penalty to recruit the best and the brightest who used to come to NASA to avoid these hassles in the private sector and academia and to focus instead nearly exclusively on cool R&D? If individuals or groups of entrepreneurial scientists and engineers are responsible for teaming and finding their own "seed corn" or for finding their own niche in a large external proposal as well as performing the R&D itself, what then is the role of management?

A9. As part of the transformation of the aeronautics research program, the Aeronautics Research Mission Directorate is in the process of establishing a "foundational technology" effort that will provide the long range "seed corn" for future breakthrough demonstrations. At the moment, the foundational technology effort comprises three components—basic research and development, university-based fundamental and applied research, and a strategic investment in major aeronautics test facilities. The combination of these investments will enable ARMD to support a stable, ongoing effort in longer-term R&D.

Q10. By setting aside a large portion of the aeronautics budget for a very small number of large demonstration projects in which corporations will play a large role, is not ARMD prejudging which areas of industry should prosper over others? How is such an approach consistent with free and open competition? Furthermore, consider an analogy to NIH's successful campaign to eradicate polio, in which NIH chose to support a wide array of long-range, science-driven studies to discover the polio virus, how it infests humans, and how it could be stopped from doing so, rather than striving to develop more technologically-advanced iron lungs. What evidence is there that large government investment in a small number of expensive demonstration projects is the best approach to stimulating bona fide technology breakthroughs?

A10. By focusing the Aeronautics Research program on breakthrough demonstrations, NASA will actually be expanding—not limiting—the areas in which others might invest. These demonstration efforts will address technologies and concepts that are still too unproven or risky to attract attention and capital from the private sector or other interested parties. It should also be noted that the selection of the demonstrations themselves has been, and will be, guided by inputs from a wide variety of sources, including the National Research Council. NASA feels it can continue to attract the best and brightest to perform aeronautics research. The demonstration projects offer opportunities for scientists and engineers to be part of breakthroughs, such as our recent success on the X–43A program. And, as noted in Questions 5 and 6 above, the long-term basic research offers opportunities for high-risk research that may lead to future demonstrations. NASA has had success in advancing the state-of-the-art in aeronautical research and technology using both focused demonstrations and a broader, more fundamental research effort. And, NASA plans to continue pursuing both avenues through the combination of the barrier-breaking demonstrations and a fundamental technology investment. The ARMD Program as submitted in the FY 2006 budget simply shifts the balance between the breakthrough and the fundamental to optimize the government's investment.

Q11. Four of the five Field Centers that are reporting extreme workforce distress have had a tradition of focusing on aeronautics. Why do you think that your centers and Ames are planning such dramatic workforce downsizing? Does it not worry you that these Centers are planning on losing more than a third of a workforce that has dedicated their lives to primarily to aeronautics, many of whom have been and continue to be world-class contributors to NASA's mission? How is this consistent with the "NASA family" value that management has been touting? Do you believe this course of action is best for the future of NASA aeronautics, the Agency, and the Nation?

A11. This question was addressed in #7 above.

Q12. Are you not worried that the increase of direct NASA funding to aircraft manufacturers, such as Boeing, or other aeronautics industry entities that may result from NASA's "competition" for aeronautics R&D work will violate the GATT? If not, why not?

A12. The objective of increased competition is to ensure the best value for the taxpayers' money. The aeronautics research that will be completed targets technologies

that are "beyond the horizon" of the aeronautics industry. Since the results are available equally to all of industry, it is not a violation of GATT.

ANSWERS TO POST-HEARING QUESTIONS

Responses by John M. Klineberg, Committee Chairman, National Research Council Panel

Questions submitted by Chairman Sherwood L. Boehlert

Q1. The National Academy of Sciences study recommended that NASA "dispose of underutilized facilities." What did the Academy mean by that? Should NASA consider any factors other than current utilization in deciding which wind tunnels to maintain? Do you believe that NASA needs to close down at least some of its wind tunnels to maintain a viable research program given the budget outlook?

A1. Our committee completed its report in November 2003, before the latest round of budget cuts. At that time we already were concerned that NASA was trying to do too much within the available funding. For this reason, we recommended that NASA "continue to dispose of underutilized facilities," meaning that they should continue to look at their facilities, particularly those that were not unique, with the goal of consolidation or deactivation as a way to reduce long-term fixed costs.

We specifically recommended that NASA not use current utilization as the only consideration in deciding which facilities to close. In our comments about full-cost accounting, we stated the following: "The committee is concerned that, if not carefully managed, full-cost accounting could result in (1) the closure of critical infrastructure and special-purpose facilities that will be needed for future program execution and (2) a disincentive to use large-scale facilities and flight test to fully demonstrate technology readiness." As a result of item (2), we cautioned that: "The testing infrastructure will be underutilized and will not generate the resources needed to sustain it."

Given the budget outlook, it is evident that NASA needs to do everything possible, including placing some of its wind tunnels in stand-by mode, to attempt to maintain a viable research program. It is very possible that they already have decommissioned all the facilities that are appropriate to close. My personal concern, as I stated in my testimony to the Committee, is that the current reduced funding levels may have put NASA very close to the point at which "This program is on its way to becoming irrelevant to the future of aeronautics in this country and in the world."

Q2. If the budget for aeronautics is limited, is it more important for NASA to fund long-term, high-risk research or to continue with incremental subsonic research? Should improving air traffic control be the top priority for NASA's research program?

A2. This critical issue was not addressed by our National Academies Committee. The NASA Administrator, the Associate Administrator for Aeronautics, the program managers at NASA headquarters and their counterparts at the field centers, working in conjunction with the various aeronautics advisory committees, all are responsible for addressing this question.

Our committee did not set priorities among the various parts of the program. We were chartered to assess NASA's Aeronautics Technology Programs at their then (FY 2003) funding level, which we did by performing an in-depth examination of the various technical elements to identify strengths and weaknesses. We attempted to answer the following four questions:

1. Is the array of activities about right?
2. Is there a good plan to carry out the program?
3. Is the program doing what it set out to do?
4. Is the entire effort connected to the users?

Our conclusion was that "in general, the Aeronautics Technology programs are very good but could be greatly improved by following the committee's 12 top-level recommendations."

I believe our committee would agree that the answer to the question of priorities is that it is important to pursue both long-term and short-term research. We need to continue to improve the reliability, safety and cost effectiveness of subsonic transports and the effectiveness of the air traffic control system. And we also need to investigate "innovative concepts that are critical to meeting aviation needs in the next decades."

NASA should develop advanced technology that addresses today's critical problems in air transportation. NASA also should establish the technical foundation for

future improvements that may be beyond the time horizon of the industry or the FAA.

Q3. How high a priority should research on hypersonics be? If NASA aeronautics research were flat funded in Fiscal Year (FY) 06, that is, given $54 million more than the President has proposed, where would you put that money?

A3. Our National Academies Committee did not address these issues, of course, since they are primarily directed at decisions concerning NASA's FY 2006 aeronautics budget.

The Committee did conclude, however, that hypersonics was an appropriate area for research and that it was an example of the high-risk, high-payoff technologies that NASA should pursue. The Hyper-X sub-project also was identified as one of the best planned activities in the entire program. The Committee's support for research in this area was not so much because we were convinced in the potential viability of a hypersonic-cruise airplane, but because we believed that hypersonics serves as an important focus for innovative thinking about advanced concepts in propulsion, aerodynamics, structures, materials, controls, handling qualities, etc.

As to where to put the additional funds, an increase of $54 million, even if it does not fully restore the FY 2006 run-outs to the earlier program, is a very substantial change. I would recommend that NASA be allowed to re-plan the aeronautics program to the new funding level with the goal of reducing some of the onerous disruptions previously contemplated.

Questions submitted by Representative Mark Udall

Q1. Some have argued that aviation is a mature industry and thus the Federal Government should no longer invest in aeronautics R&D. Do you agree or disagree with that conclusion?

A1. I personally do not believe that aviation is a mature industry. In fact, I would argue that it is an industry that will change dramatically in the near future if it is to remain viable. Commercial air transportation is so vital to the economic well-being of this country that it cannot be allowed to become a major inhibitor of increased productivity.

The pressures for change are there, for example in the financial problems currently experienced by all major airlines, problems that are becoming worse as the price of jet fuel increases. Air travel also has become less enjoyable for the traveling public, with long lines for security at airports, fewer on-time arrivals and more frequent delays because of air traffic congestion. The entire commercial air transportation system seems to be headed for eventual gridlock.

