

**NASA'S FISCAL YEAR 2007  
BUDGET PROPOSAL**

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**HEARING**  
BEFORE THE  
**COMMITTEE ON SCIENCE**  
**HOUSE OF REPRESENTATIVES**  
ONE HUNDRED NINTH CONGRESS

SECOND SESSION

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FEBRUARY 16, 2006  
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# **NASA'S FISCAL YEAR 2007 BUDGET PROPOSAL**

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**THURSDAY, FEBRUARY 16, 2006**

HOUSE OF REPRESENTATIVES,  
COMMITTEE ON SCIENCE,  
*Washington, DC.*

The Committee met, pursuant to call, at 10:10 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood Boehlert [Chairman of the Committee] presiding.

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

**Hearing on**

*NASA's Fiscal Year 2007 Budget Proposal*

February 16, 2005  
10:00 a.m. – 12:00 p.m.  
2318 Rayburn House Office Building

**WITNESS LIST**

**The Honorable Michael Griffin**  
Administrator  
National Aeronautics and Space Administration

Accompanied by:

The Honorable Shana Dale  
Deputy Administrator,  
National Aeronautics and Space Administration

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HEARING CHARTER

**COMMITTEE ON SCIENCE  
U.S. HOUSE OF REPRESENTATIVES****NASA's Fiscal Year 2007  
Budget Proposal**THURSDAY, FEBRUARY 16, 2006  
10:00 A.M.—12:00 P.M.  
2318 RAYBURN HOUSE OFFICE BUILDING**Purpose**

On Thursday, February 16th at 10:00 a.m., the Committee on Science will hold a hearing on the National Aeronautics and Space Administration's (NASA) Fiscal Year 2007 (FY07) budget.

**Witnesses:**

**Dr. Michael D. Griffin** is the NASA Administrator.

**Ms. Shana Dale** is the NASA Deputy Administrator.

**Brief Overview:**

NASA's overall proposed budget for FY07 is \$16.8 billion, an increase of 1 percent from the FY06 appropriated budget, or up 3.2 percent if one excludes the hurricane emergency supplemental funding (\$350 million) from the FY06 base. (That can be compared to the .5 percent cut proposed for non-security discretionary spending as a whole.) The FY07 budget includes projections for the out-years that show NASA increasing by two to three percent a year in FY08 through FY11.

The proposed NASA FY07 budget differs significantly from how NASA projected it would proceed when it released its FY06 budget. (Each NASA budget submission includes a five-year runout.) There are two reasons for this. First, the FY07 proposed budget is \$170 million below the level that NASA was projected to receive in FY07 in last year's budget. Second, and more significantly, NASA Administrator Mike Griffin announced at a Science Committee hearing last year that the FY06 five-year projections for the Space Shuttle were \$3–5 billion below the amount actually needed to keep the Shuttle flying through 2010. As a result, compared to past projections, the FY07 budget shifts funding from Science and, to a lesser extent, Exploration to fully fund the Shuttle program through 2010. Compared to the FY06 projections, the FY07 budget proposal provides about \$2.2 billion more to the Shuttle program between FY06 and FY10.

The proposed FY07 budget is also about \$1.1 billion less than the level authorized in the *NASA Authorization Act* (P.L. 109–155) Congress passed in December. This is because in writing the Act, Congress handled the Shuttle shortfall by adding money to NASA's total spending. Congress also provided more money than NASA had then requested for Science (to handle cost overruns in several programs and an unfunded commitment to the Hubble Space Telescope) and to Aeronautics (to prevent further cuts).

The key features of the proposed FY07 budget include:

- The Space Shuttle is fully funded through FY10 with an assumption of 16 flights to complete construction of the International Space Station (ISS) and one flight to service the Hubble. (The Shuttle budget for FY07 is actually lower than it was in FY06 because one-time expenses necessary to return the Shuttle to flight after the *Columbia* accident no longer need to be funded. But previous projections assumed that the continuing expenses associated with the Shuttle would begin to decline in FY08, and they will not.)
- NASA plans to award a contract for development of the Crew Exploration Vehicle (CEV), which would take astronauts to the Moon, toward the end of FY06. The budget for the CEV and related vehicles would increase by 76 percent in FY07 under the budget proposal. NASA cannot yet predict whether it is technically or financially possible to fly the CEV before 2014. (President Bush set 2014 as the date for the first manned CEV flight when he announced the *Vision for Space Exploration* in 2004.) NASA is trying to fly the

vehicle sooner—probably late 2011 is the earliest possible date—to reduce the time between the retirement of the Shuttle and the launch of the CEV.

- All programs in the Exploration Directorate other than those related to the CEV are cut back significantly. This includes all programs to develop technology that is not immediately needed by NASA (such as nuclear propulsion) and much of the ISS research program.
- Funding for the Science Directorate is increased by 1.5 percent in FY07 and by one percent thereafter—significantly below the levels previously projected. That level of budget growth, along with increased costs for some projects, will necessitate the deferral or cancellation of a number of space and Earth science missions and will make it hard for new missions to get into the queue.
- Funding for aeronautics declines by 18 percent in FY07 with further reductions projected for the outyears. For reasons unrelated to the budget, NASA is totally revamping its aeronautics program to focus more on fundamental research questions and less on building demonstration projects. Work to develop a new air traffic control system in coordination with the Federal Aviation Administration and the Department of Defense will continue.

#### Overarching Questions:

Questions about the budget proposal basically fall into three categories:

1. **BUDGET PRIORITIES:** Is the overall level of spending appropriate and is the budget properly balanced among human space flight, space science, Earth science and aeronautics? Is the emphasis on near-term commitments over longer-term technology development and science missions appropriate? Given the level of funding, should Congress eliminate any of the requirements placed on NASA in the *NASA Authorization Act*, which mandated that NASA continue the Shuttle and ISS programs, launch a CEV as close to 2010 as possible and carry out robust programs in space and Earth science and aeronautics?
2. **IMPLEMENTATION OF THE EXPLORATION VISION:** In implementing its plans for returning to the Moon, how will NASA avoid the cost growth, schedule delays and technical problems experienced by other space programs? If the program's costs grow, will NASA "go-as-you-can-pay" as stated by the President or will it redirect funds from other programs?
3. **SPACE SHUTTLE AND STATION:** What is the status of plans for the second return to flight Shuttle mission, and how realistic is the plan to complete 16 flights to Space Station and one to Hubble before the Shuttle is retired in 2010? Will NASA be able to use private companies to fly cargo flights to the ISS?

#### Key Issues:

**Impact of Science cuts.** The FY07 budget proposes to cut Science by \$3.1 billion from FY06–FY10 compared to what was projected in the FY06 budget over the same period. Programs that sustained the largest cuts include the Mars robotic exploration program (by focusing on science-based missions every other year and dropping activities that were more related to laying the groundwork for human exploration), planned advanced telescopes to find planets around distant stars, and several programs to observe phenomena predicted by Einstein's theories, such as black holes, the Big Bang, and "dark energy." Several key Earth science missions are deferred or canceled. In addition, the FY07 budget proposes cutting funds for research (as opposed to the satellites or telescopes themselves) by 15 percent. What will be the long-term impact of these cuts? Is Earth science any better off than it was last year when the National Academy of Sciences raised alarms about the future viability of the program? Will there be enough programs coming down the line to provide sufficient opportunities for scientists and engineers?

**Space Shuttle and Space Station Challenges Remain.** NASA believes it has solved the foam shedding problem that occurred again on the most recent Shuttle flight and hopes to launch the next Space Shuttle in May, although that could slip to July. NASA's latest plan calls for conducting 16 flights to complete the assembly of the International Space Station (plus one flight sometime in 2008 to repair the Hubble Space Telescope). The Space Shuttle will then be retired in 2010. The tentative plan is to launch two flights in FY06, four in FY07, five each in FY08 and 09 and one in FY10, with the Shuttle retiring by Dec. 31, 2010. While the Shuttle program has accomplished that launch rate in the past, there is little tolerance for any delays. To accomplish this, the Shuttle program faces a number of challenges,



including maintaining its key staff as the program moves toward completion. Between FY06 and the Shuttle retirement, NASA intends to spend approximately \$20 billion on the program. (The program costs about the same amount regardless of how many Shuttles are launched because the primary expenses of the program are the continuing costs of maintaining the workforce and facilities.)

On the Space Station side, NASA has cut ISS-related research funding by 50 percent for the second year in a row. Between FY06 and FY10, NASA intends to spend more than \$10 billion on the Space Station program. Can the Shuttle successfully complete the projected number of flights? How high a priority are the Shuttle and ISS programs?

**Are the synergies between Shuttle and CEV/CLV realistic?** NASA is assuming that it will save money by finding “synergies” between the Shuttle program and the efforts to develop the CEV and its launch vehicle (CLV). This is plausible because NASA has decided to use several key Shuttle parts in the CEV and CLV. For example, the Solid Rocket Boosters (SRB) used on the Shuttle will be the first stage of the CLV. To ease the transition on the workforce and to take advantage of facilities, systems, and capabilities that the two programs have in common, NASA has tried to identify areas of “synergy” to save money. Given the constrained budget, has NASA been realistic in its assumptions for these savings?

**Challenges of Implementing the Exploration System Architecture.** NASA estimates that it will need about \$100 billion between now and 2018 to return to the Moon. Given that nearly every major government space program has run into cost growth and schedule delay problems, often because they were overly optimistic about the technologies, underestimated the complexity, and underestimated the cost, what is NASA’s approach to minimize the possibility that the CEV and CLV will run into the same problems? If the CEV or CLV run into cost growth problems will NASA stretch the program schedule, as it has done on the Webb telescope program, or will it look to other non-Exploration programs for funds?

**Hurricane Katrina Response and Recovery.** Hurricane Katrina inflicted significant damage on the Stennis Space Center in Mississippi and the Michoud Assembly Facility in Louisiana. The Michoud facility is located just outside New Orleans and is the manufacturing facility for the Space Shuttle’s External Tanks. NASA’s cost estimate for the damage, including emergency response and programmatic costs is \$760 million. Last year, Congress provided NASA with \$350 million in emergency relief funding. In total, NASA has put \$450 million toward hurricane relief. To pay back the \$100 million NASA internally redirected and make up the shortfall from NASA’s estimate of the damage, the agency will need about \$300 million in additional funds. Another hurricane supplemental request may be sent to Congress shortly. How will NASA handle hurricane relief if additional funds are not available?

#### **FY07 Budget Details:**

##### *Science Budget Highlights:*

NASA’s Science budget request for FY07 is \$5.33 billion, an increase of \$76 million, or 1.5 percent over the FY06 appropriated budget, but \$354 million less than was projected for FY07 in the FY06 budget.

Over the period from FY06–FY10 the Science program is to be cut by approximately \$3.1 billion as compared with the FY06 projected budget over the same period. These cuts were primarily used to fund the shortfall in the Space Shuttle program.

The following are highlights of NASA’s FY07 budget for Science:

- The Mars Exploration program is significantly scaled back compared to previous plans, primarily by cutting missions that had more to do with future human exploration than with science. NASA continues to operate several ongoing Mars missions, including the twin Mars rovers Spirit and Opportunity, and the proposed plans call for flying a robotic mission to Mars approximately every two years. But the FY07 budget proposes cancellation of several future missions, such as the Mars Telecommunications Orbiter, two Mars testbed missions, and future Mars human precursor missions. The Mars Sample Return mission to robotically bring back a sample from the Martian surface has been indefinitely deferred.
- NASA is planning a Shuttle mission to service the Hubble in 2008, assuming the next Shuttle flight shows the vehicle can operate safely. Over the last several years, NASA has implemented conservation measures to help extend the life of the batteries and gyros on Hubble so that it should remain operational

into 2008. To pay for continued operations and preparations for the planned servicing mission, the FY07 budget for Hubble has been increased. (Note: the Shuttle portion of the costs for the servicing mission is not included in the Science budget, but is included as part of the Shuttle program.)

- In Earth science, NASA plans to fly as independent satellite missions two research instruments that were previously going to “hitch a ride” on vehicles intended for other purposes. The Committee had long questioned the viability of the “hitching” approach. The two missions are Glory, which will measure chemicals in the atmosphere, and Landsat, the continuing effort to provide large-scale imagery of the Earth.
- The Stratospheric Observatory for Infrared Astronomy (SOFIA) program is zeroed out in the FY07 budget, but is under review. The SOFIA observatory, a joint program with the German Aerospace Center, is significantly over budget and behind schedule. SOFIA was planned to work in conjunction with the Spitzer telescope but now would have little overlap with Spitzer. SOFIA is still funded in FY06, but NASA has directed that no new work is to be started until the review is completed. A final decision on SOFIA is expected in the next few months.
- The James Webb Space Telescope (JWST) budget is increased to cope with the projected \$1 billion cost growth, and its launch is delayed two years to 2013. JWST, which is ranked as the top priority in the National Academy’s decadal survey of astronomy and astrophysics programs, is designed to be the follow-on mission to Hubble. To avoid damage to other science programs’ budgets, NASA plans to make up the remaining portion of the \$1 billion overrun by stretching the program out and delaying the launch date to 2013. NASA is reviewing the program now. Detailed cost and schedule estimates will be completed in spring 2006 and will be reflected in the FY08 budget.
- The Navigator program, a series of ground-based and space-based telescopes used to detect planets around other stars, is cut significantly. The programs under Navigator are the Space Interferometry Mission (SIM), the Terrestrial Planet Finder (TPF), the Keck Interferometer, and the Large Binocular Telescope Interferometer (LBTI). SIM is under review with a launch date no earlier than 2015. TPF has been deferred indefinitely. The Keck Interferometer is in operations, but proposed upgrades to improve performance are canceled (four additional “outrigger” telescopes will not be added to the two main telescopes).
- NASA is reviewing the elements of the Beyond Einstein program to determine priorities. The program is designed to observe phenomena predicted by theoretical physics, such as phenomena that would shed light on the Big Bang, black holes, and the existence of a “dark energy.” NASA plans to proceed with studies related to the missions in FY07.
- The FY07 budget request does not include any funding for planning a mission to Europa, a moon of Jupiter that may have, or may have had in the past, liquid water. A mission to Europa was a top-rated mission by the National Academy of Sciences decadal survey of priorities for solar system exploration. NASA cannot afford such an expensive mission right now and also wants to determine whether it should set its sights instead on Saturn’s moon Titan, which recent studies have shown may be an even more promising target. However, Congress directed NASA in the FY06 *Science, State, Justice Commerce Appropriations Act* (H.R. 2862) to begin planning a mission to Europa and include it as part of its FY07 budget.
- Funding for Research and Analysis (R&A) across the entire Science program was cut. The R&A account provides funds to scientists to perform the research on the data collected by the various missions. The reduction was driven by the overall cuts in the Science budget and the fact that fewer missions are planned to be flown as a result of program cancellations.

*Exploration Systems Budget Highlights:*

Since becoming Administrator, Griffin has overhauled NASA’s approach for returning to the Moon. As a result of NASA’s Exploration Systems Architecture Study (ESAS) completed last year, NASA hopes to accelerate the delivery of the Crew Exploration Vehicle (CEV) to minimize the gap following the Shuttle retirement in 2010. The budget documents state that CEV will come “on-line by 2014, and potentially much sooner.” In briefings, NASA has said that until it awards a CEV development contract, it cannot be sure whether it is technically or financially feasible to move ahead before 2014. The contract solicitation sets 2012 as a target launch

date, and NASA officials have said it would be extremely unlikely in any event to launch before late 2011.

The plan also calls for NASA to develop two new launch vehicles to be derived from Shuttle elements, one to launch the CEV and one to launch heavier loads to return to the Moon by 2018. The preliminary ESAS cost estimate through 2018 is \$104 billion, excluding the operational costs of CEV missions to the ISS, which are expected to cost \$12 billion between FY12 and FY16. Estimates for cost and schedule will be refined as the program moves forward. To fund CEV development, NASA has virtually eliminated all of the long-term high-risk research and technology projects beyond what is necessary to return humans to the Moon for short visits.

NASA's Exploration Systems budget request as a whole for FY07 is \$3.98 billion, an increase of \$930 million, or 30 percent, over the FY06 appropriated budget. Compared to projections made in last year's budget, however, the Exploration Systems budget is cut by nearly \$1.6 billion over the period from FY06–FY10. This cut, in addition to cuts in the Science program, was required to pay for the funding shortfall in the Shuttle and Station budgets.

Not all the funding for CEV requested for FY07 will be spent next year. NASA wants to "bank" funding for CEV, so that it can begin to accumulate funds that will be needed in the peak years of development. NASA has not yet said how much will actually be spent in FY07.

The following are highlights of NASA's FY07 budget for Exploration Systems:

- The funding request for the CEV and the CLV, as well as the main elements needed to return to the Moon, such as heavy-lift launch systems, communications and navigations systems, and new space suits (collectively called Constellation Systems) for FY07 is \$3.1 billion, an increase of \$1.3 billion, or 76 percent, over the FY06 appropriated budget. To try to accelerate the CEV and CLV, the FY07 budget proposes to add more than \$5.6 billion over the period from FY06 to FY10 over what was planned in the FY06 budget projection. CEV will initially be used to transport crews to and from the Space Station.
- The ISS Crew and Cargo budget is increased slightly in the near-term and reduced overall over the next five years. The ISS Crew and Cargo budget contains two components, funds to purchase Soyuz capsules and Progress supply vehicles from Russia and funds for a commercial crew/cargo demonstration project, the Commercial Orbital Transportation Systems (COTS) demonstration project. Under COTS, NASA has solicited proposals from private sector companies that want to demonstrate that they could fly missions to supply cargo and perhaps crew to the ISS. The proposals are due in March. NASA has set aside \$500 million for the program through FY09, and the funds would help the winning private company or companies develop their spacecraft. Then NASA would pay the company or companies to actually fly missions if they demonstrate that they can do so successfully for less money than it would cost to pay the Russians or Europeans.
- Exploration Systems Research and Technology (ESRT) is dramatically cut and scaled back. The ESRT budget includes the Robotic Lunar Exploration Program, and some technology projects for returning to the Moon. This cut-back has resulted in the cancellation of more than 80 projects that were deemed not essential to getting humans back to the Moon. Project Prometheus, NASA's nuclear power and propulsion program, which was once planned as a \$400 million per year program, is now a small technology initiative funded at \$10 million per year. The Robotic Lunar Exploration Program (RLEP), which will launch satellites to learn about the Moon in advance of a human landing, remains on track with the launch of its first mission, the Lunar Reconnaissance Orbiter, scheduled for 2008.
- The Centennial Challenges prize program receives little funding. At NASA's request, the *NASA Authorization Act* included language giving the agency the authority to conduct large prize contests for concepts that could contribute to NASA's mission. The FY07 budget provides \$10 million for the program in each of FY07 and FY08 and no funding beyond that. NASA does plan to move forward with several new small prize programs, and will decide about future prizes after that.
- The Human Systems Research and Technology (HSRT) budget is cut by more than 50 percent. HSRT funds life and microgravity research, primarily on the ISS. Projects in all areas have been cut back to the bare minimum, with the focus on programs to get health data from astronauts aboard ISS. Some projects will be continued to meet the requirement in the *NASA Authorization*

*Act* that at least 15 percent of the research funded aboard the ISS be unrelated to future human space missions.

*Aeronautics Research Budget Highlights:*

Beginning last fall, NASA has been revamping its aeronautics program to move away from narrowly focused technology demonstration projects and toward a more fundamental research program. The *NASA Authorization Act* directs NASA to lead a government-wide effort to develop a National Aeronautics Policy to guide NASA's aeronautics research program. That policy plan is due at the end of 2006.

NASA's FY07 Aeronautics Research budget request is \$724 million, a \$160 million reduction, or 18 percent cut from FY06. NASA's aeronautics research program consists of three integrated research programs: the Aviation Safety Program, the Airspace Systems Program, and the Fundamental Aeronautics Program. A new component has been added this year called the Aeronautics Test Program. It was created to ensure that critical facilities, such as wind tunnels, remain available at a reasonable cost to users.

The following are highlights of NASA's FY07 budget for Aeronautics Research:

- The Fundamental Aeronautics Program budget is increased in the FY07 budget. The Fundamental Aeronautics Program represents a complete revamping of what used to be called the Vehicle Systems Program. The Fundamental Aeronautics Program will develop advanced tools and capabilities to better understand the underlying physics of flight. These tools and capabilities will enable new classes of aircraft to be more efficient and more economical with reduced noise.
- The Aviation Safety Program budget is cut over the next several years. The Aviation Safety Program conducts research to improve safety of future aircraft and to eliminate safety-related technology barriers. Areas of research include the development of technologies to improve situational awareness during flight and to improve vehicle health management and aging-related hazards.
- The Airspace Systems Program budget is cut. The Airspace Systems Program conducts research and development to address the future air traffic management needs.
- The aeronautics program would move away from research on "human factors" and from security issues. NASA argues that security issues do not fit well with its expertise and responsibilities.

*Space Operations (Space Shuttle and Space Station) Budget Highlights:*

In developing the FY07 budget, the Administration had a clear choice regarding Shuttle and Station. Given that the fixed costs on the Space Shuttle and Space Station consume the vast majority of their budgets, the only choices basically boiled down to either finding the funds to make the program "whole" or ending the Shuttle program, thereby prevent any future assembly of the ISS. The FY07 budget reflects the Administration's decision to make the program whole.

NASA's FY07 Space Operations budget request is \$6.2 billion, which is about 40 percent of the whole NASA budget. This is about a four percent cut from last year's level, but an increase of \$47 million over last year's projection for the FY07 budget. Over the period from FY06–FY10 the Space Operations budget is increased by \$3.6 billion as compared to the levels projected in last year's budget for the same period. This account includes the Space Shuttle, the International Space Station (ISS), and a much smaller line called Space and Flight Support.

The following are highlights of NASA's FY07 budget for Space Operations:

- NASA now plans to fly the Shuttle on 16 missions to complete the International Space Station and one mission, probably in 2008, to service the Hubble Space Telescope. The Shuttle will be retired in 2010. While the Shuttle has averaged over four flights each year over the past 25 years, it will be challenging to complete all 17 of these missions by 2010 because there are only three Shuttles instead of four, missions to the ISS can be conducted only during limited launch windows, and the missions must be conducted in a specific order so that the ISS can be assembled. On the other hand, all three of the Shuttles have been thoroughly refurbished. What can't be predicted, of course, is some new problem with the Shuttle that would require another significant stand down.
- Last November, the Space Station program marked the fifth anniversary of continuous U.S. presence in space. Despite the grounding of the Shuttle over

the past three years, the Space Station program has continued, albeit in a reduced mode with only two crew members aboard and no progress on completing the assembly of the ISS. NASA intends to increase the crew size from two to three beginning with the next Shuttle flight, currently planned for May. NASA has also been able to continue the ISS program because Congress provided NASA with an exception to the *Iran Nonproliferation Act* allowing the agency to purchase Soyuz capsules and Progress supply vehicles from Russia. This exception will sunset in 2012. NASA hopes to have the CEV online by then to meet the U.S. commitment to provide crew transportation for the program. A top concern for the ISS program is resuming a regular tempo of Shuttle flights so that the ISS can be completed by 2010 when the Shuttle is to be retired. The Space Station budget is increased by \$167 million for FY07 and by nearly \$1.5 billion over the period from FY06–FY10 as compared to levels projected in last year’s budget over the same period, when the transfer of the ISS Crew/Cargo project to Exploration Systems is taken into account.

*Other programs and issues:*

- The Education program is cut slightly from what was projected for FY07 last year and is essentially flat funded for the next several years at about \$150 million per year. NASA proposes to spend \$47 million on elementary and secondary education, \$54 million on higher education, \$12 million for E-Education and informal education, and about \$40 million on the Minority University Research and Education Program (MUREP).
- As NASA shifts its focus from the Space Station and Space Shuttle to the CEV and CLV, it plans to reassign workers to new jobs, as well as cut back on the overall number of positions. NASA plans to reduce its workforce from 18,410 in FY06 to 17,979 for FY07. NASA officials have said that many employees will be shifted to different positions or locations, and attrition will take care of some of the problem. Some layoffs maybe needed, but the *NASA Authorization Act* prohibits a layoff (Reduction In Force, or RIF) until March of 2007. In an effort to rebalance and reshape the workforce, the agency is conducting buyouts at all NASA Centers and Headquarters. Buyouts have been offered to employees in positions identified with excess competencies. To date, 303 employees have taken advantage of these buyouts in FY06. NASA’s current estimate of “uncovered capacity”—personnel not directly assigned to a program—is about 920 civil servants. NASA hopes to rebalance its workforce and eliminate or reduce the need for a RIF. The objective is to assign work among the 10 NASA Centers to maintain a balance and meet the projected workforce levels. Earlier this month, NASA released its draft workforce strategy to its unions so that they can comment on it.

<i>(Budget authority, \$ in millions)</i>		FY 2006 Op Plan	FY 2007	Change	FY 2008	FY 2009	FY 2010	FY 2011
<b>Science, Aeronautics, and Exploration</b>		<b>9,721.3</b>	<b>10,524.4</b>	<b>8.3%</b>	<b>10,594.4</b>	<b>11,136.4</b>	<b>11,747.0</b>	<b>15,526.4</b>
<b>SCIENCE</b>		<b>5,253.6</b>	<b>5,330.0</b>	<b>1.5%</b>	<b>5,383.1</b>	<b>5,437.1</b>	<b>5,491.5</b>	<b>5,546.4</b>
Solar System Exploration		1,582.3	1,610.2	1.8%	1,598.6	1,840.4	1,899.6	1,846.7
The Universe		1,507.9	1,509.2	0.1%	1,500.9	1,307.9	1,276.1	1,309.7
Earth-Sun System		2,163.5	2,210.6	2.2%	2,283.7	2,288.9	2,315.8	2,390.0
<b>EXPLORATION SYSTEMS</b>		<b>3,050.1</b>	<b>3,978.3</b>	<b>30.4%</b>	<b>3,981.6</b>	<b>4,499.8</b>	<b>5,055.9</b>	<b>8,775.1</b>
Constellation Systems		1,733.5	3,057.6	76.4%	3,067.6	3,612.9	4,083.8	7,698.4
Exploration Sys Res & Tech		692.5	646.1	-6.7%	632.2	605.1	679.2	764.6
Human Sys Res & Tech		624.1	274.6	-56.0%	281.8	281.8	292.8	312.1
<b>AERONAUTICS RESEARCH</b>		<b>884.1</b>	<b>724.4</b>	<b>-18.1%</b>	<b>731.8</b>	<b>732.4</b>	<b>722.8</b>	<b>722.7</b>
<b>CROSS-AGENCY SUPPORT</b>		<b>533.5</b>	<b>491.7</b>	<b>-7.8%</b>	<b>497.9</b>	<b>467.1</b>	<b>476.9</b>	<b>482.2</b>
Education Programs		162.4	153.3	-5.6%	152.4	153.2	154.0	153.3
Advanced Business Systems		156.3	108.2	-30.8%	106.9	73.8	78.5	80.6
Innovative Partnerships		214.8	197.9	-7.9%	205.5	206.2	209.7	212.9
Shared Capabilities		0.0	32.2	-	33.1	33.9	34.7	35.5
<b>EXPLORATION CAPABILITIES</b>		<b>6,519.9</b>	<b>6,234.4</b>	<b>-4.4%</b>	<b>6,680.4</b>	<b>6,442.3</b>	<b>6,242.9</b>	<b>2,896.7</b>
<b>Space Operations</b>		<b>6,519.9</b>	<b>6,234.4</b>	<b>-4.4%</b>	<b>6,680.4</b>	<b>6,442.3</b>	<b>6,242.9</b>	<b>2,896.7</b>
International Space Station		1,753.4	1,811.3	3.3%	2,200.3	2,255.6	2,197.1	2,360.8
Space Shuttle*		4,427.7	4,056.7	-8.4%	4,087.3	3,794.8	3,651.1	146.7
Space and Flight Support		338.8	366.5	8.2%	392.8	392.0	394.7	389.2
<b>Inspector General</b>		<b>32.0</b>	<b>33.5</b>	<b>4.7%</b>	<b>34.6</b>	<b>35.5</b>	<b>36.4</b>	<b>37.3</b>
<b>TOTAL AGENCY (not incl emergency supp)</b>		<b>16,273.2</b>	<b>16,792.3</b>	<b>3.2%</b>	<b>17,309.4</b>	<b>17,614.2</b>	<b>18,026.3</b>	<b>18,460.4</b>
Year to Year Increase			3.2%	-	3.1%	1.6%	2.3%	2.4%
Emergency Hurricane Supplemental		349.8						
<b>TOTAL AGENCY (with emergency supp)</b>		<b>16,623.0</b>	<b>16,782.3</b>	<b>1.02%</b>				
Year to Year Increase			1.02%					

Chairman BOEHLERT. The hearing will come to order.

I want to welcome everyone here. The title on my statement, opening statement, says opening statement for NASA hearing. The subtitle might be a reality check.

I want to welcome everyone here this morning for this important hearing on the future of NASA, the first of a number of hearings the Committee will hold related to NASA's proposed budget. Let me start in what has almost become a ritual at these hearings, by praising Administrator Griffin. In tough times and in easy times, Mike Griffin has continued to be a steady model of competence and candor, to which everyone in government should aspire, and he has recruited to the Agency an impressive team, including the adept Deputy Administrator, an alumna of this committee, who is appearing with him here today. I want to thank him publicly, as the staff and I have already done privately, for making the Agency responsive and open to our inquiries, as demonstrated in this year's series of budget briefings for the Committee staff.

But to understand the budget is not necessarily to love it. The Administrator did an excellent job of balancing the Agency's mission, given the box he was put in, but it is our job to examine the box, as well as its contents, and by the box, I mean both the total funding for the Agency, and the missions that it is being mandated to perform. I am extremely uneasy about this budget, and am in a quandary at this point about what to do with it. This budget is bad for space science, worse for Earth science, perhaps even worse for aeronautics. It basically cuts or de-emphasizes every forward-looking, truly futuristic program of the Agency to fund operational and development programs, to enable us to do what we are already doing or have done before. Admittedly, that is a bit of a caricature, but I think we face some stark choices. Now, maybe that is all we can do, given our options.

I support the *Vision for Space Exploration*, although I don't see any reason to accelerate it beyond the President's original plans, but given that NASA is not yet sure that it can accelerate it, it is not clear that we can save much money on the Crew Exploration Vehicle and its launcher, compared to the proposed budget.

As for the Space Station and Space Shuttle programs, we have a pretty clear decision to make. We can either have these programs, or we can end them. There isn't any logical way I see to continue those programs for less money than NASA is proposing, and given the costs of shutdown, it is not clear how much money would even be saved through cancellation. We can add more money to the total NASA budget, and I would be willing to support that, as long as any additional money went to the unmanned side of the program, and as long as the money didn't come from other science agencies. But money is not exactly growing on trees around here.

So what to do is not clear. Except for one concern, I would even be willing to convince myself that this budget is just fine, a tough few years of transition to set the Agency back on a sensible path in all its programs, which is, I think, how the Administrator legitimately thinks of it, but that one concern is a big one. We may never escape from the pattern we set this year. If science becomes secondary, if scientists leave the Agency, if new missions don't keep young researchers going, then it will be hard to leave this pattern.

If the lunar programs, like all programs run by humans, can't live within the original cost projections, will money keep coming from science? And let me point out that science isn't just good for scientists, and its rewards are not just psychic. Science programs, with their satellites and instruments, also push forward the technical frontiers, and Earth science programs help us figure out what policy choices we should be making on the most important planet in the universe, Earth.

So the budget has just been out for a week, and I am still figuring out what to do. Again, I want to point out that given the requirements that Congress and others have imposed on him, the Administrator and his team have come up with a thoughtful budget, probably the best that could be expected given the circumstances. But now, the ball is in our court. I said when our authorization bill passed, that if NASA didn't receive as much funding as was authorized, we would all face some tough choices. Now, we do.

Before I close, let me just update everyone for a moment on another NASA issue, one that shouldn't be as tough, and that is the question of scientific openness. Since the concerns of Dr. Hansen became known, the Administrator, the Deputy Administrator, and Mr. Gordon and I have been working together to ensure that NASA is a model of scientific openness. From the start, NASA has been responsive to our inquiries, and Administrator Griffin began taking steps to rectify the problems right away. NASA still has a lot of work to do to ensure openness. That is Administrator Griffin's view, as well as my own, but they have laid out a plan to do that work, starting with engaging in an open process to develop a clear policy on scientific communication. We will be working with NASA and following the development of that policy and its implementation closely, but I have high hopes that NASA will end up being a model of how agencies can guarantee scientific openness.

When Administrator Griffin last appeared before us, I said that he had brought forth a Renaissance at NASA. I want him to follow that up with an Enlightenment. We need free and open inquiry, and an agency that recognizes that the greatest exploration takes place inside the human mind. I look forward to continuing to work with the Administrator and his team to make sure that enlightenment occurs.

Mr. Gordon.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to welcome everyone here this morning for this important hearing on the future of NASA, the first of a number of hearings the Committee will hold related to NASA's proposed budget.

Let me start, in what has almost become a ritual at these hearings, by praising Administrator Griffin. In tough times and easy times, Mike Griffin has continued to be a steady model of competence and candor to which everyone in government should aspire. And he has recruited to the Agency an impressive team, including the Deputy Administrator, an alumna of this committee, who is appearing with him today. I want to thank him publicly, as the staff and I already have privately, for making the Agency responsive and open to our inquiries, as demonstrated in this year's series of budget briefings for the Committee staff.

But to understand the budget is not necessarily to love it. The Administrator did an excellent job of balancing the Agency's missions given the box he was put in, but it's our job to examine the box as well as its contents. And by "the box" I mean both



the total funding for the Agency and the missions that it's being mandated to perform.

I am extremely uneasy about this budget, and I am in a quandary at this point about what to do about it. This budget is bad for space science, worse for Earth science, perhaps worse still for aeronautics. It basically cuts or de-emphasizes every forward looking, truly futuristic program of the Agency to fund operational and development programs to enable us to do what we are already doing or have done before.

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Now maybe that's all we can do, given our options. I support the *Vision for Space Exploration*, although I don't see any reason to accelerate it beyond the President's original plans. But given that NASA is not yet sure that it can accelerate it, it's not clear that we can save much money on the Crew Exploration Vehicle (CEV) and its launcher compared to the proposed budget.

As for the Space Shuttle and Space Station programs, we have a pretty clear decision to make. We can either have these programs or we can end them. There isn't any logical way I see to continue those programs for less money than NASA is proposing, and given the cost of shutdown, it's not clear how much money would even be saved through cancellation.

We can add more money to the total NASA budget. And I'd be willing to support that as long as any additional money went to the unmanned side of the program, and as long as the money didn't come from other science agencies. But money is not exactly "growing on trees" around here.

So what to do is not clear. Except for one concern, I'd even be willing to convince myself that this budget is just fine—a tough few years of transition to set the Agency back on a sensible path in all its programs, which is, I think, how the Administrator legitimately thinks of it. But that one concern is a big one—we may never escape from the pattern we set this year.

If science becomes secondary, if scientists leave the Agency, if new missions don't keep young researchers going, then it will be hard to leave this pattern. If the lunar programs, like all programs run by humans, can't live within the original cost projections, will money keep coming from science?

And let me point out that science isn't just good for scientists, and its rewards are not just psychic. Science programs, with their satellites and instruments, also push forward the technical frontiers. And Earth science programs help us figure out what policy choices we should be making here on Earth.

So the budget has just been out for a week, and I am still figuring out what to do. Again, I want to point out that given the requirements that Congress and others have imposed on him, the Administrator has come up with a thoughtful budget—probably the best that anyone could under the circumstances. But now the ball is in our court. I said when our authorization bill passed that if NASA didn't receive as much funding as we authorized, we'd all face some tough choices. Now we do.

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When Administrator Griffin last appeared before us, I said that he had brought forth a Renaissance at NASA. I want him to follow that up with an Enlightenment. We need free and open inquiry, and an agency that recognizes that the greatest exploration takes place inside the human mind.

And I look forward to continuing to work the Administrator and his team to make sure that Enlightenment occurs. Thank you.

Mr. GORDON. Thank you, Mr. Chairman, and I want to join you in welcoming Administrator Griffin and Deputy Administrator Dale, and let me once again associate myself with your remarks. We are on the same page completely.

Dr. Griffin has always been forthright in his testimony to this committee, and I am confident that we will get straight answers from him again today. He demonstrated that attribute again in his recent statement to NASA employees on the issue of scientific integrity, and I think this is important, because unfortunately, the Hansen situation, it is becoming apparent, is not isolated.

I am afraid that scientific censorship permeates this entire Administration, with NASA being no exception, but the Administrator is taking a forthright role, as Chairman Boehlert said, and I hope it will be a model for—as we have seen, NOAA has come out also recently, and others, to try to set the record straight.

It is now a little more than two years since President Bush announced his Exploration Initiative. I think it is appropriate for this committee to step back and see how the implementation of the President's vision squares with what Congress has—was led to believe by the White House and NASA two years ago. As you will recall, when the Exploration Initiative was rolled out, the Administration said that the President's vision for space exploration would be both affordable and sustainable. In support of those assertions, the Administration presented a multi-year budget plan that demonstrated its commitment to providing the resources needed to carry out the President's Exploration Initiative, fund the Space Shuttle and Space Station programs, and ensure that NASA's space and Earth science programs would grow at a healthy annual rate.

