NASA'S FISCAL YEAR 2008 BUDGET REQUEST

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

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March 15, 2007

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NASA'S FISCAL YEAR 2008 BUDGET REQUEST

THURSDAY, MARCH 15, 2007

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

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

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

Hearing on

NASA's Fiscal Year 2008 Budget Request

March 15, 2007
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Dr. Michael Griffin
Administrator
National Aeronautics and Space Administration

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HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NASA's Fiscal Year 2008 Budget Request

THURSDAY, MARCH 15, 2007
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, March 15, 2007 at 10:00am, the Committee on Science and Technology will hold a hearing on the *National Aeronautics and Space Administration's (NASA) Fiscal Year 2008 Budget Request* and NASA's proposed Fiscal Year 2007 Operating Plan.

Witness:

Dr. Michael D. Griffin, Administrator, National Aeronautics and Space Administration

Background Information

Overview

The National Aeronautics and Space Administration (NASA), which was established in 1958, is the Nation's primary civil space and aeronautics R&D agency. The current civil service workforce consists of approximately 18,100 full time equivalent (FTE) employees. According to NASA's budget request, that level is projected to decline to 17,000 FTEs by 2012. NASA has ten field Centers, including the Jet Propulsion Laboratory (JPL) FFRDC. Although there have been discussions in the past regarding the future disposition of NASA's Centers (e.g., potential closure or privatization of one or more Centers), NASA Administrator Griffin has stated his intention to maintain "ten healthy Centers."

NASA conducts research and development activities in a wide range of disciplines including aeronautics, astrophysics, heliophysics, planetary science, Earth science and applications, microgravity research, and long-term technology development. NASA also operates a fleet of three Space Shuttles and is assembling and operating the International Space Station. NASA also maintains a space communications network that supports both NASA missions and other federal agency requirements. Almost 90 percent of NASA's budget is for contracted work. In addition, a number of NASA's scientific and human space flight activities involve collaboration with international participants.

In January 2004, President Bush announced his "Vision for U.S. Space Exploration" (VSE). According to the President, the United States is to do the following:

- *"Implement a sustained and affordable human and robotic program to explore the solar system and beyond;*
- *Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;*
- *Develop the innovative technologies, knowledge, and infrastructures both to explore and support decisions about the destinations for human exploration; and*
- *Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests."*

With respect to the Space Shuttle, the President's policy stated that NASA should:

- *"Focus use of the Space Shuttle to complete assembly of the International Space Station; and*
- *Retire the Space Shuttle as soon as assembly of the International Space Station is completed, planned for the end of this decade."*

With respect to development of a new human transportation system, the President's policy states that the U.S. shall:

- *"Develop a new crew exploration vehicle to provide crew transportation for missions beyond low-Earth orbit;*
- *Conduct the initial test flight before the end of this decade [i.e., before end of 2010] in order to provide an operational capability to support human exploration missions no later than 2014."*

Budgetary Information

NASA's proposed budget for FY 2008 is $17.3 billion, an increase of 3.1 percent over the FY07 President's request for NASA and an increase of 6.5 percent over the FY 2007 Joint Resolution [P.L. 110–5] appropriation for NASA. Attachment 1 summarizes the FY08 budget request and its five-year funding plan. It should be noted that NASA has once again changed its accounting structure, and the budget request now incorporates "full cost simplification." As a result, some of the overhead burden has been reallocated among the Mission Directorates at NASA, leading to some accounts having to include more of the overhead costs in their budgets (and other accounts including less). NASA has stated that no program funds have been increased or decreased as a result of the full cost simplification process.

As noted in the Committee's Views and Estimates submitted to the Budget Committee, the FY08 budget request is *"approximately $690 million less than the amount stipulated for FY 2008 in the FY 2005 five-year budget plan that accompanied the President's Vision for Space Exploration* (VSE). That shortfall replicates the practice in each of the previous two years, i.e., the Administration's FY 2006 NASA request and its FY 2007 NASA request were approximately $546 million and $1.02 billion less than the amounts stipulated for FY06 and FY07 respectively in the five-year budget plan that accompanied the President's VSE. The cumulative effects of those budgetary shortfalls, coupled with OMB's under-budgeting for the costs of Space Shuttle and the International Space Station (ISS) in that same five-year budget plan, are manifested in the strains and stresses that are visible in all of the Agency's programs."

The Minority Views and Estimates echoed that conclusion, stating that the Minority Members of the Committee are *"concerned that NASA's budget request, together with reductions in FY07 appropriations, may jeopardize NASA's ability to successfully accomplish its portfolio of missions, and is especially threatening to our manned space flight capabilities."*

Attachment 2 compares the NASA budget plan that accompanied the President's Vision initiative with the actual funds requested (or planned to be requested per the FY08 budget request's five-year plan) by the President for the years FY06–12. As can be seen, the President's requests have been significantly less (i.e., typically on the order of a half-billion dollars or more in the early years) than what was projected by the Administration as being needed to carry out the Exploration initiative and NASA's other core missions. The cumulative shortfall over that period is in excess of $3.8 billion.

The FY07 appropriation contained in the Joint Resolution maintains NASA's overall funding level at the FY06 level. As a result, the FY07 appropriation is approximately $545 million lower than the FY07 budget request for the Agency. NASA was not given the authority to transfer funds between appropriations accounts. Under the terms of the Joint Resolution, NASA is to submit to Congress by March 15, 2007 a revised Operating Plan that reflects how the Agency will allocate its FY07 appropriation within the constraints of the Joint Resolution. Administrator Griffin has been asked to discuss the FY07 Operating Plan at the hearing.

To put the FY08 budget request into context, NASA has been tasked with flying the Shuttle safely until the end of decade and then retiring the Shuttle fleet; assembling, operating, and utilizing the International Space Station; completing the development of a new Crew Exploration Vehicle/Crew Launch Vehicle by 2014; pursuing human exploration of the Moon no later than 2020; and conducting science and aeronautics programs. The *NASA Authorization Act of 2005,* which was signed into law in December 2005, authorized an FY07 funding level for NASA of $17.93 billion; the FY07 NASA appropriation is $16.25 billion. The *NASA Authorization Act* authorized an FY08 funding level for NASA of $18.69 billion; the President's FY08 budget request is $17.3 billion.

With respect to NASA's contract management practices, NASA remains on GAO's "high risk" list for its contract management practices. With respect to its financial management, NASA once again failed to pass an independent audit, and the auditors identified a number of "material weaknesses" that NASA will have to address.

Program Areas

Space Science

The President's FY 2008 budget requests $4.019 billion to fund NASA's space science programs, including Heliophysics, which seeks to understand the Sun and how it affects the Earth and the solar system; Planetary Science, which seeks to answer questions about the origin and evolution of the solar system and the prospects for life beyond Earth; and Astrophysics, which seeks answers to questions about the origin, structure, evolution and future of the universe and to search for Earth-like planets. The proposed budget represents a $16.5 million increase (or about 0.4 percent) over the President's proposed FY07 budget.

Programmatic content changes in the FY08 budget include the following:

- Geospace Missions of Opportunity Phase B studies not funded
- MMS Solar Terrestrial Probe descoped to stay within budget profile
- New Millennium ST–9 technology demonstrator mission award delayed at least two years
- Planetary Science program reserves reduced and re-phased; future Planetary Science projects and Juno and New Frontier missions "re-phased"
- New "Lunar Science" budget line created
- GLAST and Kepler astrophysics mission launch dates slipped
- Reserves for James Webb Space Telescope (JWST) increased
- Space Interferometry Mission (SIM) deferred and reduced to a technology development program with no identified launch date
- SOFIA project reinstated.

The FY08 budget request maintains the research and analysis (R&A) accounts at FY07 budget levels and thus sustain the 15 percent R&A cuts included in the FY06 and FY07 NASA budgets. Astrobiology, an interdisciplinary field that NASA created to study the origin, evolution, and possible existence of life in the Universe, has been cut by some 50 percent since FY06. The competitively-selected Explorer and small missions programs that National Academy Decadal Surveys have emphasized as vital, continue to lack the required funds to restore the two-year cycle of issuing announcements of opportunity (AOs). The current AO rate has been diminished considerably compared to earlier periods. The last Explorer AO was issued in 2003; under the FY08 budget request, the next AO is expected to be issued in late 2007 or 2008 leaving a gap of approximately five years in new selections.

Other Space Science issues include the following:

Mission Size and Programmatic Balance—The FY08 budget request continues budgetary trends that are creating imbalances in science programs, especially in the research and analysis (R&A) accounts, which fund grants to analyze science mission data, and in the portfolio of sizes for science missions. Science programs that lack balance are not robust: they cannot be sustained or contribute adequately to high priority research questions laid out in National Academy decadal surveys. Moreover, in addition to their high scientific productivity, small and medium-sized missions are instrumental in training young scientists and engineers and in exciting the science and broader communities through the Principal Investigator team's promotion of the mission.

Cost-Growth in Missions—Several of the increases in the proposed FY08 Science budget provide funds for projects that have run over budget or schedule, or that run the risk of doing so. The factors contributing to cost and schedule growth are not easy to pinpoint, but include under-estimates in the technology developments required for mission readiness; increases in launch vehicle costs; inadequate models to estimate mission costs; internal decisions to delay missions or alter budget profiles; project management difficulties; and delays in contributions from international or interagency partners. Mission cost growth erodes opportunities to conduct other high priority science and can lead to delays, cancellations, or reduction in funds for other NASA science missions and activities.

Launch Services/Access to Space—Officials from NASA's Science and Space Operations Mission Directorates have called attention to a potential crisis in launch vehicle access for science missions. The Space Science program has been a regular user of Delta II vehicles, which are reported to have a 98 percent success rate for science missions flown since 1961. Between 2007–2009, NASA's Science Mission Directorate plans to launch at least eight missions on the Delta II vehicle. NASA is uncertain about the availability of the Delta II beyond 2009 and is conducting a study to investigate options for alternatives to the Delta II. The potential loss of Delta II raises

the question of reliable access to space for science missions. Shifting to alternative vehicles could affect mission costs and schedule.

Earth Science

The President's budget for FY08 requests $1.497 billion for Earth science research, applications, Earth observing missions, education and outreach, and technology development. The proposed FY08 Earth science budget represents an increase of $32.8 million (or about 2.2 percent) over the President's FY07 budget request. The increase reflects the net addition of funds to address cost and schedule issues for Earth Science missions under development including the Landsat Data Continuity Mission, Glory mission, NPOESS Preparatory Project (NPP), and the Global Precipitation Measurement mission (GPM). Increases were also provided for Earth System Science Pathfinder missions (Orbiting Carbon Observatory and Aquarius) to help maintain schedule.

The proposed FY08 budget maintains the nearly 20 percent cuts to the Earth science research and analysis (R&A) accounts that were proposed in FY07 budget. The R&A accounts fund grants for fundamental research, technology development, training of graduate students, theory research, and data analysis, in essence the intellectual underpinning for the program. As stated in the Decadal Survey, *"Without adequate R&A, the large and complex task of acquiring, processing, and archiving geophysical data would go for naught. Finally, the next generation of Earth scientists—the graduate students in universities—are often educated by performing research that has originated in R&A efforts."*

Other Earth Science issues related to the FY08 budget request include the following:

Future Earth Observing Missions and Measurements—As discussed in the full House Committee on Science and Technology hearing on February 13, 2007, the National Academy of Sciences recently released the results of the first-ever decadal survey on Earth science. The report, which was requested by NASA, NOAA, and USGS, states that *"the number of operating sensors and instruments on NASA spacecraft, most of which are well past their nominal lifetimes, will decrease by some 40 percent"* by the end of the decade. The report also states that *". . .the United States' extraordinary foundation of global observations is at great risk."* Many of the measurements that may be lost with these sensors provide critical information on weather and climate. Some of the planned replacement sensors, which are to be flown on NPOESS, are less capable than existing sensors and may affect future abilities to forecast El Niño events, hurricanes and weather forecasts in coastal areas. Moreover, the Decadal Survey notes that between 2000 and 2006 NASA's Earth science budget decreased by more than 30 percent when adjusted for inflation. The proposed FY08 budget for NASA's Earth science programs responds to the recommendations of the interim report of the Decadal Survey by adding funds to complete missions currently under development that will sustain critical, high priority measurements (e.g., the Landsat Data Continuity Mission, the Glory mission and the GPM). However, the proposed FY08 budget does not provide out-year funding that would enable development of even the first few of the 15 new, high-priority NASA missions recommended in the Decadal Survey.

Aeronautics Research

The President's FY 2008 budget requests $554M for Aeronautics Research, which includes aviation safety, airspace systems, fundamental aeronautics, and aeronautics test program. While the FY08 budget for Aeronautics represents a $170.4 million decrease from the President's FY07 NASA budget request, NASA states that the decrease can be attributed to changes in NASA's allocation of overhead rates (referred to as "full cost simplification") and does not reflect any changes in programmatic content. If full cost simplification is taken into account, NASA would say that the FY08 request is an increase of $24.7 million (or about 4.7 percent). After FY08, the NASA Aeronautics funding would decline to $546.7 million in FY09. As a point of comparison, NASA Aeronautics funding was about $1.85 billion (2006 dollars) in 1994—the current budget request is thus only about 30 percent of that level.

The FY08 five-year budget plan would increase Aeronautics funding by $222 million (or about 10 percent) over the period FY08–11 relative to the amounts in the FY07 five-year budget plan (assuming full cost simplification). However, the budget request for FY08 is approximately $336 million less than the $890.4 appropriated for NASA Aeronautics in the FY07 Joint Resolution, or approximately $141 million less if NASA is able to apply full cost simplification to the FY07 appropriated amount. Thus the funding reduction from the FY07 appropriation to the FY08 budget request would largely or completely negate the funding increase to Aeronautics over the FY08–11 period.

The aeronautics community relies upon NASA for aeronautical research and development. Beginning in late 2005, NASA began restructuring its aeronautics program to move away from a program that included technology demonstration projects and R&D that led to greater technology maturity and towards a program focused on more fundamental research. In addition, NASA has cut back substantially on the amount of the research that would be conducted by universities and industry, with almost 90 percent of the research conducted in-house at NASA. The specific types of projects that NASA will undertake and the level of technical maturity that the R&D will be allowed to reach are still unclear. These changes in NASA's Aeronautics program occur at a time when the Next Generation Air Transportation System (NGATS), which will modernize the air traffic control system to accommodate projected growth in air passenger and cargo rates over the next decade, is ramping up. The FAA has traditionally relied on NASA for a significant fraction of the R&D related to air traffic management, and concerns have been expressed that NASA's redirection of its aeronautics research priorities could lead to a significant "technology gap" in a number of key next generation air traffic management programs.

International Space Station

The President's FY 2008 NASA budget requests $2.2 billion for the International Space Station (ISS) program to continue ISS assembly and development of assembly elements, augment ISS robotic capability (by adding the Canadian Special Purpose Dexterous Manipulator), conduct ISS crew exchanges (two Russian Soyuz flights per year); carry out ISS operations, including conducting extra vehicular activities for maintenance, science, and assembly. The proposed FY08 budget represents an increase of $476 million (or about 27 percent) over the FY07 budget request. The increase reflects a number of factors, including the such things as the transfer of the ISS Crew and Cargo Services budget from the Exploration Systems budget where it had been book-kept; addition of funds to deal with the Shuttle transition and retirement impacts; and an increase in the amount of overhead allocated to the ISS program.

Some of the issues related to the FY08 budget request include the following:

ISS Cargo and Crew Transportation Services—According to NASA, the FY08 budget request and five-year budget plan include an estimated shortfall of $924 million in funding needed for ISS Crew and Cargo transportation services. $308 million of the shortfall is supposed to be made up by the Space Operations Mission Directorate and the remainder has been placed as a lien against the Exploration Systems Mission Directorate's programs. Commercial orbital transportation services [COTS] are still being developed and the costs of these privately-provided options for cargo services are uncertain. The recently released Final Report of the International Space Station Independent Safety Task Force notes that COTS, as a new development activity, will likely cost more and take longer than expected. Purchases of Russian Progress, European ATVs, Japanese HTV launch vehicles, or possibly other commercial systems could potentially provide some back-up should the COTS program not deliver an operational capability when needed, but those alternatives would require some time to procure.

International Space Station Research—The ISS is intended to serve as an on-orbit facility where R&D in support of both human exploration and non-exploration purposes and other exploration technologies is to be conducted. However, the ISS research budget, which is book-kept in the Exploration Systems (ESMD) budget has been significantly cut back in recent years to help fund the Crew Exploration Vehicle/Crew Launch Vehicle and for other purposes. The FY08 budget request for the ESMD ISS research budget is $78 million, a 25 percent decrease from the FY07 budget request, which itself represented a cut relative to previous years.

ISS Reserves—According to NASA briefing charts, the ISS program is *"facing most challenging period of assembly with minimal reserve posture. . .negative reserves in FY 2007; nearly depleted reserves in FY 2008."*

Space Shuttle

The President's FY 2008 budget requests $4.0 billion to operate and maintain NASA's three Space Shuttles, and to conduct four ISS assembly flights and a Hubble Space Telescope (HST) servicing mission in FY08. The proposed budget represents a decrease of $10 million from the President's FY07 budget request. The decrease represents the net difference between funding increases for flight and ground operations and flight hardware and a funding decrease for program integration.

Some of the issues related to the FY08 budget request include the following:

Space Shuttle Program Transition and Retirement—There will be a significant level of effort required for program shutdown after the Shuttle's retirement in FY10. However, the FY08 budget request's five-year plan doesn't include funds to address Space Shuttle program transition and retirement past FY10 even though NASA knows there will be costs associated with the shutdown. In addition, the budget number for FY11 only includes a "placeholder" amount for severance and retention payments.

Space Shuttle Program Reserves—NASA states that the FY08 budget request has reduced the level of reserves that would be available to address remaining program threats. For FY08, NASA is bookkeeping $62 million in program reserves for a $4 billion Shuttle program.

Exploration Initiative

The President's proposal for NASA's FY 2008 budget provides $3.92 billion for Exploration Systems to fund Constellation Systems, which includes the development, demonstration, and deployment of the Orion Crew Exploration Vehicle (CEV) and the Ares 1 Crew Launch Vehicle (CLV) as well as associated ground and in-orbit infrastructure; and Advanced Capabilities, which includes human research to support ISS and future exploration; a lunar precursor robotic program; microgravity research; and technology development to support Orion and other exploration programs.

The proposed FY08 budget represents a decrease of $229 million (about 5.5 percent) from the President's FY07 budget request. In addition, the President's request for the Constellation program (which funds the CEV and CLV development) declines from the FY07 request level of $3.23 billion to $3.07 billion in the FY08 budget request. The bulk of the decline is due to the transfer of the ISS Crew and Cargo services account from the Exploration Systems Mission Directorate to the Space Operations Mission Directorate.

Some issues related to the FY08 budget request and FY07 appropriation include the following:

CEV and CLV schedule and budget—The President's Vision statement directed NASA to have the CEV operational no later than 2014. The *NASA Authorization Act of 2005* directed the NASA Administrator *"manage human space flight programs to strive to achieve. . .launching the Crew Exploration Vehicle as close to 2010 as possible"* subject to the proviso that the Administrator shall *"construct an architecture and implementation plan for NASA's human exploration program that is not critically dependent on the achievement of milestones by fixed dates."* NASA had been saying that its budget plan would deliver an operational CEV in 2014. However, independent of any potential impact of the FY07 Joint Resolution, NASA has recently concluded that *"As a result of this analysis over the past two months, the FY 2008 budget request does not support a 2014 initial operational capability, but March 2015, even before the FY07 CR impact. . .."* NASA is now projecting a six-month slip in the CEV schedule, independent of the Joint Resolution impact. NASA estimates that the Joint Resolution could potentially add another four to six-month delay on top of that, although that would depend on how NASA implemented the Joint Resolution.

ISS Cargo and Crew Transportation Services—The Exploration Systems budget has had a lien of $616M put on it to help fund the $924 million shortfall in funding for ISS Crew and Cargo transportation services during 2010–2015 when the Shuttle is no longer operating. Those transportation services are expected to be provided by privately-provided Commercial Orbital Transportation Services [COTS]. COTS are still being developed and the costs as well as the viability of these privately-provided options for cargo services are uncertain. The shortfall will likely have to be taken from the Exploration Systems Advanced Capabilities program.

Lunar Robotic Precursor Program—NASA indicates that funding will be eliminated for any lunar robotic missions that were to follow the Lunar Reconnaissance Orbiter (LRO) and its accompanying payload—the LCROSS—which is scheduled to launch in October 2008.

Exploration Technologies—As a result of the shift of Advanced Capabilities funds to support the CEV/CLV development program, the amount of money available to support technologies not directly related to the CEV/CLV program needs has been significantly constrained, and the funding outlook is bleak for any near-term restoration of such long-term technology development activities.

Space Communications

The Tracking and Data Relay Satellite System (TDRSS) system, which provides in-orbit communications links between on-orbit systems (e.g., the Shuttle, Hubble, and near-Earth orbiting satellites) and the ground is aging. Other agencies such as DOD also rely on TDRSS. The communications support provided by TDRSS is projected to decline by 2011. After seeking funds to replace TDRSS satellites in several past budgets without success, the Space Operations Mission Directorate redirected $78.4 million from the Space Shuttle Transition and Retirement (STAR) budget and ISS reserves, as well as $33.6 million from Shuttle reserves as a down-payment on two TDRSS replacement spacecraft. NASA has also secured an agreement from the DOD to fund approximately two-thirds of the total cost of TDRSS replacements. These replacements will ensure TDRSS support until 2016.

Education

The President's budget proposes $154 million in FY 2008 to support NASA's Education program, including projects targeted at higher education, minority university research and education, elementary and secondary education; and the E-education project, which supports development of technology products, services, and applications, as the informal education project, which seeks to expand student, educator, and public learning in STEM areas. The proposed FY08 budget represents a reduction of $13.7 million (about eight percent) from the President's FY07 budget request. In addition, funding for NASA's educations programs is projected to decline over the next five years from the FY07 request level.

Commercial Technology

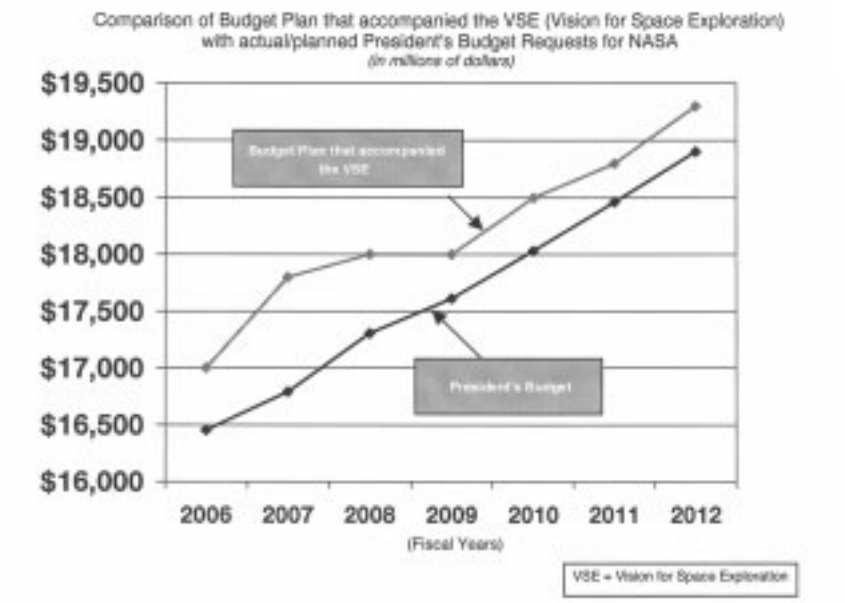
The President's budget proposes $198 million in FY 2008 to fund NASA's Innovative Partnerships Program, which is intended to establish partnerships with industry, academia, other government agencies and national laboratories in the interest of leveraging technologies and capabilities for NASA missions and programs. These programs include technology transfer, Small Business Innovative Research (SBIR) and Small Technology Transfer Research (STTR) programs. The proposed FY08 budget represents a decrease of $17 million (about eight percent) from the President's FY07 budget request. The Red Planet venture capital fund program, which was modeled on CIA's In-Q-Tel program, is eliminated in this budget request.

Attachment 1
FY 08 NASA Budget Request

(Budget authority, $ in millions)	FY 2007 Request*	FY 2007 H.J. Res. 20	FY 2008 Request	FY 2009 Request	FY 2010 Request	FY 2011 Request	FY 2012 Request
Science, Aeronautics, and Exploration	10,669.6	10,075.0	10,483.1	10,888.4	11,364.2	15,388.5	15,888.6
SCIENCE	5,466.8	5,251.0	5,518.1	5,555.3	5,600.6	5,656.9	5,802.7
Earth Science	1,464.5		1,497.3	1,545.8	1,520.1	1,411.2	1,353.2
Heliophysics	1,028.1		1,057.2	1,028.4	1,091.3	1,241.2	1,307.5
Planetary Science	1,411.2		1,395.8	1,676.9	1,720.3	1,738.3	1,748.2
Astrophysics	1,563.0		1,565.8	1,304.2	1,268.9	1,266.2	1,393.8
EXPLORATION SYSTEMS	4,152.5	3,401.0	3,923.8	4,312.8	4,757.8	8,725.2	9,076.8
Constellation Systems	3,232.5		3,068.0	3,451.2	3,784.9	7,666.0	7,993.0
Advanced Capabilities	920.0		855.8	861.6	973.0	1,059.1	1,083.9
AERONAUTICS RESEARCH	529.3	890.4	564.0	546.7	545.3	549.8	554.7
CROSS-AGENCY SUPPORT	502.0	531.8	489.2	453.5	460.4	454.7	454.4
Education Programs	167.4		153.7	152.8	152.7	149.8	149.6
Advanced Business Systems	97.4		103.1	69.4	71.6	67.6	67.5
Innovative Partnerships	215.1		198.1	197.2	199.8	200.0	200.0
Shared Capabilities	22.1		34.3	34.2	36.2	37.3	37.2
EXPLORATION CAPABILITIES	6,108.3	6,140.0	6,791.7	6,710.3	6,625.7	3,038.6	2,978.0
Space Operations	6,108.3		6,791.7	6,710.3	6,625.7	3,038.6	2,978.0
Space Shuttle	4,017.5		4,007.5	3,650.9	3,634.4	116.2	0.0
International Space Station	1,752.6		2,238.6	2,515.1	2,609.2	2,547.5	2,600.8
Space and Flight Support	338.1		545.7	544.3	382.0	372.9	377.2
Inspector General	33.5	32.0	34.6	35.5	36.4	37.3	38.3
TOTAL AGENCY	16,722.30	16,247.00	17,309.40	17,614.2	18,026.3	18,480.4	18,905.0
Year to Year Increase	3.2%	-3.2%	3.1%	1.8%	2.3%	2.4%	2.4%

* Adjusted for FY 07 Budget Request and beyond for Full Cost Simplification

Attachment 2



Chairman GORDON. The Committee will come to order, and I want to welcome everyone. We normally meet on Wednesdays, and so folks try to keep their schedules available for Wednesday. On a Thursday morning, we are competing with a variety of markups today, so we will have folks that will be, I am afraid, coming and going. But we will still gain all of this good information, and we welcome all of you here.

And I particularly would like to begin by welcoming Dr. Griffin to today's hearing. And we look forward to your testimony. You have always been straightforward with me and this committee, and I very much appreciate that, as I have told you on a number of occasions.

And in that same spirit of candor, I will say that—what I have said before, and that is that I am afraid that NASA is headed for a financial "train wreck" if things do not change.

Your testimony outlines some of the challenges NASA is facing as a result of the fiscal year 2007 Joint Resolution. We will explore those in more detail during today's hearing, but it is clear that NASA's problems run much deeper. And let me—or budget problems run much deeper.

Let me just list a few of them. First, the fiscal year 2008 budget request continues a pattern of the Administration's requests that fail to ask for the level of funding that the White House had said NASA would need to carry out the Exploration Initiative and some other core activities.

Specifically, in the three years since the President announced his Exploration Initiative, the White House has cut NASA's five-year budget plan by a total of $2.26 billion. And based on this year's budget submittal, the shortfall will worsen by another $420 million in fiscal year 2009. The impact of the $2.7 billion shortfall is compounded by the Administration's under-budgeting of the Space Shuttle and the International Space Station programs in that same five-year budget.

The under-budgeting forced you to take some $3.7 billion out of the rest of the Agency's programs to cover that shortfall, which brings me to the fiscal year 2008 budget request and its five-year budget plan.

The budget plan includes an estimated shortfall of $924 million in ISS crew and cargo services funding, a shortfall that will have to be made up one way or the other. The budget plan does not include funds to address Space Shuttle program termination and retirement costs past fiscal year 2010, although NASA concedes that there may be additional costs.

The budget plan doesn't include funds for the required upgrade of the aging Deep Space Network, although NASA says it will need to start funding it in fiscal year 2009. The budget plan reduces the amount of Space Shuttle reserves available to address remaining Shuttle program threats during the remaining missions.

The budget plan contains almost no funds to initiate the series of new missions recommending by the National Academies *Earth Science Decadal Survey*. The budget plan defers a significant amount of research to be done on the International Space Station and provides no grounds for optimism that the research will be

adequately funded prior to NASA's planned withdrawal from the ISS program.