On the manufacturing side, Boeing, our single remaining commercial aircraft provider and the largest exporter of U.S. products, is facing serious competition in the world market from a subsidized European competitor and may not be able to be profitable in building commercial transport aircraft. And our jet engine manufacturers, Pratt and General Electric, need the revenue from the service business and the sale of derivative stationary power plants to remain in business. A viable air transportation system will not be possible unless all of its components have the opportunity for dramatic improvement.

The solutions are complex. We need to develop advanced transport aircraft of various sizes and different capabilities that are considerably more fuel efficient, easier to maintain, and more environmentally friendly than the current fleet. We need to develop aircraft that can be operated by one or two on-board personnel supervising the control system of a semi-autonomous vehicle, rather than operated by highly-trained (and costly) pilots and crew as we do today. And we need transport aircraft that are as part of an efficient, safe, secure, weather-independent and predictable world-wide air traffic control system. Aeronautics R&D certainly can help provide the foundation for these improvements.

Q2. Your panel recommended that "NASA should conduct research in selective areas relevant to rotorcraft." *Why did your panel make that recommendation? What areas did the panel consider to be worthy of research by NASA?*

A2. Our committee was unhappy to learn that NASA had abandoned all rotorcraft research because the OMB apparently had decided that because the Army is a major beneficiary of such work, the research should be funded as part of the DOD budget. This is a narrow point of view and ignores the difficulty of having an operational organization be responsible for R&D. As a result, rotorcraft research in this country has suffered in recent years.

The committee felt that rotary wing aircraft are probably the aeronautical vehicle system most in need of substantial technology advancements in structures, materials, aerodynamics, displays, controls and handling qualities if they are to become more efficient, safer and more reliable. These areas of disciplinary research deserve attention by NASA.

The committee made several specific suggestions in the report, as follows: "Rotorcraft are an important constituent of air transportation. Many of the research projects currently underway in the Aeronautics Technology Programs, such as synthetic vision and human factors, would be directly relevant to rotorcraft with only minimal additional investment. NASA could make a significant impact in under-researched areas of rotorcraft such as decision aids, synthetic vision, pilot workload, and situational awareness. Further, the existing U.S. Army programs in rotorcraft technologies and industry research and development in rotorcraft could be leveraged by NASA to meet civilian needs in this area."

This recommendation was stated in another section of the report as follows: "NASA led many of the revolutions in rotorcraft design that we now find in the commercial and military sectors. Unfortunately, however, the NASA plans reviewed by the panel had no focused rotorcraft activities. If the U.S. rotorcraft industry is to remain competitive in the international marketplace, NASA leadership and innovation will be required to respond to the European and Asian products now entering the market."

Q3. Your testimony states that ". . .NASA's decision to discontinue rotorcraft research has left critical civilian needs unaddressed." *Can you provide some specific examples of critical needs that will be unaddressed?*

A3. This question is answered, in part, above. In addition, some examples are contained in on of the Committee's specific recommendations in the report, as follows: "The Aviation Safety Program should reincorporate rotorcraft research into its program. The research should consider the most effective approaches for reducing the workload of rotorcraft pilots and improving their ability to conduct safe, low speed, low altitude rotorcraft operations in obstacle-rich environments and in adverse weather."

Rotorcraft have many specific civilian applications, such as in medical emergencies, highway traffic monitoring and control, police assistance of all kinds and logging in remote regions. One of their major uses, in this era of increasingly limited energy supplies, is in the maintenance and supply of off-shore drilling platforms throughout the world. Many aspects of these civilian operations are not address by technology activities that focus only on military requirements.

Q4. What will be the impact of OMB's directive to NASA eliminating federal research in subsonic transport aeronautics?

Will it be possible to make major breakthroughs in noise and fuel consumption and aviation safety and security research in the future without being able to treat the subsonic transport aircraft as an integrated system?

A4. Our committee completed its report in November 2003 and therefore did not review NASA's response to this latest round of budget cuts. At that earlier time, however, we already were concerned about the lack of funding for important areas of research that could provide major breakthroughs to enable the air transportation system of the future.

The committee made the following recommendation in the report: "Many innovative concepts that are critical to meeting aviation needs in the next decades will not be pursued by industry or the Federal Aviation Administration (FAA). NASA should fill this void. The committee applauds the inclusion of high-risk, revolutionary subprojects in many areas and believes the program portfolio could benefit from additional far-reaching efforts with the potential for high payoff. This type of research is critical to investigating the feasibility of innovative concepts and reducing risk to the point where the concepts are suitable for advanced development and transfer to industry or the FAA."

Q5. Did your panel consider hypersonics research to be an appropriate activity for NASA to pursue? Why or why not?

A5. Our committee believed strongly that hypersonic research was an appropriate area for NASA research and that it was very much in keeping with one of the top-level recommendations, that "NASA should pursue more high-risk, high-payoff technologies."

One of the major activities in hypersonics was singled out for praise as follows: "The Hyper-X sub-project shows some of the best planning seen across all the pro-

grams reviewed by the committee. The NASA planning reflects the high-risk aspect of this task by providing for three vehicles and anticipating possible loss. The first flight test was not successful because a rocket booster failed, demonstrating the wisdom of the contingency aspect of this plan."

The committee continued its uncharacteristic praise as follows: "The sub-project is well connected programmatically to its antecedents, another of its notable features. Indeed, many of the detailed aspects to be investigated are directed at answering key questions surrounding hypersonic flight. By virtue of careful consideration of this background and good planning, the goals of the sub-project are realistic and the risk associated with it has been mitigated. The ultimate goal is to demonstrate positive net thrust of the scramjet; this is a laudable, though difficult, goal that the committee hopes can be achieved."

Q6. Is NASA's establishment of a focused effort in four breakthrough technology demonstration projects fully responsive to the findings and recommendations of your panel regarding NASA's overall Vehicle Systems program? Are the goals of the demonstration projects achievable under the Vehicle Systems five-year budget plan?

A6. Again, our committee completed its report in November 2003 and therefore did not review NASA's response to the latest round of budget cuts. The ground rules we established for our committee precluded us from recommending an increase in funding for NASA so that we could focus on providing an independent review of the technical quality of the work being conducted. At that time, however, we already were concerned that NASA was attempting to do too much within the available budget, and for this reason we recommended that NASA attempt to improve its processes for program management, reduce the number of tasks in its technology portfolio and consolidate or deactivate underutilized aeronautics facilities.

The current budget is considerably reduced from the one we reviewed and as such makes continued progress even more difficult. As I said in my oral testimony before the committee: "This program is on its way to becoming irrelevant to the future of aeronautics in this country and in the world."

Q7. Your panel recommended that "NASA should reconstitute a long-term base research program, separate from other aeronautics technology projects and programs."

What would such a base research program consist of, and does the restructured aeronautics R&D program contained in NASA's FY 2006 budget request adequately address your panel's recommendation?

A7. The committee's concern about NASA's base research program was of such magnitude that it was addressed in three top-level recommendations, as follows: NASA should eliminate arbitrary time constraints on program completion. . . NASA should pursue more high-risk, high-payoff technologies. . . and NASA should reconstitute a long-term base research program, separate from the other aeronautics technology programs and projects."

This last recommendation was further elaborated as follows: "The current research is mostly product-driven, with not enough fundamental work. Fundamental research is crucial for the development of future products. NASA needs to provide researchers the opportunity to conduct forward-looking, basic research that is unencumbered by short-term, highly specified goals and milestones. Historically, NASA has been a world leader in its core research areas; however, that base has eroded in recent years as the amount of in-house basic research diminishes. NASA needs to reassess its core competencies and assure their support through a base research program."

We have not been briefed on NASA's FY 2006 budget request to be certain that this recommendation has been adequately addressed. We suspect that, because of the very serious fiscal constraints imposed on the program, there is no longer adequate funding for NASA to pursue those technologies that have a high risk of unsuccessful completion (high risk/high payoff) and that the industry is unwilling to fund on its own. Unfortunately, over the past two decades the industry has reduced its investment in basic research, which serves at the seed corn for future technology opportunities. The committee was very concerned that NASA aeronautics is following this same path.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Philip S. Antón, Director, Center for Acquisition and Technology Policy, RAND[1]

Questions submitted by Representative Mark Udall

Q1. Is aeronautics mature?

A1. Parts of aeronautics are mature while others are evolving. Some aeronautic sectors have shown marked reductions in new vehicle development rates, and the aeronautic engineering discipline is relatively mature compared to where we were decades ago. However, we have not exhausted all aeronautic design opportunities, and aeronautic engineering discipline maturity relies on the test infrastructure that America has developed.