That was what the Administration said would happen. How does that compare what actually did happen? Well, since the simple fact—well, the simple fact is that two years since the Exploration Initiative was announced, the Administration has never sent a budget request to Congress equal to what it said NASA would need to carry out the Exploration Initiative and NASA's other programs. Specifically, the budget plan for two years ago that accompanied the Exploration Initiative, said that NASA would need \$17 billion in fiscal year 2006, yet the Administration wound up sending over a request that was more than half a billion dollars lower than that level.

Unfortunately, that wasn't an aberration. Its budget plan for two years ago also said that NASA would need \$17.815 billion in fiscal year 2007, yet the Administration has just sent over a budget request for NASA that is more than \$1 billion less than that amount. Supporters of the President's initiative are fond of saying that is a long-term undertaking, but the challenge will be to ensure that future Administrations and Congresses sustain the Exploration Initiative.

I disagree. I think the real challenge is in getting the Administration that proposed this initiative to adequately fund the agency tasked with carrying it out. Why should we expect future Administrations to sustain a commitment to the Exploration Initiative when the Bush Administration has not seen fit to provide the resources that the Administration itself said NASA would need?

Of course, it will be argued that we are at war, that we have a deficit to get under control, and so we shouldn't expect NASA to receive all the money that was promised. That argument has merit. However, it ignores the fact that the war and the deficit were al-

ready uncomfortable realities when the President's initiative was announced. There are also those who would argue that NASA did better than any other agencies in the competition for funds this year. That is an interesting observation, but largely irrelevant. The issue is not whether NASA got higher percentage increases than some other agencies. Rather, the issue is whether NASA got the funding that is needed to carry out the programs successfully.

That is why I and other Members were concerned two years ago about the likely impact of trying to shoehorn a big new Moon to Mars Initiative into a NASA budget that was going to be under increasing pressure in the coming years for a variety of reasons. We were assured that we didn't need to worry, that the budget plan was credible, that NASA would undertake the advertised science programs, invest in a range of new technologies, and do all of the other things described in the budget plan that accompanied the Exploration Initiative.

Again, what is reality two years later? Well, last year, the budget runout for NASA space and Earth science activities was cut by \$1 billion. This year, the President's fiscal year 2007 budget request for NASA would cut an additional \$3.1 billion from the space and Earth science runout relative to last year's plan, and NASA's new space, or rather life sciences and microgravity research programs have been eliminated altogether, or rather, all but eliminated.

The runout for investment in new exploration-related research and technologies has been cut by a total of more than \$4.6 billion, relative to last year's plan, and the runout for investment in human science research and technologies has been cut by more than \$1.9 billion, relative to last year's plan. The budgetary runout for aeronautics bears little resemblance to the budget plan that accompanied the fiscal year 2005 budget request, with the funding proposal for aeronautics in fiscal year 2007 alone more than \$200 million lower than what was planned, and according to OMB, NASA has cut its funding for applied research overall by 36 percent, compared with fiscal year 2006.

Unfortunately, the situation is even worse than simply an unwillingness of the Administration to provide the needed resources. It turns out the budget plan sent to Congress by the White House to demonstrate the affordability of the vision underestimated the out year funding requirements of the Space Shuttle and the Space Station programs by billions of dollars, and now, bless his heart, Dr. Griffin has been left to deal with this shortfall. We are being assured that we only have a temporary problem, that once the Shuttle is retired, everything will work out.

We will see, but I think we have to be guided by the hard data at hand, and the record of the past two years demonstrates that many of the assumptions underlying Congress' support for the President's initiative have not been borne out. That doesn't prove much—or provide much grounds for optimism as we look ahead. I certainly don't fault Dr. Griffin. I believe he has done his best to make responsible decisions. I can agree or disagree with those decisions, but I respect his willingness to try to make the best of the situation the Agency finds itself in. Nevertheless, the reality is that the glowing vision that Congress was given two years ago bears little resemblance to the situation at hand. As I have said in the past,

I support the exploration, as long as it is paid for, and as long as it isn't paid for by unwisely cutting other important missions of NASA.

It is becoming painfully obvious to me that we are going to get—that we are not going to get there from here, if we continue on the present course. While I have not yet decided on my final position, I think we have a number of alternatives to consider, either increase NASA's overall funding along the lines of the *Authorization Act of 2005*, slow or stop all or part of the Exploration Initiative until the Nation is prepared to provide the necessary resources, or step back and consider whether there are meaningful alternatives to the President's Exploration Initiative that might be more appropriate, given our overall goals for NASA, and the resources consistent, or constrains that we are likely to face.

None of these options will be easy, and I don't claim to have the answers at this point. However, I want to make it clear that I do not want to see Congress signing up for another big, underfunded hardware program that winds up costing more, doing less, and cannibalizing other important NASA missions. We have been down that road too many times in the past, and I have got no desire to do that again.

With that, I again want to welcome Dr. Griffin and Deputy Administrator Dale. I look forward to your testimony, and Mr. Chairman, I appreciate your tolerance in my—in the length of my statement.

[The prepared statement of Mr. Gordon follows:]

PREPARED STATEMENT OF REPRESENTATIVE BART GORDON

Good morning. I want to join Chairman Boehlert in welcoming Administrator Griffin and Deputy Administrator Dale this morning's hearing.

Dr. Griffin has always been forthright in his testimony to this committee, and I am confident that we will get straight answers from him again today. He demonstrated that attribute again in his recent statement to NASA employees on the issue of scientific integrity.

It is now a little more than two years since President Bush announced his exploration initiative. I think it is appropriate for this committee to step back and see how the implementation of the President's Vision squares with what Congress was led to believe by the White House and NASA two years ago.

As you will recall, when the exploration initiative was rolled out, the Administration said that the President's *Vision for Space Exploration* would be both "affordable" and "sustainable." In support of those assertions, the Administration presented a multi-year budget plan that demonstrated its commitment to providing the resources needed to:

- carry out the President's exploration initiative,
- fund the Space Shuttle and Space Station programs and,
- ensure that NASA's space and Earth science programs would grow at a healthy annual rate.

That was what the Administration said would happen. How does that compare with what actually *did* happen?

Well, the simple fact is that in the two years since the exploration initiative was announced, the Administration has never sent a budget request to Congress equal to what it said NASA would need to carry out the exploration initiative and NASA's other programs.

Specifically, the budget plan of two years ago that accompanied the exploration initiative said that NASA would need \$17 billion in Fiscal Year 2006. Yet the Administration wound up sending over a request that was more than half a billion dollars lower than that level. Unfortunately that wasn't an aberration.

Its budget plan of two years ago also said that NASA would need \$17.815 billion in Fiscal Year 2007. Yet the Administration has just sent over a budget request for NASA that is more than a *billion dollars less* than that amount.

Supporters of the President's initiative are fond of saying that it is a long-term undertaking, and that the challenge will be to ensure that future Administrations and Congresses sustain the exploration initiative. I disagree—I think the real challenge is in getting the Administration that *proposed* this initiative to adequately fund the agency tasked with carrying it out.

Why should we expect future Administrations to sustain a commitment to the exploration initiative when the Bush Administration has not seen fit to provide the resources that the Administration itself said NASA would need?

Of course, it will be argued that we are at war, and that we have a deficit to get under control, and so we shouldn't expect NASA to receive all of the money that was promised. That argument has merit. However, it ignores the fact that the war and the deficit were *already* uncomfortable realities when the President's initiative was announced.

There will also be those who argue that NASA did better than many other agencies in the competition for funds this year. It's an interesting observation, but largely irrelevant.

The issue is not whether NASA got a higher percentage increase than some other agencies. Rather, the issue is whether NASA got the funding it needs to carry out its programs successfully. That is why I and other Members were concerned two years ago about the likely impact of trying to shoehorn a big, new Moon-Mars initiative into a NASA budget that was going to be under increasing pressure in the coming years for a variety of reasons.

We were assured that we didn't need to worry—that the budget plan was “credible,” that NASA could undertake the advertised science program, invest in a range of new technologies, and do all of the other things described in the budget plan that accompanied the exploration initiative.

Again, what is the reality two years later? Well, last year, the budgetary runout for NASA's space and Earth science activities was cut by one billion dollars. This year, the President's FY07 budget request for NASA would cut an additional \$3.1 billion dollars from the space and Earth science runout relative to last year's plan. And NASA's life sciences and microgravity sciences research programs have been all but eliminated.

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The budgetary runout for aeronautics bears little resemblance to the budget plan that accompanied the FY 2005 budget request, with the funding proposal for aeronautics in FY07 alone more than \$200 million lower than what had been planned. And according to OMB, NASA has cut its funding for applied research overall by 36 percent compared to FY06.

Unfortunately, the situation is even worse than simply an unwillingness of the Administration to provide the needed resources. It turns out that the budget plans sent to Congress by the White House to demonstrate the affordability of the Vision understated the outyear funding requirements of the Space Shuttle and Space Station programs by billions of dollars. And now Dr. Griffin has been left to deal with that shortfall.

We are being assured that we only have a “temporary” problem—that once the Shuttle is retired, everything will work out. We'll see—but I think we have to be guided by the hard data at hand—and the record of the past two years demonstrates that many of the assumptions underlying Congress's support for the President's initiative have not been borne out.

That doesn't provide much ground for optimism as we look ahead. I don't fault Dr. Griffin. I believe he has done his best to make responsible decisions. I can agree or disagree with those decisions, but I respect his willingness to try to make the best of the situation the Agency finds itself in.

Nevertheless, the reality is that the glowing Vision that Congress was given two years ago bears little resemblance to the situation at hand. As I have said in the past, I support exploration—as long as it is paid for, and as long as it isn't paid for by unwisely cutting the other important missions of NASA. It is becoming painfully obvious to me that “we aren't going to get there from here” if we continue on the present course.

While I have not yet decided on my final position, I think we have a number of alternatives to consider:

- Either increase NASA's overall funding along the lines of the *Authorization Act of 2005*,
- Slow or stop all or part of the exploration initiative until the Nation is prepared to provide the necessary resources or,
- Step back and consider whether there are meaningful alternatives to the President's exploration initiative that might be more appropriate given our overall goals for NASA and the resource constraints we are likely to face.

None of these options will be easy, and I don't claim to have the answer at this point. However, I want to make it clear that I don't want to see Congress signing up for another big, under funded hardware program that winds up costing more, doing less, and cannibalizing other important NASA missions. We have been down that road too many times in the past, and I've got no desire to do so again.

With that, I again want to welcome Administrator Griffin and Deputy Administrator Dale, and I look forward to your testimony.

Chairman BOEHLERT. Thank you so much, Mr. Gordon, for a very thoughtful statement.

The Chair is pleased to recognize the distinguished Chairman of the Subcommittee on Space and Aeronautics, Mr. Calvert.

Mr. CALVERT. Thank you, Mr. Chairman. I want to welcome both Administrator Mike Griffin and Deputy Administrator Shana Dale. Welcome back to the Science Committee, Shana. This room is familiar to you. I know that you and Michael make a great team. You certainly both know NASA, you know Capitol Hill, and you certainly know the industry, and the American people, I think, is lucky to have both of you during this exciting and challenging time of our space program.

Last year, as you know, the Congress passed an authorization bill for NASA for the first time in five years. That progress underscored the lack of funding, which is the key factor blocking the Agency from realizing its highest potential of all, its core mission area, space, aeronautics, and science. Dr. Griffin alerted the Committee during the November '05 hearing about what is now calculated to be \$2.3 billion shortfall in the NASA budget, which the prior speakers have mentioned. As a result, the Agency has had to move funding from science and from exploration to the Space Shuttle program. We understand this shortfall is a result of miscalculations and costs for return-to-flight activities and operations for the Shuttle through its retirement in 2010, and certainly, that was exacerbated by the hurricane-related costs, and certainly, those miscalculations were not done on your, on your watch, Dr. Griffin. I understand that, yet they need to be resolved.

Hurricane Katrina's destructive path through the Gulf Coast left NASA with \$760 million in damage to Stennis and the Michoud Assembly Facility. Recognizing the severity of this situation and its implications on the Agency's already strained budgets, this committee urged the Administration, and certainly the Appropriations Committee, increase recovery funds for NASA in the December supplemental. As you know, \$349 million was included in the final package, which was increased from the initial President's request to \$325 million, and we certainly recognize that we need to get some additional money to fix that. So, we will be working on that. Also, the Agency did receive, it was mentioned, a 3.2 percent increase on '06, or a 1.5 increase, including Katrina funding for '06, but it is certainly not enough to fund all the sectors of the Agency, as everyone on this dais is beginning to figure out.

Doctor, I know the hard decisions have to be made. The Agency has made some really difficult choices to keep the exploration programs optimally funded, so our nation can move to the Crew Exploration Vehicle, to assure the safety of the Shuttle program, to meet the obligations of our agreements with the partners of the International Space Station, to have our science programs working on a balanced program, and to have our aeronautics program producing forward-looking research and technology, that will keep this country globally competitive.

I certainly congratulate you on putting together a finely-tuned budget request. It is a much stronger budget we have had in the past, with the number of placeholders that we were given. One of the areas that is critical for you to address, as I know you are quite aware, is the—to get NASA's financial house in order. As I have mentioned before, as a businessman, I try to run a business without—with a credible accounting system. It would be a disaster if I didn't have one. And certainly, in all of the areas in the President's management agenda ratings, NASA is doing very well, except in the financial management area, and I know you have made improvements in your working in that area, and as you know, we need to make those improvements as soon as possible.

Our office just received yesterday the corrective action plan for fiscal year 2005 financial audit. I assume that we have to make sure that this is implemented as soon as possible. But now that the *NASA Authorization Act of 2005* has been signed into law, we can look forward to working with you to get the information we need to have more effective and productive oversight. When the Administration proposing its Competitiveness Initiative, I look forward to working with you to assure that NASA is contributing to this important national objective.

I know the United States is beginning its long journey back to the Moon, and then, to Mars, through the exploration program, but I worry that we are not taking these challenges from other nations seriously. The United States, I believe, must maintain its global position. We have heard that India is preparing for a lunar orbital mission in '07. Japan plans to send a robotic rover to the Moon by 2013, and the European Space Agency has a probe that is orbiting the Moon. These countries are talking about sending people to the Moon, only two—I mean, only two are talking about sending people to the Moon, the United States and China, and have actually set dates for the lunar landings.

As you know, from your schedule, we are back on—we are planning our first manned mission back to the Moon in 2018. China is heading for a landing, as I understand it, as early as 2017. While this is generally a lean budget year, we must maximize every penny to keep our great nation competitive. I look forward to hearing from you and from Shana.

Thank you very much, Mr. Chairman.

[The prepared statement of Chairman Calvert follows:]

PREPARED STATEMENT OF CHAIRMAN KEN CALVERT

Mr. Chairman, I want to welcome both Administrator Mike Griffin and Deputy Administrator Shana Dale. Welcome back to the Science Committee, Shana! You and Mike will make a great team. You both know NASA; you both know Capitol Hill; and you both know all facets of the industry. The American people are lucky

to have such a well-qualified Administrator and Deputy Administrator for NASA during this exciting and challenging time.

Last year, the Congress passed an authorization bill for NASA for the first time in five years. That process underscored the lack of funding which is the key factor blocking the Agency from realizing its highest potential in all of its core mission areas—space, aeronautics, and science.

Dr. Griffin alerted this committee during the November 2005 hearing about what is now calculated to be a \$2.3 billion dollar shortfall in the NASA budget. As a result the Agency has had to move funding from science and from exploration into the Space Shuttle program. We understand that this shortfall is a result of miscalculations in costs for return-to-flight activities and operations for the Shuttle through its retirement in 2010—and exacerbated by the hurricane related costs. These miscalculations were not made on Dr. Griffin's watch, yet must be resolved.

Hurricane Katrina's destructive path through the Gulf Coast left NASA with \$760 million in damage to its Stennis Space Center and Michoud Assembly Facility. Recognizing the severity of this situation and its implications on the Agency's already strained budget, Members of this committee urged the Administration and Appropriators to increase recovery funds for NASA in the December supplemental. While the \$349 million that was included in the final package was an increase from the President's request of \$325 million, the discrepancy only added more pinch to the already tight squeeze on the budget.

So this leaves us with the Fiscal Year 2007 budget request for NASA. The Agency did receive a 3.2 percent increase over the FY 2006—or a 1.5 percent increase when including Katrina funding in Fiscal Year 2006—it is not enough to fully fund all the sectors of the Agency as everyone on this dais would like to see them budgeted.

Dr. Griffin, I know that hard decisions have had to be made. The Agency has made some really difficult choices to keep the Exploration programs optimally funded so that our nation can move to a Crew Exploration Vehicle; to assure the safety of the Shuttle program; to meet the obligations of our agreements with the partners of the International Space Station; to have our Science programs working on an exciting, balanced program; and to have our Aeronautics programs producing forward-looking research and technology that will keep our nation globally competitive.

I congratulate you on putting together a finely-tuned budget request. It is a much stronger budget than we have had in the past with the number of "placeholders" that we were given.

One of the areas that is critical for you to address—as I know you are aware—is to get NASA's financial house in order. As I have mentioned before, as a businessman, if I tried to run a business without a credible accounting system, it would be a disaster waiting to happen. In all areas of your President's Management Agenda ratings, NASA is flying high—except in the financial management area. I know that you have made improvements and have provided leadership in this area, but improvements must be shown as soon as possible.

Now that the *NASA Authorization Act of 2005* has been signed into law, we look forward to working with you to get the information that we need to have more effective and productive oversight. With the Administration proposing its Competitiveness Initiative, I look forward to working with you to assure that NASA is contributing to this important national objective.

I know that the United States is beginning its long journey back to the Moon and then on to Mars through the Exploration program, but I worry that we are not taking these challenges from other nations seriously. The United States must maintain its global position.

We have heard that India is preparing for a lunar orbital mission in 2007; Japan plans to send a robotic rover to the Moon by 2013, and the European Space Agency has a probe that is orbiting the Moon. Although these countries are talking about sending people to the Moon, only two—the United States and China—have set dates for manned lunar landings. NASA is hoping to schedule its first manned mission in about 2018; China is heading for a landing as early as 2017.

While this is generally a lean budget year, we must maximize every penny to keep our great nation competitive. I look forward to hearing from you, Administrator Griffin and Deputy Administrator Dale, on your plans to move forward with the FY07 budget request for NASA.

Chairman BOEHLERT. Thank you, Mr. Chairman, and thank you very much for your outstanding leadership on the Subcommittee.

The Chair is pleased to recognize the Ranking Member on the Subcommittee on Space and Aeronautics, Mr. Udall.



Mr. UDALL. Mr. Chairman, thank you. Good morning. I, too, want to join my colleagues in welcoming the Administrator and the Assistant—Deputy Administrator, Shana Dale.

I want to thank you all for coming in and visiting with me. I look forward to conversations in the future, as we exchange views. Let me just start by saying that the fiscal year 2007 budget clearly represents a good faith effort by Dr. Griffin to construct a viable set of programs within the constraints he has been given. That is the good news.

The not so good news is that this budget request contains cuts and cancellations that will do real damage, both in the near-term and for years to come. I wanted to mention just a few items in that regard. I believe that the aeronautics activities, particularly the R&D area of NASA are very important to our quality of life and our competitiveness, yet this budget request ignores the direction of last year's appropriations and authorization legislation, and continues to put NASA's aeronautics program on a downward funding spiral. It makes a virtue of a shrinking budget by stressing its commitment to fundamental aeronautics research at the expensive of any meaningful NASA role in supporting more advanced R&D.

Just one example of what is going on in this budget request. Although NASA has pledged to support the Joint Planning and Development Office in developing the next generation air traffic management system, this budget request would cut the funding for air traffic management R&D from \$146 million to—in fiscal year 2006—to \$71 million in fiscal year 2011. That is, it would cut the funding in half. That makes little sense to me. The situation facing the space and Earth sciences is equally troubling. More than a billion dollars was removed last year from the budgetary runout for space and Earth science that had been in the fiscal year 2005 NASA outyear budget plan. An additional \$3 billion is removed from the runout in this year's budget request. So, just two years after Science Advisor Marburger lauded the robust science program that would be undertaken if the Exploration Initiative were approved, we have seen more than \$4 billion taken out of NASA's space and Earth science accounts.

One of the most inexplicable aspects of those cuts is NASA's plan to cut between \$350 to \$400 million from the research and analysis funding over the next five years. As we all know, that is the funding that helps develop the next generation of scientists and engineers at our nation's universities. I am puzzled that the same Administration that announced its American Competitiveness Initiative with such fanfare would turn around and cut research funding important to our universities' educational and research missions.

And of course, the fiscal year 2007 budget request would continue the dismantling of NASA's life and microgravity research programs. Coupled with the cuts to NASA's long-term technology programs, the effective elimination of life and microgravity science programs is a troubling indicator of an agency being forced to eat its seed corn to address near-term funding issues, and in the process, weaken NASA's ability to achieve the Nation's long-term exploration objectives.

Mr. Chairman, in that regard, I would like to ask unanimous consent that a statement by the Exploration, Life, and Medical Sciences be entered into the record of this hearing.

Chairman BOEHLERT. Without objection, so ordered. All your eloquent words will be entered into the record.

Mr. UDALL. I appreciate the Chairman's tolerance.

In closing, I want to reiterate that we, Congress and the White House, need to take the time to get it right, whether we are talking about NASA's human space flight, science, or aeronautics programs, and we need to be willing to pay what it takes to get it right, or not do it at all.

Thank you, Mr. Chairman, and I yield back any time I have remaining.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Good morning. I'd like to join my colleagues in welcoming Administrator Griffin and Deputy Administrator Dale. I enjoyed our recent conversation, and I look forward to more opportunities to exchange views.

Given the interest of all of us in hearing from the Administrator, I'll be brief in my opening remarks.

I would simply say that I believe the FY 2007 NASA budget request represents a good-faith effort by Dr. Griffin to construct a viable set of programs within the constraints he has been given. That's the good news.

The "not-so-good" news is that this budget request contains cuts and cancellations that will do real damage both in the near term and for years to come.

Let me mention just a few items.

You may be aware of my interest in NASA's aeronautics programs and my belief that NASA's aeronautics R&D activities are vitally important both to our quality of life and our competitiveness. Yet this budget request ignores the direction of last year's appropriations and authorization legislation and continues to put NASA's aeronautics program on a downward funding spiral.

It makes a virtue of a shrinking budget by stressing its commitment to "fundamental aeronautics research" at the expense of any meaningful NASA role in supporting more advanced R&D.

Just one example of what is going on in this budget request:

Although NASA has pledged to support the Joint Planning and Development Office (JPDO) in developing the next generation air traffic management system, this budget request would cut the funding for air traffic management R&D from \$146.4 million in FY 2006 to \$71.7 million in FY 2011—that is, it would cut the funding in half! That makes little sense to me.

The situation facing the space and Earth sciences is equally troubling. More than a billion dollars was removed last year from the budgetary runout for space and Earth science that had been in the FY 2005 NASA outyear budget plan. An additional \$3.1 billion is removed from the runout in this year's budget request.

So just two years after OSTP director Marburger lauded the "robust" science program that would be undertaken if the exploration initiative were approved, we have seen more than \$4 billion taken out of NASA's space and Earth science accounts.

One of the most inexplicable aspects of those cuts is NASA's plan to cut between \$350 to \$400 million from research and analysis funding over the next five years. As you may know, that is the funding that helps develop the next generation of scientists and engineers at our nation's universities.

I am puzzled that the same Administration that announced its American Competitiveness Initiative with such fanfare would turn around and cut research funding important to our universities' educational and research missions. And of course, the FY 2007 budget request would continue the dismantling of NASA's life and microgravity research programs.

Coupled with the cuts to NASA's long-term technology programs, the effective elimination of NASA's life and microgravity science programs is a troubling indicator of an agency being forced to "eat its seed corn" to address near-term funding issues—and in the process, weaken NASA's ability to achieve the Nation's long-term exploration objectives.

In that regard, I would like to ask unanimous consent that a statement by the Exploration Life and Medical Sciences be entered into the record of this hearing. [See Appendix 2: Additional Material for the Record.]

In closing, I want to reiterate that we—Congress and the White House—need to take the time to “get it right,” whether we are talking about NASA’s human space flight, science, or aeronautics programs.

And we need to be willing to pay it takes to “get it right”—or not do it at all. Thank you, and I yield back the balance of my time.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

I understand that the budget request for NASA reflects some very difficult funding decisions. In order to align the agency with the President’s challenge to travel to the Moon and Mars, NASA has reorganized and streamlined its structure again this year under new Administrator Griffin. Despite a 3.2 percent requested increase in FY 2007, in order to fund the next generation human space vehicle and to retire the Shuttle by 2010, \$1.5 billion has been transferred from the science mission budget at NASA. At this time, NASA has been forced to prioritize the completion of the International Space Station and the development of the Crew Exploration Vehicle above the science missions.

While I realize that the impacts of unanticipated budget constraints—on the order of \$3 to \$5 billion—have been felt across the entire agency, I remain concerned that we will finance the return to the Moon and travel to Mars at the cost of other critical scientific discovery. Basic science and engineering research underpin all of NASA’s major accomplishments as well as many of the technologies you and I use everyday. Furthermore, basic research at NASA will support the future exploration endeavor; if we continue to reduce basic research in the outyears, our astronauts will be implementing the Vision with outdated technology, or the implementation will be delayed.

I know that Administrator Griffin is committed to balancing all of these priorities and look forward to working with him and the Committee to do so. However, I continue to be skeptical about the path and timeline being followed, especially in view of the limited funding available at this time.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good morning. I want to thank Administrator Griffin for appearing before our committee to discuss the NASA’s FY07 budget proposal. Today’s hearing serves as an opportunity for oversight of certain departmental programs.

NASA continues to be our gateway to the universe. It is through NASA’s efforts that we will understand our planet, our solar system and beyond. NASA’s budget should reflect a strong commitment to, and emphasis on, continuing to build the Agency’s core foundation of aeronautics and aerospace research and development as well as its missions of exploration and discovery to educate and inspire.

There are two points implicit in the FY07 budget request. First, this budget request confirms suspicions that the “affordable and sustainable” *Vision for Space Exploration* (VSE) presented by the President in 2004 was based on assumptions and budgetary planning that were not realistic. In the two years since the President announced his *Vision for Space Exploration* the White House has sent three NASA budget requests to Congress. The first of those budget requests (FY05) laid out a multi-year funding plan for NASA that the Administration said would demonstrate the affordability and sustainability of the President’s initiative. However, last year the Administration sent over an FY06 budget request that under-funded NASA by more than a half-billion dollars relative to what it had said NASA would need. This year the Administration has submitted an FY07 budget request that cuts NASA programs by over a billion dollars, despite the growth in the cost estimates for Shuttle Return-to-Flight, the International Space Station (ISS), and the James Webb Space Telescope, and the desire to accelerate the development of the Crew Exploration Vehicle.

The Administration has argued that the exploration initiative will be carried out on a “go as you can pay” basis, but it is unclear how such an approach would work once large procurement contracts have been awarded. Further, I am concerned that delays in program execution likely would lead to significant cost growth due to the “standing army” costs of the contractor and civil service workforce.

Second, the FY07 budget continues to shift a significant amount of funding from science and aeronautics to human space flight (Shuttle, ISS, and Exploration). However, it is unsettling to learn that even that shift in funding has not helped NASA prioritize or narrow the scope of what it seeks to accomplish within the VSE. As a result, there is a sizable reduction in the funding for research and development into advanced technologies, such as nano-materials and electronics, intelligent robotic systems, flight experiments for technology validation, and nuclear power and propulsion, that could support longer-term exploration goals.

The President's exploration initiative continues to move forward with a high price tag, but should not come at the cost of our commitment to our children, our veterans, our seniors, and our other important domestic priorities. The federal deficit for 2006 will be a record \$377 billion and the case is going to have to be made to this committee and the American people why the space exploration initiative should be supported in the face of that deficit.

I welcome our witnesses and look forward to their testimony.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman and Ranking Member.

I welcome Administrator Griffin to today's hearing on the NASA budget for fiscal year 2007.

NASA is important to Texas.

The space and aeronautics research and other related research have touched Americans' everyday lives like few other federally-funded initiatives.

However, I am concerned that the President's plans for space exploration are hurting aeronautics and Earth science research.

Frequently-shifting priorities have led to the decision to transfer \$3.1 billion from the space and Earth sciences over the next five years, to severely cut funding for International Space Station research, to continue to cut aeronautics funding, and to cut \$4.6 billion from NASA's exploration technology research program.

I believe that NASA is a good agency, and it has my support and admiration for the fruits of its research over the years.

It is my hope that the Administration will enact a sensible budget that places strong emphasis on technology, aeronautics and Earth sciences. Investment in these areas creates jobs here on Earth.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

I thank Chairman Boehlert and Ranking Member Gordon for holding this important hearing today, and I thank our distinguished witnesses for making the time to be here.

I remember when Administrator Griffin said that the President's space exploration program would not cost science a thin dime, and looking at this budget, I have to marvel at how things have changed. The future of scientific activities within NASA, be it the science that falls within the Science Mission Directorate or that which supports exploration within the Exploration Systems Mission Directorate, looks bleak.

The list of things that are going away is long. The Deep Space Climate Observatory, which contributes not only to climate and climate change research but also to our understanding of the solar wind, which will have significant impacts on humans taking part in a mission to Mars. The Stratospheric Observatory for Infrared Astronomy (SOFIA), which successfully passed what amounted to three termination reviews in the Fall of 2004. And the Explorer Program, where missions like the NuSTAR Explorer face termination.

These are but a few of the programs that this budget shortchanges, all in the name of extending tax cuts for the wealthiest Americans. At a time when the President is hyping a competitiveness initiative and trying to attract students to science and engineering, NASA is sending the message that it is an unreliable partner to the research and university communities, driving potential students away from fields that they cannot trust will still be viable in the coming years.

We have had this debate before, and unfortunately it looks like we will be having it again. I just don't agree with the short range view you are taking to implementing a very long range program, where you are setting aside the work that will be essential to our understanding of what will be needed for humans to survive a trip to

Mars. You say you want to get on with the business of building the Crew Exploration Vehicle, but I just don't see how you can design it properly if you don't know what systems are going to be needed to sustain those astronauts it will be carrying. And if your answer is that we are just rushing to build a vehicle to get to the Moon, and we know what it will take to get people there and back, then I have to ask, is all of this investment worth it to replicate what we were able to do over 35 years ago?

[The prepared statement of Mr. Davis follows:]

PREPARED STATEMENT OF REPRESENTATIVE LINCOLN DAVIS

Good morning. Thank you, Mr. Chairman and Ranking Member, for the opportunity to discuss the current status of NASA. Thank you, Administrator Griffin, for your presence today.

I think we can all agree that NASA has provided the United States with invaluable research over the years. The scientific information NASA has provided, has advanced our country in every aspect. We can see the results of this research in our homes, in our cars, at work, and in our everyday lives. It could be argued that NASA and its scientific breakthroughs is one of the biggest reasons why our country is where it is today.

With that in mind I believe we are at a turning point with NASA and its programs. At a time when the United States has seen a decline in research dollars and a decline in students studying math and sciences at our universities we are at a great risk of losing our scientific advantage over other nations. It is my hope that the programs operating in NASA will solve these issues. However, I do not see how NASA can expect to do all of this with a smaller budget in the coming years.

In and around my district there are several facilities such as NASA Marshall Space Center and Arnold Air Force Base that benefit from NASA programs, so you can imagine why I am concerned about the White House's proposed budget for NASA. It is my hope that today's hearing will give us insight into how NASA is going to operate during these times of shrinking budgets.

Mr. Chairman, thank you and I yield back the balance of my time.

Chairman BOEHLERT. Thank you very much, and now, to our distinguished witnesses, the Administrator of NASA, the Honorable Michael Griffin, and the Deputy Administrator, an alum of this prestigious committee, the Honorable Shana Dale.

Mr. Administrator, you are up.

**STATEMENT OF DR. MICHAEL D. GRIFFIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY HON. SHANA DALE, DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

Dr. GRIFFIN. Thank you. Thank you, sir. Actually, Shana, I think I have a pressing engagement. Do you think you could take this hearing? There might be somewhere else I would rather be.

With that aside, sir, good morning, Chairman Boehlert, Ranking Member Gordon, Members of the Committee. Deputy Administrator Shana Dale and I are before you today to present NASA's Fiscal Year 2007 budget and answer questions like you have asked about how NASA is implementing the priorities of the President and the Congress within the resources provided.

Let me thank this committee, especially Chairman Boehlert, Ranking Member Gordon, as well as Congressmen Calvert and Udall, the Subcommittee Chair and Ranking Member, for your leadership in shepherding through Congress the *NASA Authorization Act of 2005*. This seminal endorsement of the *Vision for Space Exploration* will help us to sustain this journey, fulfilling our commitments with the International Space Station, retiring the Shuttle in 2010, developing the Crew Exploration Vehicle to journey to the

Moon, Mars, and beyond. We are now poised to carry out a balanced portfolio of space exploration, scientific discovery, and aeronautics research. We must balance these competing interests of time, resources, and energy within the budget provided, so setting priorities is vitally important.

The President's budget request for NASA is \$16.8 billion in Fiscal Year 2007. This is a 3.2 percent increase over the 2006 appropriation, not counting our emergency supplemental for Hurricane Katrina recovery at NASA's Michoud and Stennis facilities. This request demonstrates the President's commitment to carrying out the *Vision for Space Exploration*, and the more so in view of all the other pressures on the Federal Government.

Our budget is roughly seven tenths of a percent of the overall federal budget, and it is a modest investment that our nation can afford. Formulating a budget requires discipline, making difficult decisions based on the best facts and analysis available, and one very plain fact is that we cannot afford to do everything that each of our constituencies would like us to do. The President and Congress have set those priorities, and we at NASA have adjusted our plans to match them within the resources provided. At the same time, we must leverage the investment of others, government agencies such as National Science Foundation, Department of Defense, as well as those of other spacefaring nations with whom we have common interests, and commercial industry.

We are applying lessons from what has worked and what has not in managing our programs. We are applying the lessons learned in how to conduct aeronautics research from the National Advisory Committee on Aeronautics, NASA's predecessor, in the '40s and '50s, and NASA itself in the '60s and '70s. We are applying lessons from NASA's Apollo program. There are many fundamental questions to be answered in the aeronautical sciences, that must be answered to benefit the American public. Our aeronautics research efforts, funded at \$724 million in Fiscal Year 2007, will return us to our roots, mastering the intellectual stewardship of subsonic, supersonic, and hypersonic flight.

While some vested interests will focus solely on the budget for aeronautics, it is more important to focus on the desired outcomes from this research, and how it benefits the public, by supporting a broadly-based community of researchers. I have also adapted the management model of the Apollo era to establish clear lines of reporting for NASA's mission directorates and our ten field centers. We have many challenges in the Agency, but none are more important than the technical excellence of our workforce in carrying out NASA's missions.

The challenge of the Apollo era is not one whit less daunting than that of our own. Friends of mine from that era have opined that space station assembly is even more complex than an Apollo mission. Completing the International Space Station, retiring the Shuttle by 2010, managing the effective transition from the Shuttle to the new Crew Exploration and Crew Launch Vehicles, are fully the equal of the tasks which were set before any earlier generation. So, while we have our hands full, this budget provides the necessary resources to achieve these objectives.

I understand that many of you will question whether NASA has the wherewithal to carry them out. I believe we can. I believe that we can demonstrate that our nation will keep its commitments to our partners on the International Space Station project through thick and thin, so that they will join us for future exploration endeavors. By completing the ISS, we can finally achieve the research objectives for this facility.

This budget provides the resources to bring the Crew Exploration and Crew Launch Vehicles online by 2014, and potentially sooner. The budget also provides the funds necessary to conduct a fifth and final servicing mission to the Hubble Space Telescope with the Space Shuttle. The decision to carry out this mission will be made after we have the results from the next Shuttle test flight, STS-121, commanded by Colonel Steve Lindsey. This budget provides \$5.3 billion for an armada of Earth and Space Science missions to explore the universe with telescopes more advanced than Hubble, with satellite probes of our Solar System like Deep Impact, Messenger, the Mars Rovers, Spirit and Opportunity, and with Earth Science missions for global climate research, weather prediction, and land resource use.

However, we simply cannot afford all of the missions that our scientific constituencies would like us to sponsor. My decision to slow the rate of growth for NASA's Science missions in order to pay for the Space Shuttle and Space Station budget shortfall should not be taken to indicate a lack of appreciation for the world-class achievements of NASA's Science missions. It is simply a matter of timing and resources. NASA's Science program remains one of our nation's greatest achievements. We are a world leader, with 54 satellites and payloads currently operating, in concert with the science community and our international partners. Our science portfolio remains robust. In fact, NASA's science budget has grown more, as a percentage of the Agency's budget, than has NASA's top line grown over the past 15 years. In 1992, the Science budget was 24 percent of the NASA budget. Today, the Science budget is 32 percent of the Agency's budget. Within the NASA top line, Science has grown by fully one-third of its base 15 years ago.

Over the next several years, we are simply moderating that rate of growth for Science, and especially so at a time when overall non-defense discretionary spending in the Federal Government is actually a half a percent lower than last year. Just as NASA's exploration mission is a go as you can afford to pay strategy, so, too, must NASA's Science missions be go as you can afford to pay. We are delaying some missions, but we are not abandoning them.