The budget plan continues the Administration's under-funding of NASA's aeronautics program. The budget plan continues to cut back on NASA's long-term exploration technology program. For example, NASA will eliminate its lunar robotic program, the precursor program for its human lunar initiative after only one mission.

And even before the Joint Resolution impact is factored in, NASA's personnel were looking at a six-month slip in the Crew Exploration Vehicle schedule to 2015.

I could go on, unfortunately, but I think it is clear we have budgetary situation that bears little resemblance to the rosy projections offered by the Administration when the President announced the mission for space exploration three years ago and a vision that is now increasingly, and unfortunately, blurred.

And, Dr. Griffin, in your testimony, you mention the negative impacts of the Joint Resolution passed to deal with the unfinished fiscal year 2007 appropriations left to us by the previous Congress.

I agree with you that those impacts are not good, and that is the reason that I went before our Budget Committee and urged them to increase the budget to over $1 billion, to our authorized levels. However, I am afraid you were left hanging by your own Administration when it said nothing about NASA in the Statement of Administration Policy that it sent over to the House.

The Administration's silence, unfortunately, sent a message that it was not helpful. I will not kid you that it is going to be—or it is not going to be easy getting the funding you are requesting in this year's budget, especially if the White House remains disengaged. Yet, based on the items I have already listed, I am worried that even getting the President's requested level is just going to push the looming budgetary problem down the road until the next election.

And so today, I would like to find out at least the following.

Given your assessment of the negative impact of the Joint Resolution, did you ask the White House to weigh in with the House of Representatives? If so, why not? If you think the submittal—or if you think submitting a budget request with a shortfall of almost a billion dollars in ISS crew and cargo funding embedded in it makes sense, was it your idea or OMB's? Given the agreement I thought NASA had with the OMB on the ISS and the Shuttle funding last year, why did this year's budget request come over with shortfalls and reduced reserves in the Shuttle and the ISS accounts? Did you shift the money or did OMB change the agreement?

Well, we have a lot to talk about, and I am sorry to start off on such a negative or a—I won't say negative, but a difficult posture, but these are issues that are very important, and we need to know more about them.

Thank you.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

Good morning. I'd like to begin by welcoming Dr. Griffin to today's hearing. We look forward to your testimony.

You always have been straightforward with me and this committee, and I appreciate it. And in that same spirit of candor, I will say what I've said before—that I'm afraid that NASA is headed for a "train wreck" if things don't change.

Your testimony outlines some of the challenges NASA is facing as a result of the FY 2007 Joint Resolution. We will explore those in more detail during today's hearing, but it is clear that NASA's problems run much deeper.

Let me just list a few of them:

First, the FY 2008 budget request continues a pattern of Administration requests that fail to ask for the level of funding that the White House had said NASA would need to carry out the exploration initiative and its other core activities.

Specifically, in the three years since the President announced his exploration initiative, the White House has cut NASA's five-year budget plan by a total of $2.26 billion. And based on this year's budget submittal, that shortfall will worsen by another $420 million in FY 2009.

The impact of that $2.7 billion shortfall is compounded by the Administration's under-budgeting of the Space Shuttle and International Space Station programs in that same five-year budget plan. That under-budgeting forced you to take some $3.7 billion out of the rest of the Agency's programs to cover that shortfall.

Which brings me to the FY08 budget request and its five-year budget plan. That budget plan includes an estimated shortfall of $924 million in ISS crew and cargo services funding—a shortfall that will have to be made up one way or another. The budget plan does not include funds to address Space Shuttle program termination and retirement costs past FY 2010, although NASA concedes there will be additional costs.

The budget plan doesn't include funds for the required upgrade of the aging Deep Space Network, although NASA says it will need to start funding it in FY 2009. The budget plan reduces the amount of Space Shuttle reserves available to address remaining Shuttle program threats during the remaining missions.

The budget plan contains almost no funds to initiate the series of new missions recommended by the National Academies' Earth Science Decadal Survey. The budget plan defers a significant amount of the research to be done on the International Space Station and provides no grounds for optimism that the research will be adequately funded prior to NASA's planned withdrawal from the ISS program.

The budget plan continues the Administration's underfunding of NASA's aeronautics program. The budget plan continues to cut back on NASA's long-term exploration technology program. For example, NASA will eliminate its lunar robotic program—the precursor program for its human lunar initiative after just one mission-LRO—has flown.

And *even before the Joint Resolution impact is factored in,* NASA personnel were looking at a six-month slip in the Crew Exploration Vehicle schedule to 2015.

I could go on, but I think it's clear we have budgetary situation that bears little resemblance to the rosy projections offered by the Administration when the President announced his "Vision for Space Exploration" three years ago—a vision that is now increasingly blurred. . ..

Dr. Griffin, in your testimony you mention the negative impacts of the Joint Resolution passed to deal with the unfinished FY 2007 appropriations left to us by the previous Congress.

I agree with you that those impacts are not good, and I urged that increased funding be made available for NASA. However I'm afraid you were left hanging by your own Administration when it said nothing about NASA in the Statement of Administration Policy that it sent over to the House.

The Administration's silence unfortunately sent a message that was not helpful.

I will not kid you that it is going to be easy to get the funding you are requesting in this year's request, especially if the White House remains disengaged.

Yet based on the items I've already listed, I'm worried that even getting the President's requested level is just going to push the looming budgetary problem down the road until after the next election.

And so today, I'd like to find out at least the following:

> Given your assessment of the negative impact of the Joint Resolution, did you ask the White House to weigh in with the House of Representatives? If so, why didn't they?

Do you think submitting a budget request with a shortfall of almost a billion dollars in ISS crew and cargo funding embedded in it makes sense? Was it your idea or OMB's?

Given the agreement I thought NASA had with OMB on ISS and Shuttle funding last year, why did this year's budget request come over with shortfalls and reduced reserves in the Shuttle and ISS accounts—did you shift the money, or did OMB change the agreement?

Well we have a lot to talk about today. Once again, I want to welcome you to this hearing, Dr. Griffin, and I look forward to your testimony.

Chairman GORDON. Mr. Hall.

Mr. HALL. Mr. Chairman, I thank you, and I would like to also welcome our NASA Administrator, Dr. Michael Griffin, to this very important hearing.

And as I have said many times before, NASA is in the business of doing difficult and challenging tasks. And our country looks to NASA to inspire us and to push the boundaries of exploration. Mike Griffin understands this. We are fortunate to have such an intelligent man and focused man leading the Agency, because NASA faces tough challenges ahead.

NASA actually performs best when it has a clear mission. In my opinion, they have a clear mission, a mission they shouldn't retreat from. The mission—the vision was established a few years ago when the economy wasn't as strong as it is now. Today, the economy is strong, and the time will come when the stresses and strains of the Iraq War are going to subside. I would like to see NASA press on. Don't be bullied into a compromise that might cost us our allies. Those are some of the things that we hope you will remember.

In the aftermath of the *Columbia* tragedy, we all recognize that NASA needed a new, clearly-defined, affordable mission, and a mission that would take us beyond the low-Earth orbit. After careful study, the Administration proposed their *Vision for Space Exploration,* which I support and which this committee and the entire Congress endorsed through the *NASA Authorization Act of 2005.* That consensus gave NASA the stable direction that it had lacked.

Since the Vision was first announced, two major financial obstacles have occurred. First, earlier estimates for the remaining Shuttle flights understated the costs by roughly $3 billion. Second, the five-year budget run-out presented at the time the Vision was announced assumed a higher funding profile. In the years since, the Administration requests for NASA have come in lower, and unfortunately, Congress failed to fully fund the fiscal year 2007 request.

Everyone bears some blame for the funding shortfalls, but the point I want to stress is that NASA continues to hold to its original schedule for the Vision, but doing it with smaller budgets, consequently, the stress on the Agency is enormous. In our own NASA Authorization Bill, written after the vision was announced, for 2008 we authorized $1.4 billion more than the Administration has requested.

Mr. Griffin, I never have been, and I will never be, critical of your performance. You are doing a superb job, and I don't know of anyone better qualified to lead the Agency, but I certainly encourage you to talk to your friends at OMB, to Rob Portman, who is a class guy and a former Member of this Congress, and to the White House and tell them that NASA's friends on Capitol Hill are

growing concerned that the Agency's squeezing too hard and will suffer for it unless realistic budgets are presented.

Congress supports the Vision. Congress certainly supports NASA's science and aeronautics program, but if forced to choose between science, aeronautics, or human space flight, I am not sure, at the end of the day, what the final choice would be. As one who believes in the necessity of having a robust, human space flight program, I want to work with you to ensure we have the CEV flying by 2014. The brave men and women we ask to explore space deserve the best equipment and the safest spacecraft we can build.

I thank you, sir, for coming before us, and I look forward to hearing your testimony to help us to understand how NASA plans to manage these challenges.

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

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Mr. Chairman, I would like to welcome our NASA Administrator, Dr. Michael Griffin, to this important hearing. As I've said many times before, NASA is in the business of doing difficult and challenging tasks, and our country looks to NASA to inspire us and push the boundaries of exploration—Mike Griffin understands this. We are fortunate to have such an intelligent and focused man leading the Agency because NASA faces tough challenges ahead.

NASA performs best when it has a clear mission. In my opinion they have a clear mission. A mission they shouldn't retreat from. The Vision was established a few years ago when the economy wasn't as strong as it is now. Today the economy is strong and the time will come when the stresses and strains of the Iraq war will subside. I'd like to see NASA press on. Don't be bullied into a compromise that might cost us our allies. Those are some of the things I hope you'll remember.

In the aftermath of the *Columbia* tragedy we all recognized that NASA needed a new, clearly defined, affordable mission that would take us beyond low Earth orbit. After careful study, the Administration proposed the *Vision for Space Exploration*—which I support—and which this committee and the entire Congress endorsed through the *NASA Authorization Act of 2005.* That consensus gave NASA the stable direction it had lacked.

Since the Vision was first announced, two major financial obstacles have occurred. First, earlier estimates for the remaining Shuttle flights understated the cost by roughly $3 billion. Second, the five-year budget runout presented at the time the Vision was announced assumed a higher funding profile. In the years since, the Administration requests for NASA have come in lower, and unfortunately Congress failed to fully fund the FY 2007 request. Everyone bears some blame for the funding shortfalls, but the point I want to stress is that NASA continues to hold to its original schedule for the Vision, but doing it with smaller budgets. Consequently, the stress on the agency is enormous.

In our own NASA authorization bill, written after the Vision was announced, for FY 2008 we authorized $1.4 billion more than the Administration has requested.

Mr. Griffin, I would never be critical of your performance. You are doing a superb job, and I don't know anyone better qualified to lead the Agency. But I'd certainly encourage you to talk to your friends at OMB—to Rob Portman who is a class guy and a former Member of this Congress—and to the White House, and tell them that NASA's friends on Capitol Hill are growing concerned that the Agency is squeezing too hard and will suffer for it unless more realistic budgets are presented. Congress supports the Vision. Congress also supports NASA's science and aeronautics programs but if forced to choose between science, aeronautics or human space flight, I'm not sure at the end of the day what the final choice would be. As one who believes in the necessity of having a robust human space flight program, I want to work with you to ensure we have the CEV flying by 2014. The brave men and women we ask to explore space deserve the best equipment and the safest spacecraft we can build.

Thank you for coming to talk to us today, and I look forward to hearing your testimony to help us understand how NASA plans to manage these challenges.

Chairman GORDON. Thank you, Mr. Hall.

You know, during the last couple of years, I think Sherry Boehlert, Chairman Sherry Boehlert and I, could have exchanged opening statements many times and not known a difference. I think you and—I certainly could have—would have welcomed to have given that same opening statement today. I think we are very much in tune.

And now the Chair recognizes Mr. Udall.

Mr. UDALL. Thank you, Mr. Gordon.

Given your comments, it is tempting to just submit my statement for the record, as well, but I think I will go ahead and present it to Dr. Griffin, because I, too, agree with Judge Ralph Hall and our Chairman, Mr. Gordon.

Dr. Griffin, always great to see you. Thank you for coming up here today. As you know, this is the first formal review of the 2008 budget request, and we are, of course, looking forward to your testimony.

You have got a tough job, and we need to understand the basis of the decisions you are making as well as the—any concerns you have about the budget. As I mentioned, I agree with Chairman Gordon's assessment of the situation we are facing.

It is going to be a tough year to get the resources that we need for space and aeronautics, but all of us are going to make the best effort that we possibly can. And we are going to do so because NASA's space and aeronautics programs are a very important component of our overall R&D enterprise throughout this nation. And I think there is agreement across the board that we need to be investing more, not less, in these areas.

On Tuesday, we held a hearing on science and technology leadership in the 21st century global economy, and we heard a distinguished panel of witnesses stress the importance of investing in basic research if we are going to remain competitive in this nation. And NASA's space and Earth science basic research activities, along with microgravity research, are prime examples of research investments that cannot only advance our knowledge but benefit society. And it should be known, I think we all agree here, that the investments also play a critical role in educating the next generation of scientists and engineers.

Aeronautics R&D, we have discussed that at some great length, is another area where investments we make benefit our economy, our quality of life, and our national security. And when we fail to invest adequately in a range of basic and applied aeronautics R&D, as I fear we are doing in this budget, we foreclose future options and fail to meet future needs in ways that we are likely to regret.

Human space flight and exploration is another area that offers benefits ranging from the very important intangible inspiration it provides to the public, to the advanced technologies, and research results that can come from those initiatives.

So in sum, I strongly support a robust budget for NASA, but as I mentioned earlier, I just don't think we are getting the budget requests that are matched to the tasks we want NASA to undertake. And those stresses resulting from the past shortfalls are now reinforced by the funding plateau imposed in fiscal year 2007 by the Joint Resolution.

Dr. Griffin, I know it is your job to put the best face on the budget that you have to defend, but as Judge Hall and Chairman Gordon mentioned, we need to know where the stresses are as well as the deferred opportunities that result from this budget request. And as an example of that, last month, we heard from the National Academies about their recommendations for future science research and applications missions, something that we all care deeply about. However, as I look at the out-year budget request, I see very little that would give me confidence that NASA will be able to undertake any substantial fraction of the recommended missions for the foreseeable future.

Another example is the International Space Station. You testified that NASA expects to cease funding the ISS after 2016, yet the plan, the budget plan, continues the deferral of any significant investments in the ISS research through the five-year budget horizon associated with the fiscal year 2008 budget request. And the research plan still contains no clear research objectives and associated milestones to complete the needed research during the Space Station's operation life. And that troubles me. And it raises questions about the Administration's stewardship of this unique lifetime, limited orbital research and engineering facility in which the country has invested so much to build.

Again, I don't fault you for attempting to prioritize within a hopelessly inadequate budget, but we, here in the Committee and in Congress, have to step back and consider whether the Administration's approach to the Nation's civil space and aeronautics R&D enterprise is credible and supported by the needed resources, and your testimony today will help us gather the information needed for the tough decisions that lie ahead.

Again, let me join Chairman Gordon and Judge Hall and thank you for your service. And I look forward to your testimony, and, as important, to continue to work with you.

Thank you.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Good morning. I'd like to join my colleagues in welcoming you to today's hearing, Dr. Griffin. This will be the Committee's first formal review of NASA's FY 2008 budget request, and we look forward to your testimony.

You have a tough job, and we need to understand the basis of the decisions you are making, as well as any concerns you have about the budget.

I agree with Chairman Gordon's assessment of the situation we are facing. It is going to be a tough year for space and aeronautics supporters to get the budgetary resources NASA needs, but we are going to try.

We are going to try because NASA's space and aeronautics programs are a very important component of the Nation's R&D enterprise, and we need to be investing more in those areas—not less.

On Tuesday, this committee held a hearing on Science and Technology Leadership in a 21st Century Global Economy. We heard a distinguished panel of witnesses stress the importance of investing in basic research if this nation is to remain competitive.

NASA's space and Earth science basic research activities, along with microgravity research, are prime examples of research investments that cannot only advance our knowledge but also benefit our society. And it should be noted that those investments play a critical role in educating the next generation of scientists and engineers.

Aeronautics R&D is another area where the investments we make benefit our economy, our quality of life, and our national security. And when we fail to invest adequately in a range of basic and applied aeronautics R&D—as I fear we are in

this budget—we foreclose future options and fail to meet future needs in ways that we are likely to regret.

Human space flight and exploration is another area that offers benefits—ranging from the intangible inspiration it provides to our public to the advanced technologies and research results that can come from those initiatives.

So, I strongly support a robust budget for NASA. Unfortunately, I don't think we have been getting budget requests that are matched to the tasks we want NASA to undertake. And the stresses resulting from those past shortfalls are now reinforced by the funding plateau imposed in FY07 by the Joint Resolution.

Dr. Griffin, I know that it is your job to put the best face on the budget that you have to defend. But this committee needs to know where the stresses are, as well as the deferred opportunities that result from this budget request.

For example, last month we heard from the National Academies about their recommendations for future Earth Science research and applications missions—something I care deeply about. However, as I look at your out-year budget request, I see little that would give me confidence that NASA will be able to undertake any substantial fraction of the recommended missions for the foreseeable future.

Another example is the International Space Station. You have testified that NASA expects to cease funding the ISS after 2016. Yet your budget plan continues the deferral of any significant investments in ISS research through the five-year budget horizon associated with the FY08 budget request. And your ISS research plan still contains no clear research objectives and associated milestones to complete the needed research during the ISS's operational life.

That troubles me and raises questions about the Administration's stewardship of this unique lifetime-limited orbital research and engineering facility in which the country has invested so much to build. Again, I don't fault you for attempting to prioritize within a hopelessly inadequate budget. But we in Congress have to step back and consider whether the Administration's approach to the Nation's civil space and aeronautics R&D enterprise is credible and supported by the needed resources.

Your testimony today will help us gather the information needed for the tough decisions that lie ahead. Again, I want to thank you for your service and I look forward to your testimony.

Chairman GORDON. I think Mr. Calvert holds the record here, current record, for the—going to the most NASA centers. And so he brings us a lot of good knowledge to the Committee, and he is now recognized for five minutes.

Mr. CALVERT. Well, as my former Ranking Member, and now my Chairman, probably knows, there are a lot of golf courses near each one of those centers, so I do try to see every one of them.

Mr. Chairman, I want to certainly welcome the NASA Administrator, Mike Griffin, to this important hearing today. The American people are lucky to have such a well-qualified Administrator during this exciting and challenging time in NASA's history. And it is a challenging time for the agency.

NASA is in a budgetary vice that is making it extremely difficult for the agency to successfully meet the many demands for its diverse portfolio of missions. The demands of the Agency are legitimate and critical to maintaining the global leadership our nation has held since Neil Armstrong first walked on the Moon back in 1969 in the areas of human space exploration, science, and aeronautics.

In 2004, the President unveiled a bold *Vision for Space Exploration* to be implemented by NASA, which I strongly support. The Vision gives this nation's human space program the direction it has lacked, arguably, for several decades, and lays out an approach for long-term space exploration with measured milestones.

During my Subcommittee chairmanship in the 109th Congress, I developed a clear understanding of the many trials of budgetary, organizational, political, and technological challenges facing NASA

as it implements the Vision and works to balance the needs of its many stakeholders.

In 2005, Congress passed the first *NASA Authorization Act* 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 its core mission areas. As made clear in the 2005 Act, the Committee sought to provide NASA with the rules and tools to thrive as a multi-missioned agency with robust, cutting-edge activities in human exploration of space and space science, Earth science, and aeronautics. For fiscal year 2008, the Act authorizes $18.7 billion for NASA to achieve these programs.

Unfortunately, as we have heard, the fiscal year 2008 budget request seeks just $17.3 billion for NASA, substantially less than the authorized but still a three percent increase is well above many other agencies within the discretionary budget. Nonetheless, this parity, paired with the Agency's fiscal year 2007 appropriations reduction of $545 million, jeopardizes NASA's ability to substantially accomplish its portfolio of missions, and it comes at a time when other countries, such as China, are eagerly ramping up their own space and aeronautics program. The recent ASAT strike should remind us all that the second space age will be crowded and competitive.

Now we can all argue who is at fault for NASA's quandary, but really, the blame belongs to all involved parties: NASA, the past and current Administrations, the Congress, and the best way to resolve this situation is to move beyond the blame-game and toward a coordinated effort to secure a top-line budget for the agency that is closer to the authorized amount and consistent with the breadth of programs, projects, and missions. This committee must be instrumental in that effort, so I call on my Science Committee colleagues to work in a bipartisan fashion and aggressively educate our peers, who are not familiar with NASA's activities and the importance of the robustly-funded civil space agency.

For an agency that has made immense contributions to the quality of life, our economy, and international relations, the little more than one-half of one percent of the total federal budget investment we are providing is just not sufficient. NASA's stakeholders must stop fighting each other for a larger piece of the NASA pie and work on securing a bigger overall NASA pie.

Administrator Griffin, I don't envy your predicament to manage our civil space agency under such daunting budgetary circumstances. As you know, there is justified frustration with many of my colleagues, but I am certain that no one can be more frustrated than you. I have every confidence in your ability to lead NASA at this time and to make the hard decisions as required by the budget that is ultimately provided.

I do believe, like so many others, that you are, clearly, the right person for the job. I look forward to your important testimony, which will lay out next year's budget, as well as give us insight into the out-years. We will continue to work with you to provide NASA the Congressional resources and support needed to advance our nation's civilian space and aeronautics agency works. We have the building blocks for a fantastic space and aeronautics program, and this country should be second to none in those endeavors.

With that, I yield back the balance of my time, Mr. Chairman.
[The prepared statement of Mr. Calvert follows:]

PREPARED STATEMENT OF REPRESENTATIVE KEN CALVERT

Mr. Chairman, I want to welcome NASA Administrator, Dr. Michael Griffin, to this important hearing today. The American people are lucky to have such a well-qualified Administrator during this exciting and challenging time in NASA's history.

And it is a challenging time for the Agency.

NASA is in a budgetary vise that is making it extremely difficult for the Agency to successfully meet the many demands of its diverse portfolio of missions. The demands on the Agency are legitimate and critical to maintaining the global leadership our nation has held since Neil Armstrong first walked on the Moon in 1969, in the areas of human space exploration, science and aeronautics.

In 2004, the President unveiled a bold *Vision for Space Exploration* to be implemented by NASA, which I strongly support. The Vision gives our nation's human space program the direction it has lacked, arguably for several decades, and lays out an approach for long-term space exploration with measured milestones.

During my Subcommittee Chairmanship in the 109th Congress, I developed a clear understanding of the many trials—budgetary, organizational, political, and technological—facing NASA as it implements the Vision and works to balance the needs of its many stakeholders.

In 2005, Congress passed the first *NASA Authorization Act* 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.

As made clear in the 2005 Act, this Committee sought to provide NASA the "Rules and Tools" to thrive as a multi-mission agency with robust, cutting edge activities in human exploration of space, space science, Earth science and aeronautics. For FY 2008, the Act authorizes $18.7 billion for NASA to achieve these programs.

Unfortunately, the FY 2008 budget request seeks just $17.3 billion for NASA, substantially less than authorized but still with a three percent increase that is well above many other agencies within the discretionary budget. Nevertheless, this disparity, paired with the Agency's FY 2007 appropriations reduction of $545 million, jeopardizes NASA's ability to successfully accomplish its portfolio of missions. And it comes at a time when other countries, such as China, are eagerly ramping up their own space and aeronautics programs. Their recent ASAT strike should remind us all that the Second Space Age will be a crowded and competitive.

Now we can all argue who's at fault for NASA's quandary but really the blame belongs to all involved parties—NASA, past and current Administrations and the Congress. The best way to resolve the situation is to move beyond the blame game and toward a coordinated effort to secure a top-line budget for the Agency that is closer to the authorized amount and consistent with the breadth of programs, projects and missions. This committee must be instrumental in that effort and so I call on my Science Committee colleagues to work in a bipartisan fashion and aggressively educate our peers who are not as familiar with NASA's activities on the importance of a robustly funded civil space agency.

For an Agency that has made immense contributions to our quality of life, economy and international relations, the little more than one-half of one percent of the total federal budget investment we are providing is just not sufficient. NASA stakeholders must stop fighting each other for a larger piece of the NASA pie and work on a securing a bigger overall NASA pie.

Administrator Griffin, I do not envy your predicament to manage our civil space agency under such daunting budgetary circumstances. As you know there is justified frustration among many of my colleagues but I am certain that no one can be more frustrated than you. I do have every confidence in your ability to lead NASA at this time and to make the hard decisions as required by the budgets ultimately provided. I do believe, like so many others that you are clearly the right person for the job.

I look forward to your important testimony which will lay out next year's budget, as well as give us insight into the out-years. We will continue to work with you to provide NASA the Congressional resources and support needed to advance our nation's civilian space and aeronautics agency's work. We have the building blocks for a fantastic space and aeronautics program—and this country should be second to none in these endeavors.

Chairman GORDON. Thank you, Mr. Calvert.

And once again, I think you can see, there is enmity in our thoughts here, and I want to echo Mr. Calvert when he says that we have to work with the other Members outside this committee. We are going to have a challenge on the House Floor when it comes, and it will be whether it is a motion to strike, whether it is a motion to change, we are going to have a challenge at that time, and we need to work together. We have already started, in a bipartisan way, talking with the appropriators so that we can try to move forward. And we want to—we will have a—we will join this committee with them earlier. I really would—even been thinking about having some joint hearings with the appropriators, because this is going to be a tough one, and we are going to have to work together. And again, I don't want to get into the blame-game, but I do want to say, we need the President to help us. And I mean, that is part of it. We can't do it—well, I won't say that. It would be very difficult to do it without the Administration and OMB's help. And so, we need to all get on this together, because it is going to be a challenge.

If there are Members who wish to submit additional opening statements, your statements will be added to the record.

[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 this committee to examine the National Aeronautics and Space Administration's (NASA) Fiscal Year 2008 (FY08) budget request as well as NASA's proposed FY07 Operating Plan.

The President's budget proposal for FY08 provides $17.3 billion for NASA, which represents an increase of 3.1 percent over the FY07 Continuing Resolution. I signed the Committee's Views and Estimates to the Budget Committee expressing our concerns that the FY08 budget request is approximately $690 million less than the amount authorized for FY08, based on the FY05 five-year budget plan that accompanied the President's *Vision for Space Exploration.* As the appropriations process moves forward, I urge the Committee to work together in a bipartisan fashion to ensure NASA's ability to continue to pioneer the future in space exploration, scientific discovery, and aeronautics is not hindered by a low funding allocation.

NASA has played a vital role in the advancement of aerospace engineering jobs and development in the U.S. A number of NASA's scientific and human space flight activities involve collaboration with international participants and almost 90 percent of NASA's budget is for contract work. While I recognize the vital need to work in conjunction with foreign countries and maintain the Agency's flexibility to procure goods and services overseas, it is important that NASA keeps track of these contracts and subcontracts. To this end, I authored a provision in the NASA reauthorization legislation Congress passed and the President signed into law, to require NASA to submit an annual report to Congress, beginning January 2007, regarding its contracts and subcontracts performed overseas. Following the bill's enactment, Congressman Mark Udall and I asked the Government Accountability Office (GAO) to look into the matter and report their findings to Congress. In October of last year, GAO concluded that NASA will not be able to issue its reporting requirements. While I find this conclusion concerning, I am pleased that NASA is taking steps to be in full compliance with the reporting requirement and has agreed to work with the Office of Management and Budget (OMB) to improve its performance and establish a federal database to track these subcontracts more fully in 2008.

I look forward to hearing from the Administrator on NASA's progress.

Finally, I am opposed to the decrease in the President's FY08 budget request for aeronautics research, which includes aviation safety, airspace systems, and development programs. The Federal Aviation Administration (FAA) has traditionally relied on NASA for a significant portion of the R&D related to air traffic management. I am concerned that NASA's funding reduction of its aeronautics research priorities could affect the FAA's attempts to transition to our Next Generation air traffic control system. As Chairman of the Aviation Subcommittee and a senior Member of this committee, I intend to monitor the funding levels for aeronautical research and

development closely to ensure technology continues to progress to accommodate projected growth in air passenger and cargo rates over the next decade and beyond.

I welcome Administrator Griffin and look forward to his testimony.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman.

As a Texan, I have a great admiration for NASA. NASA research and contracts provide important economic development for our State.

NASA inspires generation after generation of young people to pursue careers in space, aeronautics, engineering, physics and mathematics.

Not only that, but NASA research has yielded important results that have affected Americans' everyday lives.

The computer mouse is a product of NASA research. Cochlea implants came from NASA research. Wine making has benefited from NASA research. Even Internet dating match technologies came from NASA research.

As you can see, NASA funding affects us all. We on the Science and Technology Committee want to protect and support NASA. We just need clear information on how to do that.

It is my hope that the NASA budget receives the support it needs to sustain strong programs that will continue to benefit Texas, and our nation.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman, thank you for holding today's hearing on the *National Aeronautics and Space Administration's (NASA) Fiscal Year 2008 Budget Request.*

As the primary civil space an aeronautics research and development agency, NASA plays a leading role in sustaining American technological competitiveness and economic security.

I am concerned that the President's 2008 budget request neither adequately supports NASA, nor gives NASA the support the Administration promised in 2004 when the President announced his *"Vision for U.S. Space Exploration."*

While the President's budget request does propose a modest increase of 3.1 percent over the FY07 President's request, the President's proposal still leaves NASA nearly $690 million behind the amount promised for FY 2008 in the budget plan that accompanied the President's *Vision for Space Exploration.* This also comes after years of deep cuts and budget freezes for NASA.