Some have argued that aeronautics is a "mature" industry and thus the Federal Government should no longer invest in aeronautics R&D or test infrastructures.

Earlier in my testimony I noted that the aeronautics industry has matured, but the question of industry maturity consists of two major components: market maturity (i.e., whether aeronautic vehicle designs have stagnated), and engineering maturity (i.e., the degree to which engineers know how to research, design, and produce new aeronautic concepts).

While some aeronautics markets are mature in that they are "no longer the subject of great expansion or development"[2] in raw design numbers, other markets are expanding to explore continued evolutionary development or even revolutionary concepts.

There has been a marked decline in the number of new major civil and military aircraft designs since the 1950s.[3] However, the U.S. and foreign countries are continuing to push the design envelopes in the vehicles it is developing (including efficiencies, noise reductions, capacity increases, increased aeronautic performance, reductions in takeoff and landing length requirements, and hybridization of vertical-takeoff-and-landing capabilities with traditional jet flight.) Also, the U.S. is exploring new vehicle types and concepts. For example, many unmanned air vehicles and unmanned combat air vehicle concepts are being researched, developed, and produced. Military concepts for larger vertical-takeoff-and-landing (VTOL) and super-short take-off-and-landing (SSTOL) transport require continued R&D. Interests in commercial supersonic business jets require additional R&D for vehicle designs and sonic boom reduction. Air-breathing hypersonic concepts employing ramjet and scramjet engines are in their infancy yet hold potential for space access, aerospace planes, and military missiles.

The aeronautics community itself has been grappling with the question of how many potentially valuable opportunities await our examination. Professor Ilan Kroo of Stanford University, for example, laid out the data that seems to indicate a lack of innovation giving the appearance of maturity, but he also outlined some innovative concepts that indicate the field has significant expansion and development opportunities.[4] Also, the NASA Blueprint[5] discusses a number of R&D concepts that NASA is considering. Other aeronautic trends and interests are listed in the RAND Corporation's study on test facilities.[6]

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[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of RAND or any of the sponsors of its research. This product is part of the RAND Corporation testimony series. RAND testimonies record testimony presented by RAND associates to federal, State, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

[2] The definition of *maturity* offered for an industry, market, or product by *The American Heritage College Dictionary,* third edition, 1997.

[3] See, for example, Figure 2.1, p. 15, of Antón et al., *Wind Tunnels and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Serve National Needs,* Santa Monica, Calif.: RAND Corporation, MG–178–NASA/OSD, www.rand.org/publications/MG/MG178/, 2004.

[4] See Kroo, Ilan, "Innovations in Aeronautics," 2004 AIAA Dryden, Lecture, #AIAA–2004–1, *42nd AIAA Aerospace Sciences Meeting,* Reno, NV, January 5–8, 2004.

[5] www.aerospace.nasa.gov/aboutus/tf/aero_blueprint/ (last accessed 4/20/05).

[6] See, for example, Chapter 2 of Antón, et al., *Wind Tunnels and Propulsion Test Facilities: Supporting Analyses to an Assessment of NASA's Capabilities to Serve National Needs,* Santa Monica, Calif.: RAND Corporation, TR–134–NASA/OSD, www.rand.org/publications/TR/TR134/, 2004.

There are technical challenges in many of these concepts, but that is the nature of R&D, requiring careful consideration, exploration, and engagement on these challenges to understand their ultimate viability and benefits.

Thus, U.S. aeronautics industry "maturity" (lack of great expansion or development) is less a question of needs and opportunities and more a question of national intent, investment levels, and policy. For example, the cost to produce new vehicle designs continues to rise, and that has a constraining effect on development rates but not absolute cessation of development opportunities.

Conversely, while only parts of the aeronautics *industry* are relatively mature, the *discipline* of aeronautics engineering shows a level of maturity. In particular, while we do not have complete, closed-form understanding of the aeronautic physics in which our vehicle components operate, we know how to use test techniques to experimentally explore the new physical realms in which new vehicle concepts operate. This is especially true for revolutionary new concepts that are not extensions of established systems with which engineers have extensive practical design experience, computational models, and flight experience. Even improving the performance at the margin of well-established and refined designs depends on appropriate and sufficient testing at wind tunnel and propulsion test facilities. Thus, aeronautic engineering *discipline* maturity *relies on the test infrastructure* that America has developed.

Q2. Did the DOD attempt to use, and then abandon, full-cost recovery for its test facilities? If so, why?

A2. The Air Force experimented with recovering full costs from users during 1969 to 1972 but found the policy to be detrimental to their facilities, causing unstable and unpredictable pricing and resulting in significant drops in usage despite need.

NASA has recently required full-cost recovery of full operating costs from the users of its aeronautical test facilities. The DOD tried a similar approach long ago, but it rather quickly went back to an approach that established a budget line to provide funding for its test facilities, with users just being charged for the costs of their tests.

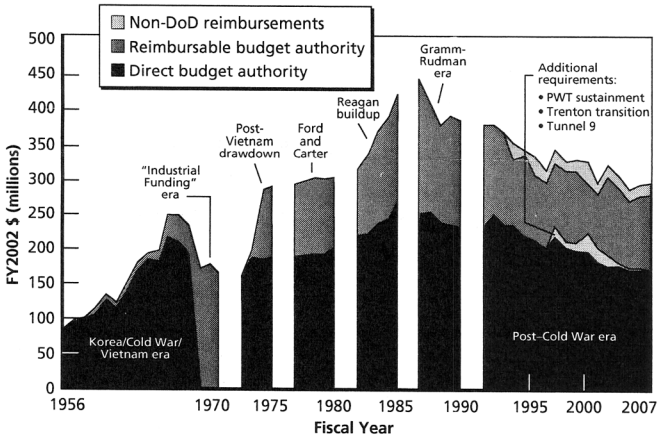
Conceptually, setting test prices to cover all costs is not recommended because it can discourage use and endanger strategic facilities. This approach does give users more information about the full costs for conducting their tests at a facility. If this cost is too high, users can respond by seeking an alternative source of services if it is available; alternatively, users may avoid important testing or test in inferior facilities and obtain degraded or even misleading data. The approach would lead to good outcomes if the alternative facilities are a better value over the long term and strategically important resources are retained. Unfortunately, this approach leads to poor outcomes if a facility is a better long-term value but low near-term utilizations and resulting higher near-term prices mask the long-term value of the facility. The approach is also bad when the remaining users cannot afford the costs to keep open strategic facilities needed in the long-term.

When the Air Force experimented with recovering full costs from 1969 to 1972, AEDC found that their prices became inherently unstable and unpredictable because large infrastructure-driven costs had to be spread over an annually variable customer workload base.[7] Also, test customers were not given time to adjust their budgets to accommodate increases in testing prices. As a result, the test workload decreased dramatically (see the "Industrial Funding" era in Figure 1 below). This, in turn, drove up overhead costs and initiated a positive feedback loop that continued driving up prices and driving away users. AEDC found that *testing decisions were being made based on near-term cost considerations rather than strategic considerations to reduce long-term program risks through testing.* The resulting reduced testing loads and reduced income caused significant detrimental effects on AEDC's facilities, including the loss of skilled people, loss of independent analysis and evaluation capabilities, decreased investments for the future, and reduced facility readiness through the loss of maintenance resources.

The financial collapse at AEDC was only halted when shared support through direct budget authority was restored to AEDC. Combined with the need to better account for the full costs of test facilities, the DOD established the Major Range and Test Facilities Base (MRTFB) and advocated that users need to see the cost they impose on a facility while not being asked to pay for unused and underutilized capacity at strategically important test facilities they use. Since 1972 (when direct budget authority was reinstated at AEDC), reimbursements consistently paid for

[7] See Antón et al., *Wind Tunnels and Propulsion Test Facilities: An Assessment of NASA's Capabilities to Serve National Needs,* Santa Monica, Calif.: RAND Corporation, MG–178–NASA/OSD, www.rand.org/publications/MG/MG178/, 2004, pp. 60–62, for a discussion of this topic.

less than half of total operating costs. Thus, over many decades, the DOD has found it vital to provide shared support for its facilities despite fiscal pressures in various eras.



SOURCE: AEDC.
RAND *MG178-4.2*

Figure 1—Historical AEDC Funding

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mike J. Benzakein, Chairman, Department of Aerospace Engineering, Ohio State University

Questions submitted by Chairman Sherwood L. Boehlert

Q1. If the budget for aeronautics is limited, is it more important for NASA to fund long-term, high-risk research or to continue with incremental subsonic research? Should improving air traffic control be the top priority for NASA's research program?