At the same time that we are servicing Hubble, and developing the James Webb Space Telescope and other missions, NASA cannot afford a robust budget for other astronomy missions like the Space Interferometry Mission or Terrestrial Planet Finder, or a satellite mission to Jupiter's moon Europa. We plan to do these missions, but not just now.

I truly wish that it could be otherwise, but there is only so much money. We must set priorities. This is a once in a generation or more transition period from Shuttle to CEV. I believe that it would be strategically more damaging to our nation to delay any further the development of the CEV than it would be to delay these

Science missions. This is a judgment to be made carefully, and I believe that I have done that. We have established the best possible balance within our overall portfolio for the next few years, and we need your help to maintain it. If we cannot maintain this priority, we will further extend the gap between Shuttle retirement and CEV capability. This will increase the risk and the overall cost of bringing new systems online, helping to create a self-fulfilling prophecy of not being able to manage our programs within budget.

As a younger engineer in this business, I lived through a six year gap in human space flight, between the end of Apollo and the first Shuttle flight in 1981. I know firsthand that our nation's space program suffered from this loss of critical expertise. Some capabilities withered, and some died. We must not repeat this mistake again.

Chairman Boehlert, your words of concern about sacrificing capabilities in Space Science, I could change those words, I could substitute the nouns and leave the verbs the same, and I would have exactly the same concerns about an extended gap in human space flight. Our human space flight program is not an optional program. We are already strained to the limit.

Moreover, the U.S. risks both a real and a perceived loss of leadership on the world stage, if we are unable to launch our own astronauts into space for an extended period of time, when other nations possess their own capabilities to do so. Put simply, human space flight is one of those strategic capabilities that in the 21st Century, define a nation as a superpower. An extended gap in U.S. human space flight capability also increases the risk that we will not be able to maintain the International Space Station, which requires capability beyond that presently available to our international partners or with commercial capability.

Again, I understand these are difficult decisions that require a very careful balance of priorities and resources. I stand by the approach we have presented. We are implementing the priorities of the President and the Congress within the resources provided in the budget.

Mr. Chairman, America is a frontier nation. We at NASA carry on that heritage through our journeys into space, and exploration of the cosmos is the most technically challenging thing that any nation can do. This is rocket science, and America, through NASA, must lead the way.

I would like now to turn it over to Shana. She has some comments about the reforms underway within NASA and her recent discussions with some of our international partners. Thank you for your time.

[The prepared statement of Dr. Griffin follows:]

PREPARED STATEMENT OF MICHAEL D. GRIFFIN

Mr. Chairman and Members of the Committee, thank you for this opportunity to appear today to discuss NASA's plans as represented in the President's FY 2007 budget request for NASA. I will outline the highlights of our budget request and discuss the strategic direction for NASA in implementing the priorities of the President and Congress within the resources provided. The President's FY 2007 budget request for NASA of \$16,792 million demonstrates his commitment to the *Vision for Space Exploration* and our nation's commitment to our partners on the International Space Station. The FY 2007 budget request is a 3.2 percent increase above NASA's FY 2006 appropriation, not including the \$349.8 million emergency supplemental for NASA's recovery and restoration efforts following Hurricane Katrina.



However, let me put NASA's budget into perspective. NASA's budget is roughly 0.7 percent of the overall federal budget. This is a prudent investment to extend the frontiers of space exploration, scientific discovery, and aeronautics research. With it, we enhance American leadership, our safety and security, and our global economic competitiveness through the technological innovations stemming from our space and aeronautics research programs. Our nation can afford this investment in NASA.

On January 14, 2004, President George W. Bush announced the *Vision for Space Exploration* to advance U.S. scientific, security, and economic interests through a robust space exploration program. NASA is grateful to the Congress for endorsing this Vision last December in the *NASA Authorization Act of 2005* (P.L. 109-155) as well as providing guidance and expectations for us in carrying out the Agency's missions of space exploration, scientific discovery, and aeronautics research. To that end, NASA is implementing the priorities of the President and Congress within the resources available. NASA's Strategic Plan and FY 2007 Congressional Budget Justification, provided to the Congress last week, reflect those priorities and describe how NASA is implementing those policies into practice describing our programs, projected resources, and workforce needs.

#### **Implementing the Vision**

Later this year, NASA will continue the assembly of the International Space Station (ISS) with the minimum number of Space Shuttle flights necessary to fulfill our commitments to our international partners before the Shuttle's retirement in 2010. With the commitment of resources in the President's budget, my hope is that our international partners will view NASA and the United States as good partners through thick and thin and will team with us in future endeavors of space exploration and scientific discovery. NASA has consulted with our international partners on the configuration of the International Space Station, and is working closely with them to determine the crew size and logistics necessary during and after assembly. The FY 2007 budget request provides the necessary resources to purchase Soyuz crew transport and rescue for U.S. astronauts as well as minimal Progress vehicle logistics support for the International Space Station from the Russian Space Agency. Likewise, the FY 2007 budget request provides necessary funds for U.S. commercial industry to demonstrate the capability to deliver cargo and/or crew to the International Space Station. If such cost-effective commercial services are successfully demonstrated, NASA will welcome and use them.

The next return to flight test mission, STS-121 commanded by Colonel Steve Lindsey, will help us determine whether we can safely return the Space Shuttle to its primary task of assembling the International Space Station. We continue to develop a fix to eliminate the risk associated with the release of foam debris from the liquid oxygen protuberance air load ramp. We are continuing to work towards the May launch window. The next available window is in July. NASA will launch when we are ready. Pending the results of this test flight, I plan to convene my senior management team for space operations as well as my Chief Safety and Mission Assurance Officer and my Chief Engineer in order to determine whether the Space Shuttle can safely conduct the remaining ISS assembly missions as well as a fifth servicing mission to the Hubble Space Telescope in 2007-08. NASA's FY 2007 budget provides the necessary resources to conduct this mission.

In previous budget requests, NASA reported only placeholder budget estimates for the Space Shuttle for FY 2008-10. The Agency's management focus on return-to-flight efforts of the Space Shuttle resulted in NASA deferring this analysis until the FY 2007 budget. As I testified to this committee, NASA's estimates of the budget shortfall required to safely fly out the Space Shuttle with the minimum number of flights necessary to complete ISS assembly and meet our international partner commitments were \$3-\$5 billion. With the FY 2007 budget runout, NASA has added \$2.4 billion to the Space Shuttle program and almost \$1.5 billion to the international Space Station in FY 2008-10 compared to the FY 2006 budget runout. There is no "new money" for NASA topline budget within the budget projections available given our nation's other pressing issues, so working with the White House, NASA provided sufficient funds for the Space Shuttle and ISS programs to carry out their missions by redirecting funds from the Science and Exploration budgets.

There are several strategic implications behind this decision. Foremost among them is that our nation will keep its commitment to our international partners on the International Space Station and maintain goodwill with them. Thus, with limited resources, we need to make some difficult decisions. Leadership means setting priorities of time, energy, and resources, and I have tried to make these decisions with the best available facts and analysis. As I have previously stated to this committee, the plain fact is that NASA simply cannot afford to do everything that our many constituencies would like the Agency to do. We must set priorities, and we

must adjust our spending to match those priorities. NASA needed to take budgeted funds from the Science and Exploration budget projections for FY 2007–11 in order to ensure that enough funds were available to the Space Shuttle and the ISS. Thus, NASA cannot afford the costs of starting some new space science missions, like a mission to Jupiter’s moon Europa, or the next-generation space astrophysics missions beyond the James Webb Space Telescope, at this time. It is important to know that NASA is simply delaying these missions, not abandoning them. NASA will still proceed with the Space Interferometry Mission and the Global Precipitation Measurement Mission, as well as conduct a mission to Europa. However, with the limited resources available, I believe that fulfilling our commitments on the International Space Station and bringing the Crew Exploration Vehicle (CEV) online in a timely manner, not later than 2014 and possibly much sooner, is a higher priority than these science missions during this period.

There are several reasons not to delay the CEV further. First and foremost is increased risk to the Vision due to an extended gap in our nation’s ability to launch humans into space. I lived through the gap in human space flight between the end of the Apollo program to the first flight of the Shuttle in 1981, and I know firsthand that our nation’s space program suffered greatly from the unintended loss of critical expertise. Our nation’s space industrial base withered. A longer gap in U.S. human space flight capabilities will increase risk and overall costs and lead to even more delays. In addition, the U.S. may risk a perceived, if not a real, loss of leadership in space exploration if we are unable to launch our astronauts into space for an extended period when other nations are establishing or building on their own abilities to do so. An extended gap in U.S. human space flight capabilities also increases our risk posture to adequately maintain and utilize the International Space Station. Further, unless a commercial capability arises to transport our astronauts, NASA would continue to be reliant on the Russian Soyuz.

Thus, further delays in the CEV are strategically more damaging to our nation’s space program than delays to these other science missions. I stand by my decision for how to implement the priorities of the President and Congress within the resources provided, and I will work closely with our stakeholders in Congress and the scientific community to make sure they understand my rationale. Some of our stakeholders may not agree with my position, but it is important for everyone to understand the rationale. These are difficult decisions, but we must balance the competing priorities for our nation’s civil space and aeronautics research endeavors with the limited resources available.

If the funds budgeted for Exploration Systems were to be used to provide additional funds for these Science missions, additional Aeronautics Research, or other Congressionally-directed items, I must advise the Congress that such redirection of already-budgeted funds will directly impact NASA’s ability to safely, effectively, and efficiently transition the workforce and capabilities from the Space Shuttle to the new Crew Exploration Vehicle (CEV) systems. Funds available to carry out this transition are already lean, with little management reserve or margin for error. This transition from the Shuttle to the CEV is NASA’s greatest management challenge over the next several years, and we will need everyone’s help within NASA, industry, and our stakeholders to make the transition successful.

Beyond fulfilling our existing commitment, NASA’s FY 2007 budget provides the necessary resources to carry out the next steps of the *Vision for Space Exploration*. The FY 2007 budget provides \$3,978 million for Exploration Systems. Last summer, NASA defined the architecture for the exploration systems that will be necessary in carrying forth that Vision, and we notified the Congress of NASA’s need to curtail several research and technology activities not directly contributing to the near-term priorities of timely development of the CEV and Crew Launch Vehicle (CLV) based on the results of that exploration architecture study and the limited funds available. I want to thank the Congress for its endorsement of the general architecture plans in the *NASA Authorization Act of 2005* (P.L. 109–155) as well as the *FY 2006 Appropriations Act for NASA* (P.L. 109–108).

The FY 2007 budget request is sufficient to bring the CEV online no later than 2014, and potentially much sooner. The Agency is continuing with its “go-as-you-can-afford-to-pay” strategy toward space exploration. NASA is currently seeking industry proposals for the CEV, and we have considerable incentives for an industry bidder to propose a planned development for the CEV as close to 2010 as possible. However, NASA cannot begin evaluating those proposals until next month, with a currently planned contract award in late summer/early fall 2006. NASA plans to select one industry contractor team for the design and development of the CEV. Concurrently, NASA will refine its independent cost estimates for the CEV and launch systems as well as find cost savings through workforce synergies and contract efficiencies between the Shuttle and CEV launch systems within the budget profile pro-

jected in FY 2007. We believe that synergies and contract efficiencies between sub-systems, personnel, resources, and infrastructure can be found between the Space Shuttle propulsion elements and the CEV, CLV, and Heavy-Lift Launch Vehicle. I believe that with the FY 2007 budget, NASA and industry have a real opportunity to make the CEV operational much sooner than 2014. I should be able to report a more definitive date for bringing the CEV online by the time we award the CEV contract. Until then, NASA is in source selection for the CEV procurement, and we are limited in our ability to provide information in this competitive environment involving a multi-billion dollar procurement.

For the CLV, NASA has funded two industry teams to begin initial development of the vehicle's propulsion systems and develop designs for the CLV upper stage; the Agency also plans to award design, development, test, and evaluation contracts later this year. NASA is planning a systems requirements review for this project in the fall with a preliminary design review in 2008 in order for this new launch vehicle to be ready for when the CEV comes on-line.

While NASA needed to significantly curtail projected funding for biological and physical sciences research on the International Space Station as well as various research and technology projects in order to fund development for the CEV, the U.S. segment of the International Space Station was designated a National Laboratory in the *NASA Authorization Act*. Thus, NASA is seeking partnerships with other government agencies like the National Science Foundation, Department of Defense, Department of Energy, and the National Institute of Standards and Technology as well as the commercial sector to conduct research on-board the ISS. However, the research utilization of the ISS is limited primarily due to limited cargo and crew transportation. Thus, NASA's investment to spur a commercial cargo and/or crew transportation service is even more compelling.

#### **Scientific Discovery**

In 2005, NASA's science missions enjoyed a year of significant achievements. Deep Impact traveled 268 million miles to meet comet Tempel 1, sending its impactor to collide with the comet and providing researchers with the best-ever comet data and images. The Mars twin rovers continue studying the harsh Martian environment, well beyond their expected mission life. Cassini's Huygens probe successfully descended through the murky atmosphere of Saturn's largest moon, Titan, revealing some of its "Earth-like" features. The Mars Reconnaissance Orbiter successfully launched, and beginning in March 2006 will help us better understand the history of water on Mars. The Voyager I spacecraft entered the vast, turbulent expanse of the heliosheath, 8.7 billion miles from the sun, where no human-made object has traveled before. The Hubble Space Telescope continues its successful mission of discovery and exploration. Among its many achievements was the discovery that Pluto may have three moons, offering more insights into the nature and evolution of the Pluto system and Kuiper Belt. Through coordination of observations from several ground-based telescopes and NASA's Swift and other satellites, scientists solved the 35-year-old mystery of the origin of powerful, split-second gamma-ray bursts. The Tropical Rainfall Measuring Mission provided data to aid our understanding of the changes inside a hurricane, helping scientists re-create storms on computer forecast models, which can assist in the forecasting of future tropical cyclone transformations. And on January 19, 2006, the New Horizons Mission successfully launched, beginning its nine year journey to Pluto. Truly a successful year of science achievements—a trend I expect to continue.

NASA's FY 2007 budget request provides \$5,330 million for the Agency's Science portfolio to explore the universe, solar system, and Earth. My decision to curtail the rate of growth for NASA's Science missions is not intended in any way to demonstrate a lack of respect for the work done by the NASA Science team. On the contrary, NASA's science missions remain one of the Nation's crowning achievements, and NASA is a world leader with 54 satellites and payloads currently operating in concert with the science community and our international partners. My decision to slow the rate of growth for NASA's Science missions is simply a matter of how the Agency will use the available resources within the overall NASA portfolio. In fact, the Agency's Science budget has grown much faster than NASA's total budget since FY 1993. In 1992, the Science budget represented 24 percent of the overall NASA budget while today 32 percent of the Agency's budget is allocated to Science in FY 2007. NASA's Science budget is moderated to 1.5 percent growth in the FY 2007 budget request compared with the amount appropriated for NASA in FY 2006 (in accordance with NASA's Initial Operating Plan provided to the Committee) and then one percent per year thereafter through FY 2011.

In the FY 2007 budget, there are some additional budget shifts within the Science portfolio to rebalance the program to reflect our original science priorities and con-

sistent with the FY 2006 Budget Amendment. Within the Science budget, the Solar System Exploration budget provides \$1,610 million to fund missions to all solar system bodies, and to maintain the Deep Space Network. Mars exploration is kept at roughly its current level of funding which allows missions every 26 months when the Earth and Mars are in the proper alignment. Mars is and will continue to be the most thoroughly studied planet besides our own Earth. NASA continues a series of openly competed missions for Discovery, New Frontiers, and Scout missions to various planetary bodies in the solar system. Juno, a competitively-selected mission to study Jupiter, is slated to be the next New Frontiers mission, following the New Horizons mission on its way to Pluto after a successful launch in January.

After an extensive review, NASA has extended the mission operating life of several Earth Science missions including TRMM and Terra, Heliophysics missions such as both Voyager spacecraft, and Astrophysics missions including Chandra and WMAP.

### **Aeronautics Research**

NASA's FY 2007 request for the Aeronautics Research Mission Directorate is \$724 million. Proper stewardship of this funding requires a coherent strategic vision for aeronautics research, which we are working to develop. While I am concerned that our nation's aviation industry not lose market share to global competitors, NASA's research must benefit the American public by supporting a broad base of aeronautics research. NASA's aeronautics research cannot and will not directly subsidize work to specific corporate interests. There are fundamental questions in aeronautics research needing to be answered, and NASA will focus its aeronautics research on those issues. NASA will take responsibility for the intellectual stewardship of the core competencies of aeronautics for the Nation in all flight regimes, from subsonic through hypersonic flight. We will also conduct the fundamental research that is needed to meet the substantial challenges of the Next Generation Air Transportation System (NGATS), and we intend to work closely with our agency partners in the Joint Planning and Development Office (JPDO).

Across our aeronautics portfolio, NASA is taking a long-term, strategic approach to our research plans to ensure that we pursue the cutting-edge across the breadth of aeronautics disciplines that will be required to support revolutionary capabilities in both air vehicles and the airspace in which they fly. NASA's commitment to technical excellence requires a commitment to rigor and discipline and will not focus on demonstrations that lack the traceability and scalability that are required for true scientific and engineering advancement. Hence, we are turning away from the four-demo approach proposed last year under the Vehicle Systems Program. Instead, our Fundamental Aeronautics Program will focus on fundamental research that addresses aeronautics challenges in areas such as aerothermodynamics, acoustics, propulsion, materials and structures, computational fluid dynamics, and experimental measurement techniques. The Fundamental Aeronautics Program will generate data, knowledge, and design tools that will be applicable across a broad range of air vehicles in subsonic (both fixed and rotary wing), supersonic, and hypersonic flight.

In the Aviation Safety Program, NASA is taking a proactive approach to developing our strategic research plans, ensuring that the research conducted will lead to capabilities and technologies for improving safety consistent with the revolutionary changes anticipated in air vehicles foreseen in the future. The focus will be vehicle-centric, with areas of research that include vehicle health management, resilient aircraft control, aging and durability challenges, and advanced flight deck technologies.

In the Airspace Systems Program, NASA will conduct the fundamental research required to bring about the revolutionary capabilities articulated in the JPDO's vision for the NGATS. Our research will focus on the development of future concepts, capabilities, and technologies that will enable major measurable increases in air traffic management effectiveness, flexibility, and efficiency.

In addition to the Aeronautics Research Mission Directorate's three research programs, NASA is committed to preserving as national assets those aeronautics test facilities which are deemed mission critical and necessary to meet the needs and requirements of the Agency and the Nation. NASA has established the Aeronautics Test Program (ATP), a component of the Shared Capability Assets Program (SCAP), as a long-term, funded commitment by NASA to retain and invest in test capabilities that are considered important to the Agency and the Nation. ATP's purpose is to ensure the strategic availability of a minimum, critical suite of wind tunnel and ground test facilities which are necessary to meet immediate and future national requirements.

As part of our overall portfolio, NASA program managers and researchers will work closely and constructively with industry, academia, and other government entities to enhance our nation's aeronautics capability. In this vein, as a principal member of the interagency JPDO, NASA has established investment priorities that directly address the research and development needs of the NGATS which will enable major increases in the capacity and mobility of the U.S. Air Transportation System. NASA also plans to collaborate closely with industry and academia through the use of competitive research awards and Space Act agreements on prospective research work in line with the critical thrust areas of the Aeronautics program that will enable numerous commercial aviation and scientific applications. Our goal is to focus our total research investments on fundamental aeronautics questions that need to be answered, and that will benefit the broader community of academia, industry, and government researchers. The results from the research and technology developments achieved by NASA's Aeronautics program will be transitioned for use by both government and industry. Additionally, and in line with the refocused program's priorities, NASA will leave to others work more appropriately performed or funded by other agencies or the private sectors.

In accordance with the *NASA Authorization Act of 2005*, NASA and the Office of Science and Technology Policy have been jointly developing a National Aeronautics Policy which will establish a long-term policy and guidance for future aeronautics research and development activities. This policy will establish the appropriate role for federal investment in U.S. aeronautics research: near- and far-term, high-priority objectives; roles and responsibilities of the multiple agencies involved; and, guidance on related infrastructure and workforce challenges.

#### **Cross-Agency Support Programs**

In the FY 2007 budget, NASA proposes a new direct budget category for programs that cut across NASA's portfolio of space exploration, scientific discovery, and aeronautics research. These Cross-Agency Support Programs include: NASA's Education programs funded at \$153.3 million; Advanced Business Systems, or more commonly known as the Integrated Enterprise Management program, is called out as a separate program rather than being budgeted from within Corporate and Center General and Administrative accounts and is funded at \$108.2 million; NASA's Innovative Partnership Program, including Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), has been transferred from Exploration Systems so that these partnerships may better address Agency-wide needs and is funded at \$197.9 million; and the Shared Capabilities Assets Program is funded at \$32.2 million (with additional funding located in the Mission Directorates) and will ensure that NASA's unique facilities (e.g., wind tunnels, rocket engine test stands, high-end computing, thermal vacuum chambers, and other capital assets) are adequately managed with agency-level decision-making to address NASA's and our national needs.

NASA's Education budget request sustains our commitment to excellence in science, technology, engineering and mathematics (STEM) education to ensure that the next generation of Americans can accept the full measure of their roles and responsibilities in shaping the future and meeting the workforce needs to implement the *Vision for Space Exploration*. NASA will continue to provide innovative programs that use STEM resources (NASA content, people and facilities) to inspire the next generation of explorers and innovators. I have outlined three primary goals for our education investments: (1) strengthening NASA and the Nation's future workforce; (2) attracting and retaining students in the STEM pipeline; and, (3) engaging Americans in NASA's mission. The greatest contribution that NASA makes in educating the next generation of Americans is providing worthy endeavors for which students will be inspired to study difficult subjects like math, science, and engineering because they too share the dream of exploring the cosmos. These students are our future workforce and our education investment portfolio is directly linked to our overall workforce strategy.

#### **NASA Workforce Strategy**

The *Vision for Space Exploration* is a unique endeavor that will last many generations. The NASA management team has been working on the issues and means to build NASA as an institution having ten healthy field Centers known for technical excellence. We continue to define program management and research roles and responsibilities for each Center in order to carry out NASA's missions of space exploration, scientific discovery, and aeronautics research. All of our centers must contribute to NASA's primary missions. We are beginning the process of assigning specific research programs and projects to appropriate NASA Centers. We are not done, but we are taking steps in the right direction.

We have many challenges in the Agency, but none more important than the technical excellence of NASA's workforce. Likewise, we are beginning to address the problems posed by the aging of NASA's facilities and physical assets. The overall objective is to transform the composition of NASA's workforce so that it remains viable for the long-term goals of NASA's missions. We have a lot of work cut out for us in the coming months and year ahead in assigning these program responsibilities and re-building the Agency's technical competence in performing cutting-edge work. NASA has been addressing the challenge of mitigating the number of civil servants in the field that are not currently assigned to NASA programs (the so-called "uncovered capacity") through a number of means recently addressed in a draft report shared with the Committee in compliance with the *NASA Authorization Act of 2005*. NASA will conduct a reduction in force of our civil servants only as an action of last resort consistent with our statutory constraints. Instead, NASA is focusing its efforts to solve its uncovered capacity workforce problems through a number of other actions, including the assignment of new projects to research Centers that will strengthen their base of in-house work, the Shared Capability Assets Program that should stabilize the skills base necessary for a certain specialized workforce; the movement of certain research and technology development projects from certain centers not suffering from uncovered capacity problems to centers that are; retraining efforts at field centers so that the technical workforce can develop new skills; and the pursuit of reimbursable work for projects and research to support other government agencies and the private sector through Space Act Agreements.

#### **NASA's Financial Management**

NASA must accurately account for the taxpayer's money, and we must change the way we have done business in the past in order to achieve this goal. NASA continues to face significant challenges in improving the quality of its financial reporting. In order to address this, NASA developed a Corrective Action Plan based on the expert advice of NASA's Inspector General, the General Accountability Office, and a Senior Advisory Group composed of senior government executives from several federal agencies. Data reconciliation issues to the conversion from ten separate accounting and reporting systems to the Integrated Enterprise Management Program presented challenges in preparing the Agency's FY 2003–FY 2005 financial statements. NASA is implementing an aggressive action plan to correct these deficiencies, and NASA senior management is regularly reviewing Agency progress on the corrective actions. Although these corrective actions will require some time to implement, NASA is committed to improving its financial reporting.

#### **NASA's Neat Steps**

For over three decades, NASA and the Nation's human space flight program have been focused on the development and operation of the Space Shuttle and the Space Station. In its final report, the *Columbia* Accident Investigation Board (CAIB) was very forthright in its judgment that these goals are too limited to justify the expense, difficulty, and danger inherent to manned space flight, given the limitations of today's technology. The CAIB was equally forthright in calling for a national consensus in the establishment of a program having broader strategic goals. The *Vision for Space Exploration* is that endeavor. The Congress has endorsed it, the public supports it, and NASA is working to implement it. But to effect these changes, NASA must engage in a major transformation—taking the capabilities we have throughout the Agency and restructuring them to achieve a set of goals for the 21st Century that we have outlined earlier this month in our 2006 NASA Strategic Plan. This is an enormous challenge, but we have begun to transform our entire organization to foster these changes and to enhance a positive, mission-driven culture.

The CAIB was also clear in its assessment that the lack of open communication on technical and programmatic matters was a direct cause of the loss of *Columbia*. We have understood and embraced this assessment, and are absolutely and completely committed to creating an environment of openness and free-flowing communication. However, NASA must still make improvements in its internal communications as well as our external communications with our stakeholders, the scientific community, and the public. We are making a concerted effort to address any problems in this area.

For America to continue to be preeminent among nations, it is necessary for us also to lead in space exploration, scientific discovery, and aeronautics research. It is equally true that great nations need allies and partners. The spirit of innovation and muscle of government and industry are needed to turn the Nation's *Vision for Space Exploration* into reality. These journeys to the International Space Station, the Moon, Mars, or even Pluto are the most difficult things our nation does. June Scobee Rodgers, the widow of Dick Scobee, Commander of the Space Shuttle *Chal-*

lenger on that ill-fated day twenty years ago, recently noted, "Without risk there's no discovery, there's no new knowledge, there's no bold adventure. . . the greatest risk is to take no risk." We must continue our journey. America, through NASA, leads the way.

Once again, thank you for the opportunity to testify today. Mr. Chairman and Members of the Committee, I would be pleased to respond to any questions that you may have.

**National Aeronautics and Space Administration  
President's FY 2007 Budget Request**

(Budget authority, \$ in millions)	FULL COST							Chapter Number
	Operating Plan 1/18/06		FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
By Appropriation Account	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
<b>Science, Aeronautics, and Exploration</b>	<b>9,050.7</b>	<b>9,721.3</b>	<b>10,524.4</b>	<b>10,594.4</b>	<b>11,136.4</b>	<b>11,747.0</b>	<b>15,526.4</b>	
<b>Science</b>	<b>5,501.6</b>	<b>5,253.7</b>	<b>5,330.0</b>	<b>5,383.1</b>	<b>5,437.1</b>	<b>5,491.5</b>	<b>5,546.4</b>	
Solar System Exploration	1,720.5	1,582.3	1,610.2	1,588.6	1,840.4	1,899.6	1,846.7	SAE SMD
The Universe	1,474.9	1,507.9	1,509.2	1,500.9	1,307.9	1,276.1	1,309.7	SAE SMD
Earth-Sun System	2,306.2	2,163.5	2,210.6	2,283.7	2,288.9	2,315.8	2,390.0	SAE SMD
<b>Exploration Systems</b>	<b>2,209.3</b>	<b>3,050.1</b>	<b>3,978.3</b>	<b>3,981.6</b>	<b>4,499.8</b>	<b>5,055.9</b>	<b>8,775.1</b>	
Constellation Systems	422.3	1,733.5	3,057.6	3,067.6	3,612.9	4,083.8	7,698.4	SAE ESMD
Exploration Systems Research & Technology	898.9	692.5	646.1	632.2	605.1	679.2	764.6	SAE ESMD
Human Systems Research & Technology	888.1	624.1	274.6	261.8	281.8	292.8	312.1	SAE ESMD
<b>Aeronautics Research</b>	<b>962.0</b>	<b>884.1</b>	<b>724.4</b>	<b>731.8</b>	<b>732.4</b>	<b>722.8</b>	<b>722.7</b>	
Aeronautics Technology	962.0	884.1	724.4	731.8	732.4	722.8	722.7	SAE ARMD
<b>Cross-Agency Support Programs</b>	<b>377.8</b>	<b>533.5</b>	<b>491.7</b>	<b>497.9</b>	<b>467.1</b>	<b>476.8</b>	<b>482.2</b>	
Education Programs	178.9	162.4	153.3	152.4	153.1	154.0	153.3	SAE CASP
Advance Business Systems (IEMP)	0.0	156.3	108.2	106.9	73.8	78.5	80.6	SAE CASP
Innovative Partnerships	198.9	214.8	197.9	205.5	206.2	209.7	212.9	SAE CASP
Shared Capabilities	0.0	0.0	32.2	33.1	33.9	34.7	35.5	SAE CASP
<b>Exploration Capabilities</b>	<b>7,114.4</b>	<b>6,869.7</b>	<b>6,234.4</b>	<b>6,680.4</b>	<b>6,442.3</b>	<b>6,242.9</b>	<b>2,896.7</b>	
<b>Space Operations</b>	<b>7,114.4</b>	<b>6,869.7</b>	<b>6,234.4</b>	<b>6,680.4</b>	<b>6,442.3</b>	<b>6,242.9</b>	<b>2,896.7</b>	
International Space Station	1,591.3	1,753.4	1,811.3	2,200.3	2,255.6	2,197.1	2,360.8	EC SOMD
Space Shuttle*	5,049.2	4,777.5	4,056.7	4,087.3	3,794.8	3,651.1	1,467.7	EC SOMD
Space and Flight Support	473.9	338.8	366.5	392.8	392.0	394.7	389.2	EC SOMD
Inspector General	31.3	32.0	33.5	34.6	35.5	36.4	37.3	IG
<b>TOTAL</b>	<b>16,196.4</b>	<b>16,623.0</b>	<b>16,792.3</b>	<b>17,309.4</b>	<b>17,614.2</b>	<b>18,026.3</b>	<b>18,460.4</b>	
Year-to-Year Change**			3.2%	3.1%	1.8%	2.3%	2.4%	

\* Includes emergency supplemental of \$349.8 million in FY 2006.

\*\* Not including emergency supplemental of \$349.8 in FY 2006.

Totals may not add due to rounding.

Ms. DALE. Chairman Boehlert, Ranking Member Gordon, and other Members of the Committee, it is an honor to be back here in front of the Committee, among so many friends and colleagues. I look forward to working collaboratively and cooperatively with some of our most important stakeholders, and that includes the Members and staff of this committee.

In working with Mike to establish and implement overall Agency objectives, one of my chief duties is to manage the institutional support offices of the Agency. Those offices are represented on the Agency's Operations Management Council, a body that I chair, and that is concerned with NASA's capital investments, human resource planning, budget guidance, and institutional policies.

Part of that institutional responsibility is the Agency's workforce. I want to emphasize that we appreciate the guidance that was given to us in the *NASA Authorization Act of 2005* to develop a

human capital strategy, defining the workforce that the Agency will need through Fiscal Year 2011 to effectively implement the Vision. I am pleased to report that, pursuant to the requirements of the Act, we have shared our draft workforce plan with our union stakeholders. After this consultation, we will formally submit the plan to Congress. The plan identifies specific competency gaps and surpluses anticipated in NASA's civil service workforce between now and 2011. It also addresses the strategies that NASA is taking to respond to its most critical challenges, and outlines the Agency's recruitment and retention approaches.

Addressing our future workforce is also a primary focus of NASA's Education programs. NASA's education portfolio is geared to engage students in NASA's science, aeronautics, and exploration missions, provide hands-on experience to educate these youths interested in STEM fields, and support the training of undergraduates, graduates, and faculty necessary to supply the workforce to achieve the *Vision for Space Exploration*.

I am also working closely with our international partners to ensure that we meet our obligations on the International Space Station and other cooperative projects, and that we engage potential partners in the exploration of the Moon, Mars, and beyond. I was in Europe, and met with a number of the heads of space agencies last month, and I can tell you, based on these discussions, there is definitely interest on the part of future collaboration in the exploration mission.

Mike and I are committed to not only strengthening the Agency's financial management, but also, the entire foundation that enables NASA to do its business. Our CFO has just approved an Agency Corrective Action Plan reviewed by NASA's Inspector General and OMB, which was delivered to your committee, I believe yesterday. We understand that our credibility in this area is particularly vital as we embark on complex projects.

Thank you for your time today, and I look forward to your questions.

#### DISCUSSION

Chairman BOEHLERT. Thank you very much.

Mr. Administrator, I think NASA is doing a better job than ever before in cost estimating, and your partner at the table is, in large measure, responsible for that. But still, new programs tend understandably to have cost increases, and in the case of the CEV, the current cost estimate has to be soft, because NASA hasn't heard yet from the contractors that develop the vehicles, so I have a few questions.

#### ACCURACY OF THE CEV COST ESTIMATE

First, what level of certainty can you put on the current CEV cost estimate, and how have you concluded the level of certainty? Just let me add that you said elsewhere, that first time development programs that have historically—have cost overruns of about 30 percent. How does your CEV estimate take into account that history?



Dr. GRIFFIN. Yes, sir. It is, and I would not want to be shot if I don't have this accurate to the second decimal place, but it is broadly true that in first time aerospace development programs, it might be said that the average program overruns by 30 percent. So, if I could rephrase that, I would say you have a 50 percent chance of overrunning by 30 percent or more, and a 50 percent chance of not overrunning by as much as 30 percent.

We have in fact, this is not new, there is nothing I have said which is a surprise to anyone in the business—some years ago, in fact, this topic was a subject of discussion by a committee that the esteemed former NASA Center Director and Martin Marietta CEO Tom Young ran, and pointed out that government space acquisition programs in general, NASA, DOD, across the board, did not budget for adequate—did not have a history of adequately budgeting for cost growth.

I believe that message was resoundingly heard throughout the community, and we have tried to react to it, so our budget for the CEV and for the exploration program generally, all new hardware, has been budgeted so that statistically, we believe we have a two out of three chance, and you appreciate it, all this is using backward-looking cost models. We cannot, of course, predict the future, but our backward-looking cost models would predict that we have a two out of three chance of underrunning, and a one of three chance in overrunning on all of our stuff, so we have budgeted at what I would call the 65 percent confidence level.

#### THE EFFECTS OF CEV COSTS ON OTHER PROGRAMS

Chairman BOEHLERT. The—our Authorization Act requires a report by April of this year on how different levels of spending on the CEV will affect other NASA programs, and you know of our interest on other NASA programs.

Dr. GRIFFIN. I do, sir.

Chairman BOEHLERT. You think you are going to be able to make that deadline by April 1?

Dr. GRIFFIN. I don't think we will make the April deadline on how different levels of spending on the CEV will affect other programs. We will get it to you as soon as we possibly can.

Chairman BOEHLERT. Well, can you give us sort of a gut estimate on when we might realistically expect something? April 1 might not be the best day, April Fool's Day, but I mean—

Dr. GRIFFIN. If you don't mind, I would like to get back to you on that. With all respect, there are 52 reports, if I count correctly, that I owe you this year, and we are struggling a little bit.

#### THE "BANKING" OF CEV FUNDS

Chairman BOEHLERT. I understand that, and one thing you haven't struggled with is candor, and I really appreciate that. You are looking at banking funds for the CEV, so it has enough funds reserved for the peak development years, and how much of the fiscal year 2007 request for CEV is reserve, and how did you decide the pace at which reserves should be built up, and what will be the peak year of development spending, and how would that change if the CEV were accelerated? A lot of questions in one.

Dr. GRIFFIN. Yes, there are. Let me try to be responsive to the intent of the question. When we plan real programs in the real world, there are two considerations. One is the overall magnitude of the money required, per our estimates, and I would like not to get into specifics, because we are, after all, in the middle of source selection here. But so one consideration is the total amount of money required, and the other consideration is the rate at which that money might be made available to us, the so-called funding profile.

The plain fact is that when we have to buy aerospace stuff, there are long lead times for acquisition, and contractors and subcontractors have to be forward funded to buy that. If we don't give them the money that they need when they need it, the—we do incur delays, and we do absolutely, and it is a demonstrated fact, we incur—we run the risk of incurring cost overruns, and we just plain incur higher costs.

Chairman BOEHLERT. I understand all that, and—

Dr. GRIFFIN. So—

Chairman BOEHLERT.—that is good planning, but I am just trying to get a feel for—

Dr. GRIFFIN. So—

Chairman BOEHLERT.—you know, what percent—how much this year for reserve, and—

Dr. GRIFFIN. I really don't have that number. I can get it for you. I would not like to air it publicly, even so. I just do not, I cannot get into discussing in public in the middle of source selection NASA's total estimates, or our year by year estimates for—

Chairman BOEHLERT. But you can understand our desire to have—

Dr. GRIFFIN. Absolutely.

Chairman BOEHLERT.—to be guided by this information.

Dr. GRIFFIN. Absolutely, and I would be happy to discuss it with your staff in private, but this is a procurement integrity issue, and so, while I can say that we have tried to adjust our budget to reflect our internal cost modeling predictions of what money we will need, and when we will need it, we have tried to do that, I—

Chairman BOEHLERT. Yeah, because that is very important for us to be guided, because as you know, we are trying to, I think, we are trying to do too much with the resources we have, and so, I am trying to figure out just what flexibility we have, too. We want to work with you, as you understand.