Despite the importance of the aeronautics industry to our nation, the budget request for aeronautics research in FY 2008 is approximately $336 million less than the $890.4 million appropriated in the FY 2007 Joint Resolution. This budget request represents a long decline in Aeronautics Research, and NASA funding in general.

I know that today's hearing will be informative. I look forward to hearing your testimony, Dr. Griffin. Thank you very much for being here today.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

Over that past few weeks the Committee has reviewed many aspects of the President's budget proposal. We have seen over and over again how this proposal under funds long-term research and undercuts American competitiveness.

I am pleased to see that the President's proposed budget includes an increase for NASA above the Fiscal Year 2007 levels. Increased funding for NASA is good for Arizona.

NASA business and educational contracts and grants for my district in Fiscal Year 2007 totaled nearly $6.5 million. ASU, also in the 5th district, receives funding from NASA to conduct important research for the space agency.

At the same time, once again, while Fiscal Year 2008 proposed funding is increased for space operations and exploration, educational programs and long-term research and development are under funded.

The Decadal Survey report which we reviewed in February found that the Earth observation systems are at "the risk of collapse" and are in "disarray." These critical satellites enhance our understanding of the planet, and global warming. At ASU,

researchers use data generated from Earth observation satellites to investigate rapid urbanization. However, development of Earth observation satellites is not a budget priority.

Maintaining American competitiveness also means increasing the number of innovators. We must encourage and inspire a new generation of scientists and engineers. Under funding education programs does not accomplish this.

If we don't invest now and invest well, we will fall even further behind. I am concerned that the President's budget priorities are misguided and I look forward to today's testimony.

I yield back the balance of my time.

Chairman GORDON. And at this time, now, I would like to introduce our witness today, our only witness, and that is the Director and Administrator, Dr. Michael Griffin. He is no stranger to this committee. And as we have said on a number of occasions, he is straightforward and candid.

And, Dr. Griffin, let me remind you that we all recognize you are the messenger, and it is not our effort to shoot the messenger. And so please keep that, as I know that you will, in mind. We just wish you had a better message.

So I will yield, and you may proceed.

I can understand for you not wanting for us to hear this, but you do need to turn your microphone on.

STATEMENT OF DR. MICHAEL D. GRIFFIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. GRIFFIN. I am sorry.

Chairman Gordon, Mr. Hall, thank you for having me here today. I was about to say, I am a big boy, and I think I can take the beating with a smile.

I had a written opening set of remarks that I would, at this point, like to enter into the record rather than to read to give you back the most amount of time. I would like to make a couple of very brief remarks.

The substance of my written remarks was to the point of asking for your strong support to get the full President's request. I see that is not quite the topic on the table today, so let me enter this for the record and make just a couple of brief remarks.

First of all, there are—I think it needs to be said that there are two ways to approach a problem of budgeting. We must first have a strategy. And I want to remind you that when the—and that when the *Columbia* Accident Investigation Board released their findings, they made a couple of very significant statements at the strategic level that went beyond the root causes of the problem. One of the things they said was that the U.S. civilian space effort has moved forward for more than 30 years without a guiding vision. And they also expressed dismay at how previous attempts to develop a replacement vehicle for the aging Shuttle represent a failure of national leadership.

Now, I agreed with those statements. I agreed with those statements in testimony to this committee as a private citizen. And they were damning statements, citing, as they did, a lack of leadership in space policy in this country that had gone on for a couple of generations.

I think we now have the strategic vision that will tie this agency and our space and aeronautics program together. I think we have the right strategic vision. And I certainly appreciate, with you, that

if that is the right strategic vision, which I hear—to which I hear no one objecting, if that is the right strategic vision, it is certainly true that one can adopt a budgeting approach to say what does it take to purchase all of the things in that vision.

The other budgeting approach that one can take, which this Administration has taken, is to say that we will allocate a generous budget, generous in comparison to other domestic discretionary agencies, and we charge you, the Administrator, with preparing the best program that you can that will fit within that budget. And that, sir, is what I have—is what we have done at NASA. We have—the Administration requires of me that I carry out the best space and aeronautics program that can be done for the budget dollars to be made available. I have tried—I have submitted to you a balanced budget that respects all of our portfolios, but, nonetheless, adheres to that guiding vision, which came out of the tragedy of *Columbia.* It is $17.3 billion. It is 3.1 percent above last year's request. And it is well above the average domestic, non-defense discretionary program.

It does reflect a strong commitment by the Administration to NASA. It does not purchase all of the things that all of us would like to purchase. But that is a fact of life, in public life as well as the private, and I am here to defend that budget as best I can do.

Thank you, sir.

[The prepared statement of Dr. Griffin follows:]

PREPARED STATEMENT OF MICHAEL D. GRIFFIN

Mr. Chairman and Members of the Committee, thank you for the opportunity to appear today to discuss the President's FY 2008 budget request for NASA. The President's FY 2008 budget request for NASA is $17.3 billion. This represents a 3.1 percent increase over the FY 2007 request for the Agency, but not the enacted FY 2007 appropriation. The FY 2008 budget request for NASA demonstrates the President's continued commitment to our nation's leadership in space and aeronautics research, especially during a time when there are other competing demands for our nation's resources. The FY 2008 budget request reflects a stable plan to continue investments begun in prior years, with some slight course corrections. Overall, I believe that we are heading in the right direction. We have made great strides this past year, and NASA is on track and making progress in carrying out the tasks before us.

Before I outline the FY 2008 budget request for NASA any further, in the invitation to testify today you asked that I address current NASA plans for the use of FY 2007 funding. On February 15, 2007, the President signed into law a joint resolution stipulating FY 2007 funding levels for NASA and other federal agencies. This appropriation represents a funding level that is $545 million below the President's FY 2007 request. The FY 2008 budget request could not possibly factor the impact of this reduced level from the FY 2007 request for NASA's carefully-considered multi-year programs, and thus, several programs in the FY 2008 budget request will be impacted. The FY 2007 appropriation further specifies funding levels in human space flight of that are $677 million below the request—$577 million of that from Exploration Systems. This reduction from the requested level may significantly impact our ability to safely and effectively transition from the Shuttle to the Orion Crew Exploration Vehicle and Ares I Crew Launch Vehicle. It will have serious effects on many people, projects, and programs this year, and for the longer term. As I noted during last year's Congressional hearings on NASA's FY 2007 budget request, we have a carefully balanced set of priorities to execute on behalf of our nation. So as a result of these funding levels that are less than the FY 2007 request, NASA is carefully assessing the implications to overall Exploration priorities and milestones, and will present detailed impacts after a full analysis is complete. The initial NASA Operating Plan for FY 2007, which we are endeavoring to finalize as soon as practicable, will reflect the impacts of less funding than planned and the requisite decisions. As always, we are here to carry out our nation's civil space and aeronautics programs with the resources made available by the Congress. All of our

programs proceed in a "go-as-we-can-afford-to-pay" manner; so if we receive less funding than requested, we will adjust our pace. Our stakeholders have my commitment to continue to keep them informed as to what I believe is the best approach to carrying out NASA's space and aeronautics research missions with the resources provided. In this determination, I will be guided by the NASA Authorization Acts, annual Appropriations Acts, Presidential policy, and the decadal survey priorities of the National Academy of Sciences. If we determine that there is an Agency objective that we will be unable to meet, I will inform our Agency's stakeholders, including this committee.

Highlights of the NASA FY 2008 Budget Request

The FY 2008 budget request for NASA is a carefully considered and balanced request formulated over many months with the White House. Unfortunately, the Congress had not completed action on the FY 2007 budget at the time the FY 2008 budget was being finalized, so the impact of the final FY 2007 appropriation outcome is not accounted for in NASA's FY 2008 budget request. The FY 2008 budget request weaves together the Nation's priorities in space exploration, scientific discovery, and aeronautics research that will help fuel this nation's future, creating new opportunities for scientific benefit, economic growth, national security, and international cooperation.

The greatest challenge NASA faces is safely flying the Space Shuttle to assemble the International Space Station (ISS) prior to retiring the Shuttle in 2010, while also bringing new U.S. human space flight capabilities on-line soon thereafter. We must understand that, given proper goals, human space flight is a strategic capability for this nation, and we must not allow it to slip away. In January, we remembered those whom we have lost in the exploration of space. In the aftermath of the *Columbia* tragedy, President Bush addressed the NASA workforce, saying, "In your grief, you are responding as your friends would have wished—with focus, professionalism, and unbroken faith in the mission of this agency." We must commit ourselves to the focus of professionalism and unbroken faith every day in order to carry out the tasks before us.

In analyzing not only the root causes, but also the systemic reasons behind the *Columbia* accident, the *Columbia* Accident Investigation Board (CAIB) made critical observations that guided the formulation of our present civil space policy. I fear that with the passage of time and the press of other concerns, we may be losing sight of some of these principles, so let me reiterate some of them here today. First, the CAIB noted that, "The U.S. civilian space effort has moved forward for more than 30 years without a guiding vision." Second, "because the Shuttle is now an aging system but still developmental in character, it is in the Nation's interest to replace the Shuttle as soon as possible as the primary means for transporting humans to and from Earth orbit." Third, "the previous attempts to develop a replacement vehicle for the aging Shuttle represent a failure of national leadership." And finally, the Board noted that "this approach can only be successful: if it is sustained over the decade; if by the time a decision to develop a new vehicle is made there is a clearer idea of how the new transportation system fits into the Nation's overall plans for space; and if the U.S. Government is willing at the time a development decision is made to commit the substantial resources required to implement it."

Since then, the President, the Congress and NASA have charted a new course in U.S. civil space policy that addresses all of these points, and the President's FY 2008 budget reaffirms that commitment with the necessary funds for the Space Shuttle and the ISS. NASA will continue forward at the best possible pace with the development of the Orion and Ares I crew vehicles. However, due to the cumulative effect of previously underestimated costs to retire/transition the Space Shuttle and support the International Space Station, the reduction from the FY 2007 request reflected in the FY 2007 Continuing Resolution, and the maturing design and integrated flight tests baselined for the Constellation program, it is unlikely that NASA will be able to bring these new Exploration capabilities online by 2014. Full funding of NASA's FY 2008 Exploration Systems request is critical to ensuring the gap between retirement of the Space Shuttle and the new U.S. human space flight capability does not grow longer. If the gap in our human space flight capability extends even further than already planned, I believe our nation will be ceding leadership in human space flight at a time when China and Russia have their own indigenous capabilities and India is developing its own capabilities. If we do not quickly come to grips with this issue, America may have a prolonged gap between the end of the Shuttle program and the beginning of Orion and Ares I operational capability, a gap similar to the one that occurred from 1975 to 1981 when our nation transitioned from Apollo to the Space Shuttle.

NASA has a lot of hard work ahead of it and many major milestones this year and next. The transition from the Space Shuttle to the Orion and Ares launch vehicles over the next several years must be carefully managed, and we must be focused, professional and committed to our mission. This is NASA's greatest challenge, and I ask the Committee's help in meeting it.

In the important area of Earth Science, we recently received the first-ever Decadal Survey for Earth Science from the National Academy of Sciences, which NASA, the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS) requested in 2003. As the first of its kind, the Survey has drawn considerable attention, and we will observe the programmatic priorities for Earth Science which it advocates. In addressing the Survey's Earth Science priorities, and consistent with ensuring that NASA maintains a balanced portfolio of science as directed by the *NASA Authorization Act of 2005* (P.L. 109–155), we have added funding to the Global Precipitation Measurement (GPM) mission, the follow-on to the highly successful Tropical Rainfall Measuring Mission (TRMM), to improve our ability to keep this mission on schedule. Our plan is to launch the first Core satellite for the GPM mission not later than 2013, followed by the second Constellation spacecraft the following year. The FY 2008 budget request also augments funding for the Landsat Data Continuity Mission (LDCM) and Glory missions in order to help keep those projects on schedule. Within Planetary Sciences, funding has been identified for Lunar Science research project beginning in FY 2008 to leverage the many opportunities for payloads on NASA and other nations' lunar spacecraft, such as India's Chandrayaan-1, as well as to analyze the science data from these missions, including NASA's Lunar Reconnaissance Orbiter. In 2008, we will launch a host of Heliophysics missions, many with international and interagency partners, to analyze the effects of solar flares, coronal mass ejections, and galactic cosmic rays. In Astrophysics, the final Hubble servicing mission is currently planned for a Space Shuttle flight in September 2008. And, as I advised the Congress and the science community last summer, NASA has reinstated the Stratospheric Observatory for Infrared Astronomy (SOFIA) mission. Though we know of no technical showstoppers in regard to the airworthiness of the aircraft or operation of the telescope, this program has some remaining hurdles to overcome and so remains subject to a management review later this spring. NASA will launch or participate in seven science missions in FY 2007, followed by 10 missions in FY 2008, resulting in many new Earth and space science discoveries in the years ahead.

The FY 2008 budget request increases the budget profile for Aeronautics Research over the President's FY 2007 request, aligns our aeronautics activities with the President's recently issued Aeronautics Research and Development Policy, and advances U.S. technical leadership in aeronautics. NASA has made significant progress in reformulating its approach to aeronautics research by collaborating with the broad research community including industry, academia, and other government agencies including the Federal Aviation Administration (FAA) and the Department of Defense (DOD). Through these changes, NASA will help ensure that America continues to lead the way in aeronautics research.

NASA continues to monitor and manage our "uncovered capacity" (employees not directly assigned to specific projects and programs). A little over 18 months ago, nearly 3,000 of NASA's 19,000 employees were designated as "uncovered capacity." Today, largely with the work defined in the Constellation program, we have greatly reduced that problem to manageable levels. As of February 2007, we have fewer than 200 uncovered capacity employees in FY 2007 and FY 2008. More importantly, many of our best engineers are working diligently on the great challenges before us. Every NASA Center is now vested in our space exploration mission. While we are proud of the progress that has been made, significant human capital challenges remain. These include matching available skills with the important work to be done, managing attrition, retraining and hiring, and improving our workforce planning for future years in FY 2009 and beyond. To address these challenges and any potential impacts resulting from the FY 2007 funding reductions, we have established a new intra-agency Workforce Planning Technical Team.

In addition, beginning in FY 2007, the Agency revised overhead allocations to simplify how we manage under full cost accounting. These changes will ensure a uniform cost rate for all NASA civil servants across the Agency's Government field centers. All changes are revenue-neutral to programs and projects; none of NASA's missions gain or lose funding as a result of this accounting change. At first glance, this accounting change appears to reduce the Aeronautics Research budget because so much of that work is done at our smaller research Centers. However, in actuality, NASA's direct spending for Aeronautics Research has increased in the FY 2008 budget run-out by $205 million through FY 2011 compared to the FY 2007 budget run-out.

Beyond our budget request, NASA is beginning to transition the workforce, infrastructure, and equipment from the Space Shuttle to new Exploration systems. Many of our most experienced people will be considering retirement between now and 2010. We will need the means to manage this attrition in a targeted manner to achieve better alignment of the workforce with our mission without creating unwanted losses and skills imbalances. One tool we may be using is the authority for the Agency to be able to re-employ selected retirees without an offset to their annuity—thus giving them an incentive to see a project or program to completion. To assist employees with transition to the private sector, and to ease that upheaval, another tool would authorize NASA to continue their coverage under the Federal Employees Health Insurance for one year after departure.

We will also need better tools to manage the transition of our facilities. The Agency is proposing slight changes and expansion to existing authority to permit leasing of underutilized facilities and related equipment. The Agency would retain the proceeds of those leases to be deposited in a NASA capital asset account and invested in activities to improve and sustain our facilities and infrastructure. We plan to discuss the details of these legislative requests with Members of Congress in the weeks and months ahead.

The remainder of my testimony outlines the FY 2008 budget request for NASA in greater detail.

Science Mission Directorate

This past year was truly remarkable for science discovery about the Earth, Sun, solar system, and universe. NASA was responsible for 11 percent of *Science News* magazine's top stories (covering all fields of science) for 2006, which is an all-time record in the 34 years of tracking this metric. NASA's findings ranged from new observations of familiar phenomena like hurricanes, thunderstorms, and rainfall, to the identification of 16 new extra-solar planets orbiting distant stars near the center of our galaxy. As NASA continues to add observations from long-lived assets such as the Spirit and Opportunity Mars Exploration Rovers, it continues to successfully develop and launch the next generation of missions and to support a vigorous scientific community.

In 2006, NASA launched four new science missions, one technology demonstration mission, and partnered with other federal and international agencies to launch three other science and technology missions, as well as the GOES–O satellite, to bring the current total number of operational science missions to 52. In January 2006, we launched the New Horizons spacecraft to the planet Pluto. Scheduled to arrive at Pluto in 2015, the spacecraft is making its closest approach to Jupiter as we speak. With the April 2006 launch of the CloudSat and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) spacecraft, NASA added to the "A-train" of satellites flying in close proximity around Earth to gain a better understanding of key factors related to climate change. In October 2006, NASA's twin Solar Terrestrial Relations Observatories mission (STEREO) spacecraft were launched to help researchers construct the first-ever three-dimensional views of the sun. Although the two spacecraft will not return images until later this year, initial results from STEREO have provided us with an unprecedented look at solar activity. On February 17, 2007, we launched five Time History of Events and Macroscale Interactions during Substorms (THEMIS) microsatellites to study the Earth's magnetosphere, and we are on track to launch the Dawn mission to main belt of asteroids between Mars and Jupiter and the Phoenix Mars mission later this year.

NASA's FY 2008 budget requests $5.5 billion for the Agency's Science portfolio. This represents an increase of $49.3 million (or one percent) over the FY 2007 request and it will enable NASA to launch or partner on 10 new missions, operate and provide ground support for more than 50 spacecraft, and fund scientific research based on the data returned from these missions. For FY 2008, NASA separated the Earth-Sun System theme into two themes: Earth Science and Heliophysics, and programmatic responsibility for studies of Near Earth Objects is transferred to the Exploration Systems Mission Directorate.

The Earth Science budget requests $1.5 billion—an increase of $27.7 million over the FY 2007 request—to better understand the Earth's atmosphere, lithosphere, hydrosphere, cryosphere, and biosphere as a single connected system. This request includes additional funding for the Global Precipitation Measurement (GPM) mission to improve schedule assurance in response to the high priority placed on GPM in the Decadal Survey. As the follow-on to the highly successful Tropical Rainfall Measuring Mission, NASA's plans to launch GPM's first Core satellite no later than 2013, followed by the second Constellation spacecraft the following year. The Earth Science budget also includes increased funding for the Landsat Data Continuity Mission and Glory in order to help keep them on their schedules, and provides funds

for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) to reflect instrument availability and launch delays. Funds are requested for continued development and implementation of the Ocean Surface Topography Mission to launch in 2008, the Aquarius mission to measure the ocean's surface salinity to launch in 2009, and the Orbiting Carbon Observatory mission planned for launch in 2008. NASA will continue to contribute to the President's Climate Change Research Initiative by collecting data sets and developing predictive capabilities that will enable advanced assessments of the causes and consequences of global climate change. Over the coming months, NASA will evaluate opportunities for implementing the recommendations of the National Research Council's Earth Science Decadal Survey and responding to challenges to the continuity of climate measurements resulting from the Nunn-McCurdy recertification of the NPOESS program.

The Heliophysics budget request of $1.1 billion will support 14 operational missions to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by astronauts, and to demonstrate technologies that can improve future operational systems. During FY 2008, the Explorer Program will launch the Interstellar Boundary Explorer (IBEX) mission, focused on the detection of the very edge of our solar system, and the Coupled Ion-Neural Dynamics Investigation (CINDI) Mission of Opportunity conducted by the University of Texas. The Solar Dynamics Observatory (SDO) to study the Sun's magnetic field will complete launch readiness milestones in FY 2008 and is presently scheduled for launch in August of 2008. The Geospace Radiation Belt Storm Probes (RBSP) mission, presently in formulation, will undergo a Preliminary Design Review and a Non-Advocate Review in FY 2008 in preparation for entering development in early FY 2009. RBSP will improve the understanding of how solar storms interact with Earth's Van Allen radiation belts. While the ST–7 and ST–8 missions are on track for launches in 2009, the New Millennium ST–9 mission, along with follow-on missions, is delayed.

The Planetary Science budget request of $1.4 billion will advance scientific knowledge of the solar system, search for evidence of extraterrestrial life, and prepare for human exploration. NASA will get an early start on Lunar science when the Discovery Program's Moon Mineralogy Mapper (M3) launches aboard India's Chandrayaan-1 mission in March 2008, along with the Mini-RF, a technology demonstration payload, supported by NASA's Exploration and Space Operations Mission Directorates and the Department of Defense, which may glean water in the Moon's polar regions. In addition, the budget requests $351 million from FY 2008 to FY 2012 for new Lunar Science research, including Missions of Opportunity, data archiving, and research. The budget supports the Mars Exploration Program by providing for a mission every 26 months, including the Phoenix spacecraft, scheduled for launch in 2007, and the Mars Science Laboratory, with a launch scheduled for 2009. The Discovery Program's Dawn Mission is scheduled to launch later this year, and the Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) spacecraft is already on its way to Mercury. Three Discovery mission proposals and three Missions of Opportunity were selected in 2006 for Phase A studies, and the Discovery Program will invite proposals for additional new missions in 2008. With the New Horizons spacecraft continuing on its way to Pluto, the New Frontiers Program's Juno Mission will undergo a Preliminary Design Review and a Non-Advocate Review in FY 2008 in preparation for entering development. The New Frontiers Program will release its third Announcement of Opportunity (AO) in late 2008.

The Astrophysics budget requests $1.6 billion to operate NASA's astronomical observatories, including the Hubble Space Telescope (HST), Chandra X-Ray Observatory, and Spitzer Space Telescope, and to build more powerful instruments to peer deeper into the cosmos. HST is scheduled for a final servicing mission in September 2008 using the Space Shuttle Atlantis. Along with service life extension efforts, two new instruments will be installed during the servicing mission that are expected to dramatically improve performance and enable further discoveries, including enabling some science observations that have been affected by the recent failure of the Advanced Camera for Surveys. After the servicing mission, HST will once again have six fully operational instruments (including a suite of cameras and spectrographs that will have about 10 times the capability of older instruments) as well as new hardware capable of supporting at least another five years of world-class space science. The ESA Herschel and Planck missions, both of which include contributions from NASA, will launch in FY 2008 aboard an ESA-supplied Ariane-5. Kepler instrument and spacecraft integration and test will be completed in preparation for launch in November 2008, to determine the frequency of potentially habitable planets. The Gamma-ray Large Area Space Telescope (GLAST) will launch in

FY 2008 to begin a five-year mission mapping the gamma-ray sky and investigating gamma-ray bursts. The James Webb Space Telescope will undergo Preliminary Design Review and a Non-Advocate Review in FY 2008, in preparation for entering development. The SOFIA observatory has been reinstated. Though we know of no technical showstoppers in regard to the airworthiness of the aircraft or operation of the telescope, this program has some remaining hurdles to overcome and so remains subject to a management review later this spring chaired by the NASA Associate Administrator. The SOFIA program baseline will be finalized at that time.

Exploration Systems Mission Directorate

The FY 2008 budget request for the Exploration Systems Mission Directorate (ESMD) is $3.9 billion to support continued development of new U.S. human space flight capabilities and supporting technologies, and to enable sustained and affordable human space exploration after the Space Shuttle is retired in 2010. With this budget, ESMD will continue to develop our next-generation crew exploration vehicle, while also providing research and developing technologies for the longer-term development of a sustained human presence on the Moon. However, due to the cumulative effect of previously underestimated costs to retire/transition the Space Shuttle and support the International Space Station, the reduction from the FY 2007 request reflected in the FY 2007 Continuing Resolution, and the maturing design and integrated flight tests baselined for the Constellation program, it is unlikely that NASA will be able to bring these new Exploration capabilities online by 2014. ESMD will also continue to work with other nations and the commercial sector to leverage its investments and identify opportunities for specific collaboration on lunar data and lunar surface activities. New human space flight development of this magnitude, such as the Orion Crew Exploration Vehicle, occurs once in a generation. The next five years are a critical period in our nation's space flight efforts.

The Constellation program includes the Orion Crew Exploration Vehicle; Ares I, a highly reliable crew launch vehicle; Commercial Orbital Transportation Services (COTS) demonstrations of cargo and crew transport to the International Space Station; Ares V, a heavy-lift launch vehicle; spacesuits and tools required by the flight crews and; associated ground and mission operations infrastructure to support either lunar and/or initial low-Earth orbit (LEO) missions.

For FY 2008, pending a full analysis of the FY 2007 budget impacts, ESMD is on track to maintain its commitments for Ares I and Orion, and to continue meeting major milestones. This year Constellation will continue to mature and develop overall. Formulation of the Constellation elements will continue, leading to the Preliminary Design Review in 2008, at which time the program will be baselined. NASA will conduct an update for the overall Constellation Systems Requirements Review (SRR) in 2007 after the completion of all the Program Element SRRs—the Orion Project recently completed its SRR on March 1, 2007. ESMD released the Ares I Upper Stage Request for Proposals (RFP) on February 23, 2007. The RFP for the Ares I Avionics Ring is scheduled for release in May 2007, with selection and contract award scheduled for November 2007.

Facility, equipment, and personnel transitions from Space Shuttle to Constellation will be the major emphasis of the FY 2009 budget process. NASA transition activities are focused on managing the evolution from current operations of the Space Shuttle to future operations of Constellation and emerging commercial services, in a safe, successful and smooth process. This joint effort between the Space Operations Mission Directorate (SOMD) and ESMD includes the utilization and disposition of resources, including real and personal property, personnel, and processes, to leverage existing Shuttle and International Space Station assets for NASA's future Exploration activities. Formalized Transition Boards are working to achieve this outcome. A Human Space Flight Transition Plan was developed in 2006; updates are in work, and metrics for the plan are being refined and will be implemented in 2007.

In August 2006, NASA signed Space Act Agreements with Space Exploration Technologies Corporation, of El Segundo, California, and Rocketplane-Kistler, of Oklahoma City, Oklahoma, to develop and demonstrate COTS that could open new markets and pave the way for commercial providers to launch and deliver crew and cargo to the ISS. The Space Act Agreements establish milestones and identify objective criteria to assess their progress throughout Phase 1 of the demonstrations. In the FY 2008 budget, funding for the purchase of crew and cargo transportation services, either from international partners or preferably from commercial providers, is transferred from ESMD to SOMD. COTS demonstration funding remains in ESMD to better exploit potential synergies with the Constellation Program.

With activities in the Advanced Capabilities program, NASA seeks to understand the space environment as it relates to human performance by addressing respective

recommendations from the Exploration Systems Architecture Study that was conducted 2005. This included refocusing biomedical research and human life-support activities through new milestones and requirements to target the timely delivery of research products. Accordingly, ESMD created two new programs under Advanced Capabilities: the Human Research Program (HRP) to study and mitigate risks to astronaut health and performance and the Exploration Technology Development Program (ETDP) to enable future Exploration missions and reduce cost and risk. Plans for 2008 include:

- Testing of prototype ablative heat shield materials, low-impact docking systems, and landing attenuation systems;
- Testing of advanced environmental control systems on the ISS;
- Developing a lightweight composite command module test article for the Orion;
- Conducting studies to assess risks of long-term radiation exposure and continuing the use of the ISS as a testbed for studying human health and safety in space;
- Spacecraft integration and testing in preparation for the Lunar Reconnaissance Orbiter (LRO) launch in October 2008;
- Next-generation spacesuit capable of supporting exploration; and
- Developing jointly with the U.S. Air Force the RS–68 engine that will be used on the Ares V.

Finally, the LRO and the Lunar CRater Observatory Sensing Satellite (LCROSS) to the Moon is planned to be launched in early FY 2008. These dual-manifested spacecraft have completed Critical Design Review and are currently in development. The science yielded from these missions will enable future outpost site selection and new information about the deep craters at the lunar poles. The LRO/LCROSS missions represent NASA's first steps in returning to the Moon.

Aeronautics Research Mission Directorate

In 2006, NASA's Aeronautics Research Mission Directorate (ARMD) conducted a significant restructuring of its aeronautics program, allowing NASA to pursue high-quality, innovative, and integrated research that will yield revolutionary tools, concepts, and technologies to enable a safer, more flexible, environmentally friendly, and efficient national air transportation system. As such, ARMD's research will continue to play a vital role in supporting NASA's human and robotic space activities. The reshaped Aeronautics Program content and direction is consistent with the National Aeronautics Research and Development Policy, signed by the President on December 20, 2006.

A primary goal across all of the programs in ARMD is to establish strong partnerships involving NASA, other government agencies, academia, and industry in order to enable significant advancement in our nation's aeronautical expertise. Because these partnerships are so important, NASA has put many mechanisms in place to engage academia and industry, including industry working groups and technical interchange meetings at the program and project level, Space Act agreements for cooperative partnerships, and the NASA Research Announcement (NRA) process that provides for full and open competition for the best and most promising research ideas. During 2006, ARMD's NRA solicitation resulted in the selection of 138 proposals for negotiation for award from 72 different organizations representing 29 different states plus the District of Columbia. NASA's FY 2008 budget request for Aeronautics includes $51 million for NRA awards.