A1. The NASA aeronautics expenditures need to maintain a balance between short- and long-term research. It is also important for NASA to explore new ideas and concepts that might come to fruition in 20 to 50 years. It is important for NASA to address the needs of commercial aviation and the flying public. This requires technologies that need to be available five to ten years from now to permit cleaner, safer and more efficient travel. It is also essential for the Nation to maintain its preeminence in commercial aviation, a position which is coming under competitive pressure from Europe.

Improving air traffic control should be a high priority for NASA's research program. It is needed as we move forward, and the air traffic volume is growing. It should be one of the top priorities at NASA in conjunction with subsonic and supersonic research, hypersonics, rotorcraft, and aviation safety and security. The recommendations for a NASA Aeronautics Program have been submitted in a report to the United States Congress in April of this year by the National Institute of Aerospace. This report summarizes the work performed by a team of 250 scientists and engineers from industry and academia who have worked intensely to define the needs of the Nation.

Q2. How high a priority should research on hypersonics be? If NASA aeronautics were fat funded in Fiscal Year (FY) 06, that is, given $54 million more than the President has proposed, where would you put that money?

A2. Hypersonics is on NASA's list of priorities. It needs to be addressed. It comes however, after subsonic and supersonic research, and air traffic control. I see the first application of hypersonics to be military. So DOD should take the lead in funding that research. If $54 million in additional funding became available, I would put those dollars in subsonic and supersonic airframe and propulsion research.

Questions submitted by Representative Mark Udall

Q1. Some have argued that aviation is a mature industry and thus the Federal Government should no longer invest in aeronautics R&D. Do you agree or disagree with that conclusion?

A1. Is aviation a mature industry? It depends on how you define "mature"; if you mean "experienced," yes it is. We have come a long way over the last 50 years. Tremendous progress has been made in every facet of aeronautics both in the commercial and military fields. Does this mean that further major breakthrough technology developments are not in the cards? The answer is a resounding NO! Significant progress is required in every aspect of aeronautics. Let me just list a few areas.

1. Air traffic Management
2. Safety
3. Noise
4. Pollution Control
5. Fuel Burn
6. Maintainability

Every forecasting indicates that the world will be adding over 20,000 commercial airplanes to the system by the year 2020. We are close to gridlock today. To avoid long delays and jeopardizing the safety and convenience of the flying public, we need to have a better, more efficient airspace system.

Noise is getting to be a barrier to growing airports and improvements are needed in the aircraft and engine design. The same goes for Aircraft emissions which are growing significantly as air traffic grows. They require further research in clean combustion systems. We need more fuel efficient engines to reduce CO_2 and its threat to Global Warming. This is just for subsonic airplanes. When we go to super-

sonic airplanes, we have not even scratched the surface. Beyond the noise and emission challenges, flying at supersonic speeds for sustained periods of time brings up the need for a plethora of technologies that are yet to be developed. The challenges are similar to the one faced in the military world when one goes to the Long Range Strike Fighter and other applications. The Hypersonic World is also out there and this is just the beginning.

So there is a lot to be done in the "mature" industry. There is a lot to be done also on the education side to ensure that we properly train the work force, the engineers, and the scientists in the U.S. so they can face these technology challenges.

So the need is there. Should the Federal Government invest in Aeronautics R&D? The answer is YES. The question is often asked: Why does not the industry pick up the effort? The answer is that the industry is geared to perform the development of new products. This investment is large (10 fold the amount of R&D effort described above). The industry is focused on products it wants to bring to market in the next five to 10 years. The Federal Government needs to invest in technologies that will be needed in 10 to 20 years. It needs to evaluate a number of technologies, do the screening so that the industry could pick up the winners and develop them into products. In summary, I believe that Aviation has made tremendous progress over the last 50 years. There is a lot yet to be done and the Federal Government has a key role to play in Aeronautics R&D.

Q2. In 2001 the European Commission announced a multi-year initiative in aeronautics with ambitious goals. To quote the "Vision 2020" report, the goal of that initiative is that: "In 2020, European aeronautics is the world's number one. Its companies are celebrated brands, renowned for the quality of products that are wining more than 50 percent shares of world markets for aircraft, engines, and equipment. . . The public sector plays an invaluable role in this success story. . . Crucially [European governments] are coordinating a highly effective European framework for research cooperation, while finding programs that put the industry on more equal terms with its main rivals."

Q2a. How seriously do you take the European Initiative in aeronautics R&D?

Q2b. Do you believe that the NASA aeronautics budget request for FY06 and the out-years is a sufficient response to the European Initiative?

A2a,b. In the last month, I have been to Europe twice to visit European industry and European universities. I can assure you that the European initiative in aeronautics R&D is serious, very serious indeed. They have a detailed plan outlining their goals, the technology barriers as well as the research programs they need. These programs are funded and on their way. There is an excellent collaboration between industry, academics and European governments. The programs are led by the industry. They are focused and results oriented. I believe that the EU community has put in place the elements of a program to give them the leadership in aeronautics in the next decade.

I do not believe that the NASA Aeronautics Budget request for FY06 and the out-years represents an adequate response to the European Initiative. It does not come close to facing the needs of the Nation in Aeronautics. As I mentioned in my testimony, I believe that aeronautics needs a national vision and an agenda to move forward. I believe that its vision and strategy must be developed in partnership by industry, academia, and the Federal Government. As related in my testimony, the National Institute of Aerospace, at Congress' request, has chartered a task team of scientists and engineers to examine the subject and define some specific recommendations. This work has been completed and is summarized in a report that was delivered to the Chair and Ranking Member of both Appropriation Subcommittees last week . I believe that the type of effort outlined in this report is what is required in the next five years to address the aforementioned European Initiative.

ANSWERS TO POST-HEARING QUESTIONS

Responses by R. John Hansman, Jr., Director, International Center for Air Transportation, MIT

Questions submitted by Chairman Sherwood L. Boehlert

Q1. "If the budget for aeronautics is limited, is more important for NASA to fund long-term, high-risk research or to continue with incremental subsonic research? Should improving air traffic control be the top priority for NASA's research program?"

NASA should have a balanced portfolio of near and long term focused research. As with any portfolio the long-term research can and should be higher risk with high future payoff while the near-term research is focused on well identified needs.

I would point out that many of the high payoff areas are likely to be in subsonic vehicles which will always constitute the vast majority of our aircraft. Breakthrough technologies which enable more efficient, cleaner, safer and more accessible aircraft operations would have enormous benefit.

Air traffic control is clearly an area of urgent national attention. NASA has an important role in the national strategy to improve air traffic control and has been a strong member of the JPDO. Consequently, air traffic control should be one of the key priorities at NASA but this should not be to the exclusion of air vehicle or air safety research.

Q2. "How high a priority should research on hypersonics be? If NASA aeronautics were flat funded in Fiscal Year (FY) 06, that is, given $54 million more than the President has proposed, where would you put that money?"

A2. Hypersonics research is in the long-term, high-risk category where the impact would most likely to be in military or space applications. I believe that it is wise to have some capability in hypersonics but for civil aeronautics would put this at a lower priority than other areas.

Given the modest increase over the President's proposed aeronautics budget, I would invest part in improved engine efficiency research which will have strong leverage in fuel and environmental benefits. Given the emergent fuel shortages I would also look for opportunities for NASA research to have spinoff applications to automobiles and other vehicles. I would also invest in a program of small scale (single investigator) aeronautics innovation grants to stimulate new ideas and enthusiasm across a range of technologies.

Question submitted by Representative Mark Udall

Q1. "Some have argued that aviation is a mature industry and thus the Federal Government should not longer invest in aeronautics R&D. Do you agree or disagree with that conclusion?"

A1. I disagree with both the premise and the conclusion.

Aviation continues to be a dynamic and evolving industry. There are rich and exciting opportunities for vehicle systems driven by potential advances in propulsion, information technology, materials, micro technologies, complex systems engineering, aerodynamics, navigation, human-machine integration and many other areas. We can expect new vehicle configurations new operating paradigms and new industries to emerge if we maintain a healthy aviation industry.

The aviation industry will also need to grow to a new level of maturity to meet the challenges of the future. For example, increasing fuel prices will drive a new round of technical development to improve fuel efficiency. Aviation based innovations will have impact and applications in other vehicle classes such as automobiles. Environmental considerations will also stimulate innovation and the need for a deeper understanding of approaches to minimize environmental impact. Low emission and functionally silent aircraft are real possibilities. The increased demand and reliance for air transportation services coupled with airport and roadway congestion will drive the need for new classes of vehicles and new operating paradigms to improve the safety, efficiency and capacity of aviation.