Dr. GRIFFIN. I fully understand. You don't want us to bank money now, and causing the cancellation or the delay of some other important project—

Chairman BOEHLERT. Exactly right.

Dr. GRIFFIN.—when we could have got by without that money right now, if money is appropriated later.

Chairman BOEHLERT. That is very perceptive.

Dr. GRIFFIN. But I would again—you know of, if anyone in this room knows, that if we at NASA come in with a funding peak or a funding spike later on, reflecting a requirement that we did not tell you about in advance, because we did not properly estimate the funding profile, that frankly you will and you should ding us for that.

Chairman BOEHLERT. Yeah.

Dr. GRIFFIN. So, we are trying to plan a program that will have, inevitably, peaks and valleys in time, and we are trying to smooth those out with smooth funding requests, so that we do not have to come back to you, and say we made a mistake.

Chairman BOEHLERT. Understand. But I hope, and my time is expired, but I hope you appreciate that we are not against banking. We think that is a prudent way to go.

Dr. GRIFFIN. You just want to make sure—

Chairman BOEHLERT. But don't try to get it all in one year. We just—we'd like to know the rate of banking, and know what flexibility we have.

Dr. GRIFFIN. Offline, we will be happy to work with you and your staff.

Chairman BOEHLERT. Thank you so much.

Dr. GRIFFIN. But I cannot discuss those numbers in public.

Chairman BOEHLERT. Understand.

Dr. GRIFFIN. Thank you, sir.

Chairman BOEHLERT. Thank you very much. Mr. Gordon.

#### SLOWING DOWN THE VISION

Mr. GORDON. Thank you, Mr. Chairman. Dr. Griffin, you had mentioned the good vote that the authorization bill received, and how it was an endorsement of the Exploration Initiative, and I think that is correct, but let me also remind you that the reason that we have got that good vote was a part of that bill also set up firewalls that said that you could not poach into other areas of NASA, and I think that is an important thing to remember.

Now, I am not going to belabor, you know, the budget numbers. We have done that enough. They speak for themselves. We know that there is a shortfall, and even with your best estimates trying to give today, I am concerned that the Administration could give you additional shortfalls to have to deal with. You know, this could very well be reminiscent of "trust me on the prescription drug costs," or "don't worry about the cost of Iraq, the oil revenue will take care of it." And so, I think we have to be thinking of our contingencies, and I want to quote to you who the person who I think is the most authoritative, thoughtful expert in the area of exploration, and that is you. "Within the community of spacefaring nations today, America alone can bring to bear the discretionary financial resources to provide man-related heavy lift exploration requirements." In other words, we are the only one that we can do it any time in the near future.

So, quoting President Bush, this is not a journey, or rather, this is a journey, it is not a race, and so here is my dilemma, and I want you to try to help me with that. If we assume for budgetary purposes that it is going to probably be worse than better, and that there could be this potential of, again, cannibalizing other programs in NASA, and really doing great harm to the NASA overall, being we have to think about contingencies. Now, I know you, and I appreciate you wanting to go full speed ahead, and that you want to stick with the exploration program, and get there as quickly as we can. That may put some of us in an awkward position of either, you know, all or nothing, and I would not like to be there.

So with your expertise, can you give me some suggestions, even though it is not what you want to do, about how we could slow down or modify, you know, why is 2018 a magic date, rather than 2020 or later, so that we could take a more prudent approach here, and not put some of us into an all or nothing situation. So, if we were to look at an alternative, what would that alternative be?

Dr. GRIFFIN. Fair enough.

Mr. GORDON. Of slowing down or modifying the program.

Dr. GRIFFIN. Fair enough, sir. Let me try to comment, and again, get to the intent of your question. First of all, you made the point about one piece of the NASA portfolio not cannibalizing another, and you are referring to human space flight cannibalizing science, but in fairness, I would ask, as someone who supports both portfolios, why was it not considered cannibalizing when the science budget in NASA grew from 24 percent to 32 percent of the Agency's top line? When that was happening, no one complained, and yet, human space flight was suffering. But our constituency groups didn't find a problem with that.

Mr. GORDON. Well, let me tell you something.

Dr. GRIFFIN. Yes, sir.

Mr. GORDON. No one complained, and they are complaining now.

Dr. GRIFFIN. Touche. But I am complaining. The human space flight portion of our portfolio, as fully revealed in the wake of the loss of Columbia, has been damaged, and it has been damaged for three decades. Nowhere was those—were those points made more eloquently. We had the wrong goals. We had goals that were plainly stated by the *Columbia* Accident Investigation Board not to be worthy of the cost and the risk of the enterprise, and yet it was plainly stated that the enterprise was viewed by that Commission to be strategically important for this nation, and so it needs to be fixed, and what I am—

Mr. GORDON. I know you are doing your best, and I know you have strong feelings about this, but again, with our limited amount of time here—

Dr. GRIFFIN. Yes.

Mr. GORDON.—if we had to make—again, I don't want to be put into an all or nothing situation, because it may be nothing. So, if we were to make a thoughtful approach to trying to modify, slow down, our Exploration Initiative, so that we could better handle potential underfunding, how would we approach that?

Dr. GRIFFIN. The only responsive answer I can give you is that we have, before we started slowing down any Science missions, we had already slowed down the development of the CEV, which is the Shuttle replacement, to the 2013–2014 timeframe. That is where we are sitting. We already have a Lunar Return Program which, sitting here today, will return humans to the Moon by 2018, without allowing for any possible program slips in the future. To slip out beyond that is, I think, to court lack of credibility. We took our slips up front in planning this effort. We took our slips in the human space flight program first.

Mr. GORDON. Would we save—or I don't know that we would save money on the whole, but would we—we would spread out the cost if we went beyond 2018?

Dr. GRIFFIN. Well, of course, in any given year, if we reduced—if we extended the dates, we would save money for our—

Mr. GORDON. And it would be less—

Dr. GRIFFIN.—bank deposits.

Mr. GORDON. I want to close, because I don't want to take—I want Ken to have a chance to rebut or ask questions.

Chairman BOEHLERT. Thank you very much. Mr. Calvert.

#### NASA/DOD COOPERATION

Mr. CALVERT. Well, I am one of those folks that did complain, so I want to be put on the record. I think you are on the right track, Mike. I think you do have to have priorities, and I think if you ask most people in America what NASA represents, I suspect most people would say human space flight. I think that is what they associate NASA with. Science is certainly important. I don't discount that a bit, but you are faced with a difficult budget, and you have to prioritize and manage money, and do the things you need to do, and I think you are doing a good job.

One thing that I had mentioned earlier in my opening testimony is that why—somebody said why—Mr. Gordon mentioned why 2018? Well, China is going to be on the Moon in 2017. I think that is something we ought to be concerned about. I think we ought to be concerned about other competitors that want to get access to outer space for various reasons. I also serve on the Armed Services Committee, and I, you know, there was just a report that was in the Washington Post last week, which we were aware of earlier, but nevertheless, that China is doubling their expenditures on space programs. And of course, that is all wrapped up into their military budget, which brings me to my question.

In the past, NASA had a relatively close association with the Department of Defense, and obviously, we spend quite a bit of money in space for various reasons, and I want to know, since you have become the Administrator, if there are any more details on stronger partnerships developing between NASA and the Department of Defense on attempting to more efficiently and effectively use limited dollars to—for exploration and other purposes?

Dr. GRIFFIN. Yes, sir. We, as I am sure you know, but I will state for the record, I mean, I have defense and intelligence community clearances, because I have worked in those arenas in my own past, and I enjoy what I like to believe are very good relationships with my defense counterparts. As a matter of fact, within the last couple of weeks, I have had, I believe three principals level meetings with senior DOD and intelligence community officials to make sure that we are working as synergistically as possible.

Synergies are possible at the technology level, individual component parts of our rocketry, our, in many cases, highly fungible between our man-rated systems and DOD systems, and we are trying to take advantage of that. And operational capabilities, at Cape Canaveral, as you know, for our Science program, we purchased the same rockets that DOD makes available. So there are opportunities for synergy. We have excellent working relationships, and we are trying to make them better. I think that is a good news story.

## SHUTTLE/CEV GAP

Mr. CALVERT. Good. I wanted—you had mentioned the gap, and the difficulties that you had between the Apollo program and when we were able to finally get the Shuttle operational. Obviously, we have had difficulties with the Shuttle, and it is a very complex machine, obviously very successful in certain parameters, but it is getting old, and you have been very public and open about the fact that we need to retire the Shuttle no later than 2010, and in your budget, you pretty much outline pretty precisely how many more Shuttle missions are left between now and retirement.

Could you explain to me and to the Committee why it is, you know, in more detail, why it is extremely important that we do not have a gap, you know with the workforce both at Kennedy and Houston, and what would happen if there was a significant gap, and how long could that gap grow, and our access into space, and what could occur?

Dr. GRIFFIN. Yes, sir. Let me first give a few details, and then I will mention what I believe to be the strategic issues. At the detail level, we have a gap, okay. It will be several years, at least a couple. The issue is not having it be extended any more than absolutely necessary, because here is what will happen.

We cannot retain everybody in the workforce through that gap, because if we do, we save no money. All of our money goes either to pay people or to buy things, so therefore, we must terminate subcontractors, or we save no money. We must terminate people, or we save no money. Since saving money is the goal, it follows that we will do those things. If we terminate people, those people will go into other lines of activity. We will not get them back. This is what happened, in very substantial measure, between 1975 and 1981. When we terminate subcontractors, because, quite frankly, the human space flight business in this country is a niche business. As a venture capitalist might say, it is a boutique firm. There are a few tens of thousands of people, in the low tens of thousands at most, engaged in it in this country. If we get rid of a substantial fraction of those people, whether they work for our subcontractor tier or directly in our launch and mission operations segment, or in our development activities, we will not get them back. We will then, when we choose to resume human space flight at some later date, we will have to retrain this cadre of people. We will have to create new subcontractors. We will resume our progress in a very stumbling and halting way. We will increase the risk of flight.

When the Space Shuttle *Challenger* was lost, the failure board of that time identified one of the difficulties of the whole several years of operation leading up to *Challenger* was that even five years after the resumption of human space flight, by the time of the *Challenger* loss, we were still pulling parts and subsystems off of one orbiter, cannibalizing one orbiter to put parts and subsystems on another orbiter, because we didn't have an adequate supply of people and things to do the job. I have become convinced that with a slender reed, this is not an activity like making automobiles, that engages hundreds of thousands of people in the country. This is a very slender industrial base that we have, and it must be protected and preserved. It has been damaged. It is not all that we want it

to be. You have given me, this Congress and the Senate and the President, this President, have given me the job of attempting to fix it. I cannot fix it by first destroying it.

At the strategic level, I absolutely believe that human space flight is a strategic activity of the United States, as is our Science program, and I meant it when I said we took our delays, we took our delays in the human space flight program first, and when I got to the point where I believed we had taken all of the delay that we could reasonably tolerate, then I delayed some science missions, and that honestly was my last alternative. I had no other.

Mr. CALVERT. Thank you.

Chairman BOEHLERT. Thank you. Mr. Administrator, we have a call of the House, so I think we are going to have two votes, which means that we are probably going to have to recess for about 20 to 25 minutes, and our lounge is available to you and the Assistant Administrator, and when we come back, Mr. Udall will be first up.

Mr. HALL. Mr. Chairman.

Dr. GRIFFIN. And I am at your service, as you know.

Chairman BOEHLERT. Thank you.

Mr. HALL. Mr. Chairman.

Chairman BOEHLERT. Mr. Hall.

Mr. HALL. I have a unanimous consent that, inasmuch as we have probably the two best leaders of any administrative agency on this Hill, and it is a shame we can't all be here to ask our questions, but we have those votes, and we are going to be adjourning pretty soon, people are going to be running for planes, could we have asked the Administrator to allow us to submit questions to him, and—

Chairman BOEHLERT. By all means.

Mr. HALL.—in a reasonable time, get an answer back?

Chairman BOEHLERT. Without objection, so ordered, and Mr. Administrator, there will be several questions that we will submit to you, and we would appreciate your response in a timely manner, which has always been the case under your watch, and we do thank you for that.

With that, the Committee stands in recess.

[Whereupon, at 11:15 a.m., the Committee was recessed, to reconvene at 11:50 a.m. the same day.]

Chairman BOEHLERT. The hearing will resume, and the Chair is pleased to recognize the distinguished Ranking Member of the Subcommittee on Space and Aeronautics, Mr. Udall.

#### AERONAUTICS CUTS

Mr. UDALL. Dr. Griffin, again thanks for being here, and just to clarify the record, when the—most people think when the bells go off here, it signals that we have votes, but it is actually to identify the fact that various Members of Congress have escaped from the Hill. Thanks for your patience.

We talked earlier, before the hearing, particularly about aeronautics and what I believe are cutbacks that are of some real significance in that budget area. I want to give you a chance to respond to that, but I wanted to lay out a couple of particular numbers, and—so that the record is clear. By my reading, it looks like the Administration is proposing to cut \$175 million from NASA's

aeronautics program, and as I said in my statement, I just—I don't see the logic of such a move, given that aeronautics is making a positive contribution to our trade balance, and the other benefits that accrue.

So I wanted you to respond to that, and then particularly, if you would, I mentioned the Joint Planning and Development Office, and the runout of the Next Generation Air Transportation System, and I think you and I have differing points of view on this, and I wanted to give you as much of the five minutes that is given to me to respond to those two questions that I have presented.

Dr. GRIFFIN. Let me take the second first, Next Generation Air Transportation System (NGATS). Our new Aeronautics Associate Administrator, Dr. Lisa Porter, and I have sat with Marion Blakely and Secretary Mineta, and it is—I can always be wrong, it happens many times every day, but it is my understanding that we at NASA are doing, on NGATS, what they believe we should do, that we are—it is a multiple—a multi-agency program, but we believe we are meeting our commitments.

Now, for the record, I will take your question. We will go back, we will answer it for the record, and we will make certain that that is the case, but it was our intent to meet the agreed upon obligations of that program, and if we are not, I will figure it out, and we will get back to you.

With regard to the \$175 million cut in Aeronautics, that is versus last year's appropriated amount. The President's submission for aeronautics this year does not have such a cut. In fact, the President's submission is up slightly compared to last year's submission. I think the question before us in aeronautics is reorienting the program to do the right strategic things. For good or ill, Lisa and I simply believe we need a different aeronautics strategy than the one that has been in play at NASA for the last couple of decades. We think NASA's proper contribution to aeronautics is the doing of fundamental aeronautical science. I am an aero guy. I mean, this is what I was trained in, as a young engineer. I want to do it, but some of the demonstrations, and some of the ways in which we have been spending our money do not, to me, seem to be strategically appropriate ways to spend NASA's aeronautics money, and we are re-vectoring the program, and for now, I think we have enough money to do that.

Mr. UDALL. As the Chairman has mentioned, we all appreciate your candor, and I do in that response. My concern is not so much in the short-term, but it is in the runout over the next five years, and I think you can't, at least ask the question, where does this leave us, when you look at the trends. And I know you are operating in good faith, and trying to do more with less, but I would welcome a response to that concern, as well, when you look out on that five year timeframe.

Dr. GRIFFIN. We think we have enough money in the five year runout to make NASA great again in aeronautics, and that is what we are going to try to do. I appreciate that all of us, the comments that are made about aeronautics, again, to use a phrase I used earlier in the hearing, if we change the nouns from science, the verbs are the same. We are all worried about the fact that we are, as a nation, not just as NASA, as a nation, we are not able to afford,



within the domestic, non-defense discretionary portion of the budget, all that we would like to do. And so, we are looking at priorities. I think our aeronautics program is properly prioritized.

Mr. UDALL. We will continue to have the conversation, and I will continue to project my point of view, and you will yours. Could I just, in the time remaining to me, I have got two other areas I wanted to touch on, but particularly, this really exciting and unfolding area of remote sensing, and in the NASA reauthorization bill, there was a provision that would establish a program of pilot projects for the use of this data for State, local, regional, and tribal agency needs.

Could you give us an update, if not today, certainly in the near future, on where NASA is, and what preparations you are making to bring that program to the public's attention?

Dr. GRIFFIN. We will take that one for the record, if that is okay.

Mr. UDALL. That would be tremendous, and there are, as you know, a wide variety of applications, and there is a lot of interest in widely disseminating this data. Mr. Chairman, with your always gracious tolerance of me, I would just ask one other question.

#### SCIENCE R&A CUTS

The—back to the budget. It looks like there is a cut in the research and analysis accounts in the Science Mission Directorate, of about 15 percent, and that adds up to about \$400 million over five years, and particularly, it is concerning me, because it funds university research, and we are trying to bring more people in in the STEM disciplines, and I would appreciate an answer into why those cuts are being made.

Dr. GRIFFIN. Yes, sir. We took a look at our overall Science budget, and wanted to make a change in the balance of R&A versus doing actual missions, and as everyone has seen and talked about here today, we are no longer able to project the kind of growth in Science that was projected before. The rate of growth has slowed somewhat dramatically. And so, we chose also to slow, or to cut back on R&A, in order that we could do as many missions as possible.

In fact, I have received a lot of stakeholder comment to the effect that the level of funding in Science is one thing, but people are concerned, working scientists are concerned about the balance of R&A versus missions, and I have asked Mary Cleave, our Associate Administrator for Science, to rethink that issue. We will be working it with our advisory committees, and we will get back to you on whether or not we continue to believe that that is the right balance. But again, the balance within the Science portfolio is something that we thought we have right, but if we don't quite have what the community would most like to see, we are willing to consider changes.

Mr. UDALL. I very much appreciate your willingness to take another look, and I know you and I both await some further golf analogies from the Chairman. Thank you for being here today.

Chairman BOEHLERT. Thank you very much.

Dr. GRIFFIN. The Chairman will have to struggle to keep up with us on the golf course, I believe. But on the baseball diamond, he reigns supreme.

Chairman BOEHLERT. Thank you very much. You saved yourself on that one. Mr. Gutknecht.

Mr. GUTKNECHT. Thank you, Mr. Chairman. I want to—budgets are really about priorities. I mean, ultimately, you know, we can all argue there is not enough money for this, there is not enough money for that. But ultimately, as it used to say in the Pepsi Cola ads, life is a series of choices, and one of the things that I am concerned about, and I want to at least get an update from your perspective.

#### COSTS OF A HUMAN MISSION TO MARS

The President sort of dropped this on us about a year and a half ago, about sending human beings to Mars. How are we doing on that, and what is your latest estimate of what that might cost?

Dr. GRIFFIN. We have not got as far as looking at missions back—or missions to Mars. We are still coping with the issues of how to reclaim the capabilities we once had to take our astronauts to the Moon.

As a matter of fact earlier in the hearing, the Chairman made the remark that questioning the—or concerns of the wisdom of cutting or damaging other programs in order to redo what America had done before, and I am not quoting, but that was the essence of it, and—

Chairman BOEHLERT. I will accept that as pretty accurate.

Dr. GRIFFIN. Thank you, sir. And that would be—I think that is a very telling point. The United States did have these capabilities. We allowed them to atrophy. We proactively made decisions as a country that caused those capabilities to go away. If we were sitting here today with the capabilities that this nation had purchased as of the end of the Apollo Program, we could go to Mars within a decade.

We have a decade's worth of hard work in front of us just to be able to get back to where we were, and then Mars will be the decade after that. I don't have a cost estimate for you at this time.

#### PRIORITIZING "THE VISION" IN THE BUDGET

Mr. GUTKNECHT. Well, the reason I ask the question, and I think we need to have this discussion with you and with Members of this committee, with the Congress and with the American people, in terms of, I mean if this is just—and no pun intended, an astronomically expensive program, we have to decide, I think, at some point, whether that is the priority, or if there are a whole lot of things we could do a lot closer to our own little planet here that might yield much bigger results and dividends, not only for the American people, but the people of the planet.

Dr. GRIFFIN. Yes, sir. We have been having that debate for the last two years, and I honestly believe that it has been settled with the 2005 Authorization Act, and with this President's budget. We are not zeroing out those other activities. They are in the budget, and we are not forecasting for the long-term huge increases in manned space flight. What we are doing is—we are doing two things, and it is a delicate balance. We are trying to retire an old system, and finish up a legacy program where we have inter-

national commitments, and at the same time, we are trying to bring about a new capability and a new system, in such a way that we don't lose all of the experience base and all of the industrial base that has been created to do these sorts of things. It is a difficult and delicate juggling act, and it does create some broken china, and the—I guess the pledge I have made, and the promise I have made is to do that with every bit of care and concern, and every bit of respect for the different portfolios within NASA that I steward, as can be done. But I believe that we are—that the human space flight portion of our portfolio is the one that is in the most need of nurturing and care right now, and that is what I am trying to do.

Mr. GUTKNECHT. Well, we could—we look forward to continuing this discussion, because I think it is one that—I think the jury is still out, in terms of what the American people really want to do. I know we hear from people who are very enthusiastic about putting more humans in space, and perhaps sending them back to the Moon, and ultimately to Mars, and maybe beyond, but I think there is a growing chorus saying wait a second, you know. For all the money we are going to spend on that, it could be better spent somewhere else, and it strikes me that we have to give the American people a strong argument, and more importantly, you know, we all saw huge dividends from the early days of the space agency. I mean, transistors and microcomputers, and—

Dr. GRIFFIN. Right.

Mr. GUTKNECHT.—all kinds of amazing technologies that grew out of the research. The bottom line, I think, for the average American today, is we are not seeing those kinds of returns today. You know, we all know what Tang is. We all know what transistors are. We all know about microcomputers. But in the last ten years, I think it is hard for most Americans to put their finger on a result that we have gotten for the billions of dollars that we have spent, and so, as you participate with us in this discussion, try to include the American people in there, because ultimately, what they want is what everybody wants, and that is what—they want results, and they want to see real scientific breakthroughs that matter to them in their lives.

I yield back. You may respond to that.

Dr. GRIFFIN. Yes, sir. I do try to—it is of vital interest to me what the American people want with their tax dollars. I would emphasize again that we are already spending this money on NASA, and primarily, what we are talking about here is revectoring the money that we already spend on manned space flight to more productive goals.

I would quote, however, I do want to quote for this committee what I thought was a stunningly interesting Gallup poll that was done at the end of last year, and I had made the comment in a public venue, that questions about public support of American space flight were often not properly posed, that the proper way to pose the question would be to note first, the budgetary levels that are assigned to NASA, and then, given those budgetary levels, what do you think about what we are doing? And so, the Gallup people asked the question, given that the NASA budget remains at or below one percent, do you support the goals of returning humans

to the Moon and going to Mars, and 75 percent of people, across party lines, across genders, responded with either support or strong support. That is a stunning statistic. It echoes the fact, as I have often talked about in casual conversations with many of you, that if I do engage, you know, an average person on the golf course, and I start talking about what we each do for a living, then they find out I am in the space business, and then I ask them, well, how much money do you think NASA has, relative to DOD, and people commonly think NASA has half of what DOD has, or 20 percent of what DOD has, and I will say four percent. How much money do you think NASA, you know, is spent as a percentage of the budget, and they will say oh, 15 or 20 percent of the budget is NASA, right. And I say no, seven tenths of one percent of the budget is NASA. People are stunned. So when properly conditioned, when they understand that this is a small investment in the Nation's strategic future, to maintain its stature among nations in the 21st Century, people are very supportive of this endeavor.

Chairman BOEHLERT. Thank you very much, but I can't help but observe that you ask that in isolation, but when you begin to tell the American people in a poll of that nature that we have to make some choices, because we don't have unlimited resources, and if the choice is A or B, then what would you do, then you might get a different answer. For example, I would suggest if you asked the American people the basic investment in science, which has produced such handsome dividends for society on the most important planet in the universe, Earth, or investment in some of the other activities that are not related to human space flight, or would you invest in human space flight, then you might get a little bit different answer.

So we are all—we are with you. I mean, I will answer yes to the question you, 75 percent of the people answered yes to. I agree, but we can't do it in isolation. It has to be in context with everything else.

Dr. GRIFFIN. Well, and I certainly agree with that, and I would remind the Committee again, we are not slashing Science to the bone here with this proposal. It is a pretty strong budget for Science.

Chairman BOEHLERT. Well, and then, I also would observe, to give a point to your side of the argument, that we are conditioned, as people, to accept the arguments that we are slashing away at some program, when in fact, we are slowing the rate of growth, and nothing typifies this more than I was facing back home, during the recent recess, the public saying why are you people slashing away at Medicaid. That is a necessary program to provide for the healthcare needs of the most disadvantaged in our society. And I said well, I tried to figure out how to put it in perspective so they might appreciate it better, and I said all right, Washington is the only town in the world, where if you ask for a \$73 raise, and you get a \$70 raise, you say slashed away at my projected income. I mean, which happened in the case of Medicaid, slowed the rate of growth from 7.3 to seven percent, but—well, for another time.

Dr. GRIFFIN. Certainly take your point.

Chairman BOEHLERT. Well, let us provide some further enlightenment from Mr. Green. The Chair recognizes you.

Mr. GREEN. Thank you, Mr. Chairman. I thank you for your kind introduction. I thank the Ranking Member as well, and I would like to thank you, Mr. Administrator, and the Deputy Administrator, for being here with us today.

Just a quick comment from a person who is concerned about space flight. I think that we do have to go to the Moon. I do think that we have to go to Mars. I think we have to go beyond. I think we have to do it not because it is a part of our manifest destiny as homo sapiens, not because of the technology that we will acquire as a result of doing it, but simply because we cannot allow people who may not have our best interests at heart to control space. I really believe that we have to be wherever others are going, and it is in our own best interests that we be there first, if at all possible.

#### COTS

Now, having said that, let me come back to Earth, and talk about the budget and some of these programs. I have a concern that I would like to visit with you about, with reference to the \$500 million, the half billion dollars set aside that will stimulate commercial transportation, ultimately pass on the task of resupplying the International Space Station to private industry.

My first question is how, if you can, as tersely as possible, how will this \$500 million be used, and the followup is, the timeline for this transfer, what is that timeline anticipated to be? Thank you.

Dr. GRIFFIN. Yes, sir. It is the Administration's belief and my belief, and I believe, the belief of many here, that NASA and, indeed, other federal agencies, research and development agencies, should concentrate on the cutting edge of their technology. For NASA, the cutting edge of our technology is exploration beyond low Earth orbit. Almost 45 years after the first human space flight, we believe it ought to be possible for American industry to step, if not fully, at least partially up to the task of resupplying crew and doing—I am sorry, resupplying cargo and doing crew rotation to the Space Station in low-Earth orbit. That capability has not yet been demonstrated, but we have received, this committee has received many assertions from entrepreneurs in American industry, as well as well-established companies in American industry, who will say that if NASA will deal with us in a commercial manner, if NASA will establish an arm's-length transaction with us, that we can supply the Space Station logistics market.

My Deputy and I are among the very strongest supporters of trying to transition some of what should be very routine activities to the commercial sector. Accordingly, we are putting up \$500 million in this budget, over this next five years, we are putting up that amount of money as, if you will, I won't say seed capital, because that is not the correct term, but it is an incentive for American industry to bring their own funds to the table to produce and provide, first demonstration, and then possibly later, operational systems to NASA for the resupply of cargo to the International Space Station, and then, when able, the crew rotation. That is what we hope to—

Mr. GREEN. Because my time is going to run out, can you quickly just address the timeline on that, in terms of how you expect—

Dr. GRIFFIN. We would expect to see, we would hope to see initial demonstrations in the 2008, 2009, 2010 timeframe, and then, depending on how well those go, the ability to provide real service post-2010.

Mr. GREEN. Final question, and I will make this very brief. Is there any way to provide incentives for the persons who will implement this to help us with our persons that may be displaced as a result of some of your budget cuts, because I understand the relationship between contractors and employees, and the NASA employees? Can we find a way for people to move from one side of the street to the other side of the street as efficaciously as possible?

Dr. GRIFFIN. Well, yes, sir. I think the market will take care of that. If—we don't have a net budget cut. We have a net budget increase, and so, for those activities which are being slowed, and if people become free as a result, there are other activities which are continuing or increasing, and I think the natural employment market in aerospace will take care of that.

Mr. GREEN. Well, my hope, of course, is that we will have a minimum disruption in this, what I am calling an interlocking relationship between all of these various contractors and agencies that work together. Through the years, we have developed this web, and hopefully, we can maintain the web to the extent that it can continue to be effective for us. Thank you.

Dr. GRIFFIN. Yes, sir.

Mr. GREEN. I yield back. Thank you, Mr. Chairman.

Chairman BOEHLERT. Thank you very much. Dr. Schwarz.

#### MANNED SPACE FLIGHT VS. R&A

Mr. SCHWARZ. Administrator Griffin, I am going to add that you are going to repeat yourself when you respond to this, but I need to take what you say back to some of my constituents in Michigan who are, in part, large components of the University of Michigan and Michigan State University, and the question is, or the request for you to repeat yourself in terms that I can carry back to those folks, is they will ask me why the emphasis now seems to be going back to manned space flight, and all of the appurtenances thereto, as opposed to unmanned scientific missions, or bent science. Why the emphasis now, again, hard emphasis on manned space flight? And I don't think it will be a question that is asked that has any edge on it. I think the research community in universities like that, who receive millions and millions of dollars of federal research grants every year, like to know what is NASA—what NASA is doing, and how they are thinking. So, maybe in two or three paragraphs, you can just kind of imbue that message in this chip I have behind my ear here, and I will take it back to them, but they ask that question frequently, and I have large thousands of people in my district who work for both the University of Michigan and, up further north, for Michigan State, which as you know, are superb research universities.

Dr. GRIFFIN. I do. I am very familiar with both. Sir, I would start out with my three paragraphs by saying first of all, the change in emphasis that we are talking about here is, with respect to the Science community, is very slight. We still have a huge Science program at NASA. The sum and substance of these so-called cuts,

which are not cuts, that are being applied in the Science community, is that we are delaying the Space Interferometry Mission, the Terrestrial Planet Finder, and the Global Precipitation Monitoring. That is, those are the major impacts. They are not being cut. They are being delayed by a couple of years. As I said, we advocated a strategy in which we would cut back on R&A, research and analysis, by about 15 percent, so that we could continue to do missions. We are going to re-look at that.

The change in emphasis on manned space flight is primarily associated with doing different things with the money we are already spending on manned space flight. We are bringing the Shuttle program to an orderly and disciplined close, which I yield to no one in my desire to do. We are finishing up the Space Station, consistent with obligations made earlier, and then, we plan to take those moneys which have been allocated to human space flight, and return to the Moon, and go beyond.

The reason for that is that this is a strategically important, hugely significant activity for a great nation like ours to do. This is the paradigm of what the Nation's Civil Government Space Program ought to be doing. In order to get from where we have been for the last 30 years to where we need to be, we have a speed bump in the road for the next three or four years, because we have to get out of what we have been doing, and into, onto this new path, and we have to do it while creating as little collateral damage as we can, and that is not to say that there is no collateral damage, because there is some. But we must do the best we can to arrange it in an orderly and disciplined way, and that is what we are trying to do.

Mr. SCHWARZ. Thank you, sir. I yield back, Mr. Chairman.

Chairman BOEHLERT. The Chair recognizes Mr. Costa for five minutes.

#### INTERNATIONAL COOPERATION

Mr. COSTA. Thank you very much, Mr. Chairman.

Mr. Griffin, on the last point you made, and I think we touched upon this previous hearing, but it just is not clear to me whether or not there is due diligence that is taking place with regards to the Moon mission that you just spoke of. As to—I mean, it is clear we are a great nation, and there are responsibilities, and I think a lot of good reasons and justification on why we should pursue that effort, but what is not—what doesn't seem evident to me is exploring in a thoughtful way how we can cost-share these efforts with our European alliances, with the Russians, and others. I mean, frankly, notwithstanding the experience of the Space Station, I do think that it is not just our nation's responsibility to explore the universe, and for all the benefits that come from that, but I think there are a lot of dividends that can come with sharing the costs of such an endeavor in the 21st Century, and I just would like to know what effort NASA is really focusing on to see what opportunities might lie in terms of that cost-sharing?

Dr. GRIFFIN. Sir, if you don't mind, I am going to let the Deputy Administrator take that one, because she has been spending a good bit of time on that recently.

Ms. DALE. I would emphasize first that the *Vision for Space Exploration* actually makes a very strong statement in support of international cooperation on our future exploration missions to the Moon and Mars.

A couple of weeks ago, I did go to Europe to meet with the head of ESA, as well as the heads of agencies for Italy, Germany, and France. My intentions are to go on to our other traditional international partners of the Space Station, Canada, Russia, and Japan, and I did initiate the dialogue when I went to Europe about the potential cooperation on the Moon, Mars, Exploration Initiative, and there was interest expressed. We are planning on having an exploration workshop at the end of April, that NASA is putting together, where we will include commercial industry, academic community, scientific community, as well as our international partners, both traditional and nontraditional.

So, there is very much a desire on the part of NASA to engage with our international partners now, to bring them into this, to bring them into the planning stages early, for what we are going to do on the lunar surface, and also, what our desires are for both robotic and human exploration of Mars.

#### ISS: LESSONS LEARNED

Mr. SCHWARZ. Well, if I may, Mr. Chairman, I would suggest that, at the appropriate time, that you report back to the Committee to let us know how that effort has gone, what kind of process you are anticipating, in terms of breaking down those costs, and I might ask you one other question here that either one of you might want to address, based upon our experience with the Space Station, what lessons, and if you can't answer it here, I think that needs to be provided down the road, what lessons are there to be learned as it relates to the prospects of cost-sharing on these kinds of very large challenges that you face when you are talking about a Space Station or a lunar mission, or onto Mars.

Ms. DALE. I think one of the lessons and one of the things that we actually did with International Space Station, there is usually a no exchange of funds basis, in terms of cooperation, so different partners bring different elements to the table, in terms of our cooperation. I think that is probably the primary lesson, one of the primary lessons that is learned in terms of international cooperation, and that will be the basis, as well.

The other part of the equation is the United States human space flight capability. Our replacement of Shuttle is going to take place with the Crew Exploration Vehicle, and as Mike has stated on many occasions, we need to make sure that that strategic asset is a United States capability, although there may be potential for components to be delivered from international industry, that is an industry to industry relationship. But we need to make sure, when we have a key strategic asset like space transportation capability, that we don't have other individuals on the critical path. So, that is another key part of the equation.

Mr. SCHWARZ. Thank you very much, Mr. Chairman. I reserve the balance of my time, and I will submit further questions afterwards.



Chairman BOEHLERT. Thank you. You have 17 seconds in reserve. Mr. Feeney.

#### INTERNATIONAL INFLUENCE AND "SOFT POWER"

Mr. FEENEY. Thank you, Mr. Chairman, Mr. Administrator, Ms. Dale. Thanks for being here today.

Number one, I want to compliment you on the extraordinarily talented workforce you have put around you in the last year and a half or so. You know, I think that that is going to be really important, as we get a bang for our buck out of NASA in general, and I really want to compliment you.

Secondly, the fact that you have been incredibly transparent and honest with this committee. There are some folks on this committee, understandably, that get heartburn, because there are some wonderful programs this year that you are talking about delaying. I think the Chairman laid out some arguments about why that is a very troubling idea, and I think he represents a big portion of the science community, when he says that. The fact that we do have, you know, we have gone since 1992, from 24 percent of the NASA budget to science, up to about 32 percent, I think, is important, but trying to find ways to set priorities in tough times is something that is your job, and living up to the President's Vision is your mission, and I appreciate the way you have done that.

I want to focus on something that sometimes, you are able to, and sometimes, you are not. I just got back from China, where I was the first American ever to be permitted to see the Human Space Launch Facility, or the Vehicle Assembly Building in China. Congressman Mark Kirk and Congressman Rick Larsen joined me. No Western official has ever been permitted to do that. They threw our embassy people off the bus. The Chinese space program, as you know, is entirely within their Defense Department, actually, the procurement agency of the Defense Department, so there is a lot of non-transparency that goes there. We don't know exactly what they are spending, or what they are doing, or what their goals are, except what they show us or tell us. And I found it very interesting, as you talked about how human spacefaring, in large part, is one of the definitions nowadays of superpower status. It is very clear to me that the Chinese believe that, and they believe it very deeply, and I was appreciative of you saying that.

I think space predominance, including human space flight, is absolutely critical to peace throughout the globe, and extraterritorial. As long as peaceful, democratic nations have space predominance capabilities, including human space flight, I think we are in for a period of potential long-term world peace. U.S.-Sino relations, in my view, in large part, will write the history of the 21st Century, whether we get it really right or really wrong, or somewhere in between. But having said that, you talked about the potential to have a disastrous impact, if we have too much of a gap in time between human flight in the Shuttle and the CEV. You talked about the potential for losing the niche businesses of subcontractors that are serving our community. You talked also about human potential, and I am very interested in that.

I can tell you that while the Chinese claim they have only spent about \$2.2 billion since 1995 when they started their space pro-

gram, they have spent it very effectively. They have some 100 universities that are focused on human space research on behalf of their national space agency. Whether that is included in their budget or not, I don't know. Secondly, assuming that they are spending about a billion in human space flight today, a billion dollars goes a long way in China. You can purchase roughly the expertise of eight engineers for the cost of one engineer in America. Other work, skilled and unskilled, is even a greater ratio. They don't have the regulatory burdens that we do. In many ways, while the Chinese will humbly say that they are 30 or 40 years behind us in human space, it is like being, the Japanese were 30 or 40 years behind us in TV sets. These guys have stripped straight to the space equivalent of HDTV plasma type sets, and they are doing a remarkable job. They have got six successful Shenzhou missions, including two human space flight missions.