In FY 2008, the President's budget for NASA requests $554 million for Aeronautics Research. This budget reflects full cost simplification, which significantly reduces the Center overhead and infrastructure allocated to the Aeronautics programs.

NASA's Airspace Systems Program (ASP) has partnered with the Joint Planning and Development Office (JPDO) to help develop concepts, capabilities and technologies that will lead to significant enhancements in the capacity, efficiency and flexibility of the National Airspace System (NAS). Such improvements are critical to meet the Nation's airspace and airports requirements for decades to come. In FY 2008, NASA's budget request would provide $98.1 million for ASP to conduct further research in operational concepts and human-in-the-loop simulation modeling that supports advancements in automated separation assurance capabilities. In addition, ASP will pursue enhanced development of airport surface movement trajectory models to provide a basis for optimized use of super density airports, integrated airport clusters, and terminals where demand for runways is high. Last year, ASP took an important step toward this goal by completing development of a system-wide oper-

ational concept that provides a detailed description of future NAS capacity enhancements while assessing the benefits of such system improvements. Key to the analysis of the operational concepts was program-developed tools such as the Airspace Concepts Evaluation System and the Future Air Traffic Management Concepts Evaluation Tool, both of which have successfully transitioned from NASA to the Federal Aviation Administration and the JPDO.

NASA's Fundamental Aeronautics Program (FAP) conducts research in the engineering and scientific disciplines that enable the design of vehicles that fly through any atmosphere at any speed. The FY 2008 budget request, amounting to $293.4 million, will enable significant advances in the Hypersonics, Supersonics, Subsonic Fixed Wing, and Subsonic Rotary Wing projects that make up the FAP. These projects focus on creating innovative solutions for the technical challenges of the future: increasing performance (range, speed, payload, fuel efficiency) while meeting stringent noise and emissions constraints; alleviating environmental and congestion problems of the Next Generation Air Transportation System (NGATS) through the use of new aircraft and rotorcraft concepts; and, facilitating access to space and reentry into planetary atmospheres. A wide variety of cross-cutting research topics are being pursued across the speed regimes with emphasis on physics-based multi-disciplinary analysis and design, aerothermodynamics, materials and structures, propulsion, aero-servo-elasticity, thermal protection systems, advanced control methods, and computational and experimental techniques. A number of key activities are planned for FY 2007 and FY 2008 including the launch of a sub-orbital rocket to conduct flight experiments in hypersonic boundary layer transition and re-entry shapes, the flight test of scale models of the X–48B Blended Wing-Body concept to assess this advanced unconventional airframe configuration for its potential to decrease aircraft noise while also improving performance, the evaluation of radical new concepts for variable-speed rotor technologies that can result in highly improved performance, and the evaluation of actively-controlled inlets for supersonic transports.

The FY 2008 budget request for NASA's Aviation Safety Program (AvSP) is $74.1 million. The four projects within the Program (Integrated Intelligent Flight Deck, Integrated Resilient Aircraft Control, Aircraft Aging and Durability, and Integrated Vehicle Health Management) will develop cutting-edge tools, methods, and technologies with close coordination among them to improve the intrinsic safety attributes of current and future aircraft that will operate in the NGATS. In FY 2008, the Program will complete a study of human-automation technology that will improve safety during approach and landing operations by allowing for active operator assistance that maintains appropriate levels of workload and will be conducted to evaluate neural networks for direct adaptive control that will maximize adaptation to simulated in-flight failures while minimizing adverse interactions. At the same time, onboard sensor technology will be developed and validated to achieve significant improvement in measuring atmospheric water content that will improve the ability to detect the onset of potential icing hazards. Challenges related to aircraft aging and durability will also be addressed by developing models capable of simulating the initiation and propagation of minute cracks in metallic materials.

Finally, NASA's Aeronautics Test Program (ATP) will continue to safeguard the strategic availability of a critical suite of aeronautics test facilities that are deemed necessary to meet Agency and national aeronautics needs. The FY 2008 budget request for ATP is $88.4 million, which will enable strategic utilization, operations, maintenance and investment decisions for major wind tunnel/ground test facilities at Ames Research Center, Glenn Research Center and Langley Research Center and for the Western Aeronautical Test Range support aircraft and test bed aircraft at Dryden Flight Research Center. In FY 2006, NASA implemented procedures to ensure affordable and competitive pricing of its aeronautics facilities for use by other parties, including industry and university researchers. In FY 2008, ATP plans to continue ensuring competitive prices for ATP facilities, reducing a backlog of maintenance issues and investing in advanced technologies such as installing consistent angle of attack instrumentation at the research Centers.

Space Operations Mission Directorate

This was an extraordinary year for the Space Shuttle and International Space Station (ISS) Programs. NASA celebrated Independence Day 2006 by launching Space Shuttle Discovery on the STS–121 mission. The second of two test flights (the first was STS–114 in July/August 2005), STS–121 helped validate the improvements made to the Space Shuttle system since the loss of *Columbia* on February 1, 2003. The mission also marked the return of a complement of three crew members to the ISS. The Space Shuttle Atlantis (STS–115), which launched on September 9, marked a return to sustained Space Shuttle operations and placed NASA on track

to completing assembly of the ISS by 2010. STS–115 delivered the critical P3/P4 truss to the ISS, which will provide a quarter of the power services needed to operate the completed research facility. The last flight in December 2006, STS–116, was devoted primarily to deactivating the electrical power systems on the U.S. segment of the ISS and making a series of electrical and coolant connections between the P3/P4 truss segment and the rest of the Station. To do this, flight controllers at the mission control centers in Houston and Moscow up-linked over 17,900 commands to the ISS during the mission—all without a single unplanned or command error. STS–116 crew member Robert Curbeam also set a record for the most space walks ever conducted by an astronaut on a single Space Shuttle mission, with four excursions totaling over 25 hours.

Operational activities on-board the ISS have continued into 2007, with a series of space walks that reconfigured the thermal system on the Station and prepared us for future assembly tasks. The Station is now able to provide additional power to the Space Shuttle, allowing two extra docked days, and we have connected permanent systems in place of temporary ones. The sequence of three complex space walks within nine days also demonstrated capabilities we will need later this year to fully install Node 2 following its delivery on STS–120.

These mission achievements reflect the NASA team's dedication to safely and successfully flying out the Space Shuttle program and meeting our nation's commitments to our international partners. The program's successes also led to the decision in October 2006 to move forward with plans for a final servicing mission to the Hubble Space Telescope (HST). Following an extensive review by the relevant NASA offices of all safety and technical issues associated with conducting such a mission, it became clear that an HST servicing mission could be carried out effectively and safely. While there is an inherent risk in all space flight activities, the desire to preserve a truly international asset like the HST makes doing this mission the right course of action.

The Space Shuttle FY 2008 budget request of $4.01 billion would provide for five Shuttle flights, including four ISS assembly flights as well as the HST servicing mission. The ISS assembly flights include the launch of major research facility modules from the European Space Agency and Japan. The Canadian Special Purpose Dexterous Manipulator robotic system will also be flown in 2008. These flights are a major step towards fulfilling U.S. commitments to NASA's international partners as specified in the ISS agreements and the *Vision for Space Exploration.*

The FY 2008 budget request includes $2.24 billion for ISS activities. NASA has consulted with our international partners on the configuration of the ISS, and is working closely with them to determine the detailed plans for logistics required during and after assembly. The FY 2008 budget request provides the necessary resources to purchase Soyuz crew transport and rescue for U.S. astronauts as well as Progress vehicle logistics support for the ISS from the Russian Space Agency.

As the Shuttle approaches its retirement, the ISS Program intends to use alternative cargo and crew transportation services from commercial industry. Once a capability is demonstrated in Phase 1 of the Commercial Orbital Transportation Services (COTS) Space Act Agreements, NASA plans to purchase cargo delivery services competitively in Phase 2 and will decide whether to pursue crew demonstrations. In the FY 2008 budget, funding for the purchase of crew and cargo transportation services, either from international partners or preferably from commercial providers, is transferred from the Exploration Systems Mission Directorate to the Space Operations Mission Directorate. One item of significance in the FY 2008 budget run-out, especially in the out-years, is that it allows for increases to our previously estimated costs for purchasing commercial cargo and crew services to support the ISS, assuming these commercial services are successfully demonstrated and are cost-effective. Should costs for those services be greater than what is presently budgeted, NASA has accepted a management challenge to scale back on our space operations costs and will curtail some of our robotic lunar exploration or long-term exploration technology development in the out-years. COTS demonstration funding remains in ESMD to better exploit potential synergies with the Constellation Program.

The Space Shuttle Program's highest priority is to safely complete the mission manifest by the end of FY 2010, using as few flights as possible. Working through formalized Transition Control Board processes, the Space Shuttle Program will also play a key role in coordinating the smooth transition of Space Shuttle assets and capabilities to the next generation of Exploration systems without compromising the safety of ongoing flight operations. The greatest challenge NASA faces is safely flying the Space Shuttle to assemble the ISS prior to retiring the Shuttle in 2010, while also bringing new U.S. human space flight capabilities on-line soon thereafter. There are a number of major transition milestones set for FY 2008, including the transition of one of the four high bays in the Vehicle Assembly Building and Launch

Pad 39B to the Constellation Systems Program. Space Shuttle Atlantis may also be retired in FY 2008 after the HST SM–4 mission and its systems and parts would be used to support the remaining Space Shuttle Orbiters, Discovery and Endeavour, during the program's last two years of operations. The FY 2008 budget request reflects the current assessment of costs to retire the Space Shuttle. Over the next year, NASA will develop additional detail and refine our cost estimates for the transition.

The FY 2008 budget also provides for the procurement of two additional Tracking and Data Relay Satellite System (TDRSS) satellites to replenish the constellation. NASA projects that the availability of aging TDRSS satellites to support overall user demand will be reduced by 2009 and depleted by 2015. In order to continue to support all users, NASA must begin the procurement process immediately, with planned launches in FY 2012 and FY 2013. By replenishing the satellites, NASA will be able to meet overall user demand through 2016. The Space Operations Mission Directorate has partnered with non-NASA users to provide a proportionate investment in the replacement capabilities.

Cross-Agency Support Programs

The FY 2008 Budget Request for activities within the Cross-Agency Support Programs (CASP)—Education, Advanced Business Systems, Innovative Partnerships Programs, and Shared Capabilities Assets Program—is $498.2 million. Within this amount, $34.3 million is for the Shared Capability Assets Program (SCAP), which is designed to ensure that critical capabilities and assets (e.g., arc jets, wind tunnels, super computing facilities, rocket propulsion testing, etc.) required Agency-wide are available to missions when needed. The FY 2008 budget request for Advanced Business Systems, comprising the Integrated Enterprise Management Program (IEMP), is $103.1 million. FY 2007 and FY 2008 funding will support IEMP in implementing capabilities that improve NASA's tracking and accountability of its property, plant, and equipment; integrate human capital information, providing employees and management with new, secure tools for accessing personnel data, and planning and budgeting NASA's workforce; and, provide more relevant and accurate financial information in support to NASA's programs and projects. This funding also supports ongoing operations and maintenance of NASA's financial system and other Agency-wide business systems.

For NASA's Education activities, the FY 2008 budget request totals $153.7 million and sustains our ongoing commitment to excellence in science, technology, engineering, and mathematics (STEM) to ensure that our Agency is equipped with the right workforce to implement the *Vision for Space Exploration.* NASA will continue the tradition of investing in education and supporting educators who play a key role in preparing, inspiring, exciting, encouraging, and nurturing the youth who will manage and lead the laboratories and research centers of tomorrow. NASA Education is committed to three primary objectives to help improve the state of STEM education in our country: strengthen the Nation's and NASA's future workforce; attract and retain students in the STEM discipline and; engage the American people in NASA's missions through partnerships and alliances.

The Innovative Partnerships Programs (IPP) provides leveraged technology investments, dual-use technology-related partnerships, and technology solutions for NASA. The FY 2008 budget request for IPP activities is $198.1 million. The IPP implements NASA's Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) Programs that provide the high-technology small business sector with an opportunity to develop technology for NASA. Recently, NASA has made some changes to the management structure of these two programs to better enable technology infusion and to increase the efficiency of the operations. IPP also manages the Centennial Challenges Program. NASA has already benefited from the introduction of new sources of innovation and technology development even though the Program is relatively new and no prizes have yet been awarded. In addition, ongoing and future prize challenges will continue to inspire brilliant young minds.

Conclusion

NASA has many challenges ahead of us, but we are on track and making progress in managing these challenges. The FY 2008 budget request demonstrates commitment to our nation's leadership in space and aeronautics research, and while we may face a significant funding reduction for FY 2007, we will carry on, though not at the pace we had previously hoped.

I ask your help to ensure this nation maintains a human space flight capability. Without stable funding as requested in this budget, we face the very real possibility

of allowing that capability to slip away for the foreseeable future—even as other nations continue to develop similar capabilities.

I also need your help to effectively transition key elements of our Space Shuttle workforce, infrastructure, and equipment to our nation's exploration objectives. The provisions I referenced earlier, as well as stable funding, will help ensure we preserve a critical and unique industrial base capability that has allowed the United States to lead the world in space exploration.

Again, thank you for the opportunity to appear before you today. I would be please to respond to any questions that you may have.

National Aeronautics and Space Administration
President's FY 2008 Budget Request

(Budget authority, $ in millions)
By Appropriation Account

By Mission Directorate By Theme	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
Science, Aeronautics and Exploration	16,592.5	16,481.1	16,964.4	17,364.2	18,199.9	18,935.0
Science	**5,486.8**	**5,616.1**	**5,668.3**	**5,800.6**	**5,666.8**	**5,882.7**
Earth Science	1,469.6	1,497.3	1,539.7	1,500.7	1,411.2	1,353.2
Heliophysics	1,028.1	1,057.2	1,034.6	1,107.1	1,241.2	1,307.5
Planetary Science	1,406.1	1,395.8	1,676.9	1,723.9	1,738.3	1,748.2
Astrophysics	1,583.0	1,665.8	1,304.2	1,298.9	1,266.2	1,383.8
Exploration Systems	**4,152.5**	**3,833.0**	**4,312.6**	**4,757.6**	**6,728.2**	**8,076.6**
Constellation Systems	3,232.5	3,005.0	3,451.2	3,784.9	7,666.0	7,993.0
Advanced Capabilities	920.0	828.0	861.6	973.0	1,059.1	1,083.9
Aeronautics Research	**529.3**	**554.0**	**546.7**	**545.3**	**549.8**	**554.7**
Aeronautics Technology	529.3	554.0	546.7	545.3	549.8	554.7
Cross-Agency Support Programs	**962.8**	**489.2**	**463.6**	**460.4**	**454.7**	**454.4**
Education	167.4	153.7	152.6	152.7	149.8	149.6
Advanced Business Systems	97.4	103.1	68.4	71.6	67.6	67.5
Innovative Partnerships Program	215.1	193.1	197.2	199.8	200.0	200.0
Shared Capability Assets Program	22.1	34.3	34.2	36.2	37.3	37.2
*Continuing Resolution Rate**	(536.6)					
Exploration Capabilities	6,168.3	6,791.7	6,716.3	6,825.7	3,036.8	2,979.0
Space Operations	**6,168.3**	**6,791.7**	**6,716.3**	**6,825.7**	**3,036.8**	**2,979.0**
Space Shuttle	4,017.6	4,937.6	3,950.9	3,834.4	116.2	0.0
International Space Station	1,762.6	2,238.6	2,515.1	2,809.2	2,547.5	2,800.8
Space and Flight Support	388.1	545.7	544.3	382.0	372.9	377.2
*Continuing Resolution Rate**	(48.8)					
Inspector General	33.8	34.6	35.5	36.4	37.3	38.3
*Continuing Resolution Rate**	(2.5)					
TOTAL	16,792.3	17,339.6	17,614.2	18,026.3	18,493.6	18,935.0
Year to Year Change**		3.1%	1.8%	2.3%	2.4%	2.4%

FY 2007 column represents the 2007 President's Budget in full-cost simplification and shown in the new Theme structure.

** Modification to FY 2007 if current continuing resolution is extended for entire year, and assuming $128.1M institutional mission support transfers from Exploration Capabilities to Science, Aeronautics and Exploration Not included in totals.*

Totals may not add due to rounding.

DISCUSSION

BUDGET SHORTFALLS AND DISCREPANCY BETWEEN ADMINISTRATION REQUESTS AND AUTHORITY LEVELS

Chairman GORDON. Thank you, Mr. Griffin.

At this point, we will open our first round of questions, and the Chairman recognizes himself for five minutes.

Let me—you do have a dilemma, but it doesn't—the budget doesn't even recognize what the President is asking you to do. I mean, it is not a matter of what we want to do. I mean, certainly we would like to do even more. But the budget doesn't even pay for what you are asked to do. That is what we are talking about. We are not trying to get into some la-la land of Christmas trees. We are talking about trying to do what you are charged to do. And that is where somewhere we have to decide are you being charged too much.

And also, you had mentioned that it was obvious that we don't support the President's proposal. That is right. We don't. We support the authorizing level, not the President's level, and we would—you know, we would like for you and OMB to try to get to the authorizing level, rather than the President's level, so it wouldn't be as tough.

So I just wanted to try to get ourselves in the right perspective.

Dr. Griffin, it was my understanding that when you testified before the Committee last year that you had reached an agreement with OMB to correct for the under-budgeting that had occurred in the Space Station and the Space Shuttle accounts prior to your arrival at NASA. And it is my understanding that the fiscal year 2007 budget request and the five-year run-out reflected that agreement.

However, just a year later, we have been presented with a NASA budget request for fiscal year 2008 that, according to NASA's own data, includes an estimated shortfall of almost a billion dollars in the ISS crew and cargo service funding, does not include funds to address the Space Shuttle program termination and retirement costs past fiscal year 2010. And although NASA concedes that there will be additional costs, it reduces the amount of Space Shuttle reserves available to address remaining Shuttle programming threats during the remaining missions, and it reduces the reserves available to the ISS program during the most challenging assembly phase.

Would you agree that this is an accurate description of what budget request or that fiscal year 2008 budget request?

Dr. GRIFFIN. I can't agree or disagree, specifically. I can talk about specific points of that with you. With regard to——

Chairman GORDON. Well, just for the lack of time, did anything I state there—did you find that wasn't accurate?

Dr. GRIFFIN. No, sir, I did not find any inaccuracies in your statement. We did reach agreement last year, within the Administration, to budget—to replace the previous placeholder estimates for Shuttle and Station completion, Shuttle fly-out and Station completion. They were about—and I would like to correct the record of some earlier statements that were made during the opening statements, that the overall shortfall was about $5.6 billion in

the Shuttle and Station account, which is, you know, on the record from last year, and we were able to reduce that to a number on the order of $3.8 billion because the exploration architecture that we advanced had considerable synergy with today's Shuttle fleet. So by that means, we reduced the overall problem down to about $3.8 billion, and we did reprioritize within the NASA budget with the assistance and concurrence of the Executive Office of the President to produce a budget, which addressed those shortfalls. We did, absolutely, do that. And the budget, the 2007 budget run-out that we brought you last year, the 2007 request, addressed everything that Station and Shuttle were understood by the best minds we had to be—allow us to finish out the program.

The $924 million in crew cargo to which you refer represents a lien for transportation services against the program after Shuttle retirement because of a very simple fact. When we were still—when we were planning in the United States to fly the Shuttle indefinitely, then transportation to the Space Station of crew and cargo was essentially a free good to the Space Station program. Now that we are retiring the Shuttle in 2010, we must purchase transportation services——

Chairman GORDON. Well, I would agree with that, and I think you are doing it in the most efficient way, but we still have a shortfall. And again, I am concerned that with——

Dr. GRIFFIN. So that does represent a lien against the program——

Chairman GORDON. Yes.

Dr. GRIFFIN.—which we—it is a management challenge we have taken to try to find $924 million.

Chairman GORDON. So there is that shortfall then?

Dr. GRIFFIN. There is that lien.

Chairman GORDON. And was it your ideas or—since there was an agreement last year with OMB, apparently that agreement hasn't been kept, so was it your idea to change it or was it OMB's idea?

Dr. GRIFFIN. Well, we have, as you might appreciate, a multitude of discussions in the eight months or so that we take to prepare the budget within the Administration, and I just—I do not, and cannot, disclose or discuss which ideas came from which parties, but—or which individuals, but the end result was that we have a management challenge to find $924 million within the manned space flight accounts to address the transportation requirements——

Chairman GORDON. But I think the end result, though——

Dr. GRIFFIN.—for the Station.

Chairman GORDON.—is that the agreement that was reached with OMB wasn't honored. That is the end result.

So—and also, as you know, the *Columbia* Accident Investigation Board documented the negative effects of the schedule and budgetary pressure on the Shuttle program. And now we have a Space Station and the Shuttle program that are under pressure to complete the ISS assembly by the time the Shuttle is retired in 2010. At the same time, we have a budget request before us that reduces the Shuttle and Station reserves and includes a billion dollar shortfall in the funding needed to sustain the Station after 2010. And I guess I should say, why should I not be worried that we are see-

ing parallels to the environment that the CAIB warned us about earlier?

Dr. GRIFFIN. I understand your concerns, sir, and we have addressed that. Of the $924 million that we believe, based on existing prices for commercial service, we have budgeted the $924 million for—through the run-out to buy the services we need. Of that, $300 million, approximately, is being—will be sought within space ops, and the $600 million will be sought within exploration systems. So, on an annual basis, we are talking about an average of $60 million a year within the Space Station and Space Shuttle accounts to provide that transportation service. And I would not have allowed that to be imposed on space ops if they had not stepped forward and said they thought they could find the money.

So, with regard to safety of the Shuttle and Station programs, in respect of the budget allocated to them, I think they are okay. The larger issue is, of course, what does an additional $600 million from the exploration account—the larger issue is what does the additional $600 million cut to the exploration account do to the delivery of the CEV and the—or the Orion and the Ares vehicles? And we are still working through that.

Chairman GORDON. As you can hear, we have votes going on, so I want to let Mr. Hall move forward.

You know, I don't, in any way, want to infer that you would ever have an unsafe mission. That will not occur. I just remember, as hard—or as much as I wanted to dunk the ball when I was playing basketball, I wasn't able to. Sometimes, we can be asked—or want to do more than we are able to. I do not want us to get into a situation where, at a later date, you have to say, "This is not safe."

Dr. GRIFFIN. Right.

Chairman GORDON. And so that is what I am trying to avoid. And——

Dr. GRIFFIN. I do understand, sir. I truly do. And I believe that we are okay within space ops on our budget line.

Chairman GORDON. Okay.

Dr. GRIFFIN. We have prioritized Shuttle and Station above other things in order to complete that commitment. We are still assessing the consequences of that prioritization on the other things.

CREW SAFETY OF FUTURE PROJECTS

Chairman GORDON. I yield to—five minutes to Mr. Hall.

Mr. HALL. Yes. Thank you, Mr. Chairman. And I will try not to take the full five minutes.

I think, Mike, that money is so important and something we have to really be aware of at all times and in all budgetary gusts. I have often heard it said that money ain't everything, but it sure keeps you in touch with your kids. Well, I know that we have got to be totally aware of the funds that we are asking for and the funds that we are going to appropriate, but something that keeps biting at me and something that I keep having to note, the next thing the American people are interested in is the safety of those that still are flying a fragile mission and that we know that—we were reminded of that some couple years ago.

As you know, I have always been concerned about——

Chairman GORDON. Excuse me. Mr. Hall, would you yield for just one——

Mr. HALL. I do yield.

Chairman GORDON. We only have one vote. Mr. Lampson, would you go on and vote, if you don't mind? We only have one vote. You go—if you would go on, and if you could come back, and we will impose as little as possible on Dr. Griffin.

Anyone else that would like to—well, we are going to go to Mr. Udall, and maybe he can get through his, but any of the rest of you, if you want to go on, you can come back and be ready to ask questions.

Excuse me, Mr. Hall.

Mr. HALL. Yes, I will take the Chair for you, if you—okay. So we will get back on now.

For several years, I have been frustrated by the fact that the Shuttle couldn't be modified with the crew escape system, and it couldn't for two reasons: one was the amount of money it would have cost, and the other was the physical inability weight-wise to do it. It just was not possible. We could never say there is not—no amount of money was too much for safety, but the physical facts kept us from doing that and still keep us from doing it. But I understand that one of the benefits of the crew exploration vehicle is the ability to jettison the entire crew module if there is a catastrophic accident. Please assure us that the crew escape system plan for the CEV is robust enough to safely jettison the entire crew to safety in the unfortunate event of a catastrophic accident. And will this system be functional throughout all phases of the powered flight?

Dr. GRIFFIN. The answer to your question is unequivocally yes.

Mr. HALL. Great. That is all I would like to hear.

STATUS OF THE SOFIA PROGRAM

I want to ask you about another mission. The SOFIA mission is moving forward, as you know, but your statement indicates the program has remaining hurdles. Now, I am getting fairly tired of "remaining hurdles" on SOFIA. When we are 90 percent complete on it and have 10 percent to go, surely we are not going to have any hurdle. If it is a hurdle, it is a low hurdle and not a high hurdle. And we—that is such an important program. A management review is going to be held again after this spring, is that right? Is that what your testimony was?

Dr. GRIFFIN. Let me give you a quick couple of minutes on the status of SOFIA.

Mr. HALL. Give me the good answers you gave to my first questions.

Dr. GRIFFIN. It can't be as short, I am sorry, sir, but——

Mr. HALL. Okay.

Dr. GRIFFIN.—I will make it as short as I can.

We did a very careful review of the SOFIA program last year. We determined that the airplane modifications, due to changing external situation, United Aircraft—Airlines have gone out of the business of modifying airplanes, we needed to put the SOFIA airplane modification program at Dryden, which is where our experimental aircraft work is located. The airplane modifications are now going

much better. We expect to be on the verge of our first certification flights within months. We think we have a solid handle on getting the airplane to work properly. The German scientific payload is ready, so it is a matter of finishing up on the airplane and integrating the payload. We will do that. The science management operations group that you were referring to in your question——

Mr. HALL. Yes, sir.

Dr. GRIFFIN.—meets, I think, next month or in May. I think they meet in May. They will be looking forward to how to operate the observatory. I think we have got SOFIA back on track.

Mr. HALL. Yes. That is great. We had—it seemed like we had almost $600 million in it, and it is about 90 percent complete. Somewhere along, if those aren't exact figures——

Dr. GRIFFIN. The program was——

Mr. HALL.—the percentages are probably correct.

Dr. GRIFFIN. The program was in great distress. I think we are now okay.

Mr. HALL. I thank you. And I yield back my time.

Mr. UDALL. [Presiding.] I thank the gentleman.

DELAYS IN CEV PROGRAM

Dr. Griffin—I would, at this point, yield myself five minutes.

In your testimony, you state that, due to the cumulative effect of a number of factors, including the somewhat infamous now Joint Resolution for fiscal year 2007, that NASA is unlikely to bring the CEV online in 2015. The briefing material indicates that independent of any Joint Resolution impacts, the CEV program is already looking at a six-month delay, which would slip the operational date to March 2015. Could you explain the specific reasons for the six-month delay?

Dr. GRIFFIN. Yes, sir. And I will, in fairness, state at the outset, I will reinforce your point, that it is an accumulated set of circumstances, one of which was the extra funding needed last year to complete the Space Station and Space Shuttle fly-out that we talked about just a few moments ago. That, of course, was a major factor.

But added to all of that, the net programmatic effect of reducing by some, you know, almost $600 million, the Joint Continuing Resolution reduced the money available for the CEV program by almost $600 million over the next five years. So that is a fact. And the schedule slip that goes with that reduction is about six months.

Mr. UDALL. Now on top of that delay, the Joint Resolution could result, as we understand it, another four- to six-month delay. Is that correct? And what will determine the length of the delay due to the Joint Resolution?

Dr. GRIFFIN. That was about six months, yes, sir.

Mr. UDALL. So it is not a cumulative 12 months? It is still six months?

Dr. GRIFFIN. No, no, no. It is—the effect of the Joint Resolution, by itself, that particular reduction in ability to obligate funding, just the Joint Resolution, that effect is about six months. So we have several effects, and that one is there.

Mr. UDALL. So there are two effects, and you believe it will total up to 12 months, or you think the two, cumulatively, will result in six months?

Dr. GRIFFIN. No, there are a number of different things, which have gone on, over—let me take you back, again, a couple of years, as briefly as I can.

In the 2005 budget, the Administration planned for the start of the CEV program. At that point—or from that point, we have had reductions, as the Chairman noted earlier, in the amount of funding budgeted to NASA. We have had reductions in CEV funding, which have been necessary to pay for Shuttle and Station. We have had rescissions due to Katrina and we have had rescissions due to other reasons. And so, the combination of all of these things had, up to that point, delayed the CEV out to the very end of 2014. There—no one funding reduction is more responsible than the others. It is just that there was a chronological sequence, and the last one to be applied was the Continuing Resolution, and that was the—that is the most recent delay, not the only delay, and the magnitude of that delay was about six months.

Mr. UDALL. So, at this point, we are looking at September of 2015 or——

Dr. GRIFFIN. March of 2015.

Mr. UDALL. March of 2015. You are holding fast to that?

Dr. GRIFFIN. Yes, sir.

Mr. UDALL. Good.