These are only a few of the obvious applications. In all likelihood, the most exciting opportunities are yet to be discovered. I hope that we can create an environment where our students have the skills, motivation and environment to create them.

Appendix 2:

Additional Material for the Record

PREPARED STATEMENT OF JOHN W. DOUGLASS
PRESIDENT AND CHIEF EXECUTIVE OFFICER,
AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA

Introduction

Chairman Calvert, on behalf of the Aerospace Industries Association of America, or AIA, I wish to thank you, Representative Udall, and Members of the Space and Aeronautics Subcommittee for the opportunity to testify on the enduring connection between aeronautics research and American national interests. AIA represents more than 100 regular and 170 associate member companies, and we operate as the largest aerospace manufacturing trade association in the United States. With more than 607,000 engineering and production workers, we also have a long history in the management of aeronautics issues.

I will begin with a summary of both the strategic benefits and the resource deficiencies in the aeronautics programs of NASA. After this overview, I will discuss two key policy challenges in the aeronautics arena: the need for equity in the support of mid-term and breakthrough aviation technologies and the critical project of air traffic management modernization. My testimony will then turn to an assessment of the aggressive aeronautics programs of America's main civil aviation competitor abroad: the European Union. Finally, I will close with a few suggestions on the focus of a potential United States Aeronautics Policy.

The National Value of Aeronautics Investment

The November 2002 bipartisan report of *The Commission on the Future of the United States Aerospace Industry* concluded that continued public investment in aeronautical research and development remained vital to America's leadership in the global aviation industry (one which generated a $31 billion trade surplus in 2004) as well as our national security. In cultivating new generations of safe, high-performance aircraft, aeronautics programs strengthen the country's commercial and military power by stimulating innovations in:

- information technology;
- air traffic management;
- climate and terrain analysis;
- aerial navigation and surveillance;
- clean energy sources;
- new materials;
- advanced technologies for design and manufacturing development; and
- aircraft noise and emissions control.

Aeronautics research subsequently reduces the cost of doing business in a globally-integrated economy while supporting the Defense Department's requirement for forces that can deploy to any point on the planet or track our enemies from distant command centers. Recent budget decisions, however, do not reflect the strategic importance of aeronautics to the Nation.

During the last two decades, NASA's budget has doubled from approximately eight billion dollars to a proposed $16.5 billion for FY 2006. In contrast to this steady top line growth, the Agency's aeronautics funding has declined from a FY 1994 high point of $1.5 billion to less than $853 million today. NASA expenditures already claim a modest 0.7 percent of all Federal Government spending, with aeronautics receiving only six percent of that amount, or $717.6 million, by 2010 if the current plan remains unchanged.

Complicating these trends, NASA's transition to a full cost accounting system in FY03 significantly reduced direct aeronautics research spending by transferring administrative costs previously absorbed in the Agency's headquarters budget to each one of the mission directorates (please refer to Appendix A). Even before the adoption of full cost accounting, the Aeronautics Research Mission Directorate (ARMD), with its single-digit share of the budget, employed only 15 percent of Agency personnel yet sustained 40 percent of the Agency's facilities and infrastructure and therefore pays a disproportionate share of NASA's administrative costs.

The ability of NASA to intensify the research and testing of advanced aeronautics concepts—and to reduce its overhead—ultimately depends on congressional leadership. AIA recommends, Mr. Chairman, that Congress restore NASA's funding available for aeronautics research to the levels seen prior to the 2003 move to full cost accounting (please refer to Appendix B for historical aeronautics funding trends). In doing so, Congress should instruct the Administration to report each year on efforts

to ensure that full cost accounting does not divert a disproportionate share of resources from research to administrative functions.

It is critical that Congress also direct the administration to provide NASA with increases without jeopardizing space exploration programs. In 2004, when NASA submitted its first four-year budget incorporating the Nation's new Vision for Space Exploration (VSE), officials proposed aeronautics expenditures of $942 million for FY 2009. Barely one year later, the FY 2009 figure now stands at $727.6 million. This reversal indicates that judgments of policy, not a presumed financial trade-off between aeronautics and exploration, underlie the decisions about NASA's long-term budget. It also signals that the Administration has yet to recognize the full socio-economic value of progress in aeronautics.

Striking the Right Balance Between Near-Term and Breakthrough Research

An expansion of aeronautics research capabilities, Mr. Chairman, must occur for NASA to continue the development of both mid-term and breakthrough aeronautics and air transportation technologies.

NASA's FY 2006 proposal responds to the 2004 recommendation of the National Research Council that the government sponsor basic research on "high-risk, high-payoff" aviation initiatives. Towards this end, NASA's Vehicle Systems, Airspace Systems and Aviation Safety Programs each embrace the goal of tripling aviation system capacity and reducing passenger travel times by one-half during the next twenty years.

At the same time, NASA continues to support future industry needs. Durable, low-cost composite materials, lower fuel consumption, and automated safety and maintenance monitors, all supported in their initial phases by government aeronautics research, will become standard features of most jetliners by 2015.

But to enhance its industry support mission, the Agency should revitalize its turbine development programs. AIA regrets that NASA recently had to cancel its Ultra Efficient Engine Technology (UEET) work since this project centered directly on the improvement of engine efficiency and the reduction of fuel burn. The Agency should strongly consider the restoration of UEET since our successful experience in the 1980s with its predecessor, Energy Efficient Engines, demonstrates industry's ability to turn NASA's basic turbine research into working technology that conserves fuel and reduces emissions.

Administration officials have paid a similar lack of attention to rotorcraft technology. In the past 25 years, the United States has developed one new medium-lift helicopter while Europe has deployed three. More importantly, the lack of a vigorous NASA rotorcraft program means that the Nation continues to miss opportunities to test vertical lift applications for new modes of public transportation.

NASA must therefore plan investments in aeronautics technologies intended for system-wide transportation improvements while working with industry on aircraft innovations driven by safety and market factors. The current budget request outlines laudable objectives such as subsonic noise and supersonic boom reduction in addition to the testing of a high-endurance Unmanned Aerial Vehicle. But the decline in year-to-year ARMD budgets, unless reversed, will cripple NASA's ability to conduct basic research across the spectrum of aeronautics and confine the Agency's work to only a handful of projects with the highest levels of financial and operational risk.

Air Traffic Management Modernization: Keystone of Mobility, Security, and Growth

Our greatest aeronautics challenge in the second century of flight centers on the effort to modernize the National Airspace System. American commercial aviation stands at an unprecedented point in history. Rising fuel prices, Internet-generated business, foreign trade, the September 11th attacks and the need for dramatically improved airport security, have imposed new demands on an air transportation system designed more than 40 years ago. A 2004 report by the FAA revealed that in the next 20 years, 20 more U.S. airports will handle at least 500,000 arrivals and departures on an annual basis. Furthermore, aircraft now carry 27 percent of the Nation's imports and exports.

Delays, however, follow insufficient capacity, and lost time in the aviation sector means lost money. In 1994, 81 percent of all domestic flights took off on time yet NASA reported that delays of 15 minutes or more still cost the aviation industry 2.3 billion dollars. By 2000, the on-time rate had deceased to 72 percent, and the *Aerospace Commission* estimated that the cost of delays to the *entire* economy could exceed $30 billion each year.

Economic and national security factors make it essential that the FAA-led Joint Planning and Development Office (JPDO), created by Public Law 108–176, succeed in its mission of building the Next Generation Air Transportation System.

The House Science Committee, as well as the House Transportation and Infrastructure and the Senate Commerce Committees, have the charge of overseeing this complex project. With several government organizations involved, Congress must require interagency cooperation and accountability, particularly between NASA and the Air Force, on JPDO technology sharing and personnel assignments. AIA urges the Administration to continue in proposing clear and adequate budgets for the JPDO to reduce the risk of program delays.

NASA's budget request wisely includes a $48 million increase in Airspace Systems—the Agency's office that supports the development of ATM situational awareness tools—and directs $10 million to the JPDO. With ongoing support from Congress and JPDO agency stakeholders, AIA believes that a fully transformed air transportation system will become operational by 2025. Our public safety, mobility, and world economic leadership demand nothing less.

The Role of Aeronautics in the International Community

Based on the achievements of United States aerospace companies, the European Union (EU) and other foreign governments continue to develop aeronautics programs to build global economic and technological capabilities and to challenge the U.S. for leadership in the industry.