I believe deeply that China can either be a cooperative competitor, or they can be a dangerous adversary, much more powerful and much more capable to deliver serious harm to the United States than Imperial Japan and Nazi Germany were 100 years ago today combined, and I believe that our leadership in space is absolutely requisite, including human space.

Can you comment on the opportunities that space provides to continue American leadership, as we are currently the sole superpower on the planet with respect to space capabilities, for example, but that is not going to be true for long, and can you comment on how the loss of that workforce, if we extend that gap from two or three or four years, to six or eight or ten years, may undermine a lot of absolute strategic requirements for the safety of our country?

Dr. GRIFFIN. Yes, sir. There is much you have said that I agree with, particularly, the desire to focus on the opportunities, rather than the problems, and I certainly would agree. I believe that the record shows that nations that find a way to cooperate on great enterprises and great adventures find reasons not to quarrel, and I think we are all better off, we know which of those two alternatives we prefer, and space is—the conquest of space is the greatest enterprise of all.

But with regard to the gap, again, returning to that question, I am tempted to make another of my little jokes here, and say look, this is the part of all this that is not rocket science. If we have an extended gap in any of our enterprises—I would not allow an extended gap in our science enterprise to take place either—a gap in any of our enterprises is about one thing and one thing only. We are trying to save money, so we are trying not to pay people, and we are trying not to buy things. That is what a gap is.

If we don't pay people to be engaged in the manned space flight business, they won't. They will go elsewhere. Engineers are pretty employable. When they go elsewhere, we won't get them back. Similarly, the robotic plus the human space flight business is not a high volume business. It is, in the overall sweep of American industry, it is a niche business. It is at the cutting edge of what we do in American industry, American capabilities. If we want to own that enterprise, we must take care of it. It is not something that can be just left to founder, and so, if we incur a three, four, five, your words, six year gap, the people who are engaged in those en-

terprises and the subcontractors who are engaged in those will go elsewhere, or they will wither and die, and then, we will have to recreate that capability when we say we want it later, and we will be disadvantaged.

I don't have a better story than that. I have seen it occur in the past. I don't want it to occur again. I think we should try to prevent it. I do appreciate your comments about the quality of the team that I have been able to put together. In my case, I found that to be an absolutely essential requirement, since I couldn't really do anything by myself.

Chairman BOEHLERT. Thank you very much.

Mr. FEENEY. Thank you.

Chairman BOEHLERT. Mr. Honda.

Mr. HONDA. Thank you, Mr. Chairman, and again, welcome—

Dr. GRIFFIN. Mr. Honda, good to see you.

#### SOFIA

Mr. HONDA. Good seeing you again. I have a lot of concerns and questions around life science, but in the interests of time, I am just going to address myself to SOFIA, the SOFIA Project. And I am really curious about the decision to include no funding for the SOFIA Project until whole review in early '06, to determine the best course of action for this project. I think that was the conclusion.

As you may know, I visit Ames on a fairly regular basis, and I recall from one of those visits that in the fall of '04, three independent review committees chartered by NASA, NASA headquarters, conducted what were essentially termination reviews. My impression is that SOFIA passed each one of those reviews and in the process of implementing the recommended restructuring of that program. The administration program was approved by the Science Mission Directorate in April of '05, and it is my understanding also that the restructuring process is nearly complete, so why would NASA cancel SOFIA at this time when it has nearly completed a program restructuring, and has followed the advice of its own independent review?

Ms. DALE. Thank you, sir. What I would say about SOFIA is we are planning on doing an intensive project review. There have been difficulties with the program that include significant schedule delays of approximately two years. There has been cost growth, and there are also technical issues related to SOFIA. All of those issues are actually going to go into the project review. The Science Mission Directorate will also be looking at other competing science missions.

As we embark upon this project review, we intend to do it in full cooperations with the German Space Agency DLR. They will be observers in this process, which is traditional for U.S. project review. Also, at the conclusion of the review, we will be faced with the decision whether it is putting funds back into the Fiscal Year 2007 operating plan, and out-year budgets, or potentially initiating a termination. Either way, we will be resolving that situation closely with the German Space Agency, again.

Mr. HONDA. Well, I appreciate the mention of the German space agency, but what you are telling me is that there are some unre-

solved problems, but this project has gone through a variety of reviews, and are these the same issues that the past reviews have identified and made recommendations to address?

Ms. DALE. My understanding is that as the program continues to encounter significant technical issues related to the airplane, again, fairly significant cost growth and schedule delays, that those need to be put into the project review, and we need to review it against the other competing Science missions within NASA. We have a limited budget.

Mr. HONDA. I understand that, but you mentioned airplane. I mean, is it about the vehicle that is an issue, or the costs of having a vehicle, contracting a vehicle for taking the lens up, or what? Your comments are real general, and it doesn't—

Ms. DALE. Okay.

Mr. HONDA.—tell me anything, except—

Ms. DALE. Okay.

Mr. HONDA.—the significant problems.

Ms. DALE. Let me just say briefly that my understanding is, it seems fairly straightforward what we—what you have to do to the airplane, in terms of cutting a hole in it, so you can put the telescope in. Apparently, that is much more difficult than had been anticipated, and I think Mike wants to make a couple of comments.

Dr. GRIFFIN. I don't really, but I will. The—

Mr. HONDA. He was hiding behind your shoulder.

Dr. GRIFFIN. Yeah.

Chairman BOEHLERT. And that is called a surprise lateral.

Dr. GRIFFIN. Yeah, the issue—in fact, the question that we are getting at—the Chairman just brought the nub of the issue up to the table—is we are cutting a big hole in a large airplane, and we have to be able to put a telescope inside it, and have laminar flow over that hole and that telescope with that airplane, or we don't get good Science. That task has proven to be much harder than people thought. Now, the question before the House is are those folks, in fact, at the end of their technical problems, as they would claim, or are they still in the middle of them, and we face, you know, just an unending string of more money and more time spent trying to get the program to where we can do the Science. No one is questioning, at this point, no one is questioning the value of the Science, but we have got to be able to make it work.

Mr. GORDON. Would my friend yield quickly? Let me just quickly say that the head of the German space agency came by to see me. They are very concerned about this. They have made a major investment in this program. I think they feel that if it is canceled, that it will be an embarrassment, and make it very difficult to go back to the German people for additional funds in these kinds of partnerships.

The other problem I see here, even it is peer reviewed and decided to be worthwhile, you have already taken the money out, so then you have got to, you know, get into something else for, to fund it. I would just want to make a comment. If you—if I didn't say anything accurate, you can correct it otherwise when you move on.

Ms. DALE. I would just add that there is significant interest from both me and Mike, in terms of what is going on with this project review, and there is every intention, if we get to the end of the

project review, and it is determined that SOFIA should continue, that there is definitely a commitment from both of us that funding will be put back into the Fiscal Year 2007 operating plan and in future budget requests. We have both had discussions with Professor Wittig. We know of the great concern in Germany, and we take that very, very seriously.

Mr. HONDA. Just to reclaim my time for 30 seconds, if I may. Thank you for the question. I am not a rocket scientist, but it seems to me that all the decades that we have been studying this, the issue of it being airborne would have been one of the first things that would have been taken care of, and you know, someone needs to convince me that this is a problem that is so significant that, you know, funding is not—funding is, you know the reason for funding set aside, that that is the only reason. I mean, it just doesn't make any sense to me. I mean, you know, we are talking about NASA, you know, that is airborne, and to have that as an issue, the only issue, it passes my understanding, so I hope that you will be able to get back to us in a timely manner, to you know, so that we don't lose face with Germany, as we have done in other countries.

Ms. DALE. And we do plan to have continuing dialogue with the Committee about this issue—

Mr. HONDA. Thank you very much.

Ms. DALE.—as we go on.

Mr. HONDA. Thank you, Mr. Chairman.

Chairman BOEHLERT. Thank you, Mr. Honda.

Mr. HONDA. And thank you, Dr. Griffin.

Chairman BOEHLERT. Mr. Akin.

#### HYPERSONICS

Mr. AKIN. Thank you, Mr. Chairman. I had questions that are different, but similar, to some degree, and I had several different questions that Administrator Griffin—maybe I will just run through and try and give you a flavor of what I am concerned with.

The National Aeronautics and Space Act obligates NASA to conduct research and development, including developing experimental vehicles. However, NASA's new fundamental aeronautics program focuses only in fundamental research leading to, perhaps, some baby step flight experiments after 2013, but no development of hypersonic demonstrator vehicles at all. Please explain why NASA is seemingly ignoring this important provision of the *NASA Space Act*. That is the first one.

And then, along the same lines, the Boeing ATK team competed and won the X-43C program, and yet after successfully the X-43A flights in 2004, NASA canceled the X-43C program, and then—so I guess the question is a couple. Then, Senator Talent again added \$25 million to the budget to support the X-43C, and then, NASA claimed that the conference report language was ambiguous, so that NASA could take the money and use it somewhere else. I guess the question I have is, do you have a commitment to hypersonics, in developing that as a method of trying to get up.

And then, the second thing is, is you mentioned you have put all this number of million dollars in a pot, wanting companies to come and partner with you. If the companies put millions of their own

money into something, and then, the program gets canceled, that certainly doesn't encourage them to want to make the same mistake a second time, does it?

Dr. GRIFFIN. That is probably right. On the other hand, if we are not doing the right things with the money that we are asking the companies to partner with us, then continuing to put more money onto things that we don't believe are correct, is also not a good path. We—

Mr. AKIN. Could you unpack that a little bit? In other words, you are saying it isn't working, or—

Dr. GRIFFIN. No, I am saying I will reiterate what I have said before, is that in certain areas, we feel that the prior strategy for aeronautics was inappropriate. It was an inappropriate way to spend money, and whether we are doing it ourselves, or asking people to partner with us in spending money in those directions, is kind of a second order issue. The first order issue is what should we be doing?

Mr. AKIN. And you are saying hypersonics really just doesn't fit in your—

Dr. GRIFFIN. No, quite the contrary. I am quite enamored of hypersonics, but some of the particular programs that you are talking about may not have been the ones that we would care to pursue. Hypersonics is part of fundamental aeronautical science, and we do want to pursue it. We are, as I said earlier, reworking our aeronautics strategy to focus on these fundamental issues. Some of these particular vehicle demonstrations, that had been done, or were planned, are not things that we believe really should be done.

I understand that Boeing is annoyed. They lose no opportunity to tell me that they are annoyed. At this point, they have to get in line. I don't know what else to say.

Mr. AKIN. What was the problem? This particular vehicle just doesn't meet your needs?

Dr. GRIFFIN. I would like to take that for the record, and get back to you with a fully detailed answer on where we are there.

Mr. AKIN. Okay. Thank you. Thank you, Mr. Chairman.

Dr. GRIFFIN. Thank you.

Chairman BOEHLERT. Mr. Administrator.

Dr. GRIFFIN. Mr. Chairman.

Chairman BOEHLERT. Thank you so much. I appreciate your indulgence. I am sorry that we were rudely interrupted by the House, and so we had to take about a 40 minute break, but I really appreciate it, and I do, once again, want to restate how much we welcome your style, and the substance you bring to that style.

Thank you very much. Hearing adjourned.

Dr. GRIFFIN. Thank you, sir.

[Whereupon, at 1:42 p.m., the Committee was adjourned.]

## Appendix 1:

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ANSWERS TO POST-HEARING QUESTIONS

## ANSWERS TO POST-HEARING QUESTIONS

*Responses by Michael D. Griffin, Administrator, National Aeronautics and Space Administration*

**Questions submitted by Chairman Sherwood L. Boehlert**

*Q1. Section 102(b) of the NASA Authorization Act of 2005 directs NASA to provide a report on the expected budgets for NASA as a whole under various assumptions. The report is due on April 30, 2006. However, you testified that the report would not be completed by the required due date. Please provide a date when the report will be provided to the Committee.*

A1. NASA anticipates providing the report to the Committee on June 30, 2006.

*Q2. Last October, NASA provided the Committee with a cost estimate of \$104 billion to return to the Moon by 2018. Is this number an average of a range? If so, what is the range in the cost estimate? What technical content is included in the scope of this estimate? Does this include CEV support to the International Space Station (ISS)? If not, how much is it expected to cost for CEV to support the ISS?*

A2. The cost estimate from last fall was generally developed using parametric cost models. The estimate reflects the conceptual designs of the various architectural elements defined by the Exploration Systems Architecture Study (ESAS). The estimate of \$104 billion covered the Design, Development, Test, and Evaluation (DDT&E) and early operations costs from FY 2006 through FY 2018. It included the funds for government management of the Constellation Systems program and the costs for Crew Exploration Vehicle (CEV). This total did not include CEV support to the International Space Station (ISS). If those costs are included, the total through 2018 would be \$124 billion. This includes \$104 billion for the non-recurring cost of all the Vision for Space Exploration (VSE) systems and the recurring cost of the lunar program through 2018, and another \$20 billion booked for ISS support through 2016. It is important to note that NASA now hopes to use more cost-effective commercial services to transport crew and cargo to the ISS. The orbital cargo and crew transport demonstrations are scheduled to take place as early as 2008 and 2010 respectively.

The ESAS estimate for Constellation Systems included the development costs of the CEV, Crew Launch Vehicle (CLV), new EVA suits and crew equipment, launch and missions systems and infrastructure needed to support the CEV and CLV, and the Exploration Communications and Navigation Systems (ECANS) needed to support lunar missions. The cost estimate was based on enabling a first crewed launch no later than 2014, and potentially sooner, as well as a lunar surface expedition as early as 2018, but no later than 2020. All of these elements are necessary to the success of the exploration architecture and all are major cost drivers.

To arrive at the average value in the estimate, NASA used the NASA/Air Force Cost Model (NAFCOM). NAFCOM calculates the probable costs for a project as compared to previous and similar projects. The model can be run with a confidence level ranging from 35 percent to 50 percent (the confidence level represents the likelihood that the project will be completed at or below the estimated cost). NASA used the mean (50 percent) NAFCOM values, then increased the estimates to provide a higher confidence level of 65 percent.

Currently, the Constellation Program is refining cost estimates against a requirements review cycle for Constellation Systems as part of the overall FY 2008 budget formulation process. These cost estimates will be refined over the next six to eight months as we begin to definitize the contract costs for Constellation systems. The next estimates will provide the basis for the FY 2008 President's Budget Submit for NASA next fall.

*Q3. The Defense Science Board recommended that space programs be budgeted to an 80 percent confidence level cost estimate, including reserves. What confidence level will NASA use to develop its next set of updated cost estimates for the Constellation program? Please provide a justification for the confidence level selected. Also, we understand the current 65 percent confidence level assumes a budget profile different from the one actually proposed in the fiscal 2007 budget request. Is this correct? How much does the actual funding profile lower the confidence level?*

A3. NASA is currently formulating its risk policy for new programs. Once the risk policy is determined, it will be codified in NPR 7120.5D and the *NASA Cost Estimating Handbook*. However, we will not be budgeting to the 80th percentile for indi-



vidual projects across-the-board. Doing so, especially in Mission Directorates such as the Science Mission Directorate (SMD), where there are many individual projects and less correlation across projects, would result in a total SMD portfolio confidence level of 85 percent to 95 percent, which ties up too much money in reserves. Budgeting to a confidence level of 60 percent to 70 percent in SMD will yield a more reasonable portfolio confidence level of about 80 percent. There are numerous other considerations as well. For example, budgeting to “high” confidence levels for the Phase C/D work while still in Phase A would tend to eliminate potentially promising projects before they have had time to accomplish the risk reduction that is a natural part of Phase A.

In summary, the selection of a confidence level is multi-faceted, and should be decided on a project-by-project basis. For Category I and II projects, the NASA Headquarters Program Analysis and Evaluation Office will be performing independent cost estimates and recommending budget levels to the Program Management Council that reflect appropriate confidence levels. It may take several years for NASA to achieve revised budgetary confidence levels for ongoing programs.

*Q4. Last fall at a hearing before the Committee, you stated that you had directed two teams to examine the minority reports in the Stafford-Covey report. One team, headed by the Associate Administrator for Space Operations was to develop a set of specific actions to address issues raised by the minority reports. Another team, headed by the Program Analysis and Evaluation Directorate, was asked to assess the Safety and Mission Assurance program within NASA. What progress have these teams made? What specific results and recommendations have they made? What are your plans to implement their recommendations?*

*A4.* The Space Shuttle program is actively implementing the core observations made from several of the Task Group members. The *Vision for Space Exploration* clearly defined the mission of the Space Shuttle program as the completion of the International Space Station. It also specified that this mission would be complete by the end of fiscal year 2010. NASA has developed a clear, unambiguous plan to execute this direction that enables our exploration activities. NASA and the Space Shuttle program leadership are being held accountable to these goals.

Similarly, the Space Operations Mission Directorate leadership has reinforced the systems engineering rigor established prior to return-to-flight by ensuring that testing will be used to verify the results of analysis and modeling used in space flight programs. For example, the Space Shuttle program has established a plan for verifying the integrity of the external tank that will be flown on the second return-to-flight mission, STS-121, and subsequent missions. This plan involves both analysis and testing to verify analytical results.

NASA is working to ensure that not only our engineering but also our management practices are rigorous and appropriate. In keeping with this commitment to management excellence, the Space Shuttle program has a new management team with a strong mix of skills and experience. This management team, led by Mr. Wayne Hale, is uniquely suited to managing the particular challenges of concurrently operating and shutting down the aging Shuttle system while supporting transition of those elements necessary for exploration.

The Space Shuttle program continues to learn from its experiences and is finding ways to share those experiences both within and outside of the Program. At management status reviews, managers share decisions made and the information available at the time of those decisions to assess effectiveness. This approach was successfully applied to the International Space Station Program and, as a lesson learned from that activity, is being employed in the Space Shuttle program. The Space Operations Mission Directorate is working closely with the Exploration Systems Mission Directorate as the latter develops its new vehicles and systems for exploration to ensure the knowledge base of the current operation programs is applied.

With respect to the assessment of the Safety and Mission Assurance program, the NASA Exploration Safety Evaluation Study (NESS) team was established in October 2005. A copy of the memo establishing the team follows.

National Aeronautics and  
Space Administration  
**Office of the Administrator**  
Washington, DC 20546-0001



October 21, 2005

TO: Officials-in-Charge of Headquarters Offices  
Directors, NASA Centers

FROM: Administrator

SUBJECT: Agency Support for Exploration Safety Evaluation Study

With the announcement of the President's Vision for Space Exploration, NASA entered a new and exciting era of exploration. With the architecture developed by the Exploration Systems Architecture Study (ESAS) Team, we have begun to build on the accomplishments of the past and move forward, first to the Moon, and then on to Mars. I know that I am excited by this prospect, and I hope you are as well.

We must be fully prepared to embrace this new era. Numerous events have convinced me that we at NASA must undertake a top-to-bottom review of safety and mission assurance. It is time to review our policies, procedures, and personnel to see how we can better ensure the safety of the remaining Shuttle flights. In turn, this will better prepare us for new challenges that are certain to be presented by the exploration adventure to come.

To address these issues, I have established a NASA Exploration Safety Evaluation Study under the direction of Bill Claybaugh in the Office of Program Analysis and Evaluation. The study will be conducted in two phases, the first of which will be to gather data.

This will involve visits by a small team of individuals to the safety organizations at all the NASA Centers. The purpose of this phase will be to establish the current "on the ground" situation in the area of safety across NASA. The findings from this first phase will be used by a core team, in a second phase effort, to recommend improvements to the current safety program.

I ask all of you to support this most important effort.

  
Michael D. Griffin

### Process and Status

The team leadership organized the study, the NESS into two Phases. The first Phase, which was completed this past January, involved a small team of selected experts visiting the ten NASA Centers, the NASA Engineering and Safety Center and HQ, to "establish the current 'on the ground' situation of the Safety and Mission Assurance Organizations across NASA." The findings of the first Phase were used to establish the core team for a Second Phase effort to develop recommendations for improvements to the current safety organizations.

The core team members, consisting of a dozen specialists, were assigned areas of investigation. Each core team member in turn assembled a sub-team of additional civil servants and consultants to assist them in their investigations. The core team and sub-teams have conducted additional Center visits as required to assemble their observations and resulting findings in each of their areas.

In addition, the study leadership has selected a diverse team of senior advisors consisting of former NASA, NASA associated, non-NASA government personnel and noted academics. This Senior Advisory Group (SAG) was chartered to review the study as it developed and to provide suggestions for the study effort. The SAG has already met twice with the core team. The purpose of the first meeting was to introduce the SAG members to the study and the core team. The purpose of the second meeting was to engage the SAG in a review of the observations obtained and the findings developed. The SAG comments helped to further focus the activity of particular safety concerns, and they suggested additional areas for data collection or investigation.

The core team is now focused on the development of recommendations that can be implemented and that are directly supported by the observations collected and the subsequent findings. A draft set of recommendations are expected to be completed by the end of March. The recommendations will then be discussed in a third meeting with the SAG, which is scheduled for March 27. These recommendations will be briefed to the Administrator on March 28.

Upon completion of these reviews, the core team will incorporate final suggestions made by the SAG and the Administrator, as it deems appropriate, and then focus on the development of the final set of recommendations. Additionally, a draft final report and associated presentation will be developed to document the NESS study.

The core team activity is scheduled for completion at the end of April and a final report is currently scheduled for delivery to the Administrator in May 2006.

*Q4a. What specific results and recommendations have they made?*

*A4a.* At present, no results have been finalized and no recommendations have been made.

*Q4b. What are your plans to implement their recommendations?*

*A4b.* At present, no recommendations have been made.

*Q5. Last year, Congress provided an exception to the Iran Nonproliferation Act (INA) to allow NASA to make purchases through 2012 for Russian Soyuz capsules and Progress logistics supply vehicles. What is a rough estimate of how much money NASA plans to send to Russia through 2012? In the 1990s, money sent from NASA to Russia did not always make it into the hands of the people doing the work and the deliveries fell behind. For example, the Russian Service Module was delivered 27 months late. What controls are in place to make sure the money goes to the proper people?*

*A5.* Due to the current INA legislation, as amended NASA cannot contract with the Russian Space Agency for ISS services past December 31, 2011, although the requirement for Crew & Cargo services is expected to continue beyond 2011. There is a possibility that a U.S. commercial cargo delivery capability may exist by the end of 2009, therefore NASA is not currently contracting for Russian cargo services past 2009. Within those limitations and consistent with current laws and regulations, NASA intends to contract with the Russian Space Agency for roughly \$725 million through 2010 for crew rotation and rescue, cargo delivery services, and some accompanying hardware development and integration services.

Although delivery of the Service Module was late, its development and delivery was not part of the Russian contract with NASA. The Service Module element was a part of the Russian contribution to ISS and Russia was wholly responsible for the entire funding of that module. During the time the Service Module was being developed complications resulted from, among other things, a lack of appropriated funds from the Russian government.

Under NASA contract 15-10110 there are control mechanisms in place such as a milestone billing arrangement and audits. Milestone billing events are used to track RSA progress through the entire contract effort and each milestone is based on work completed and found acceptable for payment. Each contract line item is subdivided into numerous milestone events in order to ensure appropriate insight is maintained with respect to contract performance. Since the award of NAS15-10110, NASA has performed three audits to assess the Russian Space Agency and subcontractor financial processes. The primary focus of the audits was the flow-through process from receipt of the money from its bank in the United States to the disbursement to the first tier subcontractors. Our audits revealed traceability of the funds from the prime to the subcontractor. We continue to work closely with our Russian counterparts and the first tier subcontractors and should we encounter any issues with respect to flow down of monies to the subcontractors, NASA would perform another audit.

NASA has experienced reliable performance of those Russian deliverables that are on the contract, such as Androgynous Peripheral Docking System (APDS), Airlock Depress Pumps, and Soyuz Anthropometric modifications.

Q6. *NASA estimated that it needs \$760 million to address damage sustained as a result of hurricanes in 2005. Congress provided \$350 million in supplemental funding. Please provide a list of projects that will be completed with the current funding and a prioritized list of projects that will not be funded.*

A6. NASA's early estimate was \$760 million, but the Agency has continued to refine cost estimates for all Hurricane Katrina recovery activities. After a detailed review by the Katrina Headquarters Recovery Team, as of April 25, 2006, the Agency reduced its total estimate of all costs for responding to Katrina and for catastrophic risk mitigation projects that would protect against future hurricanes to \$483.8 million. Review of the content in this estimate is ongoing and will continue to be revised; NASA will keep the Committee informed of future adjustments to the estimate.

As has been discussed during hearings and in briefings with Committee staff, NASA borrowed \$100 million in FY 2005 funds from the Space Shuttle and International Space Station (ISS) cargo/crew programs to provide immediate support of hurricane recovery efforts in the Gulf region before any supplemental funds were provided. The intent was to eventually repay these programs for this initial outlay of funds, and NASA repaid \$20 million of the amount borrowed in the May update to the FY 2006 Operating Plan.

NASA currently has available \$384.8 million in FY 2006 funding from two emergency supplemental appropriations and \$80 million in FY 2005 funding that was borrowed from the Shuttle and ISS crew/cargo programs. NASA may repay approximately \$20 million in additional borrowed FY 2005 funds that are not yet spent in a future Operating Plan update. The Agency continues to require transfer authority to use up to \$60 million in available FY 2006 supplemental funding to repay the balance of funds borrowed and expended in FY 2005 to allow the Agency to adequately fund the requirements of the Space Shuttle and ISS programs.

Hurricane-related Center recovery and operations costs, along with real property repairs and programmatic recovery requirements are accommodated within the current funding availability. Catastrophic loss mitigation projects will be addressed on a priority basis depending on the availability of funding.

The following center recovery operations, real property repairs, and programmatic recovery activities are likely covered within available funding:

*STENNIS SPACE CENTER Estimated Cost (in \$millions)*

Center Recovery Operations Support	17.0
IT/Communications/Environmental/Other	6.0
Programmatic Recovery	3.0
Real Property Repairs	82.61*
• Repair Site wide Electrical Distribution System	7.79
• Repair/Replace Roofing Various Administration Buildings	7.95
• Replace Bldg 2204 Roof	7.91
• Repair Administration Building 1100	7.65
• Repair and Replace Perimeter Fencing	7.95
• Replace Bldg 1100 North Wing & Bldg 1105 Roof	1.03
• Repair Bldg 2205 High Bay Roof (complete)	0.73
• Repair Building 1100 North Wing—Interior	2.70
• Site wide Mold Remediation and Asbestos Abatement	2.44
• Replace Bldg 2201 Roof	3.50
• Repair/Replace Roofing Various Industrial Complex Buildings	1.74
• Repair/Replace Roofing Various Test Complex Buildings	1.99
• Site wide Debris Cleanup	1.59
• Replace Bldg 8100/8110 Roofs	3.04
• Site wide Lightning Protection Repairs (Multiple Projects)	0.80
• Relocate Roads and Grounds Building	0.87
• Repair and Pave Roads for Heavy Vehicles	2.88
• Education Center (Replacement for Bldg 1200)	1.93
• Site wide Electrical Panel Enhancements and Database	1.06

- Local Projects (<\$500K) and Maintenance Items 7.06

\* Does not include \$13.7M in program manager reserve

*MICHOUD ASSEMBLY FACILITY Estimated Cost (in \$millions)*

Center Recovery Operations Support	20.9
IT/Communications/Environmental/Other	2.4
Programmatic Recovery	42.5
Real Property Repairs	69.00*
• Hazardous Materials Investigation	0.05
• Repairs of B103, Phase 1	2.50
• Repairs of B451, Phase 1	0.75
• Repairs of B114	0.60
• Repairs to Damaged Elevator B110	0.10
• B303 Temporary Roof Repair	0.09
• TBD Projects during test and checkout	0.50
• MSFC—COSS Contractor Support for damage assessment	0.04
• MSFC—M1 Yard Roof Repairs	0.01
• MSFC—Remove Damaged Trees and Repair B4707 Tower Roof	0.02
• Work Plans for B420, 110, 114, 103, 303, 451, 220, 101, 102, 173, 175, 320, 404	0.94
• Local Projects (<\$500K) and Maintenance Items	5.21
• Repairs of B110, Phase 2	6.40
• Repairs of B173	2.02
• Repairs of B175	0.68
• Repairs of B220	1.37
• Repairs of B303	6.60
• Repairs of B320A	1.54
• Repairs of B320B	0.94
• Repairs of B404	1.49
• Repairs of B420	5.63
• Repairs of B103, Phase 2	4.77
• Repairs of B451, Phase 2	1.50
• Repairs of B101	5.04
• Repairs of B102	8.22
• Repairs B75, 105, 106, 107, 109, 113, 119, 127, 130, 131, 135, 140, 171,176, 177, 178, 179, 201, 203, 206, 207, 221, 232, 239, 301, 302, 304, 305,307, 308, 318, 321, 327, 329, 359, 351, 360, 361, 406, 409, 421, 423, 424, 419, 450, 480, 485	12.00

\* Does not include \$10.0M in program manager reserve

*NASA SHARED SERVICES CENTER Estimated Cost (in \$millions)*

Recovery/Workarounds 7.7

*OTHER NASA CENTERS/HQ SUPPORT/RESERVE Estimated Cost (in \$millions)*

Center Recovery Operations Support	2.2
Other General Support	4.0
FEMA Volunteers	1.9
Program contingency/Reserves	39.2

The following potential catastrophic loss risk mitigation projects have been identified. Unless noted, the majority of these projects have not yet been approved for funding. Projects for each Center are listed in order of priority.

*STENNIS SPACE CENTER Estimated Cost (in \$millions)*

- Hurricane Proof Emergency Operations Center 14.90\*
- Replace and Enhance Backup Generator Capability Site-wide 3.00

- Enhance Site-Wide Electrical Distribution System Hardening 18.65
- Add Additional Bulk Diesel Storage 0.50
- Enhancement to Potable Water Pump Houses 0.10
- Emergency Communications and EMCS Enhancements 0.90
- Hurricane Proof Record Retention Facility 2.50
- Relocate Electrical Equipment Building 1200 1.00
- Expand and Enhance Communication Ductbank 3.00
- Inspect Bridge and Locks 1.00
- Dredge Canal 3.00
- Enhance Administration Building 1100 3.00
- Test Complex High Pressure System Uninterruptible Power 30.00
- Design Cost (six percent) 4.89

*Total*    \$86.44

\*Project is approved for funding. The total project cost is \$21.4M; the remaining \$6.5M will be funded with FY 2005 Institutional CofF funds.

*MICHOUD ASSEMBLY FACILITY Estimated Cost (in \$millions)*

- Upgrades to Pump House 11.00\*
- Install levee floodgate at barge dock 0.70
- Upgrades to Emergency Operations Building 3.30\*
- Rewire security cameras to operate on emergency power 0.70\*
- Replace electrical feeders on poles below ground 5.00
- Reconfigure computer servers to provide critical ops during severe weather 5.00
- Replace main manufacturing building exterior siding 7.00
- Levee improvements (requires Corp of Engineers coordination and app) 5.00
- 100 percent increased labor, materials, and transportation costs 37.7

*Total*    \$75.4

\*\$1.7M in funding has been approved for MAF projects as follows: \$300K for designs and studies, \$600K for remote controls for the existing Pump House, \$500K for relocating the MAF Emergency Operations Building, and \$300K for security cameras. The "Install levee floodgate at barge dock" project will be approved for funding as soon as design is complete.

*Q7a. What is the current estimate for building and launching a free-flying Landsat mission?*

A7a. The FY 2007 President's Budget Request shows a life cycle cost for the Landsat Data Continuity Mission (LDCM) of \$554.1 million. The Operating Plan sent to Congress on May 31, 2006 transferred \$5.7 million out of LDCM for the Orbiting Climate Observatory (OCO). The present life cycle cost includes \$17.2 million for the Data Buy Mission that ended in 2003 and \$22.7 million for the development of the Operational Land Imager (OLI) instrument for flight on National Polar-orbiting Operational Environmental Satellite System (NPOESS) mission. The revised estimate for building and launching a free-flying Landsat mission is still being worked as part of the FY 2008 Budget Request.

*Q7b. Please also provide an estimate for the annual operating costs for such a mission.*

A7b. NASA is responsible for acquiring the LDCM free-flyer, launch, on orbit check-out and delivery acceptance. Following the prescribed on-orbit acceptance period, NASA plans to transfer ownership of the observatory and the associated contract to the U.S. Geological Survey (USGS) who will then operate the spacecraft and manage the data. Operating costs are reflected as a DOI/USGS responsibility and are reflected in the Department of Interior (DOI)/USGS Budget Requests.

*Q7c. Will the sensor requirements for a free-flying Landsat mission be the same as for the previously planned Landsat Data Continuity Mission?*

A7c. The Landsat Data Continuity Mission performance requirements are consistent with the previously identified performance requirements and are commensu-

rate with the definition of data continuity as prescribed in Sec. 5602, Public Law 102-555.

*Q7d. Will these requirements include the thermal band, which has been included in previous Landsat satellites, but was dropped from the Landsat Data Continuity Mission requirements?*

A7d. The acquisition approach for the LDCM free-flyer will include an option for the thermal band.

*Q8. In implementing its plans for returning to the Moon, how will NASA avoid the cost growth, schedule delays and technical problems experienced by other space programs, such as Space Station, the James Webb Space Telescope and others? If the program's cost grows, will NASA live within the projected FY 2007 budget (so-called "go-as-you-can-pay" as stated in the Vision) or will it seek to redirect funds from other programs?*

A8. The FY 2007 President's Budget Request for NASA provides the resources necessary to bring the Crew Exploration and Crew Launch Vehicles online by 2014, and potentially sooner.

Our cost estimates will be refined in an iterative process over the coming year as NASA more fully engages its field Centers and contractors, receives industry proposals, and as the architecture design is refined. Program requirements and costs are being refined through a series of design cycles—with high-level trades and costing occurring in early cycles, and complete, more refined analysis in later cycles. Definition of the exploration architecture in July 2005, as part of the Exploration Systems Architecture Study (ESAS), was the first cycle in this process. The President's FY 2007 Budget Request is the basis of the second analysis cycle. The results from this analysis represent NASA's best understanding of program costs. Refinement will continue until the program is baselined at its preliminary design review. NASA believes the current cost estimate includes sufficient cost contingency to address the normal developmental problems of complex projects.

NASA has been careful to use conservative assumptions were used in generating the cost and schedule for Constellation. Cost modeling was done using the NASA Air Force Cost Model (NAFCOM), the government standard for generating parametric estimates for complex space systems. The architecture has been based on mature, known technologies, maximizing the utilization of heritage systems from Shuttle and design data from Apollo. Costs were estimated conservatively and assume an appropriate amount of NASA oversight with reserves added ensuring a 65 percent confidence factor.

In addition, NASA is taking a more rigorous approach to the requirements definition and formulation than in some previous programs. Programmatic and technical decisions will be weighed by their impact on total life-cycle costs as opposed to their short-term budget implications. We are also implementing management tools such as Earned Value Management, a thorough Risk Management process, and are using a single Integrated Collaborative Environment to facilitate the coordination of work across the Centers.

Other factors to take into consideration:

- No credit was taken for potential outside investments from international partners and industry.
- Extra effort has been put into developing sound requirements.
- Design cycle goals:
  - Baseline requirements at system requirements review (SRR) in fall 2006
  - Complete independent review of requirements and cost estimate in spring 2007
  - Baseline technical design, cost, and schedule at preliminary design review (PDR) in 2008
- In the case of CEV, NASA has incorporated existing designs for the first stage engine and upper stage engine, which is allowing more accurate explanation of costs.
- Synergies between ESMD and SOMD activities will lead to efficiencies in capacity utilization; lowering the cost of future operations.
- NASA intends to actively pursue commercial participation in Exploration, which could reduce the cost, accelerate the schedule or increase the capability of the program.

Constellation program will continue to make the most optimal trades between schedule, content and risk to ensure the most robust program possible is done with-

in the budget available. Two essential ingredients to effectively manage a major multi-decadal program are funding stability and management performance.

*Q9. A mission to Jupiter's moon, Europa, has been ranked as the highest priority by the National Academy of Sciences. It is also a mission that has earned Congress' interest, as expressed in NASA's FY 2006 appropriations bill (Science, State, Justice and Commerce, now Public Law 109-108), directing the agency to begin planning a mission, and "to incorporate a new start for a non-nuclear Europe mission as part of its FY 2007 budget request." Why did NASA choose to ignore this direction by omitting any funding request for Europa?*

*A9.* There are insufficient funds available in FY 2007 to begin a Europa mission. Further, based on recent scientific discoveries and discussions on budget priorities, a Europa mission may no longer be the top priority. We intend to discuss this issue further with the NASA Advisory Council, with representatives of the science community and the Space Studies Board of the National Academy of Sciences, and will seek their advice to ensure that we maintain an appropriate mix within each SMD Division between R&A, small-, medium-, and large-class missions.