IMPLEMENTATION OF DECADAL SURVEY RECOMMENDATIONS

If I could, let me move to the National Academies' recommendations around the new Earth science and application missions. And while I recognize that it may not be possible to do all of the proposed missions at the rate recommended, and I also acknowledge that some of the Academies' cost estimates may be optimistic, I don't see anything in the 2008 budget request and run-out that would allow NASA to make any kind of a credible start on these new missions. What priority do you attach to the missions recommended by the Decadal Survey? And do you have any plans to initiate any of the new missions recommended by the Survey?

Dr. GRIFFIN. The answer I would give you is exactly the same as the answer I would give you for any of our four science portfolios. Our priorities are strongly influenced by the Decadal Surveys that we get from the National Academies. We do respect those. I have said that on the record any number of times. I think it is important that we do so. The National Academies is as close to a governing body of science in this nation as we are, I think, ever going to get.

That said, every one of our four portfolios has a Decadal Survey now, and every one can use up, by itself, the entire science budget. So we cannot do every mission on the Earth science Decadal with the money that we have, just as we cannot do every mission on the astrophysics Decadal or heliophysics Decadal or planetary science Decadal. So we will use the Decadal prioritization to inform the sequence in which we do our Earth science missions. We have already used it to plus-up the funding for GPM, and we will continue to use it. But we cannot immediately start a program, which is

going to go and execute every single Earth science mission on the Decadal.

Mr. UDALL. So, Doctor, I don't hear you saying you have plans to initiate any of the new missions recommended by the Survey, is that correct? I want to make sure the record reflects your point that——

Dr. GRIFFIN. I am—I will have to take that for the record. I am not sure what the next mission that we would initiate would be. It—anything we initiate will be in conformance with the priorities of the Decadal Survey.

Mr. UDALL. Thank you. I look forward to reading your response, for the record, and at this point, we will temporarily recess the Committee until the——

Dr. GRIFFIN. Okay.

MATERIAL REQUESTED FOR THE RECORD

With the Decadal Survey now in hand, NASA is actively developing an integrated Earth Science mission roadmap to address the Earth Science scientific priorities identified in the Decadal Survey. As recommended in the Decadal Survey, the new NASA integrated mission roadmap will take into account contributions from international partners, the availability of supporting measurements from precursor missions that are expected to still be operating after 2010, and the data expected from National Polar-orbiting Operational Environmental Satellite System (NPOESS) in light of the Nunn-McCurdy recertification. NASA will work to address the science priorities outlined in the Decadal Survey for Earth Science through the Earth System Science Pathfinder (ESSP) missions and Earth Systematic Missions. The FY 2008 budget request includes $492.3 million (over five years, FY 2008–FY 2012) for a new ESSP mission; this budget request supports a solicitation to be released in late FY 2008, with launch of a small-to-medium class mission in the 2014 time frame. While ESSP missions are competitively selected from among proposals submitted by researchers, the ESSP Announcement of Opportunity will solicit proposals for missions addressing one or more of the top four scientific priorities assigned to NASA in the Decadal Survey: quantitative measurement of solar irradiance and spectrally resolved Earth radiation budget; active and passive microwave measurements of soil moisture and vegetation freeze/thaw cycles; detailed measurements of ice sheet dynamics and extent; and solid Earth processes combined with measurements of vegetation canopy characteristics. In addition, the FY 2008 budget requests includes the start of a funding wedge for additional future Decadal Survey missions, with a small amount of funding ($1.2 million) for early work in FY 2009–2011 and growing to $30.6 million in FY 2012. This funding supports future Earth Systematic Missions.

Mr. UDALL. There is a vote on. There is about two minutes left. You and I running. So we will temporarily recess, and we will be back shortly.

Dr. GRIFFIN. I will be here. Thank you.

[Recess.]

Chairman GORDON. The Committee will come back to order. We thank all of you for your patience, and the—Mr. Calvert is recognized for five minutes.

NEGATIVE RAMIFICATIONS OF AMERICAN HIATUS FROM HUMAN SPACE FLIGHT

Mr. CALVERT. Thank you, Mr. Chairman.

Administrator, if the Shuttle is retired in 2010, and I assume that we are on schedule to do so, and a CEV is not operational until 2015, as NASA budget predicts, there could be a minimum of a five-year delay in our human space flight capability. The last time we had an extended hiatus between the Apollo and the Shut-

tle programs, as you know, we paid a tremendous price in the loss of the aerospace industries and workforce.

In order to assure that we do not have further slips in the CEV, is—it is vital that we maintain the funding for the exploration systems. The fiscal year 2008 is a pivotal year. If we do not quickly come to grips with the funding problems and the gap in the human space flight capability extends even further than currently planned, I believe we face the risk of losing our young and talented workforce to other industries. We must focus on maintaining funding for exploration, because without some expectation of certainty in the program, people will either choose or be forced to leave the industry.

But today, unlike the late 1960s and early 1970s, we now face increasing competition from China, Russia, India, and others, countries that may have agendas very different from our own. An extended gap in America's space flight capabilities could lead to an erosion of our workforce and our industrial supplier base, and I am very concerned about this.

So my question, Doctor, do we risk more than loss of jobs as a result of an extended hiatus? Do we risk losing our technological leadership in a vital industry as well? If we start to lose our workforce, do we run the risk of increasing the gap further, because we don't have the talent we need to get the job done?

Those are a number of questions, but can you provide us your views on that subject?

Dr. GRIFFIN. Yes, sir. I think it is clear to all those who are in or who observe the high technology sector of this country, of which, of course, space exploration and development is one, that if—that the best people tend to go where the emphasis is clearly being placed. And I do worry that if we appear to have an unfocused space program that we will lose people. And I consider that to be an issue. So that was your last question, but I will answer it first. It does concern me very greatly.

To your—to the point of your other questions, I have said many times, beginning during my confirmation hearings, that I believe that the American space program is one of this nation's strategic assets in the world. It is one of the things that distinguishes us, sets us apart from, and frankly, sets us above many other societies. Our ability to do things that other people can only dream about matters. It matters greatly. And when we compromise it, we compromise our nation's position in the world. I believe that.

When we terminated Apollo and initiated Shuttle, then, as now, we didn't have the money to do those two things together, so there was a six-year gap that developed out of what was originally planned to be a two-year gap in human space flight capability. Programmatic slips took care of the other four years.

Today, at a comparable state in the program, we are looking at a now nearly five-year gap in human space flight capability, but it is at a different time. In the 1970s, we had one competitor, the then-Soviet Union, and in what was viewed as a race to the Moon, we had won.

In today's world, energy dollars are flowing into Russia. Russia loves its space program, as they should. They have kept it despite tremendous exigencies, and they have supported it. The Chinese

now have the capability to put people in space. India has announced its intentions to join the Chinese. Other nations could do it, if they chose to, as a matter of political will. They certainly have the capability and have the money.

So I fear for our nation's posture as a nation among nations when we allow this capability to be mitigated or damaged in any way, which is why I have urged full support for the President's budget so that we can minimize any disruptions. There will be disruptions, but I would like to minimize it.

Mr. HALL. Mr. Chairman, if he has a half a minute left, could I ask the gentleman a question?

Chairman GORDON. Absolutely.

Mr. CALVERT. I will yield all my time to you, Mr. Chairman—or——

Mr. HALL. You know, I think you were here when we lost the supercollider with X billions of dollars into it. And when it came time to reauthorize it, they asked for—it is my best recollection it was $600 million to keep it going. And we had $200 million for them. And because they thought they could force Congress into keeping that program alive, and they should have been able to, they weren't able to, and they held on to demanding what they had when $200 million would have kept them alive and we would still have a—we would be having it operating by now and be a leader in the technology fields of the world. We have a hole in the ground there now and a huge amount of money spent. I think we ought to learn from that and support this program and support it the way they set it out and pull our hat down over our ears and ride this thing out.

Mr. CALVERT. Thank you, Mr. Hall.

Chairman GORDON. Mr. Lampson is recognized for five minutes.

FUNDING NEEDED TO MAINTAIN CEV/CLV

Mr. LAMPSON. And thank you, Mr. Chairman, and welcome, Dr. Griffin. It is a pleasure to have you here. It is always nice to see you.

And I have to make a comment about the opening remarks of all our colleagues and how I want to associate myself with what everyone said. I think that this is a wonderful opportunity for this committee to make a big difference right now because of the unity that we do have. And I look forward to working with you.

I am proud, also, to serve for—to serve as the Representative of the Johnson Space Center, and I can't think of anything that is as important, not just to that area of Texas where Johnson Space Center is, but that NASA is to our nation, as Mr. Hall was just now saying. So it is a pleasure, always, to consider these problems that we face and see if we can't find the right ways to address them. I certainly want to.

Your prepared statement notes that previously under-estimated costs to retire or transition to Space Shuttle and to support the International Space Station, the reduce—the reduction from the fiscal year 2007 request reflected in the fiscal year 2007 Continuing Resolution and the maturing design and integrated flight test baselined for the Constellation program have affected the ability to deploy Orion in areas by 2014. And in previous testimony to the

Senate Subcommittee on Space, Aeronautics, and Related Sciences, you remarked that the CEV/CLV program will slip to 2015, and you just said it again just a minute ago.

What is the bottom line of dollars, the additional funding that NASA needs for 2008 to maintain the 2014 CEV/CLV launch date?

Dr. GRIFFIN. I answered that question, for the record, for that Senate testimony to which you refer, and I will give you the same answer here. What we—the funding we would need to return the Orion and Ares systems, CEV, to a 2014 capability is not needed in 2008. It would be needed in 2009 and 2010. And the funding requirement would be $350 million in 2009 and $400 million in 2010. Okay. So that is the direct answer to your question.

Mr. LAMPSON. Okay. Thank you.

And the effect—what effect will slipping the date, if we don't do that of the first operational—the initial operational capability the first crewed launch have on the nature of existing contracts for the Constellation program?

Dr. GRIFFIN. Well, we are obligating money, of course, now on the contract, the existing contract, to—for the CEV, so if we do not in fiscal year 2009 and fiscal year 2010, and bear in mind that we are—we start next month to prepare the budget for fiscal year 2009. It is not as far away as it sounds. So if we, in fiscal year 2009, do not obligate additional money to buy back that schedule, then the date, as we currently project it, with no further reductions, would be March 2015.

Mr. LAMPSON. And that will, ultimately, further drive up the cost, overall, of the project.

Dr. GRIFFIN. Well, lengthening the program certainly does drive up the out-year's cost, of course. Yes, sir.

Mr. LAMPSON. Are you confident that NASA now understands the costs required to retire or transition Space Shuttle, support International Space Station, and accommodate the design and integrated flight tests for the Constellation program?

Dr. GRIFFIN. I am. When I came into this position, and I think very understandably, a decision had been made to retire the Space Shuttle in 2010 and to move on with a new system. And not everyone agreed with that, but I think the balance of the community of people who are concerned about space flight agreed to that. And Mr. Gordon, you and I have talked about that. We need—the Space Shuttle will have been in service by that time. We need to move on. But—for 30 years by that time. We need to move on, and we are moving on.

Now what had not been done was to properly allocate the costs necessary to fly the Shuttle out until 2010. That—you know, it is difficult to calculate what it is going—what is going to be needed to fly out and retire a complex system like that. So we had placeholder estimates in the budget when I came in the door. We spent a good chunk of 2005 trying to refine those estimates, and we have. And I am confident that we have the right estimates to finish out the Space Shuttle and Space Station program, completing it by 2010.

Mr. LAMPSON. Thank you very much. My time has expired.

Thank you, Mr. Chairman.

Chairman GORDON. The gentlelady from Arizona, Ms. Giffords, is recognized for five minutes.

BUDGET PRIORITIZATION PROCESS

Ms. GIFFORDS. Thank you, Mr. Chairman.

Dr. Griffin, good to see you. Thank you for being here today.

Dr. GRIFFIN. Good to see you again, Ms. Giffords.

Ms. GIFFORDS. I represent the University of Arizona, and one of the interesting things that comes up all the time is this balance between your job, in terms of manned space flight compared to research. And I know that there is great concern on behalf of astronomers and scientists, and I just think about how difficult it is to be in your position, trying to balance a budget with very different objectives.

So could you please address the Committee on how you make those determinations in this time of a shrinking budget?

Dr. GRIFFIN. Well, these are not solely my determinations. It really is a community effort. I would tell you directly that science today, at NASA, all of science, is 32 percent of our budget. In the early 1990s, science was 24 percent of our budget. In the Apollo era, science was 17 percent of our budget. So science has grown within the agency. In the Apollo era, human space flight was 63 percent of our budget. It is 62 percent of our budget today. So human space flight has remained, across decades, a remarkably stable fraction of our portfolio, and science has grown. It is, in my judgment, doing well. It is at a historic high, in terms of its fraction of the NASA portfolio.

Within science, how do we prioritize? Well, we have four major science portfolios: astrophysics; heliophysics, the study of the sun and the solar system, space; Earth science; and planetary science. And while those four portfolios are not identically equal in their funding, we try to balance them carefully. And so astrophysics has a good share of the portfolio but doesn't get the whole thing, just as in my response a few moments ago about Earth science. So within the astrophysics portfolio, one of four, we take our priorities for missions to be done from the Decadal Surveys.

Currently, number one on the Decadal Survey for astrophysics is the James Webb space telescope, and we are pushing that. Number two is SOFIA. We are pushing that. We hope to get both of those programs down the line and open up a new funding wedge in astrophysics by 2009. And whatever the next new astrophysics mission is, starting in 2009, it will come from the community of astrophysicists in accordance with what they judge to be the most important mission at the time that decision has to be made.

Ms. GIFFORDS. Thank you for that.

EDUCATION

And, Mr. Chairman—Dr. Griffin, in terms of this 2006 National Academies report, it stated that, you know, in terms of technology products or projects that, you know, basically that science not being enough, and you couple that with the testimony we had a couple of days ago in terms of *"Rising Above the Gathering Storm"* and us not producing enough engineers and mathematicians and sci-

entists. And I believe that NASA is in a unique position, because there is really no way to get kids or young people excited about science like space and exploration and, I mean, this ability to go to places that we have never been before. How do you—when you look at your overall projections in terms of your workforce, how do you figure into educating young kids, getting kids invited? I mean, how does that figure into your budget in terms of how much allocation you can spend on that next generation and educating the sort of next group of future scientists?

Dr. GRIFFIN. Well, our primary mission, of course, is to conduct space missions of all kinds and aeronautical research missions, and I mean, that is what we are paid to do, not to determine educational strategy for the Nation. It is, of course, in the role of executing space missions that I think we have our highest value, which is to provide stimulating intellectual content and fascinating things that kids can aspire to work on when they grow up. When I was a child, I was fascinated by space from the age of five years old onward. So I understand that feeling that you talk about that nothing excites kids like space flight.

Specifically, to education, we are spending about $150 million a year on specific education-oriented enterprises. Now that will be reduced, somewhat, in respect of the fiscal year 2007 Continuing Resolution, but our 2008 budget and beyond contains about $150 million a year specific to educational outreach activities. In addition to that, our science missions, when we do them as well as our human space flight missions, have money set aside for Education and Public Outreach, E&PO, we call it. The total amount that NASA spends on educational activities of one kind and another is several hundred million dollars a year. I think that is generous.

Chairman GORDON. The gentlelady's time has expired.

I was—I knew you were going to be able to work in Arizona some way, but you were creative today. We are going to have an oceanographic meeting soon, and so that is going to be a challenge for you, but I know you will—somehow, you will find a way to get Arizona, and you do every time.

Mr. Calvert, I understand, has some additional questions. He is recognized for five minutes.

Mr. CALVERT. Well, if global warming does occur, we may flood California, and Arizona will be——

Dr. GRIFFIN. Or a sufficiently big earthquake.

Mr. CALVERT. Or—that is right. We could—I remember there was great book written in the 1970s or the 1960s, actually, about California falling off a cliff. Hopefully, that doesn't happen.

STATUS OF CHINA'S SPACE PROGRAM

Mike, I want to kind of carry on a question I had earlier about the competition we have out there. You know, I used to be in the restaurant business. I used to look across the street and look at what my competition was doing and have a better menu and try to get customers through the door. And obviously, China may have different reasons why they are getting in the space business, as we saw with the ASAT demonstration recently, which I understand they managed to clutter up outer space by, what, about 10 percent

more space debris than what we had previously. So that is a problem we are going to have to endure with.

How far is China—you have been to China, and you have seen their program? How good is their space program? And more specifically, do you think they have an opportunity to get ahead of us? Do you think they have an opportunity to even get to the Moon before we do, because the American public would probably like to know that?

Dr. GRIFFIN. Well, China, of course, has engineers and scientists second to none, and they graduate more of them than we do. When you have a chance to interact with Chinese engineers and scientists, it is abundantly clear that they need to—take a back seat to no one. And China is—if their statements are to be believed, and they tend to have a record for saying what they intend to do, and then doing it, if their public statements are to be believed, they have the equivalent of about 200,000 people working on their space program. Just for reference, our NASA funding purchases the equivalent of about 75,000 people. So in terms of—I can't talk about it in terms of dollars, because the two economies are so different, but if you talk about it in terms of the level of effort that they are able to bring to bear, and if you believe their statements, and I don't have any reason not to believe them, because they have repeated them a number of times, then their magnitude of their space effort is about three times as big as ours in terms of the number of people.

Now, they are starting from a position well to our rear. I mean, their human space flight capability is—I would characterize it as being approximately equivalent to that which we had during Project Gemini in the mid-1960s. They can put two or three people up in orbit. They are proceeding carefully. They are—their intransient capability of their equipment is a little bit better than what we had during Project Gemini at the time, but its accomplishments so far have been about at that level. I would remind you that, for us, Project Gemini was only a few years before Apollo when we went to the Moon. So—and the Chinese economy today, in real dollars, is about twice as big in constant dollars as the U.S. economy was when President Kennedy declared the lunar goal.

So as a matter of technical capability and political will, if the Chinese choose to do so, they can mount a lunar mission within, you know, a reasonable number of years, say a decade. That would easily—be easily possible for them to do. I cannot speculate and won't speculate on what Chinese intentions are. I just don't know that. As to capability, within some reasonable number of years, if they wish to mount a lunar mission, they could do so.

FUTURE MISSIONS AND FOREIGN ABILITIES

Mr. CALVERT. At the present time, based upon the schedule that we have to have our new CEV and Ares program on track, what is the soonest that you think we could get back to the Moon?

Dr. GRIFFIN. Well, that is a question that I—is difficult to answer unless one associates it with a funding level. At our present funding level, we will return to the Moon around 2019.

Mr. CALVERT. So based on that, it is possible that the Chinese could get to the Moon before we do?

Dr. GRIFFIN. Of course. Yes, sir. It is possible that they could be there before we return.

Mr. CALVERT. On low-Earth orbit, on cargo delivery in a low-Earth orbit, obviously, we are retiring the Shuttle in 2010, how long will the—do you believe, in 2010, that the Russians are going to have a monopoly in low-Earth orbit in the sense that they will be able to deliver the cargo to us? Or are we going to have any other opportunities to buy that service from someone else?

Dr. GRIFFIN. Right now, it cannot be said whether the Russians will have a monopoly or not. They do today. By 2010—but after 2010, as you mentioned, we have some other possibilities. We have initiated, as you know, two COTS demonstrations, Commercial Orbital Transportation Service demonstrations, to which we have allocated half a billion dollars a year in—or half a billion dollars, total, in seed capital. Now this is not intended to cover the total development costs. It is money offered as seed capital for—to attract—to allow entrepreneurial firms to attract the total capital necessary to provide that service. We believe such efforts have a good chance of succeeding and that, if they do, they will be able to offer service considerably cheaper than we can buy it from established providers, and if it matures, believe me, we will take advantage of it. In fact, I think it may be said that we need for those efforts to be successful.

So there are those possibilities. But by the nature of a commercial transaction, which is conducted at arm's length, this is not under the government's, or NASA's, control. We are providing seed capital. We are offering all help, if asked for, but we are not interfering with how these companies go about their business. There are—by the post-2010 timeframe, there will be—we also will be close to having capability from the Japanese HTV and shortly thereafter the European ATV for cargo services. Those, of course, will be expensive. They will not allow for crew rotation. And although they are—as with the Russians, they are in partnership with the United States on the Space Station program, still, they are not indigenous providers.

Chairman GORDON. The gentleman's time has expired.

Mr. CALVERT. Thank you.

Chairman GORDON. We are going to go a little bit out of—well, either in order or out of order, and—since Mr. Rohrabacher has not had a chance to ask any questions, and then we will—and then I think Mr. Udall wants to complete some questions that he had earlier.

So, Mr. Rohrabacher, you are recognized for five minutes.

Mr. ROHRABACHER. Well, thank you very much. And I apologize for being in and out.

GLOBAL WARMING AND NEAR-EARTH OBJECT BUDGET PRIORITIZATION

Mike, you are doing a great job. It is a tough job, as everybody has said. Sometimes Congress actually makes it a little tougher by—basically, everybody is insisting that we balance the budget, but nobody wants to make decisions here, and then everybody wants to complain when you make decisions.

Your job——

Dr. GRIFFIN. I have noticed that, sir.

Mr. ROHRABACHER. Right. I used to be a speechwriter for the President, and invariably, the leadership would come to me and say, "Look. This speech is way too long." And I would say, "Okay." And they said, "And by the way, we want you to add this, this, and this to the speech." So you have a very similar problem.

It is up to us to prioritize. And I know that you have had to prioritize, and you have done your very best job at it. And we can't just expect always to say, "You are not spending enough money," and then expect just to—well, we will just add more money. Well, maybe we need to prioritize what programs are worth spending the money on and give you some help in that.

Let me note, for the shortfalls that we have had, that of the billions of dollars that we have spent over the last 10 years, perhaps as much as $5 to $10 billion, trying to prove global warming, not to do anything about it, but to prove it. The NPOESS catastrophe and the waste of those billions of dollars, and some of that can be traced back to trying to overload that satellite with missions dealing with global warming, which may or may not exist, and—which leads me to my question, my first question, which is, I read a recent report by NASA that showed that the polar ice caps were melting and that there is, indeed, warming going on on Mars. Is that right?

Dr. GRIFFIN. I did see the brief synopsis of the same report.

Mr. ROHRABACHER. Right.

Dr. GRIFFIN. So yes, sir.

Mr. ROHRABACHER. So there is global warming on Mars.

Now my question is, then, does that mean that the warming trend that we have here may be caused by sunspots and solar activity, or does it mean that there are—is human-like activity going on on Mars that is causing their temperature to warm?

Dr. GRIFFIN. I—the——

Mr. ROHRABACHER. You don't have to answer that. It is——

Dr. GRIFFIN. Okay. Thank you. Thank you.

Mr. ROHRABACHER. Now my second question, the one thing I want to focus in on, I have also read your recent report on a project that I helped try to kick off, which is a survey of near-Earth objects that might hit the Earth. Here, again, let me note that it was a professional report. I really appreciated the job that you did and that your team did. You did a very professional analysis of where we go to catalog near-Earth objects that might threaten the Earth. Your report concluded that, you know—what the threat was and how we had to—how much needed to be identified, but it also concluded that we didn't have the money to do that.

Now, let me note, unlike my other colleagues, I will just say that is my priority project, but I do fully understand your answer to that. And if we are going to deal with this, the potential challenge, I understand that there is a one in 62 chance that, in my lifetime—no, of a lifetime of a baby born today, that there will be a huge impact on our Earth of a near-Earth object that would kill millions of people. Now one chance in 62. And it seems to me that we should at least be moving—inching forward and that when we try to prioritize our various spending programs, that that should be

part—you know, that type of long-range thinking should be part of the process and should be one of our goals.

And I want to thank you for that report and thank you for the good job you are doing. And I just would suggest that of the $5 to $10 billion that we have spent trying to prove global warming, perhaps if we would have spent only $500 million, which your report states, we would have a full understanding of the potential threats of near-Earth objects that might hit the Earth and cause catastrophic loss of life. And that is the type of prioritization that I am talking about that we need to do. Now I understand that global warming is politically-trendy, et cetera, but we, in here, in Congress, you know, we don't have money to spend on everything, and we should—when we have a choice between spending it on something that we can't do anything about, global warming, even if it does exist, even if it is one of those trends that go up and down over the years with sun spots, like is happening on Mars, but if we can't do this, wouldn't it be better to spend our money on trying to catalog near-Earth objects and find a method of maybe deflecting one off its path towards the Earth if we had that opportunity—that chance to do so?

So with that, if you wanted to comment, that is fine, but I sure appreciate your job and the things that I have mentioned today, so thank you.

Dr. GRIFFIN. Thank you.

We——

Chairman GORDON. The gentleman's time has expired, and I think I can help Mr. Griffin here. We have had a lot of, I guess, bad news discussion about our economic bad news discussion, but there is one good news, and that is NASA does not have to spend any more money proving global warming. It has already been done.

And now the Chairman recognizes Mr. Udall for five minutes.

Mr. UDALL. Thank you, Mr. Chairman.

I want to propose to my good friend, Mr. Rohrabacher, that if he is willing to acknowledge that we don't need to prove the global warming theory anymore, we just take all that money and put it to applications that would address the problem, including energy independence and new technologies. And let us quit all the studying and just agree that climate change is upon us and begin to do what we need to do.

Dr. GRIFFIN. I would be happy to hold your gentlemen's coats if you wish to go at it.

ITAR

Mr. UDALL. Doctor, turning to another topic that I think concerns all of us, and that is ITAR, the Space Station Independent Safety Task Force raised questions about NASA's ability to interact with our international partners. If I could, I would like to direct a series of questions at you and then let you take your best cut.

How serious has an issue, as ITAR, been for the ISS? What are your plans for handling those restrictions? What is your timetable for resolving any outstanding issues with ITAR? And are you making changes to any other missions or mission plans as a result of these restrictions?

And I apologize for the machine-gun nature of those questions, but I think they are all related, obviously.

Dr. GRIFFIN. Well, they are.

It is a—let me say yes, ITAR is a concern for Space Station partnerships, as well as any other international partnerships that we attempt to conduct in space activities. And I would remind that our entire human space flight program is involved in an international partnership and well over half of our scientific missions are conducted in the context of international partnerships, so it can be difficult.

The difficulties are of two types. One is the length of time necessary to get ITAR approval to conduct even the government-to-government programs, which can easily be on the order of 18 months or more, from my own personal experience. And then the other thing, of course, is the question of whether or not the partnership will be allowed and the restrictions that are placed on the transfer of information.

The biggest concern that I have about it is that we oftentimes end up excluding ourselves from the global marketplace in aerospace and aerospace science because of those restrictions in a way that I think keeps American industry out of the world, the world market for these goods and services, and which does not, in the long run, of course, achieve the goal of protecting our security interests, because other nations will develop these capabilities on their own.

So, I have those concerns.

Now, our plans for dealing with it, we are a federal executive agency, and, of course, I follow the directions that have been put in place by the Congress and the Administration in response to the legislative environment, so we really do not have a significant voice in ITAR and export control. We comply with the regulatory environment that exists, and we work very hard to make sure that we are in compliance, because the difficulties of not being in compliance are hard to overstate. So my plan is that I comply with the ITAR regulations.

Mr. UDALL. Clearly, if I could make an editorial comment, we have more to do in this regard, and I think the Committee needs to spend some additional time understanding the unintended consequences of ITAR, and I couldn't agree more that we shut ourselves out of global marketplaces, and——

Dr. GRIFFIN. This was a topic that the Defense science board attempted to take on and—recently, and then I believe they had to cease because of conflicts of interest in and among their membership, but the fact that the Defense science board chose to take it on, I think, speaks volumes.

IMPACT OF REDUCTIONS ON SHUTTLE USE AND WORKFORCE FLEXIBILITY

Mr. UDALL. If I could, I would like to turn to the—back to the Shuttle and talk about the STaR reductions with which I think you are familiar.

If you could discuss, and I see the time is beginning to run down, but you may have to do some of this for the record, the impact of those reductions and your plans for assessing the appropriate num-

ber and mixture of skilled workers needed to safely fly the Shuttle through 2010 and then to transition to the CEV.

Dr. GRIFFIN. Let me get that for the record for you. Our transition is something we work, literally, every day. We discuss it with our Aerospace Safety Advisory Panel that reports, also, to you, they have talked about that with you, and with our NASA Advisory Council. I think that most people believe that we are really going at this, that it is a hard problem, and that we are doing fairly well. But we will give you an answer for the record.

MATERIAL REQUESTED FOR THE RECORD

The Space Shuttle Transition and Retirement (STaR) provides funds to ensure successful ISS operations post-Shuttle retirement. It does this through the purchase of additional spares and by realigning costs in several areas that are currently jointly funded with Shuttle, such as Mission Operations Directorate, Flight Crew Operations Directorate, and flight crew equipment. The new sparing philosophy involves buying more spares. The old plan had the failed units returned from the International Space Station (ISS) repaired on the ground and then returned to space.

The FY 2008 President's budget request provides $187 million for STaR in FY 2008, but reduces the five-year budget for STaR from the previous estimate by $270 million in favor of other higher-priority elements of the ISS program and other high priority Agency goals, particularly TDRSS replenishment satellites. The $270 million cut is achieved by reducing STaR reserves by $99 million from previous estimates and by creating a management challenge to reduce the Space Station's operations cost by $172 million through FY 2012 by finding efficiencies and reducing requirements and overall operating costs, including STaR. The resulting cost savings will be used to improve the Program's reserve posture and offset management challenges as needed.