In January 2001, the European Commission approved the plan entitled *European Aeronautics: A Vision for 2020.* This document adopts the multilateral objective of "a world-class European aeronautics industry that leads in global markets for aircraft and engines." EU officials take an integrated, strategic view of aerospace and aeronautics. *Vision 2020* notes that trade, investment, tourism, and political ties to emerging markets all depend on a vibrant air transportation industry. The Europeans also have a clear sense of the business issues at stake; their plan states that "without European aeronautics, air travel would be almost completely dominated by U.S. aircraft."

Vision 2020 declares that the time and expense associated with airliner development goes "beyond the reach of one company and of the budgets of most single nations." As a result of this assessment, European leaders announced in March 2002 the goal of increasing total R&D spending to three percent of European GDP by 2010, with the aeronautics share claiming $2.6 billion. Fourteen years ago, the EU's aeronautics budget amounted to just $45 million.

NASA's current budget submission moves in the opposite direction of the Europeans, with cuts in aeronautics programs of almost 25 percent over the next four fiscal years even though the Agency focuses on vital public interest research: initiatives that make air travel more quiet, secure, and reliable. EU companies and governments, unlike NASA, restrict international access to their aviation R&D and concentrate heavily on product-specific improvements to expand civil market share. The *spending* commitments of the EU, however, should remind us of the enduring public benefits of aeronautics—from safe forms of transportation to the expansion of export industries—and the corresponding need for Congress and the Administration to adequately fund government-wide aeronautics activities.

Conclusion: Envisioning a United States Aeronautics Policy

As it prepares to consider the FY 2006 NASA Authorization Bill, Congress has a unique opportunity to frame a national aeronautics policy to guide the aviation investment and reform strategies of the Federal Government. The policy should confirm the multi-dimensional benefits of aeronautics research to the United States in this age of the information economy and expanding military air power. Future fleets of secure and efficient aircraft, enabled by new technologies, will stimulate higher volumes of travel and investment, as well as capital and cargo flows, in an aviation sector that already accounts for about 11 million American jobs. Furthermore, the JPDO, by relying on aeronautics communications technologies, has the challenge of improving the speed and precision of airborne operations for civil and military users alike.

For these reasons, a United States Aeronautics Policy would yield long-term benefits to the Nation and should instruct the appropriate government agencies to develop comprehensive strategies for high risk, basic aviation research as well as energy, environmental, and navigational programs to support air vehicles in development. We believe that the policy, to ensure interagency coordination, should also require NASA, FAA, and the Defense Department to hold regular joint meetings on their common aeronautics research objectives.

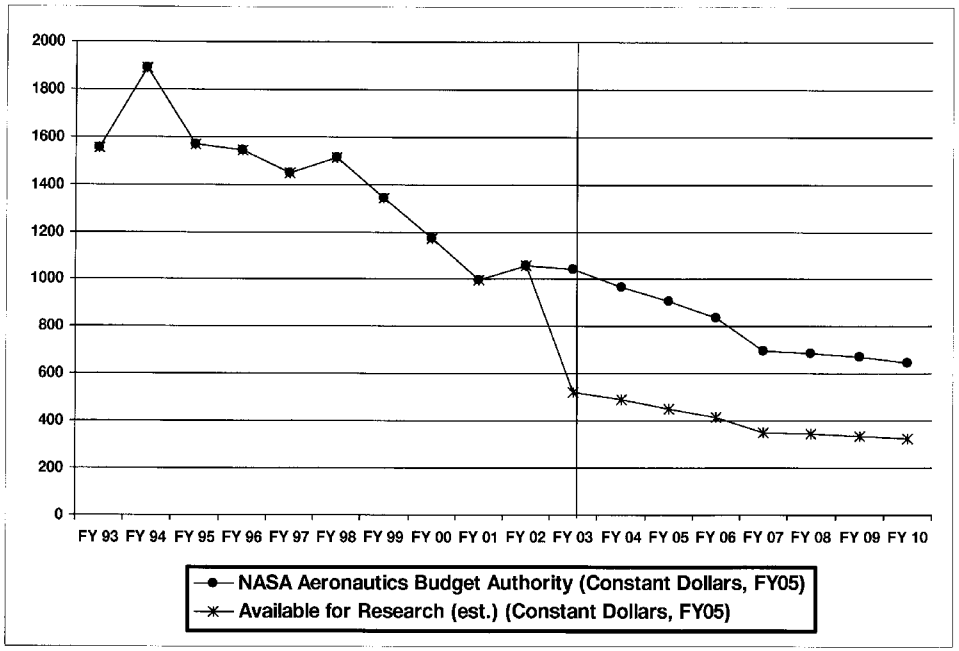
The Nation would be strengthened by such a policy since the instruments of aeronautics improve some of the basic elements that define American security and prosperity in the early 21st Century: cost-effective mobility over vast distances; geographical analysis for a safe landing or enemy surveillance; and an expanded air systems capacity for our growing international trade commitments.

Thank you, Mr. Chairman, for permitting AIA to submit these views for the record of the Subcommittee's hearing.

Appendix A

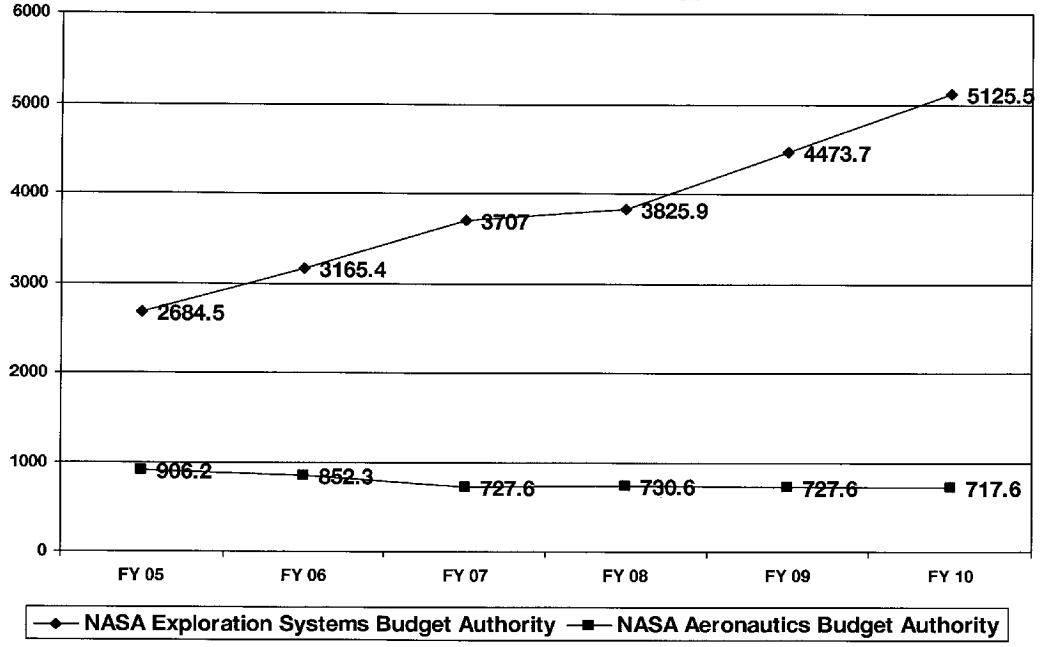
Critical Need for NASA Aeronautics R&D

(FY03 began full cost accounting)



Appendix B

NASA Aeronautics Research vs. Exploration Systems Budget Authority



AERONAUTICS TEST PROGRAM (ATP)

WHITE PAPER

INTRODUCTION

The NASA Aeronautics Research Mission Directorate (ARMD) proposes to start the Aeronautics Test Program (ATP), funded at $26M in FY06 and increasing to $31.4M by FY11. The purpose of the ATP is to ensure the strategic availability of a minimum, critical suite of wind tunnels/ground test facilities which are necessary to meet Mission Directorate, Agency and National needs and requirements. In addition, the ATP will be responsible for the strategic and business management of the aeronautics wind tunnels/ground test facilities at Ames Research Center, Glenn Research Center and Langley Research Center. It will be the responsibility of the ATP Manager to ensure funding so as to provide the appropriate levels of maintenance and investments in the ATP suite of facilities. The scope of the ATP is limited to the management of large aeronautics ground test facilities including subsonic, transonic, supersonic and hypersonic wind tunnels, propulsion wind tunnels and jet engine test cells.

BACKGROUND

There have been 13 major wind tunnel/facility studies performed during the past 15 years (see Appendix A), which have addressed the many issues surrounding the Nation's major aeronautical ground based test facilities. These studies were performed mostly at the behest of decision-makers within the senior management of various government organizations due to insufficient data being available which would justify the level of testing infrastructure being maintained by the U.S. Government and in the Nation. In general, many of these studies came to the same conclusion, wherein they recognized the importance of aeronautical ground based test facilities, wind tunnels and air breathing propulsion test facilities, to the future of this country's aeronautical industry and national security.