*Q10a. What impact will the reduction in Radioisotope Power Systems and related technology developments have on U.S. exploration and science capabilities?*

*A10a.* The reduction in budget for Radioisotope Power Systems (RPS) and related technology developments is not likely to impact science and exploration capabilities within the planning horizon. The RPS budget reductions were accommodated by delaying flight qualification of advanced technologies. Since many future science missions (such as the next Outer Planets Mission and selection of the next New Frontier Mission) have now been delayed, the budget reduction has no immediate impact on these missions. With a reduced budget, we are currently focused on developing and demonstrating advanced RPS technologies with the goal of increasing power conversion efficiency (which will reduce consumption of nuclear fuel) and specific power in terms of watts/kg (which will enable larger science payloads) to meet the needs of future science missions. The technologies, although being developed for future science missions, have potential for future exploration missions. For example, one of the technologies being developed in the RPS program, an advanced stirling radioisotope generator (SRG) with a potential for six-fold increase in efficiency, is of interest for lunar surface power applications in support of the exploration missions. The advanced technologies could potentially be transitioned to flight system development after a decision is made on the launch date for future science and exploration missions.

*Q10b. We have been told that without radioisotope power systems we will not be able to do missions beyond Jupiter and that there are no more radioisotope power system units in production. Is this true? If this is not restarted, will it still be possible to conduct future robotic missions beyond Jupiter?*

*A10b.* For most space exploration missions where sunlight is abundant, solar power has been the preferred choice. But RPSs enable missions where solar and battery power would be inadequate. RPSs can operate at vast distances from the Sun, and have little or no sensitivity to cold, radiation or other space environmental effects. They are ideally suited for long-lived missions involving autonomous operations in the extreme environments of space and on planetary surfaces. RPSs have enabled exploration of the Sun, Mars, Jupiter, Saturn, Uranus and Neptune, and soon, Pluto.

Therefore, we agree that scientifically meaningful missions beyond Jupiter cannot be accomplished without RPS. Even at Jupiter, long-duration missions would require RPSs because of its radiation environment. It may be possible to conduct missions beyond Jupiter without RPS, but the goals and the results would be quite limited in scope. Mission requirements such as mission lifetime, energy required to operate scientific instruments, and the operating environment for the spacecraft would result in a continuing need for these systems.

RPSs would be required for the exploration of numerous high-priority science destinations in the solar system. The next RPS-powered mission will be the Mars Science Laboratory (MSL) that is scheduled to launch in 2009. Beyond MSL, NASA is considering several radioisotope powered missions, such as the Mars Astrobiology Field Laboratory, Solar Probe, and the Europa Geophysical Explorer. In addition, NASA is studying the potential of various lunar surface power capabilities that may require RPS to enable extended robotic and human exploration; however, the specifics of the missions and timelines are not yet firmly established.

Most of the past NASA deep space missions (such as Galileo, Cassini, and Pluto) have used an RPS system, called General Purpose Heat Source Radioisotope Ther-



moelectric Generator (GPHSRTG), which is no longer in production. However, there are enough spare thermocouples left over from the past missions to fabricate at least two (can power two more New Horizon Pluto type missions) and possibly three more GPHSRTG units (with capability to power one Cassini type mission). We have recently initiated efforts to refurbish these thermocouples, which would enable us to fabricate these if a decision was made for the next outer planets mission and if advanced technologies have not been demonstrated.

Within the Mars program, we are currently developing a Multi-mission Radioisotope Thermoelectric Generator (MMRTG) system that is capable of operating in the deep space of vacuum as well as in planetary atmospheres. The MMRTG has the same conversion efficiency as the GPHSRTG (which cannot operate in Mars atmosphere), but is heavier. The MMRTG is targeted to be used for the Mars Science Laboratory that will be launched in 2009, with production capability established by 2008. An MMRTG could be used for future Mars missions and near-term lunar missions.

In summary, while advanced technologies are being developed in the RPS program to meet long-term science and exploration needs, we have several options available for meeting our near-term needs.

*Q11. NASA is the Federal Government's lead R&D organization for air traffic management, and the future success of the Joint Planning and Development Office (JPDO) hinges on NASA's ability to research and develop new technologies to accommodate an expected tripling in the air traffic system by the year 2025. Given the huge role played by NASA in this endeavor, why did the agency propose reducing Airspace Systems Research by almost one-third for FY 2007? How could this cut be implemented without jeopardizing the JPDO's mission?*

A11. NASA is putting in place a strategic plan for Aeronautics research that addresses many of the research challenges facing the successful realization of the JPDO vision for the Next Generation Air Transportation System (NGATS). While Air Traffic Management (ATM) is a significant element of that vision, it is not the only challenge that must be addressed. The future air vehicles of the system will need to address substantial noise, emissions, efficiency, and performance challenges. These challenges will be addressed in our Fundamental Aeronautics Program.

Furthermore, as we develop increased capabilities in our future air vehicles and airspace system, we must continue to conduct the research necessary to ensure that our high safety standards are not compromised. Our Aviation Safety Program will address aircraft safety technological barriers that would otherwise constrain the full realization of the NGATS. Thus, in addition to the fact that the entirety of the Airspace Systems Program is devoted to ATM research in support of NGATS, a substantial amount of research conducted in the Fundamental Aeronautics Program and the Aviation Safety Program will also directly address NGATS challenges. NASA has constructed a balanced research portfolio that draws upon our NASA-unique capabilities to address ATM, environmental, and safety-related research challenges, all of which must be worked in order for the NGATS vision to be realized in the JPDO mission.

It should also be noted that the decline from FY 2006 to FY 2007 in the Airspace Systems program is due in part to the phasing out of certain projects. The Small Aircraft Transportation Systems (SATS) was scheduled to be completed in FY06 after a successful demonstration in June 2005. UAVs in the (NAS) has been transitioned to the FAA, per direction from the FY 2006 NASA Appropriations language. The Space-Based Technologies Project has also been phased out, because it was duplicative of research being conducted by the Department of Defense (DOD). The sum total of these FY 2006 budgets was \$13.6 million. In addition, \$8.0 million of site-specific earmarks were not included in the FY 2007 budget. These items represent over 12 percent of the FY 2006 Airspace Systems budget.

Finally, it is important to recognize that while the NGATS vision is a very important element of NASA's aeronautics research portfolio, NASA has an obligation to ensure that it applies its unique research capabilities to other national needs. This obligation includes partnerships with the DOD and industry in support of cutting-edge research in hypersonics, supersonics, and rotorcraft. This obligation also includes a commitment to support the *Vision for Space Exploration* by conducting fundamental, cutting-edge research in such areas as hypersonics, aerothermodynamics, advanced materials, and integrated vehicle health management.

*Q12. The FY 2007 budget transfers more than \$3.5 billion to Space Shuttle and Space Station over the next five years. Are the Space Shuttle and Space Station programs now fully funded for the next five years? Do the projected budgets in-*

*clude adequate reserves? What additional funding, if any, might be necessary to make the Space Shuttle and Space Station programs whole?*

A12. With the \$3.5 billion transfer to the Space Shuttle and International Space Station programs over the next five years, these programs are now fully funded. The FY 2007 budget provides adequate reserves for the Space Shuttle program to support the program baseline, cover technical uncertainties for operations, and any residual Shuttle Return to Flight (RTF) requirements. As tasks are completed, any remaining funds will be “recovered” and applied to other tasks or held as reserve to support program phase-out and severance/retention activities as needed. The ISS program does face a reserve management challenge in FY 2006 and FY 2007 due to institutional impacts and overhead. NASA does not anticipate needing any additional money for the programs over the next five years.

Q13. *When do you expect to increase the Space Station crew size to six? How important do you consider a larger crew size, now that NASA will not be conducting the broad research program that was originally planned?*

A13. NASA expects to have the capability to increase the ISS crew to six in the 2009 timeframe. It is essential that the ISS be staffed with six crew members to complete the final stages of ISS assembly and achieve the science goals set by the U.S. and our international partners.

Q14. *NASA has dropped the requirement for the Crew Exploration Vehicle (CEV) to use a U.S. docking system, called the Low-Impact Docking System, which is now under development. Why was this done? Without a U.S. docking system, won't the U.S. continue to be reliant on Russia for these systems? What are you doing to ensure that the U.S. is not dependent on foreign suppliers for critical items?*

A14. The Low Impact Docking System (LIDS) was recommended by NASA's Exploration Systems Architecture Study (ESAS) as the docking mechanism of choice for the CEV, and NASA is continuing to develop this technology for use by the CEV and other exploration spacecraft. NASA recognizes, however, that deploying the LIDS adaptor to the International Space Station (ISS) would require that an extra Space Shuttle mission be manifested, and that development of the LIDS be accelerated to accommodate the Space Shuttle retirement schedule of 2010.

NASA is currently conducting detailed analysis and is aggressively seeking more cost-efficient approaches to incorporating LIDS on the ISS, including options that do not require an additional Space Shuttle flight. NASA recognizes the importance of avoiding reliance on foreign suppliers for mission-critical items for which there is no domestic alternative, and plans to incorporate domestic capabilities for exploration systems in a manner that is both technically sound and fiscally responsible. Consistent with the objective of creating an open architecture whereby NASA can use non-U.S. capabilities for added programmatic robustness, NASA has analyzed alternatives and identified the Russian Androgynous Peripheral Attachment System (APAS) docking mechanism as a workable option for Crew Exploration Vehicle (CEV) missions to the ISS. If technical and fiscal issues require that APAS be retained, NASA would plan to purchase units from Russia in furtherance of our obligations under the international space station agreements. However, LIDS remains the baseline system and NASA fully intends to develop that system.

Q15. *NASA plans to fly the Shuttle on 16 missions to the Space Station, plus one to service the Hubble. NASA has also said it has plans for two Shuttle logistics missions that it might fly as a contingency. What is the likelihood that these contingency missions will be necessary? What are the factors that will be used to determine whether these contingency missions will be needed? When will a decision be made on whether these contingency missions will be flown or not? Could the contingency missions delay retirement of the Shuttle beyond December 31, 2010?*

A15. NASA intends to fly only 16 more Shuttle missions to the Space Station. The budget is sufficient to fly two logistical contingency missions, but those hypothetical missions will fly if and only if (1) they are absolutely needed to complete the ISS or bring up critically needed supplies and (2) can be safely launched without jeopardizing the Shuttle's 2010 retirement date. NASA expects that the 16 Shuttle flights planned to the Space Station through 2010, plus international and commercial services, will be sufficient to meet our international commitments and support Space Station research.

Q16. *NASA has decided to alter its implementation of the Independent Technical Authority (ITA). What were the issues that drove you to conclude that the ITA*

*construct was not adequate and required modification? Explain how the latest implementation of the ITA complies with the recommendations of the Columbia Accident Investigation Board (CAIB). If you have decided to take exception to any portion of the recommendation of the CAIB, please explain the rationale for the exception.*

A16. CAIB R7.5-1 recommended establishing an Independent Technical Authority for Shuttle. NASA established Independent Technical Authority (ITA) for the Shuttle and an expanded TA (Technical Authority) across NASA. The Technical Excellence initiative will expand the Technical Authority concept across NASA, consistent with Agency Governance NASA Policy Directive (NPD) 1000.3. The new model will fully institutionalize technical authority into the day-to-day practices and processes at NASA as recommended by the CAIB. Key attributes of the Technical Authority (consistent with CAIB recommendations) include: (1) Organizational independence from programs and projects and (2) Funding independence from programs and projects. Technical Authority is part of Technical Excellence, and builds on the lessons of the independent Technical Authority and other CAIB recommendations. The goal of Technical Excellence is to refine our way of doing business so that over the long-term, technical excellence, safety and mission success are part of our institution. The initiative will institutionalize the necessary processes and organizational culture changes to enhance and maintain technical excellence to enable safety and mission success.

#### **Questions submitted by Representative Bart Gordon**

Q1. *As NASA embarks on development of the vehicles and infrastructure needed to support the Vision for Space Exploration,*

- *What are the primary technical challenges you face, and how does your plan currently intend to address them?*
- *What are the primary cost challenges you face, and how does your plan currently intend to address them?*
- *What are the primary schedule challenges you face, and how does your plan currently intend to address them?*
- *Which of these is your higher priority: technical performance, cost, or schedule?*

A1. Constellation Systems has identified several challenges, both technical and programmatic, to the successful implementation of the Vision and currently is working mitigation strategies. As the architecture and program proceed through formulation, we expect these mitigation strategies to be developed more fully.

Within the Crew Exploration Vehicle (CEV) and Crew Launch Vehicle (CLV) programs, the primary technical challenge, according to our Risk Management Plan, is developing and integrating the upper-stage engine to support potential CEV launch dates earlier than 2014. The J-2X engine development is well underway, but there are technical challenges in the design, fabrication, and test of the modifications of this engine. These challenges can be overcome with a disciplined and aggressive engine development effort that focuses on rigorous testing. While development of the J-2X is a challenge, the derivative J-2S engine has a long heritage at NASA. The J-2S was scheduled to fly on later Apollo missions before the Moon program was canceled, and the more recent X-33 had been successfully testing the J-2S. Another significant technical challenge in support of the *Vision for Space Exploration* is that faced by the companies seeking to provide commercial cargo and crew services to the International Space Station. Success in this program will require that these companies implement new and cost-effective capabilities within a relatively short timeframe.

NASA's primary budgetary challenge is ensuring that the Agency receives the President's Budget request for Constellation. Any reductions in funding could cause substantial schedule delays. Retaining our year-to-year carryover intact in order to ameliorate the non-optimal phasing will be key to our strategy to maximize the probability of program success.

We believe that we can reach the milestone of launching the CEV by 2014. The primary schedule challenge that we face is attempting to launch the CEV before 2014.

NASA is working hard to ensure that these challenges are overcome. We will continue to refine cost, schedule and performance trades throughout the design cycle as the system design matures and gains fidelity, and will formally baseline an executable program at the Preliminary Design Review in the fall of 2008.

It is difficult to segregate technical performance, cost, and schedule risks. Each one has a direct correlation with the other two. However, given these considerations, cost and maintaining a level of confidence in our budget profile is critical.

*Q2. NASA's current plan is to limit space and Earth science growth to one percent per year from FY 2008 through at least FY 2011. This is equal to at least a 1.5 percent loss in purchasing power per year based on NASA's inflation rate assumptions. Although the Shuttle is scheduled to be retired in 2010, NASA's exploration plans assume that significant additional exploration funding will be needed in 2011 and beyond due to the initiation of large lunar exploration-related development programs such as the Heavy-Lift launch vehicle program. As a result, is there any reason to assume that it will be possible to increase science funding above a one percent annual growth rate even after the Shuttle is retired? What growth rate are you assuming?*

A2. NASA's FY 2007 Budget Request represents a concerted effort to ensure that each funded program has an executable budget, and that NASA's human space flight programs transition from the Space Shuttle Program to Exploration Systems in a coordinated way that minimizes the effect of the transition on other parts of NASA. To accomplish this, we made the decision to provide sufficient funding to the Space Shuttle Program to facilitate its completion over the next several years. We also overlapped the start up of the Exploration Systems work with the completion of the Space Shuttle Program. While these decisions created a temporary growth in the human space flight program funding, we were able to accommodate this transition while funding Science missions at 31 percent of NASA's overall budget for FY 2007 to FY 2011. With the ramp-down of the Shuttle Program and the ramp-up of the Exploration Systems development efforts behind us, NASA may be better positioned in the next decade to support an increased science budget.

NASA's 2006 Strategic Plan includes a goal to "Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human space flight program to focus on exploration." NASA remains committed to this goal and to the overall planetary science, astrophysics, heliophysics, and Earth science strategies described in the Strategic Plan that support this goal. The Strategic Plan serves as a foundation for shaping NASA's longer-term program planning and, indeed, many of the missions included in the FY 2007 budget request are not planned for completion until the FY 2012 to FY 2016 timeframe. Even with these current commitments, however, NASA will be able to accommodate the introduction of additional science missions in the FY 2012 and FY 2016 timeframe consistent with this Strategic Plan without assuming budget growth beyond inflation.

*Q3. Please provide a listing of all life and microgravity sciences-related research facilities, animal or plant holding facilities, or other hardware—whether totally or partially completed—that has been terminated or for which intent to terminate has been decided, providing the dollar value of each, as well as the disposition of the hardware.*

A3.

Terminated Flight Hardware*	Brief Description of Research Supported	Totally or Partially Completed	Cost to Date (\$M)**	Disposition of Hardware (Where is it? What will be done with it?)
<b>Nucleation and Growth Rate Studies (Delta-L)</b>	Microgravity crystallization experiment to determine the effects of microgravity and growth rate on crystal quality.	Completed	3.0	Bonded Storage
<b>Observable Protein Crystal Growth Apparatus (OPCGA)</b>	Microgravity protein crystallization experiment growth to determine the effects of microgravity on crystal quality and produce crystals for structural analysis.	Completed	19.6	Transferred to PI
<b>GEDS (Gravitational Effects on Distortion in Sintering)</b>	Materials science insert for MSRR Research Facility to investigate sintering process used extensively in industrial fabrication	Partially	6.6	In storage at MSFC
<b>Quench Module Insert (QMI)</b>	Materials science furnace for performing solidification of metallic and alloy materials.	Ground Hardware Completed	28.3	In storage at MSFC
<b>Coupled Growth in Hypermonotectics (CGH)</b>	Materials science investigation into controlling solidification in complex alloy systems.	Partially	0.5	No flight hardware
<b>Particle Engulfment and Pushing by Solidifying Interfaces (PEP)</b>	Materials science investigation into the production of uniform composite materials	Partially	0.5	No flight hardware

<b>Glovebox Integrated Microgravity Isolation Technology (g-LIMIT)</b>	Vibration isolation for acceleration sensitive ISS payloads	Completed	2.6	Bonded Storage
<b>FEANICS (Flow Enclosure Accommodating Novel Investigations in Combustion of Solids)</b>	Fire Safety, FPDS	Partially	10.5	Phase B Engineering Model Hardware completed and tested. Stored at GRC
<b>PBRE (Packed Bed Reactor Experiment)</b>	Water Reclamation, ALS	Partially	1.7	Phase A design; no flight hardware; aircraft rig in storage
<b>CHESS (Condensing Heat Exchanger)</b>	Thermal Control, ALS	Partially	2.3	Phase A design; no flight hardware
<b>TOFFy (Two-Phase Flow Facility)</b>	Thermal Control, ALS	Partially	3.9	Phase A design; no flight hardware; aircraft rig in storage
<b>PCS+ (Physics of Colloids in Space Plus) and PCS-3</b>	Microgravity Fluid Physics; Transition Research	Completed	3.5	Bonded Storage
<b>Porous Tube Insert Module</b>	Plant research to determine efficient nutrient delivery regimes in spaceflight.	Completed	0.5	KSC flight hardware storage.
<b>Advanced Biological Research System</b>	Biological experiments using controlled environments.	Partially	1.5	KSC flight hardware storage.
<b>AAH (Advanced Animal Habitat)</b>	Basic and applied research with animals on ISS. Follow-on to Advanced Animal Habitat - C (see AAH-C). Orbital Technologies Corporation (ORBITEC), Madison, WI	Partially (~25% completed)	8.6	All AAH Property is currently in storage at the ORBITEC facility in Madison, Wisconsin. Recommendation for disposition

				will be part of termination proposal due to ARC in April 06
<b>AAH-C (Advanced Animal Habitat-Centrifuge)</b>	Basic and applied research with animals on ISS. Initial development work on AAH. STAR Enterprises, Inc., Bloomington, In.	Partially	20.8	AAH-C (STAR) property was transferred to AAH (ORBITEC) and will be made part of the AAH Termination proposal in April, 2006.
<b>PRU (Plant Research Unit)</b>	Basic gravitational biology and Advanced Life Support research with plants on ISS. Orbital Technologies Corporation (ORBITEC), Madison, WI	Partially (~25% completed)	13.6	PRU Property was transferred to AAH (ORBITEC) and will be made part of the AAH Termination proposal in April 2006.
<b>CCU (Cell Culture Unit)</b>	Basic and applied research with cells and tissues on ISS	Partially (~75% completed)	26.3	CCU hardware will be abandoned in place at the contractor's (PSI) facility. Single Loop Cell Culture units will be delivered to ARC on or before June, 2006.

<b>Habitat Holding Racks</b>	ISS racks tailored to accommodate life science research specimens and support equipment	Completed	80.0	Flight hardware is stored at KSC.
<b>ISS Biotechnology Facility</b>	Express rack facility that supports Research in Biotechnology/Cellular and Molecular Biology/Tissue Engineering/Clinical monitoring	Partially	43.6	Space Bioreactors and Cell Science Incubators are in Bonded Storage at JSC. Advanced Cell Science Analytical Equipment is stored at JSC.
<b>Water processor for cell culture</b>	Culture media formulation from ISS water	Partially	2.9	Bonded Storage
		<b>Total</b>	280.8	

\*Terminations are post Zero-Based Review and ESAS

\*\*Costs reflect NASA development costs to the point of discontinuance

*Q4. Given the significant cuts to the International Space Station research budget for both exploration-related and non-exploration research, what is your rationale for continuing to invest in the ISS program?*

A4. In addition to meeting NASA's commitments to its international partners, completion of the ISS plays a significant role in the *Vision of Space Exploration*. The planned research, development, test and evaluation of selected systems, evaluation of biomedical protocols for human health and performance, and the validation of operational practices and procedures for long-duration space missions are essential to future successful human missions to the Moon and Mars.

*Q4a. Does NASA have definite plans to end its use of the ISS in 2016? If so, why? If not, why does your budget charts show funding for the ISS stopping at that time?*

A4a. NASA's current life cycle cost estimate for operation of the ISS is through 2016. NASA currently does not expect to continue funding the ISS after 2016. In the 2014 timeframe, NASA may consider an option to extend the operational life of ISS. At that time, a life extension analysis will be conducted to determine what would be required to ensure that the vehicle's systems and subsystems could continue operations.

*Q4b. If the ISS does cease operations in 2016, how do you intend to collect sufficient data to answer longstanding questions about the effects of microgravity on humans undertaking long space missions, such as to Mars and back, given you don't anticipate completing ISS assembly and restarting significant ISS research activities until 2010?*

A4b. Life science research centered on human health and the long-term effects of microgravity is already being performed on ISS and will continue through 2016. A large body of operational data has already been collected, and ongoing data mining activities continue to fill gaps in our knowledge.

To increase research opportunities, ground models and ground analogs are being further correlated with microgravity data from ISS so additional research is possible on Earth. In one effort, NASA is collaborating in a multi-agency modeling activity across several agencies (NIH, NSF, DOD, DOE) correlating research results and improving our ability to develop human health countermeasures.



Beyond ISS, NASA will gather additional data from free-flyer experiments, human sorties and long duration lunar surface missions to integrate with previous data sets and help reduce the risk for eventual missions to Mars and other destinations.

*Q5a. The NASA budget sets aside \$500 million over five years to help commercial companies develop space transportation systems to service the International Space Station. What precisely will those funds be used for?*

*A5a.* This funding supports Phase 1 (Demonstration Phase) of the Commercial Crew/Cargo Project. During Phase 1, NASA will enter into funded Space Act Agreements with one or more U.S. companies to develop and demonstrate the vehicles, systems and operations to support the International Space Station. Under Phase 1, NASA seeks proposals for Earth-to-orbit demonstrations of any one or combination of four capabilities:

- unpressurized external cargo delivery and disposal,
- pressurized external cargo delivery and disposal,
- pressurized internal cargo delivery and return, and
- crew transport.

NASA released the Space Act Announcement for Phase 1 on January 18, 2006. NASA has recently selected several companies for negotiations of potential funded Space Act Agreements to perform demonstrations of Commercial Orbital Space Transportation Services (COTS) capabilities. These companies were selected out of the proposals submitted for evaluation on March 3, 2006. NASA was extremely pleased with the number of quality proposals received and is expected to announce final selections later this summer.

After one or more successful demonstrations under Phase 1, NASA will competitively solicit commercial transportation services to and from the International Space Station under Phase 2 (Services Phase) of the Commercial Crew/Cargo Project.

These services are important to establishing an independent, domestic capability for supporting the International Space Station and other human space flight activities after the retirement of the Space Shuttle. Without such a capability, the U.S. will have to continue to pay international partners to support the International Space Station until the Crew Exploration Vehicle (CEV) is available and will have no domestic alternative to the CEV once it is fielded.

In addition to providing capabilities to NASA, companies will be able to offer their services to other customers. NASA hopes that the Commercial Crew/Cargo Project will provide building blocks for non-NASA space markets.

*Q5b. Do you consider the funds to be a subsidy to the commercial companies, or is NASA planning to recover the funds from the commercial companies when it negotiates contracts with them to service the ISS?*

*A5b.* The funds are not a subsidy. NASA anticipates that companies will propose and commit to substantial cost sharing for Phase 1 (Demonstration Phase) of the Commercial Crew/Cargo Project. Specific cost-sharing details will not be known until selections, negotiations, and awards are complete.

NASA does not plan to "recover" Phase 1 funds during Phase 2 (Services Phase). However, NASA anticipates that commercial transport services to support the International Space Station will be cost-effective compared to the Space Shuttle and the CEV, which is designed primarily to meet exploration transport requirements.

*Q5c. What is your assessment of the likelihood that any of the competitors for those funds will have an operational service capability by 2010 when the Space Shuttle program is scheduled to be terminated? What is your backup plan if none is available or the costs of the commercial service are too high?*

*A5c.* NASA is currently reviewing the proposals and will be able to better assess capabilities after procurement selection, currently anticipated for this summer. However, given the existence of various commercial launch systems and International Space Station rendezvous and docking systems, there is a reasonable likelihood that unpressurized and/or pressurized cargo delivery and disposal services will be demonstrated by 2010. These services are critical to maintaining the International Space Station on orbit. If commercial services to the ISS are unavailable or too costly, NASA will continue to pay international partners to support the International Space Station until commercial services or the Crew Exploration Vehicle become operational. The Shuttle budget also is sufficient to support two contingency logistics Shuttle missions to the ISS in FY 2010. These missions could be flown to

preposition spares if the flights are deemed to be cost-effective and can be safely flown without jeopardizing the Shuttle's 2010 retirement date.

*Q6a. Although the Global Precipitation Mission (GPM) is considered one of the most important Earth Science priorities, NASA's FY 2007 Budget Request would delay that program by two and a half years.*

*What is the reason for delaying GPM by two and a half years?*

*A6a.* The Global Precipitation Measurement (GPM) mission is currently in formulation phase within the Earth Science Division of the Science Mission Directorate. The NASA Administrator has stated that formulating the NASA FY 2007 budget request required discipline and difficult decisions. As a result, the Science Mission Directorate rate of growth over the next four years was reduced. These reductions were focused on missions that had not yet been through a confirmation review and thus would be less severely impacted. Unfortunately, this resulted in delaying the launch of GPM.

*Q6b. Japan is participating in the GPM mission. Did you coordinate with the Japanese prior to deciding to delay the mission? If so, what was their reaction?*

*A6b.* Upon submission of the President's FY 2007 budget request to Congress, NASA initiated coordination with the Japanese Aerospace and Exploration Agency on the potential implications for GPM resulting from the request. NASA explained the rationale used in the decision to delay the launch of GPM, and explained that budget discussions are internal to the U.S. and cannot be discussed until the President presents the budget to Congress. The Japanese Aerospace Exploration Agency (JAXA) has encouraged NASA to minimize the delay to the mission. NASA has emphasized the importance of the GPM program and its priority within the Science Mission Directorate and has committed to continue working with JAXA as a new schedule is developed. Several discussions at various levels of management between NASA and JAXA have taken place, and these discussions are ongoing.

*Q7. Given the delay in resuming Shuttle flights, how confident are you that the Shuttle fleet will be able to fly safely through the remainder of the decade and successfully assemble the remaining elements of the International Space Station? What is the "Plan B" in the event the Shuttle encounters additional problems prior to the completion of the International Space Station assembly?*

*A7.* NASA currently is planning to fly 16 Shuttle missions to complete the International Space Station prior to 2010, with a possible additional Hubble Servicing flight. Under this manifest, the flight rate will be 2, 4, 5, 5, 1 for the next five years, beginning with the STS-121 mission, planned to launch no earlier than July 1, 2006. NASA engineers have worked diligently to address the foam liberation issues experienced on STS-114, including removing the Protuberance Air Load (PAL) ramp, and the Agency is confident that this flight rate is achievable in a safe and successful manner. The Program can accommodate some additional delays and still complete ISS assembly prior to the Shuttle retirement in 2010. Should any large-scale delay occur, NASA will confer with the International Partners on a joint course of action. That course of action will be consistent with the *Vision for Space Exploration's* goals of pursuing a robust exploration program, meeting our international commitments, and retiring the Shuttle no later than 2010. Any decision would also be driven by NASA's strong desire to carry out effective planetary science, astrophysics, heliophysics, Earth science, and aeronautics programs.

#### **Questions submitted by Representative Mark Udall**

*Q1. Despite the importance of R&D in maintaining our technological leadership in aviation, the Administration is proposing to cut some \$175 million from NASA's aeronautics program in FY 2007. Can you explain why the Administration did that?*

*A1.* The aeronautics budget was reduced because the Administration believes that this is an appropriate funding level for the program that should allow it to achieve significant benefits for the public. More important than the size of the budget, however, is what we do with it. NASA has a new focus for aeronautics that is driven by a desire to take responsibility for the intellectual stewardship of the core competencies of aeronautics for the Nation in all flight regimes, from subsonic through hypersonic flight. We will also conduct the fundamental research that is needed to meet the substantial challenges of the Next Generation Air Transportation System (NGATS), and we intend to work closely with our agency partners in the Joint Planning and Development Office (JPDO). To guide the program, NASA and the Office

of Science and Technology Policy have been jointly developing a National Aeronautics Policy which will establish a long term policy and guidance for future aeronautics research and development activities. This policy will establish the appropriate role for federal investment in U.S. aeronautics research, including near- and far-term, high-priority objectives; roles and responsibilities of the multiple agencies involved; and guidance on related infrastructure and workforce challenges.

*Q2. The five-year runout for NASA's Next Generation Air Transportation System R&D program will cut its funding \$146.4 million in FY 2007 down to \$71.7 million in FY 2011—that is, you are proposing to cut the funding in half. Given that the R&D requirements in support of the next generation system are likely to increase significantly by the end of the decade, what is your rationale for cutting funding instead of increasing it?*

*A2.* First, we need to make a correction to a budget slide that was provided to Committee staff in February. The entire Airspace Systems Program is devoted to addressing the Air Traffic Management (ATM) research needs of the NGATS. That budget is \$173.9 million in FY 2006 and declines to \$89.4 million in FY 2011. (The labels on the original budget slide implied that only a subset of the Airspace Systems Program was dedicated to NGATS research.) The corrected slide follows.



# Aeronautics Research FY 2007 President's Budget

	As of February 3, 2006									
	FY 2005	FY 2006 <sup>1</sup>	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011			
<b>Aeronautics Technology</b>										
<b>Aviation Safety</b>	962.0	884.1	724.4	731.8	732.4	722.8	722.7			
Integrated Vehicle Health Management	183.0	148.4	102.2	102.1	116.1	119.9	119.8			
Aircraft Aging & Durability		9.9	34.3	33.8	38.8	40.2	40.0			
Integrated Resilient Aircraft Control		9.8	18.5	18.8	21.2	21.9	21.9			
Integrated Intelligent Flight Deck Technologies		63.9	30.1	30.0	34.0	35.5	35.4			
Corporate Support	{11.0}	56.5	13.8	13.8	15.5	15.6	15.8			
		8.3	5.5	5.7	6.6	6.7	6.7			
<b>Airspace Systems</b>	148.8	173.9	120.0	124.0	105.4	91.1	89.4			
Next Generation Air Transportation System (NGATS)		146.4	96.9	100.2	84.5	73.1	71.7			
Air Traffic Management (ATM): Airspace										
Next Generation Air Transportation System (NGATS)		17.7	16.6	16.7	14.8	12.9	12.7			
Air Traffic Management (ATM): Airportal										
Corporate Support	{7.9}	9.7	6.5	7.1	6.1	5.1	5.0			
<b>Fundamental Aeronautics</b>	630.2	561.7	447.2	449.3	452.9	452.5	452.8			
Subsonic Project		313.7	222.8	222.8	227.6	227.6	228.4			
Fixed Wing		214.5	180.2	180.2	183.0	183.0	184.7			
Rotary Wing		47.2	42.6	42.6	44.6	43.9	44.7			
Aeronautics Test Program		52.0								
Supersonic Project		89.2	85.6	85.9	84.7	84.9	84.8			
Hypersonic Project		127.3	114.0	114.6	114.0	114.2	113.0			
Corporate Support	{32.0}	31.5	24.8	26.0	26.6	25.8	25.6			
<b>Aeronautics Test Program</b>		{52.0} <sup>**</sup>	55.0	56.4	58.0	59.2	60.7			
Aeronautics Test Project			52.0	53.2	54.5	55.8	57.2			
Corporate Support			3.0	3.2	3.5	3.4	3.5			
<b>FY 2007 President's Budget</b>	<b>962.0</b>	<b>884.1</b>	<b>724.4</b>	<b>731.8</b>	<b>732.4</b>	<b>722.8</b>	<b>722.7</b>			

<sup>1</sup> Reflects FY 2006 Initial Operating Plan.

<sup>\*\*</sup> ATP funding resides within the Fundamental Aeronautics Program in FY2006

It is critical to recognize that the R&D challenges we face in developing the future air transportation system are not limited to ATM alone. The vehicles that reside within the system will need to address substantial noise, emissions, efficiency, and performance challenges. These challenges will be addressed in our Fundamental Aeronautics Program. Furthermore, as we develop increased capabilities in our future air vehicles and airspace system, we must continue to conduct the research necessary to ensure that our high safety standards are not compromised. Our Aviation Safety Program will address aircraft safety technological barriers that would otherwise constrain the full realization of the NGATS.

In short, in addition to the fact that the entirety of the Airspace Systems Program is devoted to ATM research in support of NGATS, a substantial amount of research conducted in the Fundamental Aeronautics Program and the Aviation Safety Program will also directly address NGATS challenges. NASA has constructed a balanced research portfolio that draws upon our NASA-unique capabilities to address ATM, environmental, and safety-related research challenges, all of which must be worked in order for the NGATS vision to be realized.

*Q3. The budget request identifies broad areas of research for NASA's Fundamental Aeronautics program, but it does not propose any specific projects. In the absence of such detail, what was your basis for determining how much funding to request and how to allocate that request among the broad research areas of subsonic, supersonic, hypersonic, and rotorcraft?*

A3. The Fundamental Aeronautics Program budget was distributed among the Subsonic, Supersonic and Hypersonic Projects based on NASA's commitment to support fundamental cutting-edge research across all speed regimes. To determine the proper budget splits among the research areas, the long-term research needs and goals of the Program as well as the historical funding profiles for each research area were balanced with the capabilities currently available at the research centers.

Research proposals are being developed by researchers at the NASA research centers, and will be peer reviewed to ensure that they are of the highest quality. The proposals will ensure that NASA's mastery and intellectual stewardship of the core competencies of aeronautics in all flight speed regimes are maintained; that our aeronautics research is focused in areas that are appropriate to NASA's unique capabilities; and that the aeronautics research priorities reflect NASA's long-standing commitment to benefit the American public and enhance U.S. competitiveness.

*Q4a. The NASA Authorization Act of 2005 contains provisions directing you to establish a program of pilot projects to explore the use of remote sensing data to address State, local, regional, and tribal agency needs. What are you doing to establish that program? What is your timetable for having it established?*

A4a. In 2004, NASA established the Applied Sciences Program within the Earth Science Division of the Science Mission Directorate. The objective of the NASA Applied Sciences Program is "to expand and accelerate the realization of economic and societal benefits from Earth science information and technology."

NASA, through the Applied Sciences Program, has conducted solicitations in FY 2004 and FY 2005 for competitively selected projects—the solicitations and resulting projects are consistent with the direction in Sections 311–316 in the *NASA 2006 Authorization Act of 2005* (P.L. 109–155) related to remote sensing.

NASA policy is to include the opportunity for use of commercial remote sensing data in each of the Earth science solicitations.

NASA is a participating member of the Joint Agency Committee on Imagery Evaluation (JACIE) (<http://www.asd.ssc.nasa.gov/program.aspx?p=JACIE>) with the U.S. Geological Survey and the National Geospatial Intelligence Agency (NGA) to systematically evaluate the use of commercial remote sensing data products to serve Federal Government applications.

NASA is a member of the interagency Commercial Remote Sensing Space Policy Senior Management Oversight Committee.

*Q4b. Does the FY 2007 NASA budget request provide funds for the program?*

A4b. Yes, the FY 2007 Budget Request provides \$51 million for the NASA Applied Sciences Program. This budget includes \$18.4 million for projects competitively selected through several research solicitations including: the Research, Education, and Applications Solutions Network (REASoN) issued in the FY 2003; Decision Support through Earth Science Results issued in FY 2004; and Decision Support through Earth-Sun System Science Research Results issued in FY 2005. The next solicitation for Decision Support through Earth Science Research Results is planned for release in FY 2007.

Implementation details are as follows:

**SEC. 314. PROGRAM EVALUATION.**

(a) Advisory Committee—The Administrator shall establish an advisory committee, consisting of individuals with appropriate expertise in State, local, regional, and tribal agencies, the university research community, and the remote sensing and other geospatial information industries, to monitor the program established under section 313. The advisory committee shall consult with the Federal Geographic Data Committee and other appropriate industry representatives and organizations. Notwithstanding section 14 of the Federal Advisory Committee Act, the advisory committee established under this subsection shall remain in effect until the termination of the program under section 313.