As the Constellation System Requirements Reviews are completed this year, NASA will gain a much clearer understanding of the demands for future workforce skills, which will form the foundation for making any future decisions. Although proud of recent progress, NASA acknowledges that more needs to be accomplished. These tasks include matching available skills with future work, managing attrition, retraining and hiring, and using temporary and term appointments to get the flexibility to align agency needs with the time-phased workload.

The nature of the work many NASA employees will do will change as we transition human space flight activities from Shuttle operations to research and development-focused activities like planning, design, testing and verification for Constellation systems. NASA is striving to give its employees opportunities to build on their existing skills by working on the new exploration systems, so that when this development work comes on-line, many of them can transition into new positions. Coupled with newly gained skills, the NASA workforce can take the skills honed in Shuttle operations and apply them to the design of future vehicles to make them fly more efficiently. From a human resources perspective, the transition of these key personnel must be carefully managed given the time between Shuttle retirement and Ares/Orion operational capability.

In order to complete the remaining Shuttle missions safely, retention of the NASA workforce, with their skills and tremendous dedication, for the duration of the Shuttle program is critical. A recent survey of Shuttle personnel across the NASA field Centers clearly demonstrates that NASA has highly motivated people who want to stay for the remainder of the program and see it succeed.

Mr. UDALL. With the Chairman's indulgence, if I could ask two more questions for the record, I would appreciate it.

Chairman GORDON. Certainly.

Mr. UDALL. In that regard, too, would—if you would comment, for the record, about any legislative tools you might want to—in regard to the workforce flexibility that you may or may not need when it comes to the star reductions. And if, in fact, you do need some tools, when they might be delivered—that request might be delivered to the Congress.

MATERIAL REQUESTED FOR THE RECORD

On March 28, 2007, NASA provided the *NASA Transition Act of 2007* to the Congress for consideration. The proposed legislation would provide NASA with flexibilities essential to the successful implementation of our programs in space exploration, scientific discovery, and aeronautics research, including the International Space Station Program's Shuttle Transition and Retirement (STaR) project. Title I provides two workforce management tools.

The first authority would be used to encourage employees who are working on the Space Shuttle Program to convert to time-limited appointments that correspond to major milestones in that Program (or Program completion), enabling the Administration to plan the Shuttle workforce transition with more precision.

The second authority would add a new category of employees who would be liable only for the employee share of Federal Employee Health Benefits Program (FEHBP) premiums if they elect temporary continuation of health benefits coverage upon separation from their civil service positions. This would include surplus employees at NASA who are involuntarily separated due to reduction-in-force or because they declined a transfer, or surplus employees who are identified as occupying positions that are anticipated to be eliminated under reduction-in-force procedures. By authorizing NASA to pay the government's share of the FEHBP premium for employees who separate because their positions are being eliminated or transferred out of the commuting area, the Agency would provide a "soft landing" benefit to employees who desire continued health coverage while they seek other employment and are not otherwise eligible for FEHBP coverage without paying the full cost of the premiums.

The second question I have for the record is one that I think has been on many people's minds, and I know you have—feel it at other times, Dr. Griffin. But this has to do with the NASA mission statement. And in the previous statement, there was a clause in there "to understand and protect our home planet", and that clause was eliminated in the current mission statement. And there has been a lot of speculation about why, and was there any message that was intended to be sent by doing so.

And I do know my time is expired, but I would like an answer for the record.

MATERIAL REQUESTED FOR THE RECORD

The 2006 NASA Strategic Plan clearly states that one of our goals is to, "study Earth from space to advance scientific understanding and meet societal needs." The plan goes on to discuss the importance of current Earth science missions and those we wish to conduct over the next decade. A mission statement that calls upon NASA to pioneer the future in scientific discovery—as ours does—includes Earth science within the realm of scientific discovery.

Deletion of the phrase "protect our home planet" from the 2006 NASA Strategic Plan brought it into alignment with our statutory responsibilities and actual capabilities.

This past year was truly remarkable for science discovery about the Earth, Sun, solar system, and universe. In April 2006, the launch of the CloudSat and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) spacecraft added to the "A-train" of satellites flying in close proximity around Earth to gain a better understanding of key factors related to climate change. In May 2006, NASA launched the GOES–O satellite. NASA also recently launched five Time History of Events and Macroscale Interactions during Substorms (THEMIS) microsatellites to study the Earth's magnetosphere.

The Earth Science budget for FY 2008 requests $1.5 billion, an increase of $32.8 million over the FY 2007 request, to better understand the Earth's atmosphere, lithosphere, hydrosphere, cryosphere, and biosphere as a single connected system. This request includes additional funding for the Global Precipitation Measurement (GPM) mission to improve schedule assurance in response to the high priority placed on GPM in the Decadal Survey. As the follow-on to the highly successful Tropical Rainfall Measuring Mission, NASA's plans to launch GPM's first Core satellite no later than 2013, followed by the second Constellation spacecraft the following year. The Earth Science budget also includes increased funding for the Landsat Data Continuity Mission and Glory in order to help keep them on their schedules, and provides funds for the National Polar-orbiting Operational Environ-

mental Satellite System (NPOESS) Preparatory Project (NPP) to reflect instrument availability and launch delays. Funds are requested for continued development and implementation of the Ocean Surface Topography Mission to launch in 2008, the Aquarius mission to measure the ocean's surface salinity to launch in 2009, and the Orbiting Carbon Observatory mission planned for launch in 2008. NASA will continue to contribute to the President's Climate Change Research Initiative by collecting data sets and developing predictive capabilities that will enable advanced assessments of the causes and consequences of global climate change.

Dr. GRIFFIN. I will give you an answer, for the record, but briefly, NASA does not have the tools to "protect our home planet." We seek to understand our planet and all others, and the revised statement reflects that, but NASA is not a protection agency.

Mr. UDALL. Congressman Rohrabacher thinks you have the capacity to protect our home planet, particularly when it comes to asteroids, and I do have to associate myself with his concerns. I think there are very legitimate concerns about asteroids.

Dr. GRIFFIN. As do I.

Mr. UDALL. But thank you for the forthcoming way in which you have shared your point of view with us today, and again, I want to add my voice to those who believe you are doing an outstanding job. And it is our job to get you additional resources.

Dr. GRIFFIN. Thank you, sir.

Mr. UDALL. Thank you.

Dr. GRIFFIN. Thank you, sir.

Chairman GORDON. Yeah, the gentleman's time has expired. I will suggest that providing good information for us to adapt to threats, whether—whatever form they might be, is a form of protection.

And I think that we see that Dr. Ehlers has arrived. The gentleman is—has five minutes, if he so chooses.

Mr. EHLERS. Thank you, Mr. Chairman. I apologize, I am bouncing between three different committees here, so I can't ask a question of extreme intelligence, but I first want to thank you, Dr. Griffin, for your good work. It is always good to have a steady hand at the helm, and sometimes that is a little infrequent in the scientific—pardon me, in the governmental arena. So we appreciate you doing that.

Also, just picking up on this last comment about the asteroids, there is, of course, a probability that one will hit the Earth at some time. They have hit the Earth in the past, but I have to confess, I worry far more about nuclear weapons than asteroids. I just think the probability of improper human behavior is still, unfortunately, greater than the random probability of a heavenly body running into us. So I guess we have to take our pick as to which is most important.

SPACE STATION RESEARCH AND STATUS

I—just a question, an iconic, classic question about the Space Station. Is any significant research being done there, anything that is essential to the ongoing efforts of going to the Moon or to, some time in the distant future, Mars? Is there good reason to keep it going? And if so, for how long should we keep it going?

Dr. GRIFFIN. Peer-reviewed scientific research is now coming out of the Space Station. I can cite examples, for the record, if not off the top of my head.

MATERIAL REQUESTED FOR THE RECORD

The International Space Station (ISS) is NASA's long-duration test-bed for lunar missions as well as a flight analog for Mars transit. The six-month ISS mission increments are temporal and operational analogs for Mars transit. NASA is using the ISS as a laboratory for research that directly corresponds to the Agency needs summarized below:

1. Research, Development, Test, and Evaluation of Biomedical Protocols for Human Health and Performance on Long-Duration Space Missions.
2. Research, Development, Test, and Evaluation of Systems Readiness for Long-Duration Space Missions.
3. Development, Demonstration, and Validation of Operational Practices and Procedures for Long-Duration Space Missions.

NASA also utilizes the ISS for non-exploration-related life and physical science research when the uniqueness of the microgravity and space environment unmask phenomena that cannot be observed or studied in the normal Earth environment.

ISS international collaborations provide valuable insights into how our Partner countries approach building, operating, and maintaining spacecraft. As such, 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 missions. International collaboration allows for leveraging of data and resources to obtain answers for critical research problems.

Since the start of human occupation of the ISS in November 2000, there have been 17 NASA Human Research Program investigations with the ISS-based portions of their research completed, supporting the research of 44 investigators worldwide. Presently 16 Human Research Program investigations are ongoing on the ISS supporting 49 investigators worldwide. Over the next 12 months, NASA plans on conducting nine additional ISS Human Research Program investigations supporting 25 investigators worldwide.

Research and technology experiments have been, are being, and will continue to be conducted on the ISS in the areas of Human Research, Applied Physical Science Research, and Technology Demonstrations in support of space exploration.

For a complete list of ISS experiments and for further information see the following websites:

http://exploration.nasa.gov/programs/station/list.html

http://exploration.nasa.gov/programs/station/expedition.html

http://exploration.nasa.gov/programs/station/publications.html

http://ston.jsc.nasa.gov/collections/TRS/listfiles.cgi?DOC=TP-2006-213146

http://hrf.jsc.nasa.gov/science.asp

http://exploration.grc.nasa.gov/Exploration/Advanced/ISSResearch/

Future ISS research beyond the above will consist of the following:

- Human research content that will be documented in the Human Research Program Integrated Research Plan. This plan, to be published in December 2007, will consist of content informed by the Office of the Chief Health Medical Officer crew health standard requirements and Constellation Program needs.
- Physical science research content that will be documented in the Physical Sciences Strategic Plan for use of the Combustion Integrated Rack, the Fluids Integrated Rack, the Microgravity Materials Research Rack, the Microgravity Science Glovebox and the Expedite the Processing of Experiments to Space Station Rack—ISS Utilization from 2010 and beyond. This plan will consist of content informed by National Research Council study recommendations for research and technology supporting space exploration and Constellation Program needs.
- Technology demonstrations that will be informed by the Constellation Program needs.

As we—and I—again, I would remind everyone that we are still assembling the Space Station. It is only 55 percent complete.

Mr. EHLERS. Now that is my next question. Is——

Dr. GRIFFIN. And that——

Mr. EHLERS. What——

Dr. GRIFFIN.—several—I mean, the European laboratory, to which we have some access, and the Japanese laboratory, to which we have some access, have yet to be in place. The European laboratory and the first of the Japanese flights will be later this year. So we are still building the Station, and its full capability as a research laboratory is mostly in front of us. But we can't have a research laboratory until we get the power and the water and the air conditioning fully in place. And that is what we are doing right now.

How long should the Space Station be sustained? I believe it should be sustained as long as the costs of its operations and maintenance, once built, as long as the cost of its operations and maintenance seem to be justified by the research, which is being returned, then I think the case can be made that it should be retained.

We have already committed to the cost of building it. The cost of building it is largely sunk. The cost to complete is the cost of finishing the Space Shuttle program out to complete the flights. The equipment is built. It is largely sitting at Kennedy Space Center, ready to be put on orbit. So ceasing the Space Shuttle program—the Space Station program today would save some money, but not much, and I think we should commit to its completion, as we have—as the President has done, on multiple occasions. And when we are done, we should use it in the fashion that we have planned. And as for when the time—again, when the time comes that we are not getting research worth the cost of its logistics, we will know that, and it will be time to cease its operation.

Mr. EHLERS. And is the Centrifuge going to be installed, or is—has that part been dropped?

Dr. GRIFFIN. The Centrifuge will not be installed.

Mr. EHLERS. And is there a particular reason for that? Is that a cost factor, or is it—is there—was there a problem with building it?

Dr. GRIFFIN. We are just out of Shuttle flights to deploy a Centrifuge, and that particular set of equipment didn't make the prioritization.

Mr. EHLERS. And then what happens when the—when you retire the Shuttle? Could you expect the CEV to be the—transporting personnel and equipment back and forth?

Dr. GRIFFIN. After we retire the Shuttle, for a period of about four to five years, we will be purchasing commercial cargo service from Russia as well as from other nations and, hopefully, from indigenous cargo providers in our own nation. We will be purchasing crew-rotation services from Russia and, I hope, commercial providers within our own country, but again, that is a commercial transaction, and it is not something that I can guarantee.

Mr. EHLERS. Right.

Dr. GRIFFIN. Right now, we are—actually, we are negotiating a definitive contract with Russia to provide crew rotation and cargo services out through 2012, through the end of 2011 until 2012, in accordance with legislative relief that the Congress gave us on the ISNA Act. After 2012, we will, of course, have to rethink that. In 2015, we will start flying the CEV, and if commercial providers are not available, we will use the CEV to conduct Station logistics, but

I have made it very clear that it is my intent that our provider of choice for crew and cargo is commercial services, if those can be brought into being.

Chairman GORDON. The gentleman's time has expired.

Mr. Hall is recognized for five minutes.

CEV PROJECTING AND BUDGET

Mr. HALL. Actually, on Mr. Udall's questions, maybe I was gone to vote or something, and you may have answered this. If you have, tell me. But there is some confusion about the answer to his question. When asked about the—when he asked about the delay in the CEV, it is my understanding that your answer was based on the CEV that was delayed until March of 2015. Now, somewhere, I understand that there has been a review at NASA, or new content, I guess, is the word that you used, that have added content, and they still have a launch of 2015, the same date, or maybe a couple of months on down. Now, let me finish.

Dr. GRIFFIN. Okay.

Mr. HALL. And that is the same date. So, I guess the question is, what was deleted to keep the 2015 goal? You added new tasks or new content, and the current fiscal year 2008 budget didn't support initial operating capability in 2014, and last month, you said NASA added important content to the Constellation program, including one test flight to check out orbital systems prior to flying astronauts for the first time. Of course, that is logical, and you will be making some slippages and some changes between now and 2015, I understand that. But what would be eliminated to keep the same date and, yet, there was a slippage?

Dr. GRIFFIN. I understand the question in the large, and let me, if—I think I can do this in five minutes.

Mr. HALL. Okay.

Dr. GRIFFIN. Let me take it from the top and sketch out the whole picture——

Mr. HALL. Okay.

Dr. GRIFFIN.—because I think anything less than a complete answer is misleading, and I just don't want to do that.

Mr. HALL. Yeah, and I have found out that they have taken from my money that I put in the budget, $15 million to study the safety features and $150 million maybe to keep it going, that they took $75 million of that out to put John Glenn back into space, and I found that out when your head of NASA came and sat right where you sit there and told us about his budget. But we would like to know ahead of time.

Dr. GRIFFIN. I am completely forthcoming on that point, and——

Mr. HALL. And I was for old people going into space, too.

Dr. GRIFFIN. Well, I regard Senator Glenn as a personal hero and a valued advisor, but we are not sending him into space again with your money. So let me take it from the top.

I will start at the endpoint. Today, we are sitting on March 2015 as our—as what we think our launch capability will be for the CEV with crew. We have not "added any new content" to the program. The way that I would say that is we have finalized, after a period of about 18 months of planning, and I think a certain amount of planning is necessary, we have finalized the content that the CEV

program should have, which test flight specifically, how many test flights do we need to do, what will each test flight attempt to do, and in fact, one of the discussions we have been having is upon which test flight will we demonstrate the abort system that you earlier expressed an interest in? But by and large, content adjustments have been, you know, quite minimal. What we are trying to do is to lay out the very specific program that we will fly to get from here to the delivery of the CEV. We have that.

That amount of program content comes with a certain cost.

Now, there have been a number of delays to our hoped-for delivery date for the CEV. Let me take a couple of the larger ones. When I sat here in 2005, two years ago, it was my hope that we could deliver a Shuttle-replacement capability, the CEV, some time in 2012, and we were attempting to do that. We laid out a plan by which that could be accomplished. We were not able to fund that plan. The first disruption to that plan was, as Chairman Gordon mentioned earlier, that it was necessary to put money into the Space Station and Space Shuttle. That—from exploration systems, that required about $1.6 billion, and that delayed us from 2012 until—and I won't be specific about the time, some time in 2014. There were rescissions for Katrina and other purposes. That delayed us. As Chairman Gordon mentioned, the amount of money projected to be available for NASA from the Administration decreased. That caused delays.

The sum of all of those different delays, all on our side of the House, all on the Administration side of the House, whether within NASA or not, pushed the program out to late 2014. At that time, it had been—well, we had never—we had not yet re-baselined the program since the contract had been awarded to Lockheed. And if you will recall in earlier testimony, I had said that we wanted to do our budgeting at a 65 percent confidence level in contrast to the lower confidence levels that had been used in the past, and I believed—I strongly believe I have the support of this committee in doing that.

So then we undertook our baselining activity to establish with the known program content and given the prior reductions in funding and inserting the 65 percent confidence level requirement what date would we—what date would fall out. The date, which fell out, was March 2015.

Now, hang on with me for just another minute more.

Following that, we then had to deal with the issue of the reduction in our planned funding, not an actual cut, but the reduction in our planned funding due to the 2007 Continuing Resolution. As I testified a few moments ago, when Mr. Udall or Mr. Gordon, I now forget which, asked the question, that specific delay was an additional six months. That, then, took us from March 2015 to September of 2015. Okay. Within my own resources, within the Exploration Systems Mission Directorate, we then terminated some lower—in our judgment, lower-priority activities in order to buy back some schedule for the higher-priority activity, which is the CEV. That, then, returned us to March of 2015, which is where we sit today.

So, to end up, we are at March of 2015 today, but I no longer have any latitude, at all, within my Exploration Systems budget,

to absorb any other funding reductions. There is no lesser-priority content left that I can extract from the program in terms of moving money around.

Now, that is a long story, and I am sorry. I hope—it was as clear as I can do it.

Mr. HALL. I thank you for that. And what I gather from that is that there was not any program or part of a program eliminated or delayed. The slippage was there, and it happened just as you have put it on the record.

Dr. GRIFFIN. I think that is right, sir.

Mr. HALL. He says you did say the robotic lunar——

Dr. GRIFFIN. I did. It is in order to——

Mr. HALL. Okay.

Dr. GRIFFIN.—achieve the best schedule on CEV, I did extract what I determined to be lesser-priority stuff, which was the robotic lunar lander that would have followed Lunar Reconnaissance Orbiter and certain advanced technology development.

Mr. HALL. So as much as the CR or that elimination, you are firm—you are pretty firm, as you can be—possibly be, at this date, on the date of March of 2015.

Dr. GRIFFIN. Right.

Mr. HALL. I thank you, and I yield back my time.

Thank you.

Dr. GRIFFIN. And the CR, by itself, was a six-month delay, but there have been other delays, and that is not the only one, and I don't want to leave the impression that it was.

I also must say, for the record, that we have certainly not eliminated lunar robotics from our vision. One of the most important things we are going to do with lunar robotics is to in—place the communications and navigation structure around the Moon that will tie it to the Earth-orbiting communications and navigation network, and that will be crucial for the out-years.

Mr. HALL. You have sure clarified it for me, and I hope it helps my friend from the west.

Dr. GRIFFIN. I have tried. It is very hard.

Mr. HALL. And I yield back. You have done very well, and I thank you for it.

Chairman GORDON. Thank you, Mr. Hall.

DECADAL SURVEY SUGGESTIONS

In conclusion, Dr. Griffin, as you know, there are a lot of folks that are interested in the Earth science application recent Decadal Survey. I understand that when you were answering a question, and I wasn't here, with Mr. Udall, that you weren't prepared to say whether or not—if you are going to do any of them, not do any of them, or what—which ones they might be. So when can we—when can you tell us that you will be able to give us an indication if you are going to do any of the missions? And if not—and then, but if you are, which ones?

Dr. GRIFFIN. Well, we are working——

Chairman GORDON. We have got spare time.

Dr. GRIFFIN. We are working on a couple of things on that, and I am trying to—I just want to get the plan. There—I have been before this committee to testify in connection with the NPOESS pro-

gram on other occasions, and with my colleagues Admiral Lautenbacher and Dr. Sega. But I believe this committee is aware that the climate change research that was previously planned to have been done on NPOESS as a result of the Nunn-McCurdy breach on NPOESS, that climate research instrumentation is largely now removed. Okay. NASA's—a few years ago, NASA's climate change research money was put toward the trilateral NPOESS program, so that money is now no longer in our programming. So at OSTP's request, we, along with NOAA, are prepared—we have analyzed the descoping of NPOESS, and now we are working to provide a report back to OSTP on how we, at NASA and NOAA, will undertake to conduct the climate change research. That report is due in May. We have commissioned a National Research Council study this—to—also for this spring, to assess that same question. Into this mix must go the input from the Decadal. And so, later in the spring, at most—well, when we receive these reports and then for us later in the summer, we should be able to provide this committee with an assessment, going forward, of how 2009 and beyond budget run-out will be modified to take into account the loss of climate change research on NPOESS and the new conclusions from the Decadal. Now, bear in mind that the fiscal year 2008 budget was prepared before the Decadal was out. And we did modify the fiscal year—we had a look at the Interim Report on the new Decadal from Earth science, and we did adjust funding on GPM to—you know, to take that into account, but the full effect of the Decadal, replanning it to the extent that it affects Earth science, won't be available in 2008. It will have to start in 2009 and beyond.

Chairman GORDON. That is a fair answer, and we look forward to your reporting us—to us on that.

And again, we thank you for your testimony, as always.

If there is no objection, the record will remain open for additional statements from Members and for answers to any follow-up questions that the Committee may ask of the witness. Without objection, so ordered.

The hearing is now adjourned.

[Whereupon, at 11:55 a.m., the Committee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Michael D. Griffin, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Chairman Bart Gordon

Q1. The recently released Final Report of the International Space Station (ISS) Independent Safety Task Force recommends an additional billion dollars to support post-Shuttle logistics. This recommendation reflects the Task Force's serious concerns for long-term logistical support *to the ISS (p. 43, ISS Independent Safety Task Force) and risks of depending on the COTS program [i.e., commercial logistics carriers] to support expected logistics requirements in the post-Shuttle environment.*

Q1a. What is your response to the concerns raised by the Task Force and the funding recommendation? Are the concerns valid?

A1a. NASA is taking the International Space Station (ISS) Independent Safety Task Force (IISTF) report seriously and is continuing to closely examine the logistics support needed to safely maintain and operate the International Space Station, as well as the potential cost, performance and availability of domestic and international space transportation systems during the post-Shuttle timeframe. At this time, many variables remain in our analyses, and this represents a program risk that we are actively managing and mitigating to the maximum degree possible. The IISTF report raises valid concerns that the Agency will continue to review. NASA is actively addressing this issue as part of our FY 2009 budget formulation and are developing a compatible budget and strategy that addresses these concerns.

Q1b. If COTS systems do not prove viable for ISS crew and cargo services, what will you do?

A1b. On March 1, 2006, in response to direction in section 505 (c) (2) of the *NASA Authorization Act of 2005* (P.L. 109–155), NASA submitted to the Committee an ISS Logistics Contingency Plan that outlines the Agency's plan to provide logistics and on-orbit capabilities to the ISS in the event of a contingency such as the Space Shuttle or other commercial crew and cargo systems being unavailable. NASA is committed to purchasing commercial cargo and crew services to support the ISS once these services are successfully demonstrated and cost-effective. Although commercial services are the strong preference, NASA could also employ Orion/Ares when it is available or purchase launch services from within the ISS international partnership.

Q1c. Do you believe you will have sufficient time to procure Russian Progress/Soyuz vehicles, European ATV vehicles, or Japanese HTV systems to cover these crew-cargo service requirements?

A1c. NASA is structuring the acquisition process to undertake procurement actions as late as possible in relation to the COTS demonstration program, while still preserving options that allow lead-time for alternative sources. NASA recognizes the implications of delaying cargo transportation services and is carefully considering the risk to International Space Station maintenance while taking all steps feasible to mitigate the risk.

Q1d. With the COTS uncertainty, how great a risk is there of not having a viable Station or having it shut down, due to inadequate logistical support?

A1d. It is not possible to predict a specific degree of risk with high certainty at this time. Each International Space Station (ISS) increment yields new data on system, subsystem and component performance and our analyses are continually refined with operational experience. The ISS Program is committed to delivering the highest performance possible within available resources. The contingency Shuttle flights play a key role in providing a robust COTS transportation plan.

Q2. The International Space Station Independent Safety Task Force concluded that both of the Space Shuttle flights book-kept as "contingency" flights [i.e., ULF–4 and ULF–5 Shuttle missions] "are needed to assure the long-term viability and perhaps survivability of the ISS." *The Task Force goes on the recommend that* "The Administration, Congress, and NASA should commit to completing the Shuttle assembly manifest, including ULF–4 and ULF–5, to enable the accomplishment of the ISS program's objectives."

Q2a. Do you agree with the Task Force's recommendation?

A2a. NASA agrees the two contingency flights play an important role in assuring long-term viability of the International Space Station (ISS). For this reason, the Agency is continuing to hold open the option to add these missions following deployment of the ISS international elements and achievement of a six-crew capability—both of which remain a higher priority.

Q2b. In the wake of the Safety Task Force's report, has the Administration—including OMB—committed to completing the Shuttle assembly manifest, including the ULF–4 and ULF–5 missions?

A2b. The Administration is committed to completing the International Space Station assembly manifest and honoring our international commitments as demonstrated by the current baseline assembly sequence. The decision on whether or not to add the two potential contingency flights to this baseline and begin detailed flight planning and integration is not required at this time. A better-informed decision can be made in the future as the assembly process advances and the schedule margin available prior to Space Shuttle retirement becomes clear.

Q3. The Final Report of the International Space Station Independent Safety Task Force discusses the risks of micrometeoroid and orbital debris to the ISS. How does NASA plan to address those risks?

A3. In its final report, the International Space Station (ISS) Independent Safety Task Force (IISTF) notes that *"The ISS Program has done considerable work to research and model the MMOD environment. This work has enabled the Program to identify criteria for design and to determine the level of risk from MMOD to the ISS vehicle and crew. More importantly, these criteria have aided NASA and the IPs in identifying and incorporating design solutions to address the problem."*

The report continues to state that *"The ISS is the first crewed spacecraft to be developed considering MMOD protection as a primary design requirement."* NASA, the European Space Agency and the Japanese Space Agency (JAXA) elements meet established ISS requirements for micrometeoroid and orbital debris (MMOD) protection. As the IISTF, report states that *"Russian hardware that was designed before they were intended for use on ISS (i.e., Russian SM, Soyuz, and Progress) fall short of meeting the specifications."* The IISTF recommends that *"the ISS program should place the highest priority on options to decrease the risk of MMOD,"* specifically:

> *"5.1.1 The ISS Program should launch and install the Service Module MMOD modification kits at the earliest practical opportunity consistent with other safety risk trade-offs."*
>
> *"5.1.2 For current systems, the Russians should pursue and implement design options to meet the integrated programs MMOD requirements. If necessary, the program should negotiate or barter with the Russians to implement the Progress and Soyuz MMOD enhancements."*

NASA continues to monitor the Russian Segment MMOD risk as its top program risk and has taken steps to mitigate this risk. Roscosmos and NASA have been in discussions regarding enhancements to the Service Module (SM), Soyuz and Progress vehicles. MMOD environment models are being revalidated and the MMOD failure probabilities for docked Russian vehicles are being reviewed with our Russian partners.

In December 2006, 17 Conformal SM Debris Panels were delivered on STS–116/12A.1. The panels, along with six panels delivered earlier, will be installed on the SM in June 2007. Operational procedures are also in place to orient the SM solar arrays as a MMOD shield.

NASA is currently pursuing a modification to an existing contract with the Russian manufacturer of the Service Module, RSC–Energia, to complete a feasibility study for SM MMOD deployable wings that will further enhance protection against MMOD risks. The study is expected to verify the design and deployment methods this year, allowing sufficient time for design, manufacture, installation procedure development and crew training. The SM MMOD wings are currently manifested for delivery to ISS on Assembly Flight 20A in 2010. The proposal to execute this contract modification with RSC–Energia is currently undergoing interagency review to ensure compliance with the reporting requirements of the *Iran Nonproliferation Amendments Act* (P.L. 109–112).

Q4a. What is NASA doing to further the development of supersonic aircraft?

A4a. The Supersonics Project of the Fundamental Aeronautics Program in NASA's Aeronautics Research Mission Directorate is focused on maintaining intellectual stewardship of aeronautical core competencies for the Nation in the supersonic flight

regime and on developing advanced technologies and concepts that can be leveraged by industry to develop future supersonic aircraft.

From before the first flight of the X–1, through the development of early supersonic aircraft designs, to the understanding of rocket booster plume effects on the supersonic performance of the Space Shuttle, NASA researchers and facilities have played a key role in finding solutions to the problems of supersonic flight. Recent advances have contributed to a resurgent interest in supersonic cruise flight. Sonic boom reduction technology, for example, may make overland supersonic cruise a reality. Benefits to the general public would include reduced travel time for business and pleasure, rapid delivery of high-value, time-critical cargo such as medical items, and rapid response of disaster first responders. Supersonic cruise technology is also of high interest to the U.S. military.