The RAND Study, which is the last of the 13 studies listed in the Appendix, is also described in more detail in a later section. In implementing the Aeronautics Test Program, the ARMD has sought to appropriately respond to a common thread from many of these studies, including the RAND study. In recognition of the importance of NASA ground test facilities to the Nation's economic future and to national security, many of these studies challenged NASA to sustain key parts its existing test capabilities and capacity. The ATP is being structured to accomplish that goal.

AERONAUITCS TEST PROGRAM STRUCTURE (WHAT IS FUNDED?)

Five categories of facilities have been established under which the facilities in the ATP suite have been placed. Broadly, these categories relate to the utilization and agency/national importance of the facilities. An explanation of the five categories along with the identification of the facilities within each category is as follows:

Category I. Facilities for which substantial ARMD program usage is forecast and/or facilities for which ARMD is proposing to assume a national stewardship role. The intent with respect to Category I facilities is to provide a high level of confidence to internal and external users that a Category I Facility will be in operation and available for the foreseeable future. The Category 1 facilities are the:

- Ames Unitary Wind Tunnel
- Glenn Icing Research Tunnel
- Glenn 9 × 15 Subsonic Tunnel
- Langley National Transonic Tunnel

Category II. Facilities that NASA (other than ARMD), DOD, and industry require now or may require in the future to carry out research and for developing vehicles. ARMD makes a two year commitment to facilities placed in this category, in order to properly assess the current environment and to not make unilateral decisions that would adversely effect other mission directorates, the DOD, or the Nation. The Category 2 facilities are the:

- Langley Transonic Dynamics Tunnel
- Langley Hypersonics Complex
- Langley 20–Foot Vertical Spin Tunnel
- Glenn Propulsion Systems Lab 3 & 4
- Langley 14 × 22 Subsonic Tunnel
- Glenn 10 × 10 Supersonic Tunnel
- Langley 8–Foot High Temperature Tunnel

Category III. Facilities that are currently not required but are viewed as part of a robust ground test capability. The Category III facilities are the:

- Glenn Hypersonic Test Facility
- Ames 12–Foot Pressure Tunnel

Category IV. Facilities that are not utilized and/or not viewed as components of a future ground test capability. The Category IV facilities are the:

- Langley 16–Foot Transonic Tunnel
- Ames National Full-Scale Aerodynamic Complex
- Ames 7 × 10 Subsonic Tunnels #1 and #2
- Langley 22–inch Mach 20 Tunnel
- Langley Low Turbulence Pressure Tunnel
- Langley Unitary Supersonic Tunnel

Category V. Facilities that are defined as laboratories and as such are not recommended for inclusion in the ATP. These facilities are to be maintained by the Field Centers. Category V facilities are the:

- Glenn Aero-Acoustic Propulsion Laboratory
- Langley 0.3–meter Transonic Cryogenic Tunnel
- Langley Jet Exit Facility
- Langley 20–inch Supersonic Wind Tunnel

All categorization decisions and investment decisions will be revisited annually as part of the budget cycle. The operations of the facilities in Categories I, II, and III above in their levels of readiness is funded at $18.4M in FY06. Other activities in the ATP include prioritized maintenance of the Category I and II facilities at $4.3M, facility upgrades and test technology development funded at $1.0M, program office expenses at $1.3M and a university research component which will solicit work from university principle investigators and will require the use of the ATP facilities to accomplish proposed research goals, funded at $1.0M. The ATP is summarized in Figure 1.

The Aeronautics Test Program is being setup under the umbrella of the Foundational Technology Program. The Foundational Technology Program's purpose is twofold. The first is to fund basic and applied research in order to develop the technological foundation for the next wave of aeronautics barrier breaking technology demonstration programs. The second is to sustain the core competencies at the NASA Research Centers that are required to implement the current research program and the next wave of research programs. In addition to the ATP, the Foundational Technology Program also includes University Research Project. The University Research Project will provide funding for the same basic and applied research activities as described above, but with the stipulation that all available funding be performed in academia, so as to ensure that the ARMD avails itself of the widest possible range of research ideas and activities. This project is to be funded at one percent of the "after tax" (after ensuring that corporate and mission directorate general and administrative costs have been covered) Aeronautics Research Mission Directorate available budget guideline.

THE RAND STUDY

In November 2004, the RAND Corporation's National Defense Research Institute concluded an in-depth examination of the Nation's wind tunnel and air-breathing propulsion testing needs and the issues surrounding NASA's role in meeting those needs. The final report, entitled, "Wind Tunnels and Propulsion Test Facilities—An Assessment of NASA's Capabilities to Serve National Needs," was released in February 2005. At the highest level, the RAND Study concluded that despite aeronautics maturity, that test facilities are still critical. Specifically, RAND concluded that:

- NASA's wind tunnel and propulsion test capabilities remain critical tools for research and production in U.S. aeronautics
- Making users fund all costs can discourage use and endanger strategic facilities
- Capabilities are generally consistent with national needs, but some investments are needed
- Redundancy is minimal across NASA, and total operating costs are relatively modest

- Many facilities operate at less than full capacity
- Utilization is not the overriding metric for determining a facility's value
- Establishing and supporting a minimum set of important facilities can ensure that long-term needs are not endangered by short-term gains
- National consolidation and coordination of test facility investments is the next challenge.

The study recommended that NASA should:

- Develop a long-term, funded aeronautic test facilities vision and plan
- Use shared funding of annual full costs
- Maintain and invest in minimum set of NASA facilities
- Continue efforts to adopt consistent management processes and procedures across all three Centers
- Make sure near-term decisions (e.g., to mothball or close facilities) have financial gains relative to the long-term capability risks
- Work with the DOD to analyze the issues associated with national consolidation.

In general, NASA concurs, and is taking steps to implement these recommendations. First and foremost, NASA is changing our approach to the strategic management of these important capabilities by implementation of the ATP. During the past several decades, decisions regarding the operation and closure of specific facilities were made primarily by the NASA Center that operated each facility, based on the assumption that the Center was in the best position to assess customer demand, or lack thereof, for any given facility. More recently, the nature and pace of changes within and beyond the Agency have made it increasingly difficult for the Centers to manage and operate such facilities—particularly those with large fixed costs and uncertain levels of utilization. There has been a growing concern that Centers were being forced to make investment (and potentially, divestment) decisions that were suboptimal with respect to overall Agency direction and interests.

Thirty-one NASA ground test facilities were assessed within the scope of the RAND study. Of those 31, twenty-nine were considered be the "minimum set" that should be retained by NASA in order to serve the Nation's interests in aeronautics research and development and product test and evaluation. Furthermore, of those 29, nine were identified were identified as being, "especially detrimental to close." This is because no alternatives to these nine facilities exist within the U.S., regardless of the cost. Figure 2 shows the 31 RAND facilities with both the "minimum set" of 29 and the "detrimental to close" subset of 9. The figure also identifies the relationship between the RAND study facilities and the ATP suite of facilities.

FACILITY COSTS EXPLANATION

The implementation of the ATP by the NASA ARMD, is meant to stabilize the current environment that NASA finds itself in as the NASA Aeronautics R&D budgets continue to decline and as the Agency continues to implement full-cost accounting and management. The less than 100 percent utilization in nearly all of NASA's large ground test facilities has created a situation wherein the NASA Aeronautics Research Programs are being required to pay facility fixed costs even if the utilization of a given facility is less than (and in some cases well less than) 100 percent of the calendar year. In the many cases where the fixed costs include full staffing of the facility, these costs being borne by the program are substantial and have a measurable effect on the available procurement dollars to the aeronautics research programs. The ATP attempts to pay for a large percentage of the fixed costs of its Category I facilities. For the Category II facilities, the ATP will encourage cost savings by staffing and operating these facilities only when in use and by placing the facilities in stand-by during non-use time periods. Category III facilities, for which there is no projected usage, will be mothballed starting in FY06, and the only incurred costs will be those associated with activities required to place the facility in mothball status. Should a customer have a need for a Category III facility, that customer will be expected to bear all costs of bringing the facility back to active status, of facility operations, and of returning the facility to it's mothballed state. There are no incurred costs at the ATP level for Category IV and V facilities, which are to be either closed or maintained locally, respectively.

As calculated by RAND in doing their previously described study, the annual operating cost of the 31 facilities that they assessed was $125M to $130M, annually, in FY03 dollars. The ATP funding as mentioned previously is funded at $26M starting in FY06. The breakdown of that funding is summarized in Figure 1. Definitions as noted below are for explanatory purposes.