The Administrator has established a NASA Advisory Committee (NAC) structure with subcommittees for each of the Science Mission Directorate divisions. There is an Earth Science subcommittee as part of the NAC. In addition, the National Research Council (NRC) committee has been formed to evaluate the Applied Sciences Program. The NRC study title is “Extending Observations and Research Results to Practical Applications: A Review of NASA’s Approach.”

(b) Effectiveness Evaluation—Not later than December 31, 2009, the Administrator shall transmit to the Congress an evaluation of the effectiveness of the program established under section 313 in exploring and promoting the integrated use of sources of remote sensing and other geospatial information to address State, local, regional, and tribal agency needs. Such evaluation shall have been conducted by an independent entity.

This action is consistent with NRC study group that is currently underway with a schedule to deliver an evaluation report in 2007. The NRC study committee does include representation of the State, local, and tribal communities—as was the earlier strategic plan review conducted in 2002.

The committee members are listed at <http://www8.nationalacademies.org/cp/projectview.aspx?key=208>.

**SEC. 315. DATA AVAILABILITY.**

The Administrator shall ensure that the results of each of the pilot projects completed under section 313 shall be retrievable through an electronic, Internet-accessible database.

NASA plans for implementation of Data Availability in Section 315 through an electronic Internet accessible database that the program is developing as an Earth Science Gateway (ESG).

**SEC. 316. EDUCATION.**

The Administrator shall establish an educational outreach program to increase awareness at institutions of higher education and State, local, regional, and tribal agencies of the potential applications of remote sensing and other geospatial information and awareness of the need for geospatial workforce development.

The Administrator has contributed to the establishment of the U.S. Group on Earth Observations (USGEO) as a venue for recognizing the value of geosciences and capacity building for using and delivering geoscience information that serves society. Information is accessible at <http://usgeo.gov>. The Administrator has also designated the Program Director of the Applied Sciences Program as the Agency lead POC to the OMB Geospatial Line of Business.

*Q4c. If not, why not?*

*A4c. NASA has or will implement all sections of Title III, Subtitle B—Remote Sensing of the Act.*

*Q5. How much money has been reserved in NASA’s budget plan through 2018 to develop scientific infrastructure on the Moon to support scientific research by astronauts on the lunar surface? What will that money be used for, and where is it book-kept? If no funds have, been reserved for that purpose, why not?*

*A5. Preliminary funding levels for lunar surface science equipment and associated infrastructure to support research by astronauts on the lunar surface are defined in the Exploration Systems Architecture Study (ESAS) final report as beginning in 2013. NASA is currently developing a comprehensive lunar exploration strategy that*

will result in a more mature definition of these surface system requirements and funding needs along with providing a better understanding of the technical and financial role that international partners and commercial organizations may play in this endeavor.

In 2005, ESAS established an initial baseline architecture that supports the goal, as outlined in the *Vision for Space Exploration*, of returning humans to the Moon by 2020. The primary focus of ESAS was to define the transportation elements that will support human missions to the Moon and beyond. Although ESAS performed some preliminary analysis of the infrastructure and surface equipment required to support human lunar activities, much of this analysis was done at a high level to understand potential implications on the sizing of the transportation architecture. Based on this initial analysis, ESAS identified funding requirements, beginning in 2013, to develop science equipment and associated surface infrastructure to support human activities on the Moon.

In 2006, NASA is working to meld together scientific, exploration, commercial and international interests in the Moon into an integrated global lunar exploration strategy. This activity had a milestone in late April of 2006 with a workshop where over 200 individuals, representing international partners from 14 space agencies, academia, and industry, who will discuss various perspectives on the role of the Moon in a broad strategy of solar system exploration.

The Exploration Strategy Workshop continued the development of a global Space Exploration Strategy for future robotic and human missions. The objective is to integrate common interests and objectives of the participants into a comprehensive plan for exploration to the Moon, Mars and beyond. Key elements of this strategy include:

- Ensuring lunar exploration is an integral part of a broader exploration strategy that encompasses Mars and other destinations.
- A strategy for lunar robotic missions to collect key strategic information and develop key capabilities to enable and enhance human exploration.
- A strategy for human missions that will enable us to live and work productively on other planetary surfaces, starting with the Moon, including the development and use of lunar resources.
- Enabling opportunities for international participation through merging of common interests in our respective strategic plans for exploration.
- Characterization of opportunities for science investigations on the Moon.
- Enabling opportunities for lunar commerce.

Throughout 2006, NASA will mature these ideas, continually seeking inputs from these varied constituent groups with the resulting draft lunar Space Exploration Strategy being available late in the year. This strategy will be used to assist in defining lunar surface infrastructure and operations requirements and will provide a blueprint for discussing potential roles for international partners in this endeavor.

In addition, this strategy will be used to plan future robotic lunar missions that may pre-empt infrastructure elements required to support later human activities as well as performing trailblazing scientific research and technology demonstrations that will increase the value and decrease the risks associated with future human exploration of the Moon. As a result, updated funding estimates for lunar surface infrastructure and science equipment may be significantly different from the ESAS estimates. These updated estimates will factor in the international and commercial interests that may provide funding toward lunar exploration as well as the robotic precursor missions that may provide infrastructure pre-emption and early risk reduction / human mission optimization opportunities.

After the development of a Space Exploration Strategy for lunar activities, we will begin to define the wealth of human and robotic activities that NASA will pursue on the Moon as well as the specific budgetary requirements for these activities.

*Q6. Space life sciences research has been recognized since the early years of NASA's existence as something that is critical for the success of any long-term human exploration program. Yet NASA currently is in the process of essentially eliminating its life sciences research capability and cutting off grants to its external life sciences research community.*

*Do you think that NASA no longer needs life sciences research to support the agency's long-term human exploration program?*

A6. Prior to the *Vision for Space Exploration* (VSE), the Human Research program content, including biomedical and fundamental biology research tasks, underwent a series of internal and external reviews to insure that the research portfolio focused

on the Agency's highest priorities. The non-NASA community of researchers performed a major content review of the Exploration System Mission Directorate's (ESMD) research priorities during the Research Maximization and Prioritization Task Force (ReMap) in 2002, and provided comprehensive rankings and recommendations at that time. Beginning in the fall of 2004 and concluding in early 2005, ESMD conducted a Zero Based Review (ZBR) of the Human Systems Research & Technology (HSRT) research portfolio. The ZBR was conducted in order to reprioritize HSRT research to support the VSE. All 900 research tasks were collected and subdivided, rated with weighting factors and criteria for exploration-relevant research, and a series of non-advocate panels then examined ESMD's ZBR process. As a result of the ZBR, research not directly supporting exploration priorities was shifted to a longer-term ranking within ESMD, much of which was targeted to be gradually phased out of the program. The ZBR created a research baseline that was the focus of the Exploration Systems Architecture Study (ESAS). The ESAS Technology Assessment Report is a further narrowing of the ZBR priorities to very specific requirements emphasizing near-term needs to support Lunar surface expeditions as early as 2018, but no later than 2020.

*Q6a. How do you justify the Agency's actions?*

*A6a.* Human health and performance issues are only a small portion of the risk to astronauts. The active portions of space missions, launch, rendezvous, entry and landing, present tremendous risks to the lives of astronauts. NASA has a long history of successful space missions both in low Earth orbit and on the lunar surface. U.S. astronauts routinely stay in space for up to six months without demonstrable, short-term health effects upon return. Possible long-term health effects are still being evaluated through the Longitudinal Study of Astronaut Health. We have lost our crew members during launch and during entry. We must insure that they have a safer method of transportation from Earth to space. We are investing in the Crew Exploration Vehicle (CEV), as a safer follow-on to the Space Shuttle.

*Q6b. How do you intend to reinstate a viable life sciences research activity at NASA after it has been unfunded for an extended period?*

*A6b.* The non-exploration research language in the *NASA Authorization Act of 2005* (P.L. 109-155) requires at least 15 percent of NASA's ISS research budget be devoted to non-exploration research. This will include animal research, basic fluid physics, combustion research, cellular biotechnology, and cellular research. In addition, ground-based and free-flyer research will maintain multi-discipline and multi-national fundamental research capabilities, including animal non-exploration microgravity and space environment analogs. NASA has a long history of leveraging its resources to expand its fundamental research portfolio and plans to continue to pursue such collaborations to the maximum extent possible. Examples include NASA's participation in the International Space Life Sciences Working Group (ISLSWG; members include Canada, France, Germany, Europe, Japan, U.S., Ukraine), and NASA's research collaborations with the Russian Federal Space Agency (Roscosmos). It is important to note that the life sciences community will have opportunities to pursue fundamental ground-based life sciences research with other federal agencies, such as the NIH and the NSF. NASA will also work with other government agencies to enter into co-operative research opportunities.

#### **Questions submitted by Representative W. Todd Akin**

*Q1. NASA's FY 2007 budget does not include funds for the X-43C program. Was there a technical problem with the program or was the decision driven by budget constraints? Please explain the rationale for the decision to cancel this program.*

*A1.* NASA made the record books with the first successful demonstrations of hypersonic air breathing flight. The X-43A flights achieved Mach 7 and Mach 9. Under the Space Launch Initiative (SLI) program, the X-43C was once viewed as the next logical step in hypersonics at NASA. Interest in the X-43C demonstrator ended with the termination of the SLI in FY 2004. Since that time, the DOD has initiated two demonstrator programs (Falcon at DARPA, and the Air Force SED—Single Engine Demonstrator, recently renamed the X-51) that make the X-43C duplicative and unnecessary.

The Fundamental Aeronautics Program is taking a long-term, strategic view of hypersonics research. We have moved away from a focus on point-design demonstrators and toward a focus on flight experiments and the development of physics-based predictive design tools. We have defined a research program that spans the range of required fundamental technology, from advanced high-temperature materials to



advanced propulsion systems to guidance, navigation and control for hypersonic vehicles. Continued investment in X-43C is inconsistent with our vision and goals for a hypersonics program that emphasizes long-term cutting-edge research. NASA is working closely with the DOD to ensure that we leverage each other's strengths; for example, we intend to collaborate with the Air Force on the X-51 program, which is the logical follow-on to the X-43A.

**Questions submitted by Representative Michael M. Honda**

*Q1. Please explain why astrobiology receives a 50 percent cut in the budget request, which is much larger than the 15 percent across the board cuts to other science programs within the Research and Analysis budget, especially given the interest of Congress in this field as a priority for the space science program and the findings of the National Research Council's recent report entitled "Life in the Universe."*

A1. The 15 percent reduction in research and analysis (R&A) funding is related to the slowing rate of growth of Science Mission Directorate (SMD) programs.

Astrobiology research funding is reduced 50 percent in the President's FY 2007 budget for several reasons. The astrobiology research program experienced rapid and significant growth over the last seven years, relative to the rest of NASA's science research program, in anticipation of a large number of astrobiology-related flight missions in the near future. In FY 2005, the budget for astrobiology research was comparable to the entire research and analysis budget for Astrophysics.

The lower flight rate for robotic Mars missions including a Mars sample return mission, plus the recognition that human exploration missions to Mars are further in the future than previously assumed, has reduced some of the urgency for rapid progress in astrobiology research. In addition, the mission to Jupiter's moon Europa, which may have a subsurface ocean harboring conditions conducive to life, has been delayed. In light of the rapid growth in astrobiology funding several years ago, this reduction brings the level of astrobiology funding more into balance with the rest of the research program.

NASA will still be undertaking a vigorous astrobiology program. The \$32.5 million requested for astrobiology research in the President's Budget Request for FY 2007 supports a broad range of astrobiology research activities including the Astrobiology Science and Technology Instrument Development (ASTID) program, the Astrobiology Experiments for Exploring Planets (ASTEP) program, the Exobiology and Evolutionary Biology program, and the NASA Astrobiology Institute.

*Q2. The Deep Space Climate Observatory (DSCOVR) mission recently received a notice of termination—even though the National Academies of Science/National Research Council and NOAA are mid-way through two important studies that could affect the utilization of DSCOVR, and expand its contributions to the Nation. Can you explain the rationale behind canceling a cost-effective project that has received strong support in the past, was rated as a high priority by the NAS and plays an important role in infrastructure safety and science?*

A2. NASA selected the Triana/DSCOVR mission in October 1998 with a projected launch date (via Space Shuttle) of December 2000 and an expected two-year mission life. Congress imposed a stand-down on development in 2000 to allow the NRC to conduct a study of the scientific merits of the mission. The NRC concluded that the mission had scientific merit, and Triana was at one point set to fly on STS-107. However, ongoing scheduling conflicts lead NASA to swap Triana with the Fast Reaction Experiments Enabling Science, Technology, Applications, and Research (FREESTAR) payload on STS-107—the last flight of Space Shuttle *Columbia*. After the *Columbia* accident, the Space Shuttle fleet was grounded for twenty-nine months, precluding a flight opportunity for Triana. The completed space flight hardware was placed in clean room storage at GSFC in FY 2002.

With the release of the *Vision for Space Exploration* in 2004, the Space Shuttle manifest was refocused on completing assembly of the International Space Station and a possible servicing mission to the Hubble Space Telescope, thus continuing to preclude Shuttle's availability to launch DSCOVR. NASA has pursued various possibilities for access to space by expendable launch vehicle, including mission co-manifesting, but none have resulted in a fiscally viable solution.

*Q3. The Explorer Program is one of the few competitively run NASA programs which engages universities, industry, and other partners to explore the most cutting edge scientific discoveries in all aspects of astronomy and astrophysics. Please explain how NASA intends to fund this program in FY 2006, FY 2007,*

*and beyond. Specifically, does NASA intend to honor its commitments to all competed missions not cut for technical or cost reasons?*

A3. Yes, NASA intend to honor its commitments to all competed missions not cut for technical or cost reasons. The budget for the Explorer Program (including Explorer missions in the Astrophysics budget) is \$215 million in FY 2006 and \$141 million in FY 2007. This is sufficient to complete the development of the AIM and THEMIS missions, both of which are scheduled to launch in 2006. It also supports the continued development of the IBEX mission, scheduled to launch in 2008, and the WISE mission, scheduled to launch in 2009. The runout of the President's FY 2007 Budget Request for the Explorer Program fully supports the completion of these missions through launch and operations, as long as the projects complete development without significant technical or cost problems. The NuSTAR mission, which was in extended Phase A, has not been confirmed to preserve these other missions. The budget supports the release of the next Announcement of Opportunity for the Explorer Program in the FY 2007 timeframe.

*Q4. NASA has terminated the NuSTAR Explorer mission prior to the completion of its technical review and after several years of investment by the American taxpayers, universities, industry, and other governmental partners. By cutting this mission or suspending funding on already selected missions years into technical development, do you feel NASA is in danger of sending the message that it is an unreliable partner to the research and university communities?*

A4. In making tough budget decisions NASA sought to have the least impact on the Explorer portfolio overall. NuSTAR was in extended Phase A and had not yet completed its initial confirmation review or begun development. NASA chose to stop NuSTAR rather than any of the other missions that are approaching launch or are at a more advanced stage of development. AIM and THEMIS are already in development, while WISE and IBEX are at the mission confirmation stage. When NASA makes a selection under an Announcement of Opportunity (AO), it is for the purposes of funding an initial study of a potential new mission. Although NASA would have preferred to complete NuSTAR, assuming adequate technical progress was made during the extended study phase, the Explorer budget could not support completion of NuSTAR as well as the other Explorer missions. As a result, this was the least disruptive option for aligning the Explorers portfolio to its available funding without further delaying the next scheduled AO. It is possible that the research and university communities may perceive NASA as an unreliable partner in this instance, but budget realities are forcing the agency to make tough decisions about its programs.

*Q5. Last year, the Administration tried to impose large cuts the NASA's Aeronautics R&D but failed in the face of a bi-partisan consensus in both houses of Congress. This year, the proposed budget calls for even lower numbers than last year. This Congress has already clearly stated that this low-ball approach jeopardizes America's leadership in Aeronautics. Why is NASA ignoring the will of Congress and diverting 25 percent of what should be the Aeronautics budget to Shuttle Operations or Exploration when this only increases these latter budgets by a minuscule percentage?*

A5. The aeronautics budget was reduced because the Administration believes that this is an appropriate funding level for the program that should allow it to achieve significant benefits for the public. More important than the size of the budget, however, is what we do with it. NASA has a new focus for aeronautics that is driven by a desire to take responsibility for the intellectual stewardship of the core competencies of aeronautics for the Nation in all flight regimes, from subsonic through hypersonic flight. We will also conduct the fundamental research that is needed to meet the substantial challenges of the Next Generation Air Transportation System (NGATS), and we intend to work closely with our agency partners in the Joint Planning and Development Office (JPDO). To guide the program, NASA and the Office of Science and Technology Policy have been jointly developing a National Aeronautics Policy, which will establish a long-term policy and guidance for future aeronautics research and development activities. This policy will establish the appropriate role for federal investment in U.S. aeronautics research, including near- and far-term, high-priority objectives; roles and responsibilities of the multiple agencies involved; and guidance on related infrastructure and workforce challenges.

*Q6. Why is NASA cutting back on efforts to discover other Earth-like planets and the origins of life in the Universe, such as the Terrestrial Planet Finder, when many scientists and lay people recognize this as perhaps the most interesting and important question for NASA to address? Is there any relationship between*

*cuts to these programs aimed at understanding the origins of the universe and the efforts by some within the Administration to seek to redefine the Big Bang?*

A6. The search for Earth-like planets, and the possibility of life elsewhere in the Universe, are certainly compelling questions. NASA plans to study these questions via missions such as the James Webb Space Telescope (JWST), the Space Interferometry Mission (SIM), and Kepler, all of which remain part of NASA's budget. Given current budget realities, however, we are unable to pursue the answers to those questions as aggressively as we had once planned. JWST and SIM have been viewed as technical precursors of the Terrestrial Planet Finder (TPF); since their launch dates have now slipped to 2013 and 2015 respectively, it follows that TPF should slip as well.

TPF science goals are not related to the study of the Big Bang. TPF is a future piece of our ongoing effort to find and characterize new worlds around other stars. The worlds that TPF will study were formed long after the Big Bang; thus, TPF science will not significantly affect our knowledge of the origin of the Universe.

Q7. *What is the projected final price tag for the International Space Station (ISS) according to the Administration's proposed FY 2007 Budget Request, including the costs of continuing to fly the Shuttle through 2010 to support ISS completion? Now that you have canceled the ISS Centrifuge as well as all associated ISS Life Science experiments, what are the five most important remaining scientific capabilities that the ISS will deliver that cannot be done more cheaply and effectively using other venues? Are these scientific capabilities worth the proposed expense and why wouldn't the remaining funds be better spent on maintaining non-ISS Science and Aeronautics while also supporting your ESAS plan?*

A7. The total life cycle cost of the ISS through 2016 is about \$49 billion and, within that, the cost of flying the Space Shuttle from FY 2007–2010 is approximately \$16 billion.

The ISS provides the world's only long-duration flight analog, testbed and operational system in low Earth gravity and cannot be duplicated on Earth. The ISS is a cornerstone in advancing knowledge about how to live and work in space for long, continuous periods of time, and will remain critical to our future exploration activities. For example:

- The six-month ISS mission increments are critical temporal and operational analogs for human transit to Mars, in addition to ensuring development of our ability to live and work for long durations on the Moon.
- At assembly completion, the ISS will support research and technology development programs which meet the Agency's needs for crew health and safety, technology advancement, and operational experience essential for long-duration missions beyond low Earth orbit.
- NASA is using the ISS as a laboratory for research in human health and countermeasures, as well as applied physical science.
- The five most important scientific capabilities that the ISS supports are—
  - Human Health Countermeasures
  - Human Factors and Environments
  - Advanced Environmental Monitoring
  - Fire Prevention, Detection and Suppression research
  - Multi-phase flow research
- Beyond technical and research applications, the ISS is providing NASA and its partners with experience in managing international partnerships for long-duration human missions.
- The ISS also serves as a training ground for future leaders in space industries in areas ranging from systems engineering and development to research planning and implementation, technology development and realtime operations.
- The future of human exploration depends on the near-term investment we make in retaining and enhancing exploration-enabling research on the ISS.
- The U.S. portion of the ISS has been designated a National Laboratory, for which planning is currently underway.
- Consistent with the NASA Authorization Act of 2005 (Public Law 109–155), 15 percent of the funds budgeted for ISS research have been allocated to research not directly related to supporting the human exploration program.

**Questions submitted by Representative Lincoln Davis**

*Q1. My main concern is with NASA's funding of Aeronautics Research programs. As you may know, the X-43 hypersonic plane program is in my district. To my knowledge, this plane is the only hypersonic plane that has been successfully flown, yet in this year's budget request the Administration has cut its funding.*

*What was the reasoning behind cutting a program that is not only successful but is the only one in the U.S.?*

*Also, what does NASA have planned for the future in regards to hypersonic flight research?*

A1. NASA made the record books with the first successful demonstrations of hypersonic air breathing flight. The X-43A flights achieved Mach 7 and Mach 9. Under the Space Launch Initiative (SLI) program, the X-43C was once viewed as the next logical step in hypersonics at NASA. Interest in the X-43C demonstrator ended with the termination of the SLI in FY 2004. Since that time, the DOD has initiated two demonstrator programs (Falcon at DARPA, and the Air Force SED—Single Engine Demonstrator, recently renamed the X-51) that make the X-43C duplicative and unnecessary.

The Fundamental Aeronautics Program is taking a long-term, strategic view of hypersonics research. We have moved away from a focus on point-design demonstrators and towards a focus on flight experiments and the development of physics-based predictive design tools. We have defined a research program that spans the range of required fundamental technology, from advanced high-temperature materials to advanced propulsion systems to guidance, navigation and control for hypersonic vehicles. Continued investment in X-43C is inconsistent with our vision and goals for a hypersonics program that emphasizes long-term cutting-edge research. NASA is working closely with the DOD to ensure that we leverage each other's strengths; for example, we intend to collaborate with the Air Force on the X-51 program as the logical follow-on to the X-43A.

**Questions submitted by Representative Jo Bonner**

*Q1. Robotic Lunar Lander Project. Dr. Griffin, I was happy to hear at the end of last year that the Marshall Space Flight Center was selected to manage the Robotic Lunar Lander mission. This is the second mission under NASA's Robotic Lunar Exploration Program. However, I am concerned to see that no funds were included in the FY 2007 budget for this mission. Would you provide the Committee with an update on the status of the mission and are you still looking at options to place funds on this activity in FY 2007?*

A1. The second mission in the Robotic Lunar Exploration Program (RLEP), designated RLEP-2, is currently in the pre-formulation study phase. NASA has assigned project management responsibility to the Marshall Space Flight Center with assistance from the Goddard Space Flight Center and the Johns Hopkins University Applied Physics Laboratory.

During pre-formulation, we are conducting a series of trade studies to evaluate various options for the design of the mission. We evaluate those options against requirements, opportunities, costs, and schedule. The project office presented the results of these initial studies to NASA Headquarters this April at the Concept Design Review (CoDR).

In parallel, NASA Headquarters is developing a more formal architecture for the RLEP program as a whole. A long-term robotic architecture is under development. Called the "Lunar Robotic Architecture Study (LRAS)," it is intended to be a follow-on to Exploration Systems Architecture Study focused on robotics. The initial study completed at the end of March and a detailed report should be cleared for release sometime this summer.

This more structured architecture will better advise our assessment of the specific requirements and timing for each mission within the RLEP program.

We will iterate the results of the project office studies with the results of the architecture development over the next few months, and then make decisions about the content, magnitude, and pace of the RLEP-2 project. In the meantime, we have retained options to fund RLEP-2 in FY 2007 and beyond. At current RLEP-2 launch is scheduled for no earlier than 2010.

*Q2. I'm pleased to see the funding included for the Crew Exploration Vehicle, but was wondering about your specific plans for the development of the Cargo*

*Launch Vehicle. When do you foresee major funding being placed on this activity?*

A2. Currently, there is some funding for the Cargo Launch Vehicle, currently referred to as the Heavy Lift Launch Vehicle (HLLV) provided through \$5 million of Congressionally-directed funds for FY 2006 only.

This vehicle will provide the capability to deliver large elements required for lunar missions. Since crewed lunar missions are not scheduled until the latter part of the next decade, major funding for this vehicle is not currently needed until the 2011 timeframe, with full development scheduled to start in 2013 to support a first flight in 2018. This date may change; however, as the Constellation Program is still in early formulation and our "go as you pay" approach means that the final development schedule for the architecture is highly dependent on the budget profile.

### **Questions submitted by Representative Eddie Bernice Johnson**

*Q1. If NASA's FY 2007 budget request is approved by Congress, more than \$4 billion will have been cut from the budget plan for space and Earth science presented to Congress two years ago. What will be the impact of a cut of that magnitude?*

A1. NASA's Science budget is moderated to 1.5 percent growth in the FY 2007 Budget Request, compared with the amount appropriated for NASA in FY 2006 (as reflected in NASA's initial Operating Plan provided to the Committee in February 2006) and then one percent per year thereafter through FY 2011. This represents a total decrease of \$3.1 billion in FY 2006–2010, compared with the run-out in the FY 2006 President's budget request.

A key aspect of adjusting the balance of the Science program is a reduction in the growth of the Mars program. This program had been previously slated to grow to \$1.3 billion in FY 2010. This aggressive rate of growth had been built into the program over a period of several years. However, given current budget limitations, had we left the Mars program unchanged in this submission, it would have accounted for almost one-quarter of the total Science budget in that timeframe. The Mars budget still provides for a mission launch every 26 months.

NASA is also delaying, deferring, or reviewing several Science projects, as indicated below, reflecting both the overall level of funding for Science and programmatic changes to the Science portfolio (for example, Landsat Data Continuity Mission (LDCM) and Glory are now funded as free-flyers):

- Stratospheric Observatory for Infrared Astronomy (SOFIA): Under review
- Solar Dynamics Observatory (SDO): Delayed four months
- Space Interferometry Mission (SIM): Delayed two to three years
- Global Precipitation Measurement (GPM): Delayed two years
- Terrestrial Planet Finder (TPF): Delayed indefinitely. We still intend to pursue a TPF mission in the future.
- Beyond Einstein: A decision regarding which mission (including LISA, Con-X, and Joint Dark Energy Mission (JDEM)) will proceed into Implementation first will be made prior to FY 2009.
- Nuclear Spectroscopic Telescope Array (NuSTAR): Not confirmed
- Hydros: Back-up Earth System Science Pathfinder (ESSP) mission not confirmed

The key adjustments in the FY 2006 budget were reductions in the Explorers program, New Frontiers program, capping the in-space propulsion program, limiting mission extensions, and indefinitely delaying high capability instruments.

It is important to note that NASA's science portfolio has been strengthened in a number of areas. For example, the Glory and LDCM missions are being funded as dedicated (free-flyer) missions, funding profiles for several high-priority science missions have been improved, and operations for key missions have been extended.

*Q2. The FY 2007 NASA Budget Request makes deep cuts in NASA's Exploration research and technology program and to its Prometheus nuclear power and propulsion research and technology program. As a result, the objectives of the President's exploration initiative have been narrowed to a near-term focus on returning U.S. astronauts to the Moon. Development of new technologies had been one of the advertised benefits of investing in the President's exploration initiative. Will a narrowly defined exploration goal of returning American astronauts to the Moon provide the best return on the investment of more than \$100 billion that NASA estimates will be expended on that goal over the next 13 years?*

A2. The objectives of the *Vision for Space Exploration* have not been narrowed. The Administration remains committed to implementing a sustained and affordable human and robotic program to explore the solar system and beyond, to extend human presence across the solar system, to develop the innovative technologies, knowledge and infrastructure to support exploration, and to promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

Reduction of exploration technology development funding from the initial levels proposed after the President's announcement of the Vision was driven by the recognition that the highest priority in the early years of the vision must be to smoothly transition between the Shuttle and the next generation of vehicles that will carry astronauts on exploration missions. Following retirement of the Shuttle, and initial development of the crew exploration vehicle (CEV), the level of technology spending will be reassessed.

NASA is continuing novel technology development beyond those required for human lunar missions. Low to mid Technology Readiness Level (TRL) investments in the areas of life support, monitoring and control, power storage, fire suppression, and dust mitigation are maintained at an appropriate level. NASA has definite plans to use the International Space Station (ISS) as a test bed to validate these technologies over the next four years. These technology investments will aid in closing the life support loop and offer increased autonomy and less frequent resupply. A number of these technologies will have Earth-based applications, especially in the area of environmental monitoring using miniaturized sensors and portable life support systems.

With regards to Prometheus, NASA is reevaluating the direction of the program in terms of determining the expected power and propulsion needs for the Lunar and Martian missions, including long stays on the lunar surface and propulsion to Mars. Part of this activity will be to evaluate the development of a surface power architecture for lunar surface exploration. Since it is expected that certain architectures will have high electrical energy demands, Prometheus will also perform studies to address potential nuclear surface power systems that will likely be required to support missions beyond the initial lunar landings. These studies will identify the requirements for adding technologies to the NASA portfolio and the time phasing required for resource allocations to achieve the technical goals.

The ISS utilization plans include the validation of human health countermeasures that will support Mars-duration class missions. As mentioned earlier, technology validation is an intended use of the ISS.

#### **Questions submitted by Representative Russ Carnahan**

Q1. *I have recently been made aware of the immediate discontinuation of a NASA grant for a research project at the Donald Danforth Plant Science Center in St. Louis, MO under the direction of Dr. Roger N. Beachy. Even more disturbing, I understand that this situation has happened to hundreds of other scientists throughout the country.*

- *The grant under discussion was awarded for three years, ending on November 30, 2006. In December 2005, funding for the grant was immediately discontinued even though monies were promised well into 2006. Why was such a disruptive and unprofessional action taken?*
- *The grant would have benefited long-term space travel and developed Earth-based applications, some technologies so useful that they will be licensed by biotechnology companies. I understand NASA has decided to realign its priorities. Please explain why the reduction of biological research at NASA is so urgent that it requires discontinuing grants already obligated. Why was this action necessary? Were alternatives to this action considered? If so, what were they?*
- *Please provide for the record a listing of all grants and their dollar values that NASA has terminated or provided notice of intent to terminate in FY05 and FY06 prior to their scheduled expiration.*
- *Will NASA restore funding for the biological sciences in the future? If so, when?*

A1. The attached Excel spreadsheet lists the terminated grants and their dollar values.

**Background:**

In January 2004, NASA was challenged with implementing a new and bold *Vision for Space Exploration*. Included in the Vision is a safe return of the Space Shuttle to flight, completion of the International Space Station, a return to the Moon, and continued exploration of Mars and beyond. An internal study team was commissioned by Administrator Griffin to define a long range plan for exploration, and to identify the high-priority technologies essential to support the plan.

An important priority for the team was to accelerate development of a new Crew Exploration Vehicle to replace the Space Shuttle scheduled for retirement in 2010. Study team results were announced in September 2005. Results provide a blueprint for the future of human and robotic space exploration; and build on the Apollo program and Space Shuttle technology to create a 21st century exploration system that will be affordable, reliable, versatile, and safe.

NASA's Exploration Systems Mission Directorate has completed a realignment of its existing research portfolio to focus on work that represents the highest priority research in support of this newly defined goal.

- Portfolio focus has necessarily shifted from research on advanced technologies for long-duration missions to directed research and maturing technologies for near-term use.
- Basic and applied research efforts, valuable in the long-term, have been deferred.
- Research activities not as closely aligned with critical, near-term technology goals have been subject to reduction or cancellation.

NASA acknowledges the current impact of difficult, resource-driven decisions that have been made in order to implement and meet the objectives of the Agency's bold, new Vision. NASA is committed to retaining a core of life and physical sciences research to maintain a level of continuity in these discipline areas for the future and to achieve a balanced research program.