One of the most significant barriers common to both military and civilian supersonic cruise applications is overall aircraft efficiency. Significant efficiency improvements over what has been demonstrated to date will in fact be required to make such systems viable. Breakthroughs in cruise efficiency will be required to achieve the needed improvements, and for civil aircraft, the technical challenges are compounded by environmental factors such as airport noise, sonic boom, and high altitude emissions.

The Supersonics Project team has identified technology challenges for future supersonic aircraft. These include elimination of the efficiency, environmental and performance barriers to practical supersonic cruise flight. Recognizing that the solutions to these challenges will be highly integrated, the Supersonics Project is partnering with both the Hypersonics and Subsonic Fixed Wing teams to develop rapid multi-disciplinary design, analysis and optimization methods and frameworks that this team can in turn apply to its selected vehicle class challenges.

The specific technology challenge areas and the levels of improvement that are required to realize the vision of future supersonic cruise are:

Efficiency Challenges

Supersonic Cruise Efficiency: To achieve economic viability, supersonic cruise civil aircraft need to achieve unprecedented levels of cruise efficiency, without excessively penalizing performance in other speed regimes. Cruise efficiency, comprising airframe and propulsion efficiency needs to be increased by a combined total of approximately 30 percent in order to provide the required supersonic cruise range.

Light Weight and Durability at High Temperature: Significant reduction in high-temperature airframe and propulsion system weight is a key element of achieving practical supersonic flight. New material and structural systems must achieve these weight targets without effecting life or damage tolerance. Overall, a reduction on the order of 20 percent of structural and propulsion system weight is envisioned to be required.

Environmental Challenges

Airport Noise: Supersonic aircraft must meet the same airport noise regulations as subsonic aircraft, without incurring significant weight or cruise performance penalties. This challenge is particularly difficult because supersonic cruise requires lower bypass ratio than state-of-the-art subsonic aircraft. Approximately 20 EPNdB of jet noise reduction relative to an unsuppressed jet will be required to meet this challenge.

Sonic Boom: In order to achieve maximum utility, supersonic overland flight must be achievable. This requires that the aircraft must be designed and operated so that no unacceptably loud sonic boom noise is created over populations. It is estimated that a reduction of loudness on the order of 30 PLdB relative to typical military aircraft sonic booms will be required.

High Altitude Emissions: Supersonic aircraft cruise most efficiently at altitudes where exhaust emissions have a potentially large impact on the atmosphere. The impact must be minimized or eliminated. As an example, the emission of oxides of Nitrogen must be reduced from 30 g/kg of fuel to five.

Performance Challenges

Aero-Propulso-Servo-Elastic (APSE) Analysis and Design: Slender supersonic aircraft exhibit unique Aero/Propulsive/Servo/Elastic behavior. Controlling this behavior is key to designing a vehicle that is safe, comfortable and easy to fly. Controlling flutter, gust, and maneuver loads in a manner that is synergistic with the vehicle structural design, is an important element of reducing empty weight.

Multi-disciplinary Design, Analysis and Optimization Challenges

Understanding and exploiting the interactions of all these supersonic technology challenges is the key to the creation of practical designs. This requires the development of a flexible integration framework in which variable fidelity analysis tools can be used in a "plug and play" fashion depending on the type of problem being studied.

The Supersonic Project is addressing all of these challenges through a combination of in-house research and partnering strategies with academic and industrial entities. Detailed five-year plans have been setup to achieve the goals mentioned above and can be found at *http://www.aeronautics.nasa.gov*. It is expected that the resolution of these challenges will lead to furthering the goal of developing viable supersonic aircraft.

Q4b. What is NASA doing to develop our understanding of low-sonic boom supersonic flight so that appropriate sonic boom standards can be established? What is the timetable for those activities?

A4b. The issue of sonic boom is considered by the Supersonics Project as one of the key technical challenges that need to be addressed in order to make viable supersonic cruise flight a reality (see the answer to the first part of the question). Leveraging past NASA contributions for the understanding of sonic boom creation, propagation, impact and minimization, the Supersonics project is currently focused on furthering our understanding of the effect of the sonic boom phenomenon, and on developing tools and technologies that can be used to tailor the sonic boom so that this impact is significantly reduced.

Past research efforts have helped understand the effect of both N-wave and low-boom (tailored) signatures on outdoor noise levels. These efforts have ranged from psycho-acoustic studies (in the sonic boom simulator at the NASA Langley Research Center) to flight tests (DARPA/NG/NASA Shaped Sonic Boom Demonstrator, F–15 low-boom flights at the NASA Dryden Flight Research Center, and the Quiet Spike flights in partnership with Gulfstream Aerospace) that give a fairly good understanding of what would be acceptable to the public in an outdoor setting.

Current in-house research efforts focus on:

- Assessment of the effects of the atmosphere on the propagation of shaped sonic booms. Atmospheric turbulence and winds can significantly distort the predicted shape of a ground shaped boom signature.
- Development of building transmission models to better understand the impact on indoor perception (noise, vibration, rattle). Indoor noise is now becoming the leading obstacle to realizable low-boom aircraft.
- Development of high-fidelity prediction tools for the understanding of the creation and propagation of the entire boom signature. To date most efforts in sonic boom reduction have focused on the front portion of the boom signature (created by the front portion of the aircraft). The more complicated aspects of shaping the aft end of the signature (including engine plume effects) remain to be solved.

The timeline for the key deliverables in our understanding of the boom phenomenon and its tailoring for realizable low-boom supersonic aircraft is included in the tables of milestones (taken from our Task Plans) below:

Table 1. Key Milestones for Sonic Boom Propagation and Impact.

SUP.08.02.D1	Sonic boom building vibration and acoustic transmission database	2Q 2007
SUP.08.02.D2	Low Frequency validated building response/transmission model	4Q 2008
SUP.08.02.D3	High Frequency validated building response/transmission model	4Q 2009
SUP.08.04.D1	Validated sonic boom propagation model	4Q 2009
SUP.08.02.D4	Full Frequency validated building response/transmission model	4Q 2010
SUP.08.03.D1	Validated psychoacoustic model for indoor and outdoor listening	4Q 2011

Table 2. Key Milestones for Understanding of Sonic Boom Creation and Tailoring.

SUP.02.03.D1	Flight database of Lift and Nozzle Change effects on Tail Shocks	9/30/08
SUP.02.03.D2	Aft-end vehicle shaping with engine plume - design and analysis tool	9/30/08
SUP.02.03.D3	Highly efficient, environmentally compatible supersonic vehicle conceptual design optimization tool	9/30/09

In addition to these in-house efforts, the Supersonics Project is engaging the research and industrial communities by means of the NASA Research Announcement (NRA). The second round of the NRA closed in late March 2007, and a large number of proposals addressing the sonic boom challenge are currently being reviewed and it is anticipated that they will be awarded during the summer months. These research contributions will be aligned with the goals of the Supersonic Project in this area and will significantly enhance NASA's contributions.

Q5. NASA's FY 2008 proposed budget cuts ISS and Shuttle reserves to a total of just $100 million in FY 2008. That represents a 1.6 percent reserve level. Do you consider that an appropriate level of reserves for two large and complex human space flight programs?

A5. In the FY 2008 President's budget request, the Space Shuttle Program reserves are $62 million and the International Space Station (ISS) reserves are $38 million. These levels of reserve are tight, but executable if no major anomalies occur. NASA reduced its Shuttle reserve posture to address remaining program threats. The program retains the capability to meet the manifest, but its flexibility is reduced if technical problems arise. The ISS Program reserves in 2007 are depleted, as the program enters one of the most challenging assembly years yet. The program will seek to rebuild additional reserve levels throughout the year by closely monitoring costs.

Enactment of Katrina transfer authority to reimburse Shuttle and ISS programs would improve these programs' risk posture. Shuttle and ISS loaned funds for immediate Katrina needs in FY 2005. Without Katrina transfer authority, reserve levels assumed in the FY 2008 request for Shuttle and ISS will be insufficient to address other threats that may become reality.

Q6. We have heard you use the term "go as you can afford to pay" with respect to the components of NASA's Exploration program. NASA officials have also said the Agency is not going to use the "year by year" approach that was used for ISS development. Could you please explain the difference between these two general approaches and in what ways the development programs in the Exploration program will differ from the development program for the ISS?

A6. Both the International Space Station (ISS) Program and the Constellation Program have been planned in a phased process based upon technical requirements, but the "go as you can afford to pay" strategy for exploration includes several factors intended to avoid the problems experienced by the ISS Program. For the ISS Program, NASA planned the full architectural scope and specific deliverable content during the Preliminary Design. During that early phase, the ISS Program did not

have the cost estimation and cost management tools that NASA uses today and overran their budget during the later phases of development. Due to these overruns, limits were put on the program's annual budget late in the process, introducing many inefficiencies and limiting NASA's ability to most effectively manage the program. These annual spending constraints put the ISS Program into a "year by year" operating mode.

The cost estimation process is more refined for the Constellation Program than it was with the ISS Program, so overruns are less likely. Constellation employs a flexible development approach based on establishing milestones to achieve initial operational capability to low Earth orbit in 2015 and a first lunar landing in 2018. NASA also developed a carryover strategy, which helps to mitigate minor funding fluctuations. In addition, exploration consists of several different projects; as available resources vary, funding can shift between the exploration projects to minimize deleterious effects on development. The improved cost estimation process, carryover strategy, and separation of projects in exploration all allow NASA to be more flexible and achieve milestones within the currently projected budget.

Q7. To what level of technical maturity will NASA take it Next Generation Air Transportation System (NextGen) technologies? Does FAA agree with NASA on the level of technical maturity to be achieved by NASA prior to hand-off to the FAA? If so, please provide the agreement to the Committee.

A7. First, it is important to note that all three of the Aeronautics Research Mission Directorate (ARMD) research programs (Fundamental Aeronautics, Aviation Safety, and Airspace Systems) contribute directly and substantively to the Next Generation Air Transportation System (NextGen). Together, these programs address critical air traffic management, environmental, efficiency, and safety-related research challenges, all of which must be worked in order for the NextGen vision to be realized. The outputs of this focused commitment and investment will include advanced concepts, algorithms, tools, and methods, in addition to technologies, and all of these products will be critical to the success of NextGen.

It should be evident from the clearly stated goals of the NextGen that a focus on fundamental, cutting-edge research is absolutely essential to the successful realization of the NextGen vision. The Vision 100 Century of Aviation Reauthorization Act (Public Law 108-176) clearly states that "The integrated plan shall be designed to ensure that the Next Generation Air Transportation System meets air transportation safety, security, mobility, efficiency, and capacity needs *beyond those currently included in the Federal Aviation Administration's operational evolution plan. . ."* (emphasis added). In other words, the NextGen vision is not simply an incremental advance on the existing system; it represents a true paradigm-shift from what we have today, and it requires a commitment to cutting-edge research across a breadth of aeronautical disciplines (from noise and emissions research to safety research to advanced mathematical optimization algorithms for airspace management, just to name a few). Such a commitment is precisely what NASA's new program is offering. Our return to fundamental, innovative research will increase the probability of development of the revolutionary technologies that will be required for the successful implementation of NextGen and will broaden the advanced technology development options.

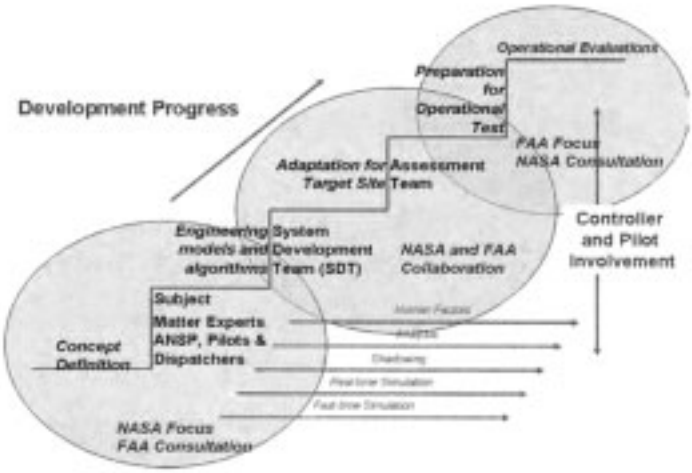
While many have embraced NASA's return to the cutting-edge, and understand that such a focus is critical to the NextGen vision, some have raised concerns about "technology transition." According to Public Law 108–176, it is the responsibility of the Joint Planning and Development Office (JPDO) to facilitate "the transfer of technology from research programs such as the National Aeronautics and Space Administration program and the Department of Defense Advanced Research Projects Agency program to federal agencies with operational responsibilities and to the private sector." In other words, the responsibility for transition resides with the JPDO and all of its five member agencies. This responsibility is reinforced in the newly drafted JPDO Memorandum of Understanding, which both NASA and the Federal Aviation Administration (FAA) have signed.

Transition of research into operational use is of course not a new challenge, nor is it particular to the FAA and NASA. One way to jeopardize successful transition, however, regardless of the agencies involved, is for the parties to become fixated on "technology maturity levels," or "technology readiness levels." The level of maturity to which a technology is developed is irrelevant if that technology does not enable the desired goals of the intended users. Successful transition requires the researchers and the users to engage closely from the very beginning on whatever is being developed or invented. The users must understand the assumptions and limitations that the researchers are operating under as they perform their research and the researchers must understand how their assumptions will impact the usefulness of

their technology or method. Successful transition relies upon a close working relationship among those who conduct the research and those who use its results, and the JPDO has been established precisely to address this challenge. NASA intends to work closely with all of the member agencies of the JPDO, including the FAA, throughout the entire technology development process to ensure that, to the greatest extent practicable, researchers and system operations personnel collaborate to make the technology development and transition as effective as possible. Figure 1 below illustrates our approach in the case of the transition of our airspace systems research to the FAA. This approach enables both NASA and the FAA to do what each does best according to its charter and mission in the best interest of the Nation.

Finally it must be noted that the Enterprise Architecture and the Integrated Work Plan, the primary planning documents of the NextGen, are still being developed by the JPDO. Baseline versions for each of these documents are scheduled for completion during FY 2007. However, these documents will need to be vetted with the stakeholder community and will undoubtedly continue to evolve over the next few years. As these documents mature, gaps will most likely be identified in technology development, knowledge, schedule, or other areas, and NASA, the FAA, and the other JPDO member agencies (DOD, DHS, DOC) will work together to address those specific gaps as they impact NAS transitions and system implementation. At the moment, in the absence of these plans, no agreement can or does exist regarding what specific gaps need to be addressed and how they need to be addressed. Therefore, in the interim, NASA will continue to work with the JPDO to refine its technical roadmaps and resource plans, which have been developed in substantial collaboration with the JPDO, as information regarding the JPDO plans becomes available.

Figure 1: Transition of Airspace Systems R&D from NASA to the FAA



Q8. In 2003, NASA was authorized to demonstrate enhanced use leasing (EUL) at two centers, allowing the agency to retain the proceeds form leasing out underutilized real property and to accept in-kind consideration in lieu of cash for rent. NASA has requested that Congress extend this authority to additional centers. GAO recently issued its report and recommended that NASA develop an agency wide EUL policy to address weaknesses in the agency's implementation of EUL.

a. What is the status of NASA's agency wide EUL policy?

b. What are NASA's plans and timeframe for implementing the policy, specifically in the areas pointed out by the GAO (best economic value criteria, measures of effectiveness, and accounting controls)?

A8. NASA has begun development of the new Agency-wide EUL policy. The NASA-wide EUL policy will include the recommendations from the Government Accountability Office (GAO) to provide clear and unambiguous requirements and procedures on EUL as well as procedures and lessons learned from the two NASA centers in the EUL demonstration program. The policy will be based on sound business practices and will establish controls and processes to ensure accountability and to protect the government's interests. NASA anticipates that the Agency-wide guidance will be implemented before the end of the current fiscal year, and guide the execution of any expansion or modifications of the existing EUL authority that may be enacted by Congress.

Q9. NASA recently delivered the report on Near Earth Objects called for in the NASA Authorization Act of 2005. However, that Act also directed NASA "to plan, develop, and implement a Near-Earth Object Survey program. . .for near-Earth objects equal to or greater than 140 meters in diameter. . ." *and to deliver a report that provides* "a recommended option and proposed budget to carry out the Survey program pursuant to the recommended option." *The report delivered does not in fact provide a recommended option that would fulfill the statutory requirement regarding surveying near-Earth objects equal to or greater than 140 meters in diameter. When do you intend to comply with the statutory requirement?*

A9. NASA intends to continue its existing NEO program as currently planned. However, NASA will also take advantage of opportunities using potential dual-use telescopes and spacecraft—and partner with other agencies—to attempt to achieve the legislative goal within 15 years. At the present time, NASA cannot initiate a new program.

Questions submitted by Representative Ralph M. Hall

Exploration Systems

Q1a,b. The FY 2007 Continuing Resolution cut the Exploration Systems program by $577 million. Please describe the program changes NASA has taken or will take in FY 2007 to accommodate these reductions? Exactly what projects within the Exploration Systems program will be reduced or eliminated as offsets?

A1a,b. The FY 2007 reduction will primarily impact the funds available for the Orion CEV and Ares I CLV development work in FY 2008–2010, not the current fiscal year. While near-term milestones will be achieved, the Constellation program will not likely be able to meet several milestones originally planned during the FY 2008–2010 timeframe. Due to the cumulative effect of previously underestimated costs to retire/transition the Space Shuttle and support the International Space Station (ISS), the reduction from the FY 2007 request reflected in the FY 2007 Continuing Resolution, and the maturing design and integrated flight tests baselined for the Constellation program, it is unlikely that NASA will be able to bring these new Exploration capabilities online by 2014. NASA is working to define program options within the Exploration Systems budget for FY 2008 to shore up funding for the Orion CEV and Ares I launch vehicle. We will communicate NASA's plan to our oversight Committees later this year.

While the Lunar Reconnaissance Orbiter (LRO) and its secondary payload, the Lunar Crater Observing and Sensing Satellite (LCROSS), remains on schedule for launch in 2008, all other activity under the Lunar Precursor Robotic Program, which were directed towards future precursor robotic missions, will cease. Exploration Systems Mission Directorate (ESMD) will not be working on additional independent robotic missions, such as a robotic lander, at this time. ESMD will instead focus on analysis and processing of available lunar data (from LRO and other international missions) and execute a Lunar Mapping effort that will support the Lunar surface operations planning of the Constellation program.

In the Exploration Technology Development Program several lower priority technology efforts will be impacted. The spacecraft autonomy and reliable software projects and the NASA Institute for Advanced Concepts will be closed out in an orderly fashion and several other research and technology efforts, such as dust mitigation, non-toxic cryogenic propulsion systems, and radiation hardened and low temperature electronics will be reduced.

Q1c. Is NASA contemplating cuts to the science and aeronautics programs as offsets, and if so please identify them along with budget offsets?

A1c. NASA's initial FY 2007 Operating Plan, submitted to the Committee on March 15, 2007, included the reductions to Exploration Systems resulting from the funding reductions reflected in the FY 2007 Continuing Resolution. No reductions to science and aeronautics were made as offsets to these reductions.

Q2. Based on your FY 2008 Budget Request, NASA plans to spend nearly $26 billion on the Constellation program beginning in FY 2008 through FY 2012. Of this $26 billion, nearly $16 billion is planned for fiscal years 2011 and 2012. What is NASA's basis for the large increases in FY 2011 and 2012?

A2. FY 2011 and FY 2012 show increased activity and costs as the Ares I Crew Launch Vehicle, Orion Crew Exploration Vehicle, and Ground Operations facilities move from design phases to hardware fabrication, integration, and ground and flight testing. This period includes two ascent abort test flights, two Orion/Ares uncrewed test flights, preparations for the first crewed flight, and the start of production for follow-on flights. Constellation is taking over selected Shuttle infrastructure and costs in this period, and staffing up ground operations to prepare for operational flights. Also, in this time frame, we will see the start of significant development work for systems to return to the Moon—the Ares V Cargo Launch Vehicle, Lunar Surface Access Module, and other lunar Surface Systems.

Shuttle

Q3. If further delays are experienced in the Shuttle flight rate it is likely that one or several flights could be eliminated from the manifest. How will NASA decide which flights to cancel?

A3. NASA is committed to safely flying the Shuttle through its retirement in 2010 to complete construction of the ISS, which will fulfill our commitments to our International Partners and enable us to conduct exploration-focused research on-board. The Shuttle manifest calls for 13 assembly flights to the ISS and one to service the Hubble Space Telescope. In addition, two ISS logistics flights may be flown There is currently sufficient schedule margin in 2010 such that if a flight had to slip out of 2008 or 2009 it could still be flown before September 2010. If any of these flights slip beyond September 30, 2010, we will investigate the current state of ISS and delete the least critical equipment to be transported to ISS. This process will evaluate the maintenance backlog to prioritize what components will be flown.

Q4. Bill Gerstenmaier has recently said that NASA is nearly "past the point of no return" in shutting down vital shuttle suppliers in anticipation of retiring the Shuttle. Exactly what milestones will signal the "point of no return?" How is NASA ensuring sufficient spares remain available to support Shuttle operations through 2010? How has NASA determined at this point whether those suppliers will be needed for Orion or Ares?

A4. There is no single "point of no return." As contracts are completed and hardware delivered, it becomes increasingly difficult to reestablish contracts and procure hardware for the Space Shuttle. For example, aluminum lithium ingot production for the external tank has been terminated and all procured ingots provided to Orion. This loss of material will eliminate the option of cost-effectively continuing manufacture of multiple tanks.

NASA is building additional spares to insure that the Agency can fully support the manifest through the end of FY 2010. NASA carefully reviews each Shuttle component with the Orion and Ares programs and determines if the supplier will be needed for the future program prior to ceasing the Agency's relationship with the supplier.

Space Station Human Research Program

Q5a. What is the limiting factor in achieving the Human Research Program goals?

A5a. The following factors could be construed as limiting to the success of the Human Research Program:

- Significant deviations from the planned Shuttle and Soyuz launch sequence.
- Sample Return capability to maintain the viability of physiological samples.
- The availability of non-assembly crew time.
- Availability of crew members as subjects for research.

Q5b. How will NASA sustain the Human Research Program if any of the Shuttle logistics flights are not flown by 2010?

A5b. NASA will have to rely on the capabilities of commercial services if available, or our International Partners if necessary, to fulfill the up mass and down mass requirements.

Q5c. How much has NASA budgeted for the alternative transportation?

A5c. The table below shows the NASA budget for ISS crew and cargo services and the budget to develop additional alternative capabilities.

FY 2008 President's Budget Request
ISS Crew Cargo Services Shortfall/Lien Phasing

	FY 08	FY 09	FY 10	FY 11	FY 12	TOTAL
Included in ESMD FY2008 Pres. Budget:*						
Commercial Cargo Crew Capability/COTS Budget	236	159	41	-	-	436
Included in SOMD FY 2008 Pres. Budget:*						
ISS Crew Cargo Budget	123	372	481	404	517	1,897
Lien/Management Challenge against SOMD	-	119	94	190	(95)	308
Lien against ESMD	-	33	131	142	310	616
Total ISS Crew Cargo Liens **	-	152	225	332	215	924
Total ISS Crew Cargo Potential Funds	123	524	706	736	732	2,821

* All budget numbers are in simplified full cost.
** Liens are for potential additional costs above what is budgeted, in the event that costs of services exceed budget.
Requirements and phasing will be reassessed during FY 2009 budget formulation process.

Questions submitted by Representative Mark Udall

Q1. Does NASA plan to initiate any of the new missions recommended by the Earth Science Decadal Survey and if so, what are the next missions that NASA would initiate? Does the FY 2008 budget request with its five-year runout currently contain any funds to initiate any of the Decadal Survey-recommended missions?

A1. With the Decadal Survey now in hand, NASA is actively developing an integrated Earth Science mission roadmap to address the Earth Science scientific priorities identified in the Decadal Survey. As recommended in the Decadal Survey, the new NASA integrated mission roadmap will take into account contributions from international partners, the availability of supporting measurements from precursor missions that are expected to still be operating after 2010, and the data expected from National Polar-orbiting Operational Environmental Satellite System in light of the Nunn-McCurdy recertification.

NASA will work to address the science priorities outlined in the Decadal Survey through the Earth System Science Pathfinder (ESSP) missions and Earth Systematic Missions. The FY 2008 budget request includes $492.3 million (over five years) for a new ESSP mission; this budget request supports a solicitation to be released in late FY 2008, with launch of a small-to-medium class mission in the 2014 time frame. While ESSP missions are competitively selected from among proposals sub-

mitted by researchers, the ESSP Announcement of Opportunity will solicit proposals for missions addressing one or more of the top four scientific priorities assigned to NASA in the Decadal Survey: quantitative measurement of solar irradiance and spectrally resolved Earth radiation budget; active and passive microwave measurements of soil moisture and vegetation freeze/thaw cycles; detailed measurements of ice sheet dynamics and extent; and solid Earth processes combined with measurements of vegetation canopy characteristics.

In addition, the FY 2008 budget requests includes the start of a funding wedge for additional future Decadal Survey missions, with a small amount of funding ($1.2 million) for early work in FY 2009–2011 and growing to $30.6 million in FY 2012. This funding supports future Earth Systematic Missions.

Q2. The FY 2008 budget total reductions of $270 million for FY 2008–2012 from the Space Shuttle Transition and Retirement (STaR) funding.

Q2a. What is the impact of the STaR reductions?

A2a. The Space Shuttle Transition and Retirement (STaR) provides funds to ensure successful ISS operations post-Shuttle retirement. It does this through the purchase of additional spares and by realigning costs in several areas that are currently jointly funded with Shuttle, such as Mission Operations Directorate, Flight Crew Operations Directorate, and flight crew equipment. The new sparing philosophy involves buying more spares. The old plan had the failed units returned from the ISS repaired on the ground and then returned to space.

The FY 2008 budget request provides $187 million for STaR in FY 2008, but reduces the five-year budget for STaR from the previous estimate by $270 million in favor of other higher-priority elements of the ISS program and other high priority Agency goals, particularly TDRSS replenishment satellites. The $270 million cut is achieved by reducing STaR reserves by $99 million from previous estimates and by creating a management challenge to reduce the Space Station's operations cost by $172 million through FY 2012 by finding efficiencies and reducing requirements and overall operating costs, including STaR. The resulting cost savings will be used to improve the Program's reserve posture and offset management challenges as needed.

Q2b. What are NASA's plans for assessing the appropriate numbers and mix of skilled workers needed to safely fly the Shuttle through 2010 and to transition from Shuttle to CEV?

A2b. As the Constellation System Requirements Reviews are completed this year, NASA will gain a much clearer understanding of the demands for future workforce skills, which will form the foundation for making any future decisions. Although proud of recent progress, NASA acknowledges that more needs to be accomplished. These tasks include matching available skills with future work, managing attrition, retraining and hiring, and using temporary and term appointments to get the flexibility to align agency needs with the time-phased workload.

The nature of the work many NASA employees will do will change as we transition human space flight activities from Shuttle operations to research and development-focused activities like planning, design, testing and verification for Constellation systems. NASA is striving to give its employees opportunities to build on their existing skills by working on the new exploration systems, so that when this development work comes on-line, many of them can transition into new positions. Coupled with newly gained skills, the NASA workforce can take the skills honed in Shuttle operations and apply them to the design of future vehicles to make them fly more efficiently. From a human resources perspective, the transition of these key personnel must be carefully managed given the time between Shuttle retirement and Ares/Orion operational capability.

In order to complete the remaining Shuttle missions safely, retention of the NASA workforce, with their skills and tremendous dedication, for the duration of the Shuttle program is critical. A recent survey of Shuttle personnel across the NASA field Centers clearly demonstrates that NASA has highly motivated people who want to stay for the remainder of the program and see it succeed.

Q3. You have indicated that ISS research is being deferred. However, you also testified last year that NASA expects to cease funding the ISS after 2016. That leaves a very limited window to conduct the research NASA has said it needs to conduct to answer questions related to human exploration of the solar system. Given that NASA's current ISS research and utilization plan contains no documentation of specific research questions to be answered along with the specific research protocols and milestones to be met to achieve the answers to those research questions, what specific documentation can you provide to Congress to

demonstrate that NASA has credible and appropriate plans for utilization of the ISS prior to NASA's planned withdrawal from the program?

A3. NASA's tactical and strategic plan for utilization of the International Space Station (ISS) and a list of recent reports are described below.