1. Annual Operating Cost—The operations and maintenance costs of a ground test facility on an annual basis. Includes staffing, utilities, and other consumables.
2. Fixed Operating Cost—This is cost incurred in order to keep a facility open and ready for business, but does not include the cost of test operations, per se.
3. Personnel Cost: Civil Servant and Contractor—These costs attempt to capture the direct and indirect personnel associated with facility and test operations.
4. Mothball-to-Operational Costs—Mothball costs are generally only those costs required to ensure facility safety. Since minimal investment is required, both the time and costs associated with moving a facility from mothball to active status can be substantial, depending upon the complexity of the system. Typically reactivation times are order-of magnitude-wise measured in months.
5. Standby-to-Operational Costs—A facility maintained in stand-by condition is one whose subsystems (electrical, mechanical, facility control, and data) are regularly maintained, or even exercised. As such, a small level of staffing is required while a facility in stand-by. The level of activity is less than would be incurred as part of the fixed costs associated with an active facility. The level of effort to bring the facility from stand-by to active status is order-of-magnitude wise measured in weeks.

Project/Task

I. Operations ($18.43M)
   A. Category 1 ($12.5M): Ensure availability of 75% of fixed cost. This includes the investment required to ensure that category 1 facilities are operational. The remaining fixed costs and the marginal costs of test operations are borne by the program/reimbursable customers. The 75% of fixed costs includes staff to accomplish keeping the facility operational, which stabilizes rates charged to the facility customers. It does not provide for staffing required to perform test operations.
   B. Category 2 ($5.4M): Ensure facility availability by providing stand-by costs only. Facilities in category 2 typically have a customer base which utilizes the facility less than 100% of the time. The costs recovered from the customers pays fixed and marginal costs over and above the stand-by levels of funding. Stand-by costs includes minimal staffing required to ensure facility safety and readiness to the stand-by level. Depending upon the complexity of the facility, re-activation to the ready to test level may take from several weeks to 6 months.
   C. Category 3 ($0.53M): Ensure availability of mothball cost only which includes staffing to do periodic safety checks. Reactivation time is between months to one year.
   D. Category 4 ($0.0M): Facility closed; no costs incurred.
   E. Category 5 ($0.0M): Laboratory that is locally funded; no ATP costs incurred

II. Maintenance ($4.3M)
III. Upgrades/Test Technology ($1.0M)
IV. Program Office ($1.27M)
V. University Research (($1.0M)

TOTAL: $26M

Figure 1: The Aeronautics Test Program Funding Approach

Aeronautics Test Program (ATP)	
ATP Facilities by Categories	RAND Study[1]
Category 1: Substantial ARMD Program Usage/National Stewardship	
Ames Unitary Wind Tunnel	
11 Ft. Transonic Wind Tunnel	2
9 ft. X 7 ft. Supersonic Wind Tunnel	2
Glenn Icing Research Tunnel	1
Glenn 9X15/8X6 Complex	
9 ft. X 15 ft. Subsonic Wind Tunnel	2
8 ft. X 6 ft. Supersonic Wind Tunnel	2
Langley National Transonic Tunnel	1
Category 2: NASA (non-ARMD), DoD, Industry Present/Future Requirements	
Langley Transonic Dyanmics Tunnel	1
Langley Hypersonic Complex	
20-In. Mach 6 CF_4 Tunnel	1
31-In. Mach 10 Air Tunnel	2
15-In. Mach 6 High Temperature Tunnel	2
Langley 20 Foot Vertical Spin Tunnel	2
Glenn Propulsion Systems Lab. 3 & 4	
Engine Test Cell No. 3	2
Engine Test Cell No. 4	2
Langley 14X22 Subsonic	2
Glenn 10X10 Supersonic	2
Langley 8-Foot High Temperature Tunnel	1
Category 3: Mothball	
Glenn Hypersonic Test Facility	1
Ames 12-Foot Pressure Tunnel	1
Category 4: Close	
Langley 16-Foot Transonic Tunnel	3
Ames National Full-Scale Aerodynamic Complex	1
Ames 7X10 Tunnel #1	
Ames 7X10 Tunnel #2	
Langley 22-Inch Mach 20 Tunnel	
Langley Low Turbulence Pressure Tunnel	2
Langley Unitary	2
Category 5: Laboratories (Centers Sustain Locally)	
Glenn Aer-Acoustic Propulsion Laboratory	
Langley 0.3-Meter Transonic Cryogenic Tunnel	
Langley Jet Exit Facility	
Langley 20-Inch Supersonic Wind Tunnel	
Other RAND Study Facilities not in the ATP:	
Langley 12-Foot Atmospheric Tunnel	3
Langley Arc-Heated Scramjet	2
Langley Combustion Scramjet	2
Langley Supersonic Combustion	2
Langley 20-Inch Mach 6 Air	1
NASA/GASL HYPULSE	2
Ames 16-Inch Shock	2
Ames Direct Connect	2
Glenn Engine Components Research Lab Cell 2b	2

*** NOTES ***

1. RAND Study Results (1 - Essential facility, 2 - Minimum Recommended Set, 3 - Noncritical facility)

Figure 2

APPENDIX

OTHER (PAST) MAJOR FACILITY/WIND TUNNEL STUDIES

The major studies are listed below with a brief description of each along with important conclusions.

1. The National Facilities Study, April 29, 1994: The objectives of the Study were to: 1) determine where U.S. facilities do not meet the national aerospace needs; 2) define new facilities required to make U.S. capabilities world class; 3) define where consolidation and phase out of existing facilities is appropriate; and 4) develop a long-term national plan for world-class facility acquisition and shared usage.
2. "Assessing The National Plan for Aeronautical Ground Test Facilities," National Research Council, 1994 reviewed and validated the National Facilities Study recommendations for new national test capability.
3. "Goals For A National Partnership In Aeronautics Research and Technology," National Science and Technology Council, 1995. This report assessed the status of the U.S. aeronautics research infrastructure.
4. Aeronautics and Astronautics Coordinating Board Cooperation Initiative, May 1996, developed 34 recommendations including the recommendation to create six NASA–DOD major facilities alliances to improve cross agency coordination and to develop costs savings and efficiencies. The alliances created were:
   - National Wind Tunnel Alliance
   - Air Breathing Propulsion Test Facilities Alliance
   - National Rocket Propulsion Test Alliance
   - Space environmental simulation facilities Alliance
   - Arc Heated Test Facilities Alliance
   - Hypervelocity Ballistic/Impact Range Testing Alliance

   In addition this study noted that the U.S. Government had closed approximately 40 percent of its major wind tunnels and air breathing propulsion test facilities since 1993.
5. The National Wind Tunnel Complex Project Archive, July 1996, describes a major new state-of-the-art subsonic/transonic test capability that would have replaced several existing facilities in the U.S. This complex was not built because of financial considerations.
6. "DOD Aeronautical Test Facilities Assessment," March 1997. The study looked at DOD's future aeronautical development program needs for wind tunnel testing and computational fluid dynamics.
7. "Assessment of Asian Wind Tunnels," Sverdrup Technology, Inc., June 1999.
8. The National Aeronautical Test Alliance (NATA) was implemented in May 2000. This is a NASA/DOD alliance that was created to coordinate activities between NASA and DOD thus moving toward a more national view point for wind tunnels.
9. National Wind Tunnel Strategic Plan—Report on 912c Wind Tunnel Study by DOD Test Environments Reliance Panel and NASA, September 2000. This study reviewed previous wind tunnel studies and provided conclusions from those studies.
10. "Competitive Assessment of the U.S. Large Civil Aircraft Aerostructural Industry," U.S. International Trade Commission Publication 3433, June 2001. Part of the study addresses the importance of the supporting infrastructure to the aircraft industry.
11. Final Report of the Commission of the Future of the United States Aerospace Industry, November 2002. This report noted that the aerospace research infrastructure is aging and that the U.S. needs to make investments in this infrastructure to successfully carryout this country's research programs.
12. "Securing the Future of U.S. Air Transportation—A System in Peril," National Research Council, 2003. This report does not directly address the aerospace research infrastructure but does describe the expected directions

of air systems development and hence provides a basis for planning the experimental requirements for the future.

13. "Wind Tunnel and Propulsion Test Facilities—An Assessment of NASA's Capabilities to Serve National Needs," RAND, National Defense Research Institute, 2004. Reviewed this country's wind tunnels and air breathing propulsion test facilities, and made a recommendation of which facilities they considered as important to this country's future.