## ESMD/HSRT Grants Cancellations

Full Title	FY 2006 Budget
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
High Speed Rainbow Schlieren Deflectometry To Quantify Buoyancy Effects In Transitional/Turbulent Flames	\$96,141
Boundary Effects On Transport Properties And Dynamic Finite-Size Sealing Near The Superfluid Transition Line Of 4He	\$104,000
National Center For Space Exploration Research (NCSER)	\$2,800,000
Flow Visualization in Liquid Metals	\$75,000
Experimental Investigations Of Impurity Effects On The Two-Phase Isochoric Heat Capacity Near The 3He Critical Point	\$17,000
Extinction Of Gaseous Microgravity Diffusion Flames In Various Atmospheres	\$115,260
Bio-Transport And Metabolism Under Microgravity Supporting Human Physiologic Processes	\$4,236
Temperature and Composition Dependence of Mass and Thermal Diffusion in Liquid Metals and Compound Semiconductor Alloys	\$75,000
Impurity Effects in 3He	\$68,000
Finite Size Scaling of the Isothermal Susceptibility Near the 3He Critical Point	\$125,000
Development and Plant Gene Switch System for Expression of Multiple Genes	\$75,676
Microstructure Evolution in Free Dendritic Growth	\$75,000
Drosophila Behavior and Gene Expression in Microgravity	\$200,633
The Role of Senseless in Sensory Organ Precursor Selection, and its Vertebrate Homologue, GF11, in Hair Cell Differentiation	\$172,544
Space Radiation Shielding Using the NASA Deep Space Test Bed	\$112,491
BEAMS: Benchmark Evaluations and Analysis of Materials for Shielding	\$124,649
Radiation Shielding Properties of Multifunctional Spacecraft Materials	\$166,291
The Effect of Skeletal Unloading on Bone Formation	\$303,582
Structure and Function of Neurovestibular Adaptation in the Utricle Following Extended Periods of Hypergravity Exposure	\$249,400
A Genomic Analysis of the Effects of Spaceflight on Transgenic Plants with Comprised Signaling Pathways	\$30,000
Otoacoustic Hearing Assessment of Space Station Crews	\$290,000
Differentiation of Bone Marrow Macrophages in Space	\$200,000
All-Optical Atomic Bose Condensates	\$80,000
Heterogeneous Combustion Of Solid Fuel Particles Under Microgravity	\$118,000



## ESMD/HSRT Grants Cancellations

<b>Full Title</b>	<b>FY 2006 Budget</b>
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Structure And Dynamics Of Freely Suspended Liquid Crystals	\$102,500
Three-Dimensional Capillary Interface Topologies And Stability	\$85,461
Investigation Of Particle Clustering Using 3D Digital Holographic Imaging And Direct Numerical Simulations	\$123,012
Numerical And Experimental Investigation Of Solidification In Biological Systems	\$41,667
Plant Growth at Subambient Atmospheric Pressures with Control of the Partial Pressures of Constituent Gases	\$128,089
Micro-Gravity Induced Changes in the Control of Muscles	\$310,000
Adaptations of Cerebral Arteries to Simulated Microgravity	\$200,176
Arterial Remodeling and Functional Adaptations Induced by Microgravity	\$300,000
The Effects of Vector-Averaged Gravity on the Development of T cells	\$167,050
Quantitative Models for Microgravity Melt Crystal Growth with Additional Applications to Detached Solidification and II-VI Materials	\$75,000
Low Velocity Flow Boiling Of Ordinary Liquids With Extension To Liquid Metals- The Effect Of Reduced Gravity	\$101,667
Development of the Otolith System in Altered Gravity Environments	\$262,147
Compact Femtosecon-Lase-Based Optical Synthesizer	\$100,000
DIFFUSION FLAME SUPPRESSION USING SPRAY AGENTS	\$100,260
Gelatin Of Colloidal Particles On Droplet Surfaces, Dimension Curvature, And Droplet Elasticity	\$117,053
A Flame Extinction Database For Unsteady Conditions Obtained Using A Flame-Vortex Experiment	\$151,709
Applications Of Electric Fields In Microgravity Combustion Science	\$110,260
Macromolecule Adsorption And Bubble Adhesion To Model Endothelial Surface Layers	\$111,296
Quantitative Studies On The Propagation And Extinction Of Near-Limit Premixed Flames Under Normal And Microgravity	\$130,260
Probing the Properties of the Plant Gravity Sensor Using a Novel Hypogravity Simulation Device	\$237,396
Resonant Acoustic Control Of Turbulent Diffusion Flames For Pollutant Reduction	\$130,260
Chemically Passive Suppression Of Premixed Flames In Spacecraft Environments At Micrograity	\$100,000
Chemically-Passive Suppression Of Laminar Non-Premixed (Diffusion) Flames	\$95,000

## ESMD/HSRT Grants Cancellations

<b>Full Title</b>	<b>FY 2006 Budget</b>
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Thermoacoustic Convection And Transport In Gases And Near-Critical Fluids Under Microgravity Conditions	\$101,908
Mems-Enabled Processing Of Liquid Fuels For Distributed Power Generation Using Fuel Cells	\$117,880
Coalescence, Transport, And Separation Of Gas Bubbles In Liquids Using Ultrasonic Processing Techniques	\$120,015
Functional Genomics of Plant Response and Adaptation to Low Atmospheric Pressure	\$168,306
Transgenic Plant Biomonitoring of Spaceflight Exposure	\$150,000
GABA Neurotransmission in Cardiovascular Function Following Simulated Microgravity in Male and Female Rats	\$234,641
Microorganisms in the Spacecraft Environment	\$131,327
Microgravity Tissue Engineering	\$481,400
Vestibular Modulation of the Circadian Timing System in Altered Gravity Environments	\$267,302
Artificial Gravity and Light as Countermeasures for Circadian Dysfunction in Altered Gravity Environments	\$293,026
Prototype Biophotonic Biosensor for Monitoring VOC Contaminants in Spacecraft Habitats	\$90,891
Wetting Dynamics Of Complete Fluids And Surfaces	\$102,500
Investigation Of Future Microgravity Atomic Clocks	\$122,000
Evolution of Local Microstructure: Spatial Temporal Correlation in Clusters Undergoing 2-Dimensional Diffusion	\$75,000
Role Of Spatially Heterogeneous Dynamics And Polydispersity In The Early Stages Of Homogeneous Nucleation: Application To The Promotion And Suppression Of Crystallization And Vitrification	\$83,333
The Role of Intracranial Pressure in Space Adaptation Syndrome	\$77,190
The CQ Experiment: Enhanced Heat Capacity Of Superfluid Helium In A Heat Flux	\$81,000
Self-Structuring In Dusty Plasmas	\$143,333
Feasibility Study For An Electron Electric Dipole Moment Experiment With Slow Atoms In Microgravity	\$85,000
Enhancing Performance Of Surface-Based Microfluidic Arrays With Chaotic Flows Of Complex Fluids	\$90,479
Optical Manipulation Of Dynamic Contact Lines: Experiments And Theory	\$92,723
University Of Michigan-NASA Bioscience And Engineering Institute	\$1,125,000
Synthesis and Analysis of Nanoparticle Composites for Space Radiation Shielding	\$115,575
Preparation For Space: Torsion Balances And Equivalence Principal Tests For NASA	\$100,000

## ESMD/HSRT Grants Cancellations

Full Title	FY 2006 Budget
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Development Of A CFD Model For Predicting Performance Of Volatile Removal Assembly In The Closed Environment Life Support System Under Microgravity Conditions	\$54,247
The Structure And Extinction Of Low Strain Rate Non-Premixed Flames By An Agent In Microgravity	\$111,260
Gravity Response Mechanisms of Lateral Organs and the Control of Plant Architecture	\$159,703
LBNP Treadmill and Resistive Exercises during Long-term Bed Rest	\$87,493
Virtual Reality Training: Cybersickness and Effects on Sensorimotor Functions	\$22,410
Spatial and Temporal Analysis of Gravitropism In Chara Rhizoids	\$25,586
The Actin Cytoskeleton: A Molecular Signature for Whole Blood Cell Cultures in the Bioreactor	\$53,120
Multiphase Flow Studies Through Packed Beds Using Combined Particle Image Velocimetry And Laser Induced Fluorescence	\$120,000
Ultra-Slow And Stopped Light In Microgravity	\$110,000
Modification Of Turbulent Non-Premixed Flames By Pulsed Fuel Injection	\$131,293
Stability And Flow Structure Of Evaporating Films In Reduced Gravity	\$97,500
Generation Of Fragile And Strongly Correlated Quantum States In Bose-Einstein Condensed Gases	\$100,000
Anatomical Studies of Central Vestibular Adaptation-NeuroLab Completion Experiment (ARC title is "NeuroLab ReFlight")	\$200,000
Mixing In Microgravity Manipulating Tangential Stresses	\$102,500
Wet Collisions In Granular Media	\$94,683
Mechanisms and Functional Consequences of Protein Kinase C Isoform Translocation Inhibition in Monocytes Exposed to Microgravity	\$350,000
Rheological Measurements Of A Liquid-Solid Flow	\$86,666
Genomic & Phenotypic Changes in Yeast Related to Selective Growth Pressures Unique to Microgravity	\$149,400
Mechanotransduction through Integrins	\$247,500
Two-Fluid Model And Interfacial Area Transport In Microgravity Condition	\$92,500
Quantum Optics Style Theory For Degenerate Bose And Fermi Gases	\$80,000
A Strongly Interacting Fermi Gas Of Atoms	\$130,000
Thermodynamic and Transport Properties of Glass Forming Alloy Liquids Using the Caltech High Vacuum Electrostatic Levitator Platform	\$75,000
Studies Of Thermal Radiation Effects On High Pressure Flame Dynamics	\$79,500

## ESMD/HSRT Grants Cancellations

<b>Full Title</b>	<b>FY 2006 Budget</b>
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Gene Expression Profiles for E. coli in Common Modeled Microgravity Systems	\$71,750
Fire Suppression And Safety In Reduced Gravity Environments	\$75,189
Mechanisms of Skeletal Muscle Atrophy Due to Simulated Weightlessness	\$119,018
Liquid Crystal Phase Transitions in the Heirarchical Assembly of Collagen	\$95,000
Adaptive Control of Alloy Microstructures	\$75,000
Atom Interferometer Test Of The Equivalence Principle	\$198,000
Graphite/PE Hybrid Fiber Reinforced Composite with Epoxy and PE Matrices for Cosmic Radiation Shielding	\$79,500
Structure and Dynamics of Fragile Glass-Forming Systems	\$75,000
Development of an Inflatable Multifunctional Damage Tolerant Wall Structure with High Radiation Attenuation Properties	\$226,000
Microscale Investigation Of The Thermo-Fluid Transport In The Transition Film Region Of An Evaporating Capillary Meniscus Using A Microgravity Environment	\$105,555
Drosophila as a Model of Immune Function in Conditions of Altered Gravitational Force	\$193,989
Structure And Dynamics Of Free Surface Flows With Heating And Vibration	\$111,833
Molecular Dynamics Of Fluid-Solid Systems	\$107,000
Study Of The Application Of Contemporary Methods And Theories Of Usage To Microgravity Activities	\$106,278
New Automated System for Real-Time Bio-Imaging of a Vascular Cell Function in Microgravity	\$143,590
Entangled Atomic Clock	\$95,000
Predicting and Assessing Postural Reentry Disturbances	\$130,605
The Study of Dynamics and Tip Selection in Thermal Dendrites via Pressure Moderated Step Changes in Supercooling	\$75,000
Dynamics And Structure In Colloidal Suspensions Far From Equilibrium	\$112,750
Analysis Of The Effect Of Gravity On Multiphase Flows	\$18,218
Computer Simulations Of Confined Quantum Systems In Microgravity	\$120,000
Experiments Along Coexistence Near Tricriticality	\$100,000
Novel Polymers for Bioreactor Based Bone Tissue Engineering	\$141,100
Aerodynamics And Chemical Kinetics Of Premixed Flames At High Pressures	\$130,260
Flow-Induced Coalescence Of Drops	\$102,500
Studies Of Atomic Free Radicals In A Cryogenic Environment	\$200,000

## ESMD/HSRT Grants Cancellations

Full Title	FY 2006 Budget
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Orientalional Ordering, Pair-Interactions And Controlled Self-Assembly Of Magnetic Nanowires In Nematic Liquid Crystal Solvents	\$94,166
Differential Gene Expression in Endothelial Cells Cultured in Rotating Wall Vessel Bioreactors & Exposed to Low Laminar Shear Stress	\$161,850
Directed Assembly of Hydroxyapatite Scaffolds	\$142,064
Mechanisms of Stochastic Resonance on Bone Cells	\$66,114
Modeling Study of Instability and Internal Flows in Levitated Droplets Under Microgravity	\$75,000
Advanced Fire Detection In Enclosed Environment Via The Detection Of Chemical Vapor Signatures From Pre-Combustion Processes Using Machine Olfaction	\$150,000
Large Scale Fire Dynamics In Spacecraft In Reduced Gravity	\$104,138
Fundamental Physics Experiments With Superconducting Cavity-Stabilized Oscillators On Space Station	\$153,000
Universality Tests On DYNAMX	\$150,000
Fuel Dilution Studies Of Coflow Laminar Diffusion Flames In A Microgravity Environment	\$115,260
Integrated Biotreatment Technology for Nitrogen-Rich Wastewaters in Advanced Life Support Systems	\$299,119
Materials Science and Particle Transport Assessment of Novel and Multifunctional Shielding Materials	\$221,250
Acoustic Radiation Pressure Control Of Confined And Open Liquid Interfaces	\$99,167
Molecular Genetics of Root Thigmoresponsiveness in Arabidopsis thaliana	\$157,676
Molecular Basis of the Altered Stress Response in Bacteria Under SMG	\$153,514
Filtration Combustion For Microgravity Applications: (1) Smoldering And Fire Safety (2) Combustion Synthesis Of Advanced Materials	\$122,270
Diffusive Mass Transport in Molten Semiconductors by Magnetic Field Stabilization	\$75,000
Determination Of Gravity Independence For Two-Phase Gas-Liquid Flows Through Conduits	\$90,015
Molecular Mechanisms of Osteoblastogenesis Inhibition by Modeled Microgravity	\$142,760
The Effects Of Shear History On The Extensional Rheology Of Complex Fluids	\$105,000
Cellular and Molecular Mechanisms Mediating Rapid Resealing of Gravity-Induced Plasma Membrane Disruptions	\$316,835
Experimental Study Of Partial Dynamics In A Dilute, Vibrated, Granular Material	\$77,465

## ESMD/HSRT Grants Cancellations

Full Title	FY 2006 Budget
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Influence of Sensory Integration on the Neural Processing of Gravito-Inertial Cues	\$304,792
High Pressure Cool Flames And Auto-Ignition At Microgravity	\$120,260
CATALYZED COMBUSTION FOR EXTRA TERRESTRIAL APPLICATIONS	\$106,744
ALS NSCORT "Maximizing Equivalent System Mass for a Regenerative Life-Support System by Optimizing Kinetics"	\$1,666,667
Performance and Sleep Consequences of Slam Shifts in Schedule	\$248,468
Flow Boiling CHF In Reduced Gravity	\$102,500
A Biosensor For Single-Molecule DNA Sequencing	\$102,498
Biological and Physical Constraints on Seed Development: the Role of Gravity	\$216,000
Direct Computational Simulations And Experiments For Internal Condensing Flows System-Instabilities/Dynamics In Microgravity And Terrestrial Environments	\$155,521
Novel Applications Of Permanent Nonwetting	\$95,579
Microgravity Investigation of Crew Reactions in Zero-G	\$350,000
Navovich Circuits For Space Fluid Applications	\$86,300
Short-Range Inverse Square Law	\$100,000
Real-Time Augmented Reality Development and Human Factors Assessment for the Special Purpose Dexterous Manipulator	\$216,675
Improving Orthostatic Tolerance in Women: Control of Splanchnic and Cutaneous Vascular Capacitance	\$300,607
Simultaneous Superfluid Density and Casimir Thinning Measurements in Thick Films of 4He Near the Lambda Point	\$75,000
The Dynamics of Heterogeneous Solidification Microstructure Genesis in Undercooled Composite Systems	\$75,000
An Experimental And Analytical Investigation Of Condensing Radiators For Application To Reduced Gravity	\$77,200
Small-Scale, Multipurpose Catalytic Reactor For Combustion, Fuel Processing And Product Synthesis In Space	\$105,434
Condensate Laboratory Aboard The Space Station (CLASS)	\$150,000
Microfabricated Optical Biosensor Arrays for In Situ Bioreactor Monitoring	\$117,860
Curved Laminar Flames In Microgravity	\$116,027

## ESMD/HSRT Grants Cancellations

<b>Full Title</b>	<b>FY 2006 Budget</b>
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
An Experimental Study Of Contact Line Dynamics On Nanostructured Surfaces	\$94,171
Studies Of Emulsions Dynamics And Flows Using Magnetic Resonance Imaging	\$97,500
Numerical Study Of Microgravity Multi-Phase Free-Surface Flows With And Without Phase Change	\$99,982
Effect of Microgravity on Vascular Signal Transduction	\$118,072
Gravitational Effects On Partially-Premixed Flames	\$124,000
Bacterial Physiology and Virulence on Earth and in Microgravity	\$200,000
Synthesis, Characterization and Processing of Genetically Engineered Polymers for Biological and Structural Applications	\$114,668
An Understanding of Gravitropism via Vacuole Biogenesis and the Identification of Gravi-active Drugs to Dissect the Pathway	\$266,320
A Galilean Laboratory Test Of The Equivalence Principle Leading To A Space Station Experiment	\$125,000
Development Of An Engineering Tool For The Determination Of Suppression Device Placement In Reduced Gravity Environments	\$127,225
Development and Application of Reliability Analysis Techniques for Early Advanced Life Support Systems	\$192,867
Quantum Transport In Optical Lattices	\$85,000
Test Of Lorentz And CPT Symmetry With An Ultrasensitive Atomic Magnetometer	\$130,000
Hypergravity Effects on The Maternal-Fetal System	\$51,363
Thermal Transpiration Based Microscale Propulsion And Power Generation Devices	\$96,356
COMBUSTION IN ARTIFICIAL GRAVITY	\$108,239
Oxygen And Fuel Jet Diffusion Flame Studies In Microgravity Motivated By Spacecraft Oxygen Storage Fire Safety	\$110,258
Study of Molecular Lesions in Dendritic Cells Cultivated in Modeled Microgravity	\$138,610
Prototype Biophotonic Biosensor for Monitoring VOC Contaminants in Spacecraft Habitats	\$265,600
Correlation Effects In Dense Wet And Dry Granular Media	\$120,000
Lattice Boltzmann Computations of Binary Diffusion in Liquids under Stochastic Microgravity	\$75,000
Computer Modeling Of The Role Of Capillary Transport In Producing Postflight Orthostatic Intolerance	\$102,500
Reduced Gravity Studies Of Soret Transport Effects In Liquid Fuel Combustion	\$80,781

## ESMD/HSRT Grants Cancellations

<b>Full Title</b>	<b>FY 2006 Budget</b>
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
Hydrogen Loaded Hollow Glass Microspheres as a Multi-Functional Radiation	\$97,759
Small Angle Scattering For Characterization Of Combustion Generated Particulate	\$123,465
A Time-Resolved Micro-Impedance Tomography System For The Determination Of Capillary Flow Instability Phenomenon	\$87,135
LBNP Treadmill and Resistive Exercises during Long-term Bedrest (MEDES Support for Co-Investigator)	\$10,115
Direct Visualization And Light Scattering Studies Of The Structure, Dynamics And Rheology Of Anisometric Colloidal Suspensions And Gels	\$92,250
Aggregation In Dense Systems: Crossover From Cluster-Cluster-Aggregation In Percolation	\$87,748
Cadmium Zinc Telluride (CdZnTe) High-Energy Radiation Sensors and Structural Transformation of Group I-III-VI-Melts	\$91,667
Novel Radiation Shielding and Structurally Efficient Materials for Space Missions	\$149,952
Continuation Of Development Of A Primary Reference Clock In Space (PARCS)	\$122,000
Catalyzed Combustion In Micro-Propulsion Devices	\$112,000
Advanced Diamond Electrodes for Electrochemical-based Monitoring of Spacecraft Water	\$190,000
Using Guided Ultrasound To Control Bubbles In Reduced Gravity	\$156,656
FLAME STABILITY, SPREAD, AND SUPPRESSION	\$89,749
Microscopic Studies of Gravi-Sensitive Microtubule Assembly in Simulated Variable Gravity Conditions	\$53,723
Negative Impacts of Altered Gravity Models on Male Mammalian Reproductive Capacity	\$258,837
Strategic Research Into Multiphase Fluid Processing And Mass Transfer In Microchannels	\$86,387
Transport Processes In Navel Oscillating Flow Systems For Separation And Containment Removal	\$83,975
Genetic and Developmental Stability in Response to Long-Term Exposure of Drosophila melanogaster to a Space Station Environment	\$116,313
Microfluids: Actuation By Modulation Of Surface Stresses-Flow Modeling To Device Implementation	\$102,500
Studies Of Forced Convection Boiling By Direct Numerical Simulations	\$131,585
Non-Equilibrium Dynamics And Statistical Mechanics Of Excited Granular Media In The Absence Of Gravitational Barriers	\$102,500
The Master Switch for Bone Formation: Structural Studies of RunX2	\$238,704
Effect of Space Travel on Skeletal Myofibers	\$200,000



## ESMD/HSRT Grants Cancellations

Full Title	FY 2006 Budget
Fundamental Evaluation Of Water Mist For Fire Safety In Spacecraft And Extraterrestrial Environments	\$130,094
DROPLETS IMPINGING UPON LIQUID FILMS: A STUDY OF COALESCENCE, JETTING, BUBBLE ENTRAPMENT AND SPLASHING	\$114,257
Quantification of Fire Signatures	\$96,260
Iginition And Combustion Of Single Complex Metal Particles Under Reduced Gravity Conditions	\$108,550
Checkpoint Reduced Cell Sensitivity to High Energy Particles-Induced Killing	\$76,236
Patterning of the Vestibular Sensory Organs	\$59,652
Microgravity Studies of Liquid-Liquid Phase Transitions in Undercooled Alumina-Yttria Melts	\$75,000
Theoretical Investigations Of Equilibrium And Nonequilibrium Superfluid Dynamics With Applications To Future Ground-Based And Microgravity Experiments	\$120,000
Fabrication Of Active Phontonic Structures With Colloid Engineering	\$92,250
Simultaneous Superfluid Density And Casimir Thinning Measurements In Thick Films Of 4He Near The Lambda Point	\$75,000
Improving Lunar Laser Ranging Tests of Gravitational Theory	\$130,000
Ebeam-Cure Fabrication of Polymer Fiber/Foam/Matrix Composites for Multifunctional Radiation Shielding	\$155,200
Transcriptional and Translational Regulation of Gravitropism in the Maize Pulvinus	\$89,708
Local Micromechanical Effects of GTPase Activation in Cells Subject to Extracellular Stimuli	\$141,100
Novel Microstructures for Vascular Tissue Engineering	\$145,250
Micro Heating Pipe Driven By Dielectrophoretic Force And Capillary Force	\$68,148
Advanced Portable Ion Analyzer for Water Quality	\$195,050
Simulations Time Keeping And Laser Ranging With An Ultrastable Short Pulse Laser	\$130,000
Theoretical Studies Of The Generation, Detection, And Applications Of Massively Entangled States Of Bose Condensed Atoms	\$80,000
Control of Bacterial Biofilm Formation in Space Exploration	\$100,000
AC Heat Capacity Measurement Using Gravity Cancellation Approach	\$110,000
Hybrid Composites with Reactive Nano-matrix for Cosmic Radiation Shielding	\$100,725
Bioreactor Technology Transfer	\$550,000
Multiphase Flow Of Emulsions Through Porous Media	\$83,314
The Influence of Rotational Cues on Human Tilt and Translation Responses	\$274,033



## Appendix 2:

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ADDITIONAL MATERIAL FOR THE RECORD



Comment and Endorsement  
of the  
NRC “Review of NASA Plans for  
the International Space Station”

An ELMS White Paper

Submitted for the record of February 16, 2006  
Hearing of the House Science Committee

**Exploration Life & Medical Sciences Coalition**



**Comment and Endorsement of the NRC**  
**“Review of NASA Plans for the International Space Station”**  
 (NRC Review of NASA Strategic Roadmaps: Space Station Panel)

In 2005 the National Research Council assembled an expert panel for a “Review of NASA Plans for the International Space Station.” For this review, NASA supplied the best available information. Nevertheless, the NRC Panel noted, with discontent, that the information was superficial (mostly viewgraphs) and incomplete. Also alarming was that these were the actual datasets used by NASA for making key funding and prioritization decisions within the agency. The NRC panel concluded that NASA’s decisions are seriously flawed; the Panel made numerous, specific recommendations to correct them and to slightly extend NASA’s extremely short-range vision to the exploration journey defined by the Exploration Vision.

The Panel found that the revised activities and priorities for ISS negate the initial intent of the ISS, reduce the ability of the ISS to advance technology, and preclude using the only manned platform available in the next several decades to develop needed mitigations for space-based risks to human health and performance, a critical priority for the Exploration Vision. Originally, the ISS was to provide high quality solutions for the fundamental problems that humans will encounter during and after long duration space missions. But, NASA’s current plans re-direct the focus to only some short-term issues. This will eliminate many Exploration-applied investigations needed to go beyond the sortie mission and adds significant risk to the safety and success of the exploration vision

The Exploration Vision, presented by President Bush, suggested changes in the paradigm by which NASA operated and avoiding focused attention on racing to a scheduled milestone that influenced both the Challenger and Columbia accidents. In the Exploration Vision, the President explicitly pointed toward long-term value creation with new and efficient operational capabilities and efficiencies that align with the priorities recommended in the NRC report–

*“Our first goal is to complete the International Space Station by 2010. We will finish what we have, we will meet our obligations to our 15 international partners on this project. **We will focus our future research aboard the station on the long-term effects of space travel on human biology.** The environment of space is hostile to human beings. Radiation and weightlessness pose dangers to human health, and we have much to learn about their long-term effects before human crews can venture through the vast voids of space for months at a time. Research on board the station and here on Earth will help us better understand and overcome the obstacles that limit exploration. Through these efforts we will develop the skills and techniques necessary to sustain further space exploration.”*

*“The vision I outline today is a journey, not a race” and the president discusses and refers to this “journey” throughout the definition of the Exploration Vision.*

In response, NASA quickly redefined and reformulated the program into another race that focuses on near-term schedules and early milestones rather than a structured development of long-term value.

Our nation is now on a new path leading to an “Apollo mission on steroids” devoid of key research and technology developments that the NRC report reiterates are critical for human exploration of space. By following this path, the nation forfeits a \$100B infrastructure of space



assets as well as an equivalent value in assets within university, government, and industry sectors. For example,

- To meet short-term milestones, the CEV will rely on open loop life support systems that are acceptable only for short-duration missions but will require redesign and redevelopment for exploration.
- Though the NRC states that we still lack adequate countermeasures and have not yet fully assessed known risks of radiation, bone and muscle loss, combined effects of radiation and microgravity, and other psychological and medical risks, NASA states that they are adequately prepared to proceed, citing that the short duration Lunar mission is as far as they are currently looking.
- The NRC states that the ISS is needed as a microgravity research platform for technological and biological investigations vital for Mars transit.

Imagine one decade from now: Having aborted the key capabilities of the ISS and terminated its national funding, we will need innovative systems for long-duration missions. Shall we then embark on the initial developments of Mars transit and surface technologies? The NRC has reiterated that significant new technologies and human health countermeasures are required to sustain humans in a microgravity space environment. Will NASA then request from Congress and the American public a new ISS, new closed loop life support, other developments that we are now canceling? We echo and endorse the NRC's call for a coherent, responsible, forward-looking plan for pursuing the exploration initiative. These plans can and should be continuously supported by our evolving transportation capabilities from Shuttle to commercial carriers, CEV, and other platforms. A coherent transportation transition plan is needed that precludes total elimination of core capabilities whether that transition occurs in 2010, 2014 or some other logically driven timeframe.

The NRC report tactfully but clearly states that NASA's current plans are insufficient to meet the needs of an exploration program. Risk-based criteria and analyses are missing from the assessments and planning. There is an inordinate focus on development of a CEV by 2011 and a lunar sortie mission in 2018. Absent are research activities to enable the long-range Exploration goals were presented to the panel. Absent are concerns or plans for the long-duration tests and microgravity investigations necessary to validate exploration mission architecture and vehicle designs. For the next twelve years, the ISS is the only long duration platform in the Exploration architecture and NASA has no prioritized utilization plan to make use of this platform. We have already learned from ISS experiences that long duration testing and validation are needed for many systems including the life support. How will NASA test long duration operation of such equipment in microgravity once ISS is not available? This is one of the major holes in the current plans.

The NRC report specifically states that "briefers [of the NRC panel] stated explicitly that no activity was completed to prioritize individual experiments in the current payload portfolio in relation to the Exploration Systems Mission Directorate research and technology requirements". More than 10 times in the NRC report, NASA was criticized for not aligning current decisions with their own Exploration priorities. Thus, hundreds of millions of dollars of national assets in programs, system capabilities, and valuable intellectual property are being cancelled without proper rationale and decision process. In fact, the NRC panel suggests that several of the



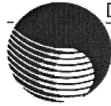
cancelled assets be recovered – in three places, the NRC specifically states that animal research aboard ISS should be reinstated.

In summary, NASA's new plan to abandon the ISS as a rigorous research platform, and to shift to near-term goals at the expense of long-term success and risk mitigation is reminiscent of the agency culture, which was the basis of the Challenger and Columbia accidents. As supporters of the Vision for Exploration and of long-term success of NASA as an agency, we strongly support a moratorium on the abandoning of core ISS activities. These capabilities are essential in the development of the infrastructure to support a safe and valuable extension of human presence into the solar system, an activity that will also create significant value to the humans on Earth.

The NRC review of the ISS provided a laudable set of insightful and compelling recommendations, both specific and general:

- ISS should be focused on validation of technologies, mitigation of crew health issues, and demonstrate operations for the long-term goals of the exploration vision well before Lunar Outpost and Mars missions; NASA should plan these activities with a smooth evolution within the transportation infrastructure from Shuttle to commercial carriers, CEV, and other platforms.
- Risk-based priorities for the long-term missions should be set high without abandoning key capabilities such as animal-based research aboard ISS and larger crews on ISS.
- Life support and environmental control technologies need long duration development and testing aboard ISS prior to use on Lunar Outpost or Mars Mission which must occur before the ISS is no longer funded.
- NASA's scientific and biomedical plans for ISS utilization, as well as infrastructure, technology development, and testing for Exploration priorities should be independently reviewed to provide NASA priorities to which it is held accountable.
- NASA needs to develop plans for long-duration, animal research and focused microgravity testing and validation after the planned elimination of ISS funding in 2017.
- Basic and fundamental investigations of human health and life support issues, as well as other physical science investigations are absolutely critical to the reduction of risk for future Exploration missions.

We agree with the NRC that NASA is prematurely abandoning the ISS and that these decisions add significant risk to the Exploration Vision. We understand the pressures for Shuttle replacement, but we also understand the need to balance long-term risks of the Exploration Vision with these short-term needs. An even balance of science and technology that is always driven by the long-term value and risk mitigation will enable a successful exploration of the solar system including transitioning science and technology values to Earth – all goals that were at the heart of the President's original vision.



February 15, 2006

The Hon. Sherwood L. Boehlert, Chair  
Committee on Science, U.S. House of Representatives

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DPS home page on WWW:  
<http://www.aas.org/~dps/dps.html>

Dear Mr. Chairman:

On behalf of the Division for Planetary Sciences (DPS) of the American Astronomical Society, the world's largest organization of planetary scientists, I am writing to express deep concern about the large cuts to basic science and research programs contained in NASA's FY06 operating plan, and the even deeper cuts in NASA's FY07 budget request.

The proposed NASA budget transfers three billion dollars (over the next five years) from solar system exploration to the human space flight program, to help pay for shuttle flights and the completion of the International Space Station (ISS). This budgetary raid has grave consequences for robotic exploration of the solar system, and even more critically, for NASA's fundamental research and analysis (R&A) programs.

Tapping the solar system exploration budget to pay for the shuttle and ISS pits human exploration against robotic missions, rather than drawing on the strengths of both. It pawns one of NASA's crown jewels - a planetary exploration program that is the envy of the world - to pay for cost overruns in human spaceflight. The reductions in research grants undercut our nation's ability to plan for future missions. The funds devoted to the analysis of the scientific data obtained from past and ongoing planetary missions, already just a small fraction of overall mission costs, are still further reduced.

The cuts to research in the FY06 and FY07 budgets undermine the Vision for Space Exploration, which calls for a robust program of robotic exploration across the solar system. They are contrary to the President's American Competitiveness Initiative to increase federal investment in critical research in the physical sciences. Finally, the proposed devastating cuts to NASA's R&A programs risk eliminating a generation of young planetary scientists that will be called upon to realize the President's Vision for Space exploration over the coming decades.

Quite simply, NASA has been directed to do more than it can afford, and the shortfall is being charged to solar system exploration. We recognize that the federal budget is tightly constrained, and that difficult decisions must be made to balance priorities among NASA's programs. Nevertheless, any short-term savings achieved by the proposed cuts to science in order to fund shuttle flights would have long-term and crippling consequences, threatening our nation's leadership in solar system exploration. NASA's science budget should grow, or (in the worst case) decline, at a rate no different than the rest of the agency.

We ask for your support in preserving the long-term health of NASA's robotic solar system exploration program in the face of rising costs for human spaceflight. Of most immediate concern to the DPS is the restoration of adequate funding for FY06 and FY07 R&A programs. As a first step in that process, it would be very useful to determine the NASA Administrator's willingness to solve this problem. During the February 16 House Science Committee hearings on the NASA budget, we respectfully request that you pose the following question to Dr. Griffin:

"Dr. Griffin, planetary scientists are telling us their highest priority is preservation of Research and Analysis budgets within the Science Mission Directorate. Given the support of the planetary science community, would you as Administrator support restoring planetary R&A funds for FY06 and FY07 through a small rebalancing of the budget in some manner?"

The House Science Committee serves a vital role in helping to set national priorities in solar system exploration and research. Thank you very much for your vigorous leadership of this effort.

Sincerely,

Richard G. French



STATEMENT BY THE PLANETARY SOCIETY

**A Better Path for NASA**

The Bush Administration's proposed five-year budget for NASA, just submitted to Congress, is an attack on science. The proposed budget directs three billion dollars (over five years) away from robotic exploration of the solar system to continue to operate the Shuttle. Last year the Administrator said, "*not one thin dime*" would be so directed.<sup>1</sup> Now we learn it is 30 billion dimes.

Science missions are being cut out of the program or delayed. Among them:

- Rejection of a request from Congress for a new start for a mission to explore the ice-covered world of Jupiter's moon, Europa.<sup>2</sup> Such a mission is the highest-priority objective outlined in the NRC/Planetary Science Community's most recent Decadal Survey<sup>3</sup>: The under-surface ocean on Europa could be a habitat for life;
- Delay of the Space Interferometry Mission—a key effort contributing to the understanding of the universe and the search for other planetary systems;
- Cancellation of the long-sought Terrestrial Planet Finder, a mission also supported in the original *Vision for Space Exploration*, to discover Earth-like planets and possible abodes for life around other stars;
- Cancellation of two Scout missions to Mars; and
- Previously announced cancellation of precursor experiments and missions for human Mars exploration.<sup>4</sup> The proposed budget continues to downplay Mars as a goal for human exploration.

In addition, a devastating 15 percent cut to science research funding—including likely cuts to some approved 2006 research programs—is being applied across all Earth and space science disciplines, and 50 percent is being cut from astrobiology research! This attack on basic science ironically comes at a time when the President announced in his State of the Union speech his intention "*to double the federal commitment to the most critical basic research programs in the physical sciences over the next 10 years.*" Apparently the physical sciences do not include either Earth or space sciences.

NASA has begun implementing these cuts immediately (fiscal year 2006) in anticipation of their 2007 budget request being granted. Since many of these actions directly contradict the wishes of Congress expressed in last year's Authorization and Appropriation bills, we ask that the Committee request NASA to take no actions in fiscal year 2006 to cut science or delay the Europa mission consideration until Congress can act of the fiscal year 2007 budget request.

NASA has cited space science funding increases from 1992 to the present as a possible justification for now using space science funds to pay for the Shuttle.<sup>5</sup> But during that same time period space science has provided the overwhelming share of NASA successes and achievements—including the Hubble Space Telescope, Mars Exploration Rovers and Orbiters, and the Cassini/Huygens mission to Saturn. The value of space science to NASA, to the Nation, and to the world during this time period has increased far more than its cost.

We strongly believe the proposal to rob from science to pay for Shuttle will undermine support for the *Vision for Space Exploration* policy and re-open the chasm between the science community and the human space flight advocates. Science was an essential component of the Vision when it was proposed two years ago.

For example the Vision stated that NASA should "conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore Jupiter's moons, asteroids, and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources."<sup>6</sup> The proposed cancellation of Europa exploration undermines the Vision.

<sup>1</sup> *Science* 23 September 2005: Vol. 309, no. 5743, p. 1975 report on NASA press conference.

<sup>2</sup> Fiscal Year 2006 Appropriations Bill, House Appropriations Committee Report.

<sup>3</sup> "New Frontiers in the Solar System: An Integrated Exploration Strategy," National Research Council, ISBN: 0-309-08495-4, 248 pp., 2003.

<sup>4</sup> Some of these were in the Science program, and some were in the Exploration program, such as the liquid oxygen/methane engine in the new exploration transportation system.

<sup>5</sup> Dean Acosta, Mary Cleave at NASA Press Conference, Feb. 6, 2006.

<sup>6</sup> "A Renewed Spirit of Discovery," President George W. Bush, January 2004.

The proposed cancellation of Terrestrial Planet Finder contradicts another tenet in the Vision, “Conduct advanced telescope searches for Earth-like planets and habitable environments around other stars.”<sup>7</sup>

But the biggest danger to the *Vision for Space Exploration* is not the removal of a few exploration missions from NASA’s budget, but the commitment made in the budget for 17 Shuttle flights. The average number of Shuttle launches per year of the Space Shuttle over its lifetime is less than five. This was with 4–5 orbiters. Now that the country is down to only three orbiters (and soon, just one launch pad) on a system with far more safety concerns and scrutiny, how can we expect the number to be larger? Three or four is a more reasonable expectation—meaning that if all goes well and there are no more accidents or gaps in readiness for flight, the 17 flights might be accomplished in four to six years.

That takes us beyond 2010, and leads to more expenditures and hence more delays in the transition to new launch vehicles and a new human space flight program beyond Earth orbit. In fact we would predict that the likely outcome is another decade or more for humans stuck in low-Earth orbit.

We don’t have to cite our anxieties about the dangers of extending Shuttle lifetime, and the delays of implementing the new Vision program. The proposed budget itself states that the CEV may not be ready until 2014, and that NASA is only hoping that some synergies and new providers will be found to enable readiness two years (not four) earlier. Hope is not a good planning tool.

Imagine this is 2010, and the CEV will not be ready until 2014. Will there be pressure to close the gap in U.S. human launch capability? Of course there will—and the likely outcome is four more years of Shuttle, and four more years of more costs leading to more delays of other parts of the program.

Continue imagining this is 2010. The Shuttle has flown about 5–6 flights since mid-2006 and has still not delivered the European or Japanese modules. Will there be pressure for the U.S. to “meet its international commitments” and continue the Shuttle flying—even at the expense of delaying the now delayed CEV from 2014 to when? Will the Congress of 2010 say about the Congress of 2006: “glad they kept the Shuttle flying so as to meet commitments and restore purpose to the human space flight program”? Or, will they wonder how this Congress could have had so little foresight about investing in the future, and why it chose to invest in the past?

We recognize that the 3.2 percent increase in the NASA budget is a positive statement of support for space exploration. We know it is not practical or reasonable to argue for more, and those who come to the Congress and say simply “add money to take care of my programs” are being disingenuous. We would like a bigger budget for NASA but can we rely on Congress to simply add much into the already overloaded and deficit-burdened budget?

The Administrator’s budget message said about the Vision, “we will go as we can afford to pay.” But the Administration hasn’t paid in this budget, and instead NASA is going forward even when they can’t afford it—by raiding the budgets for basic science research and robotic exploration. Who will be left to march to the guillotine next year when development costs rise in human space flight or if the Shuttle suffers more problems?

If they do not want to go as they can afford to pay, then the NASA Administrator is right—tough choices have to be made. Deep science cuts for NASA were a tough choice. A different tough, but better, choice would be stopping the Shuttle program now—recognizing that it embodies an intersection of cost and risk that cannot be avoided, and the roadblock it now creates on the pathway to space.

Domestic and international politics make this particular choice even tougher, which is why few even broach the option, let alone advocate it. Domestic politics allow vested interests and short-sighted job arguments to rule for continuing the Shuttle. But with retirement of the Shuttle within 3.5 years already announced, the ability to keep or attract good people to the program is small, and will get smaller. Ending it now, taking the cost savings and applying it to new programs can be a buoy for human space flight contractors, creating a new sense of purpose and a new set of jobs. Starting other programs earlier, such as the Mars-related heavy lift launch development can mitigate economic dislocations.

International politics force protocol to become the enemy of problem solving. The Planetary Society respects the expectations of international partners, and we as an organization strongly support and believe in the value of international cooperation in space. However, the Shuttle-only architecture is an international problem for all involved in the Space Station. It demands an international solution. American leadership is needed now to declare an emergency concerning the Shuttle; it can no longer be relied upon for completing the International Space Station. Instead of the

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<sup>7</sup> *Ibid.*

partners being asked to wring their hands and deplore American attitudes, let's ask them to join with us to develop international solutions and programs to advance our human space flight ambitions, as well as their own. We suggest that such honesty will provide a solid foundation on which to build international partnerships for future exploration.

The Planetary Society supports space ventures. We have supported the Shuttle: it has been a great technical achievement, unequalled on Earth. We have supported the International Space Station: it should be completed as a pathway for human expansion into the solar system. And, from the moment it was proposed, we have strongly supported the *Vision for Space Exploration*, a long overdue redirection of human space flight beyond Earth orbit.

But we cannot support a proposal that hobbles, or eventually destroys, the NASA science program. Science guides not just robots but also humans into space. Science guides the public in creating a rationale for a \$16 billion space program. Science guides exploration. And we ask, and hope, that support of science will guide you as you oversee the NASA program.

**THE PLANETARY SOCIETY:**

The Planetary Society has inspired millions of people to explore other worlds and seek other life. Today, its international membership makes the non-governmental Planetary Society the largest space interest group in the world. Carl Sagan, Bruce Murray and Louis Friedman founded The Planetary Society in 1980. <http://planetary.org>