Tactical Plan for ISS

1. Launch and conduct manifested payloads. Examples are provided:

- *Human Research*—Analyzing Interferometer for Ambient Air, Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss, Validation of Procedures for Monitoring Crew Member Immune Function, Vibrational Inhibition of Bone Erosion.
- *Life Science Research*—Streptococcus pneumoniae Gene Expression and Virulence Potential in the Space Environment, Advanced Plant Experiments on Orbit—Cambium.
- *Physical Science Research*—Shear History Extensional Rheology Experiment, Coarsening in Solid Liquid Mixtures-2, Capillary Channel Flow, Zero Boil-Off Tank Experiment, Smoke and Aerosol Measurement Experiment, Multi-User Droplet Combustion Apparatus/Flame Extinguishment Experiment, Light Microscope Module/Constrained Vapor Bubble.
- *Constellation Program Technology Demonstration*—Electronic Nose, and Vehicle Cabin Air Monitor.gQ04

For a list of specific ISS experiments and for further information see the following website: *http://exploration.nasa.gov/programs/station/list.html*

2. Develop future ISS experiments based on National Research Council (NRC) or program needs.

The Human Research Program (HRP) is currently developing an integrated research plan, which has as an important ISS research element and extends past 2010. HRP is developing NASA Research Announcements (NRA's) in the following areas: Space Radiation, Exploration Medical Capability, Human Health Countermeasures, Behavioral Health & Performance, and Space Human Factors & Habitability, which will include experiments conducted on the ISS. NASA will develop physical science NRA's based on NRC study recommendations for research supporting exploration and emphasizing the use of existing flight hardware.

Future technology demonstration experiments will be informed by Constellation Program needs.

Strategic Plan for ISS:

The ISS is NASA's long-duration testbed for lunar missions as well as a flight analog for Mars transit. The six-month ISS mission increments are temporal and operational analogs for Mars transit. NASA is using the ISS as a laboratory for research that directly corresponds to Agency needs, as summarized below:

1. Research, Development, Test, and Evaluation of Biomedical Protocols for Human Health and Performance on Long-Duration Space Missions.
2. Research, Development, Test, and Evaluation of Systems Readiness for Long-Duration Space Missions.
3. Development, Demonstration, and Validation of Operational Practices and Procedures for Long-Duration Space Missions.

NASA also utilizes the ISS for non-exploration-related life and physical science research when the uniqueness of the microgravity and space environment unmask phenomena that cannot be observed or studied in the normal Earth environment.

Reports:

1. The National Aeronautics and Space Administration (NASA) Research and Utilization Plan for the International Space Station (ISS), 2006. Website to obtain the NASA ISS utilization report: *http://exploration.nasa.gov/documents/reports.html*
2. Also, NASA is currently developing two reports—the *HRP ISS Research Plan,* to be published in December 2007, and a comprehensive *ISS Research Plan.*

Q4. With respect to the CEV program:

Q4a. What effect, if any, will slipping the date of the first Initial Operational Capability (IOC) (i.e., first crewed launch) have on the nature of existing contracts for the Constellation program?

A4a. The slip of the Initial Operational Capability (IOC) will not change the plans for the existing Orion contracts.

Q4b. How much is NASA spending on Constellation programs per month? Does current spending reflect costs at full-scale program levels or at levels to reduce the pace? What will the maximum monthly costs per month be once Constellation is fully ramped up?

A4b. The Constellation program is spending about $120 million per month as of mid-FY 2007. Constellation is still ramping up, so the current rate does not reflect any changes due to the funding reductions reflected in the FY 2007 Revised Continuing Appropriations Resolution. Peak rate within the budget horizon will be about $540 million per month in 2012, assuming the FY 2007 funding reduction is recovered.

Q4c. Are you confident that NASA now understands the costs required to retire/transition space shuttle, support ISS and accommodate the design and integrated flight tests for the Constellation program?

A4c. A major focus of NASA's formulation of the FY 2009 budget is to adequately quantify the costs to retire and transition the Space Shuttle and understand the impact of that activity on the International Space Station (ISS) and Constellation programs. NASA's Space Operations Mission Directorate and Exploration Systems Mission Directorate have a joint transition team that is managing the day-to-day issue of transition from both an overall Agency perspective, as well as issues specific to the Space Shuttle and ISS. Significant progress has been made in identifying the risks and challenges associated with Shuttle retirement, transition of key Shuttle workforce, and the disposition of facilities across all NASA Centers. While there has been significant progress made in understanding the issues under a joint transition effort, much work still remains regarding the understanding of the costs required to retire the Space Shuttle program and transition to Constellation systems. It is being managed as a top risk. Independent of transition dynamics, the operational costs of supporting the ISS are well understood and the Constellation program has completed its Systems Requirement Review and is progressing to complete the Preliminary Design Review in 2008. NASA's confidence level to achieve initial operational capability for the Orion Crew Exploration Vehicle by 2015 is currently at 65 percent.

Q5. Is funding provided in the FY 2008 budget request to develop alternative means of obtaining the climate measurements eliminated from NPOESS as a result of Nunn-McCurdy? If so, how much? If not, why not?

A5. While NASA's FY 2008 budget request does not include funding to develop alternative means for obtaining these climate measurements, NASA and the National Oceanic and Atmospheric Administration (NOAA) have recently agreed to provide those funds required to fly the Ozone Mapping and Profiler Suite (OMPS) Limb sensor on the National Polar-orbiting Operational Environmental Satellite System Preparatory Project (NPP) mission. NASA is working as part of a broad Administration effort to assess options for recovering the climate measurements that the other demanifested NPOESS sensors would provide. As a follow-on activity to the recently released Decadal Survey for Earth Science, NASA and NOAA have asked the National Research Council to assess the loss of climate measurements from NPOESS and provide mitigation recommendations. An addendum to the Decadal Survey is due this summer.

Q6. The Earth Sciences Decadal Survey discusses he need for transitioning research satellites to operational systems. The NASA Authorization Act of 2005 *calls for NASA–NOAA coordination on research to operations.*

Q6a. How often has the NASA–NOAA Joint Working Group met? When was the most recent meeting?

A6a. The NASA–NOAA Joint Working Group has formally met twice, once in January 2006 and once in April 2006. In addition to these meetings, NASA and NOAA have been working together in order to address specific issues of interest to both agencies, as described in the NASA response to question 6b below.

Q6b. What specific issues has it addressed?

A6b. The NASA–NOAA Joint Working Group has addressed a number of issues, as detailed below.

1. The primary focus of NASA–NOAA joint activities has been on the National Polar-orbiting Operational Environmental Satellite System (NPOESS). NASA and NOAA worked together in late 2006 and early 2007 to develop a white paper, requested by the Office of Science and Technology Policy, on the impacts of the de-manifestation of the NPOESS climate sensors. NASA and NOAA also worked together to restore the Ozone Mapping and Profiler Suite Limb sensor on the NPOESS Preparatory Project (NPP) mission.
2. Discussions on coordinating research and operations were held at the two NASA–NOAA roundtables in 2006.
3. As required by the *NASA Authorization Act of 2005* (P.L. 109–155), NASA and NOAA have been coordinating the development of a report to Congress detailing proposed joint activities for FY 2008. This report will be delivered to Congress shortly.
4. The NASA senior review process for operating missions has been altered to more specifically reflect the recommendations of the National Research Council (NRC) to bring NOAA in as part of a separate review involving operational users of NASA satellite data.
5. NASA and NOAA are jointly reviewing the results of the Decadal Survey for Earth Science, as well as working with the NRC on their addendum to that report to assess the loss of climate measurements from NPOESS.

Q6c. Is the Joint Working Group with NOAA able to effectively plan for transitions from research to operations?

A6c. While NASA is making progress working with NOAA, it is still very early in the planning process, especially given the relatively recent release of the Decadal Survey for Earth Science, to be able to say that the problem of transitioning from research to operations is solved. However, recent examples of NASA–NOAA coordination, such as working together to restore the OMPS–Limb sensor and conducting a coordinated senior review process to look at mission continuation, demonstrate that the agencies are making progress.

Questions submitted by Representative Baron P. Hill

Q1. A report by the National Research Council on humans in space recommended that the medical and the psychological issues related to humans engaging in long-duration space flight need to be better understood. It also suggested that countermeasures for the effects of exposure to both cosmic rays and solar proton radiation and reduced gravity will have to be developed.

What efforts is NASA undertaking to respond to these recommendations with regards to solar proton radiation?

A1. The Agency has developed the NASA Space Radiation Laboratory (NSRL) at the Department of Energy's Brookhaven National Lab at Upton, New York. The NSRL opened in October 2003 for scientific research studying the effects of space radiation and the development of shielding and biological countermeasures to solar proton and galactic cosmic rays. The NASA Human Research Program supports more than $30 million per year on research conducted at NSRL through competitive research awarded to U.S. universities or government laboratories.

The NSRL is a unique facility in the world for simulating both solar protons and galactic cosmic ray heavy ions. NSRL can accelerate protons to energies of 3,000 Megaelectron volt (MeV), and heavy ions from carbon to gold to high energies. These energies provide an accurate representation of both solar protons and galactic cosmic ray heavy ions.

In comparison, other proton facilities located around the country (i.e., Indiana University Cyclotron Facility, Loma Linda University Medical Center, Massachusetts General Hospital, the University of Florida, and the University of Texas's MD Anderson Hospital) can accelerate protons only up to energies of a few hundred MeV, which is insufficient to properly simulate solar protons. Also, such facilities cannot properly simulate galactic cosmic ray proton and heavy ions.

Q2. Researchers at the Indiana University Cyclotron Facility (IUCF) are collaborating with NASA to better understand the radiation risk from solar protons during space exploration. How has this research effort supported the recommendations from the NRC report?

A2. To date, no results from IUCF have emerged to better understand the radiation risk from solar protons. However, pilot studies of new dosimetry systems are underway and could lead to advance response capabilities for solar proton events.

Q3. The IUCF is currently being utilized by NASA to support various aspects of its mission. What additional NASA requirements might be met through the use of IUCF as a support facility?

A3. The IUCF is working with the NASA Johnson Space Center's Engineering Directorate to develop new instruments for dosimetry applicable to solar proton irradiation.

The Agency's research program at the NASA Space Radiation Laboratory (NSRL) is addressing all of the concerns of the recent National Research Council report. IUCF has severely limited capability in NASA's space radiation protection research goals because the energies possible are not sufficient to simulate space radiation. NSRL is the only facility capable of addressing the problems of solar proton and galactic cosmic radiation risk to astronauts.

Questions submitted by Representative Charles A. Wilson

Q1. As part of the Constellation Systems architecture, NASA is developing major space flight hardware, such as Orion, Ares I, Ares V, and the Lunar Surface Access Module. Experience has shown that robust testing of such space flight hardware, particularly large integrated testing, is essential for mission success. What is being done to assure that the hardware of Constellation Systems will be thoroughly tested and that NASA facilities will be effectively utilized across the Constellation Systems theme?

A1. NASA agrees that past experience has shown that a robust test and verification program is essential for mission success. Recognizing this need, the Constellation Program took the proactive approach of standing up a Test & Verification (T&V) Office early in the program to provide the necessary leadership. The T&V Office is responsible for producing a robust integrated verification strategy essential to ensuring mission success. It has documented this strategy in what is now called the Constellation Program Master Integration and Verification Plan.

The plan was baselined in December 2006 as part of the Constellation Program's System Requirement Review. This plan provides the framework for the Program's integrated verification strategies including major test activities such as Avionics and Software Integrated Testing, Propulsion Systems Testing (e.g., J–2X), individual Flight Element Environmental Testing (e.g., Acoustics or Thermal/Vacuum testing), Flight Element Integrated Testing (e.g., Orion to Ares I), Multi Element Integrated Testing (e.g., Orion to International Space Station (ISS), Orion to Lunar Surface Access Module (LSAM)/Ares V–Earth Departure Stage (EDS)), Flight Testing (Ares 1–X) and In-space Integrated Testing (e.g., Orion to ISS Rendezvous and Docking).

The T&V Office also has the lead for identifying facility requirements necessary to fulfill the Program's integrated verification strategy. To perform the function, the T&V Office set up the Constellation Asset Management Panel (CAMP) to review and provide Constellation Program recommendations on the use of existing commercial, Department of Defense, and NASA institutional assets required in support of Constellation integrated verification planning activities.

The Shuttle Program has developed a facility capability list that CAMP is currently reviewing for potential Constellation use. The Constellation Program's recommended infrastructure plan will then be coordinated with Agency Level Boards and Forums such as the Shuttle Transition Control Board or the Human Space Flight Capabilities Forum to ensure that NASA T&V facilities will be effectively utilized across the Constellation Program.

Q2. A critical element of the Exploration Vision is the establishment of lunar outposts for extended missions on the Moon. To enable such outposts, advanced technologies will need to be developed in the areas of surface power, communications, propulsion and habitation. And these technologies will need to be verified and demonstrated prior to entering into systems development. What are NASA's plans, in terms of schedule and funding, for developing and demonstrating these critical technologies?

A2. NASA is conducting advance technology development in several areas as outlined in more detail below.

Surface Power

Preliminary plans for the lunar outpost call for the use of solar power systems during the initial assembly phase. After the outpost is complete, nuclear power systems may be tested on the Moon to reduce risk for future human missions to Mars.

A key element of solar power systems that does require new technology development is energy storage, which will allow the outpost to operate during the lunar night. NASA is developing advanced batteries and regenerative fuel cells to store energy generated by solar power systems. Energy storage technologies will also provide power for mobile lunar surface systems such as rovers and spacesuits.

Major milestones for energy storage technology are:

- 2007—Demonstrate lithium-ion battery for spacesuits in desert field test.
- 2008—Demonstrate fuel cell power system for lunar rover in desert field test.
- 2009—Demonstrate 10 kW regenerative fuel cell.
- 2012—Integrated test of solar power system with energy storage.

NASA is also developing concepts and technologies for affordable nuclear fission surface power systems. NASA is developing proof-of-concept liquid metal cooling systems for the nuclear reactor, and Stirling converters to generate power from the heat supplied by the reactor.

Major milestones for nuclear power technology include:

- 2007—Complete affordable fission surface power conceptual design studies
- 2008—Demonstrate a 10 kW power conversion system in the laboratory
- 2010—Demonstrate deployment of a simulated fission surface power system in desert field tests
- 2011—Demonstrate integrated power conversion and simulated liquid metal cooled reactor operations

Communications

NASA is planning a communications infrastructure and developing advanced communications technologies to support the lunar exploration program. It is envisioned that a communications relay satellite in lunar orbit will be required to provide communications for the lunar outpost.

The Lunar Reconnaissance Orbiter mission to be launched in 2008 will fly a miniature radar instrument (mini-RF) that will demonstrate many significant technology and miniaturization improvements including an ability to operate in two frequency bands and has an antenna much smaller than previous synthetic aperture arrays.

Propulsion

NASA's technology efforts in propulsion are focused on delivering prototype high-performance cryogenic propulsion systems for the Human Lunar Lander, and on improving the performance and reliability of the RS–68 engines needed by the Ares V rocket.

The key elements of the Human Lunar Lander propulsion system include a deep throttling liquid hydrogen/oxygen engine for the descent stage, a liquid methane/oxygen engine for the ascent stage, reaction control system thrusters, and zero boil-off cryogenic propellant storage.

Major milestones for propulsion technology include:

- 2007—Testing of deep throttling RL–10 engine for Human Lunar Lander descent stage
- 2008—Prototype reaction control system thruster
- 2008—Prototype liquid methane/oxygen main engine for Human Lunar Lander ascent stage
- 2010—Demonstrate zero boil-off cryogenic propellant storage
- 2012—Integrated liquid methane/oxygen propulsion system including main engine, thrusters, and cryogenic propellant storage

The development schedule and major milestones for the RS–68 engine are still in the planning phase so that NASA and Air Force requirements can be aligned.

Habitation

NASA is developing critical life support and habitation technologies. These include atmospheric management, environmental monitoring and control, advanced air and water recovery systems, waste disposal, and fire detection and suppression.

These technologies will enable sustainable life support systems for long-duration missions and protect crew health from hazardous contaminants.

Major milestones for habitation technology include:

- 2007—Test prototype carbon dioxide and moisture removal system for Orion
- 2007—Test bacteria monitoring instrument on ISS
- 2008—Deliver eNose for flight on ISS (instrument to detect atmospheric contaminants)
- 2009—Deliver Vehicle Cabin Air Monitor instrument for flight on ISS
- 2011—Test atmosphere revitalization system for lunar outpost
- 2011—Test water recovery system for lunar outpost
- 2012—Test waste management system for lunar outpost

Funding for developing and demonstrating technologies is reflected below.

(Funding In Millions)

Technology	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
Energy storage	$2.6	$3.0	$4.0	$7.2	$12.1	$11.1
Nuclear power	$6.9	$7.8	$9.5	$10.0	$15.2	$15.4
Human Lunar Lander propulsion	$26.7	$25.5	$29.6	$29.0	$31.0	$28.5
Life support & habitation	$34.5	$20.0	$23.2	$28.3	$44.7	$44.3

Q3. Assuring the safety, health and performance of astronauts is critical to the success of the Exploration Systems Mission and must be our highest priority. However, funding for the Human Research Program has been dramatically reduced in recent years with no significant growth in funding requested for FY 2008 and beyond. It is hard to reconcile this funding plan with the criticality of keeping and maintaining the health and safety of our astronauts. What is NASA's plan to develop the necessary understanding of the effects of zero and partial gravity environments on humans, develop effective countermeasures to mitigate risks and deliver required medical care to astronauts on exploration missions, including outposts on the lunar surface?

A3. NASA believes that assuring the safety, health and performance of astronauts is critical to the success of the Exploration Systems Mission. NASA has responded to the Vision for Space Exploration by restructuring and focusing its biomedical research program. Part of this restructuring included the establishment of the Human Research Program (HRP). The HRP is working more closely with NASA's Medical Operations community to focus its research and technology investment to investigate and mitigate the highest risks to astronaut health and performance to ensure that appropriate countermeasure investments and mitigation strategies are made that satisfy exploration mission requirements.

HRP is helped by its interaction and integration with the National Space Biomedical Research Institute (NSBRI), a consortium of 12 academic institutions from across the Nation. The goal of this important partnership is to conduct research to understand the effects of microgravity on humans, and to develop effective countermeasures to mitigate the risks associated with space flight. Further, NASA has established a flow-down of requirements from the Office of the Chief Health and Medical Officer (OCHMO) to the various Program Elements of the HRP at the Johnson Space Center. The NASA OCHMO has developed an initial set of space flight health standards that serve to guide the HRP in the expansion of the evidence base regarding human space flight health and performance risks.

This document establishes NASA's space flight crew health standards for the preflight, in-flight, and post-flight phases of human space flight. These standards apply to all NASA human space flight programs and are not developed for any specific program. A copy of the document can be found at: *http://standards.nasa.gov/default.taf.* The highest priority risks have been identified by HRP and allocated to the Program Elements within the HRP.

The main Program Elements within HRP include Space Radiation, Exploration Medicine Capability, Human Health and Countermeasures, Behavioral Health & Performance, and Space Human Factors & Habitability. The HRP is using the ISS as a research platform to understand the effects of long duration space flight on humans, to identify research gaps associated with long-duration space flight, and to develop and test countermeasures that reduce the medical risks of human space flight. NASA is also using ground-based space analog environments (e.g., bed rest, Antarctica, undersea habitat) to understand the effects of zero and partial gravity on humans. The HRP strives to strengthen its partnerships with academia, other federal agencies (e.g., NIH, DOE), international space agencies, the emerging commercial space transportation industry and other private industries, in order to leverage resources and provide the most extensive evidence base possible and help ensure the timely development and validation of countermeasures and technologies to mitigate risks to our astronauts on exploration missions.

Questions submitted by Representative Ken Calvert

Exploration Systems

Q1. Based on experience to date with the Orion and Ares programs, what do you consider the three highest risks, and what steps are being taken to address them?

A1. The Constellation Program utilizes an active risk management approach, which involves regularly identifying, evaluating, and retiring the risks which are affecting the program. At the present time, the Constellation Program has identified the following top three risks: (a) a human space flight capabilities gap from Shuttle retirement until Ares Initial Operational Capability (IOC); (b) Orion Crew Exploration Vehicle (CEV) mass allowance; and (c) ground flight test qualification for the first crewed lunar return.

a. A prolonged gap between Shuttle retirement and Ares IOC increases the risk that NASA will lose launch processing and mission operations capabilities.

   Constellation is on a path to complete Design Development Test & Engineering for high-risk hardware to support IOC in a timely fashion. Additionally, test flights and requirements for crew launch & crew exploration vehicles are being reviewed to align technical, schedule, and budget targets to minimize the deleterious impact of the hiatus in NASA crewed vehicle launches.

b. Current Crew Exploration Vehicle (CEV) mass estimates are exceeding previously established allowances.

   By the late summer of 2007, the requirements will stabilize and mature, allowing NASA to analyze the design decisions and determine their effects on current and target weights. For a further risk reduction, two external consultants will accomplish mass properties reviews six months prior to preliminary design review and critical design review.

c. The first crewed lunar return may occur without a full-scale test of the CEV heat shield, since current U.S. arc jet facilities capabilities do not provide full coverage of lunar return entry environments and a flight test of the heat shield has not been programmed.

A Thermal Protection System Analysis of Alternatives study is underway to develop a risk mitigation strategy in 2007. Options being evaluated include ground facility upgrades, exploring non-NASA ground test facility capabilities, sub-scale test flights, and full-scale test flights.

Shuttle

Q2. What is the effect of the delay of STS–117 on NASA's overall plan to fly out the Shuttle manifest? If flown in mid-May, as currently forecast, will NASA still be able to fly all remaining missions, including the Hubble servicing mission by December 2010?

A2. On June 8, NASA successfully launched Space Shuttle Atlantis' STS–117 mission to the International Space Station (ISS). Completion of this mission allows NASA to fly out the remaining flights needed for ISS assembly. By the end of 2008 or the first part of 2009, the ripple in the manifest caused by this delay will have settled out, and NASA will be back on track to complete the manifest by the end

of FY 2010. NASA will still have the same schedule margin as today to complete any ISS assembly flights and the Hubble servicing mission.

The Space Shuttle and ISS Programs agreed to the manifest changes during an April 16, 2007, meeting to evaluate options following the STS–117 mission's delay, which was caused by hail damage to the external fuel tank. Flights beyond STS–124 have not been assessed. Both Shuttle and ISS Program officials will continue to assess options for the remainder of the shuttle flights, and those target launch dates are subject to change.

Upcoming shuttle missions:

— STS–118 targeted for no earlier than Aug. 9, 2007, on Endeavour
— STS–120 targeted for no earlier than Oct. 20, 2007, on Discovery instead of Atlantis
— STS–122 targeted for no earlier than Dec. 6, 2007, on Atlantis instead of Discovery
— STS–123 targeted for no earlier than Feb. 14, 2008, on Endeavour
— STS–124 targeted for no earlier than April 24, 2008, on Discovery instead of Atlantis

The orbiters for STS–120, 122 and 124 were exchanged to best meet the demands of the missions and to have the least amount of impact on the overall flight schedule.

Aeronautics

Q3. Under the FY 2007 continuing resolution, NASA's aeronautics program received an additional $166 million. How does the agency intend to allocate this unanticipated sum during the balance of this fiscal year?

A3. Below are details outlining how NASA intends to spend the $187 million increase reflected in the Agency's initial FY 2007 Operating Plan. The $187 million total includes the $166 million difference between the $724 million President's FY 2007 budget request for the Aeronautics Research Mission Directorate (ARMD) and the $890 million reflected in the FY 2007 Revised Continuing Resolution (P.L. 110–5) , and further includes an increased overhead assessment to ARMD of $21 million. NASA allocated the Congressional FY 2007 budget augmentation to the three Aeronautics Research Programs consistent with the funding priorities reflected in the FY 2007 President's Budget request. NASA also increased the Aeronautics Test Program (ATP) budget level to fund strategic facility investments that will benefit both the Agency and the aeronautics user community.

The breakdown of the FY 2007 budget augmentation by research project is shown below.

Airspace Systems Program ($31.2 million)

The Next Generation Air Transportation System (NGATS) Air Traffic Management (ATM): Airportal Project: $6.7 million

The Airportal Project develops and validates algorithms, concepts, and technologies to increase throughput of the runway complex and achieve high efficiency in the use of airportal resources such as gates, taxiways, runways, and final approach airspace. Currently, the growth of air traffic demand and fleet diversity is causing the operational volume at hub airports to rapidly approach their maximum capacity. NASA research in this project will lead to development of solutions that safely integrate surface and terminal area air traffic optimization tools and systems with Four-Dimensional (4D) trajectory operations. The budget augmentation is directed toward:

- Application of data-mining techniques to study safe and efficient surface operations
- Human-in-the-loop simulations to test runway incursions and 4D taxi clearances
- Investigation of human roles and responsibilities in the airportal to enable gate-to-gate NGATS operations
- Comparison of competing concepts for metroplex operation during super density operations

Funds have also been used to enhance critical core competencies in data mining for surface traffic optimization, human-in-the-loop simulation modeling that supports research in automated separation assurance, autonomous operations tech-

nologies, modeling and simulation for airspace system design and human factors design issues for transitioning to the future NGATS.

The NGATS ATM: Airspace Project: $24.5 million

The Airspace Project develops and explores fundamental concepts and integrated solutions that address the optimal allocation of ground and air automation technologies necessary for NGATS. The Project will focus NASA's technical expertise and world-class facilities to address the question of where, when, how and the extent to which automation can be applied to moving aircraft safely and efficiently through the National Airspace System (NAS). Research in this Project will address 4D Trajectory Operations, including advances in the science and applications of multi-aircraft trajectory optimization that solve the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties and keeping aircraft safely separated. The Project's research will develop and test concepts for advanced traffic flow management to provide trajectory planning and execution across the spectrum of time horizons from "strategic planning" to "separation assurance." Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed. The budget augmentation expands the research and development portfolio for NGATS to include:

- Integration of weather information with automation concepts, algorithms and technologies for traffic flow management and super density operations
- Development of design principles to allow multi-objective trades of capacity, safety and uncertainty for NGATS and application of these principles to examine critical technical issues regarding insertion of new vehicles, procedures, operations, technologies and safety systems in NGATS
- Models of NGATS procedures and technologies that are integrated into NASA's software baselines such as the Airspace Concept Evaluation System, ACES, a core investment analysis tool used by the Joint Program and Development Office (JPDO), and
- Multi-vehicle coupled capacity and safety concepts, algorithms and technologies.

Funds have also been used to enhance critical core competencies in human-in-the-loop simulation modeling that supports research in automated separation assurance, autonomous operations technologies, modeling and simulation for airspace system design and human factors design issues for transitioning to the future NGATS.

Aviation Safety Program ($28.5 million)

The Aviation Safety program is committed to providing the means to conduct experiments that support its program objectives. The program uses testbeds and simulators to conduct its core research experiments, however, the opportunities offered by new testbeds and improved simulators will fundamentally strengthen the outcome of the foundational, discipline and multi-disciplinary research that is planned.

Integrated Resilient Aircraft Controls (IRAC) Project: $8.6 million

The ability to conduct full-scale flight experiments as part of the IRAC Project will expand the quality and potential application of the results of the validation and verification (V&V) efforts within the project in the field of adaptive controls—the most promising direction for resilient control. The F/A–18 provides the ability to conduct full-scale experiments that, in concert with the sub-scale model and analytical methods, are key in the field of adaptive control for both aeronautics and space applications. Funds will therefore be used to provide an integrated, one-time upgrade to the F/A–18 testbed. Funds will also be used to enhance critical core competencies in adaptive flight control, software design & validation and autonomous systems technology.

Integrated Vehicle Health Management (IVHM) Project: $5.7 million

Funds will be used to develop an IVHM testbed that will provide the computer processing capability to develop and validate tools and methods for integrating and analyzing large and disparate sources of data. The capability will be used to support the development of advanced data-mining tools and methods in the IVHM Project. Funds will also be used to enhance critical core competencies in icing research, software design & validation and autonomous systems technology.

Integrated Intelligent Flight Deck (IIFD): $11.6 million

The IIFD Project relies significantly on simulation of off-nominal conditions for its research. Funds will be used for simulator upgrades that will provide unique capabilities to integrate human-display testing, as well as better integration of sensor modeling. Funds will also be used to enhance critical core competencies in computer science and human factors research.

Aircraft Aging and Durability (AAD): $2.6 million

Funds will provide large-scale composite containment test specimens that will be used for in-house experiments, as well as for research conducted under cooperative agreements with external research organizations (our NRA partners). Funds will also be used to enhance critical core competencies in composite research.

Fundamental Aeronautics Program ($93.1 million)

The Fundamental Aeronautics (FA) Program is dedicated to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation across all flight regimes. The long-term research that the FA Program conducts is both focused and integrated across disciplines, and will be used to provide feasible solutions to the performance and environmental challenges of future air vehicles. Funds from the budget augmentation are targeted to further and accelerate this mission. In order to achieve significant results more rapidly, we are focusing on investments in advanced research ideas, improved facilities, stronger external partnerships, and additional testing and validation. In addition to the project-specific content provided below, funds from the budget augmentation will be used for four program-wide research initiatives that are intended to *jump-start* efforts to develop NASA's future computational capabilities (for predictive capabilities in fluid mechanics, combustion, acoustics, and materials and structures), to create environments and standards for multi-disciplinary analysis and optimization, to generate innovative new ideas, methods, and sensors to acquire experimental data that we cannot obtain today, and to speed-up the development of advanced, high-temperature, multi-functional materials for higher propulsive efficiency and to sustain harsh environments across the speed regime (in both airframe and propulsion applications).

Hypersonics Project: $33.4 million

The goal of the Hypersonics project is to conduct long-term, cutting-edge research in the core competencies of the hypersonic regime to address the technical challenges for two high-payoff missions: Highly Reliable Reusable Launch Systems (HRRLS) and High Mass Mars Entry Systems (HMMES). Funds from the budget augmentation will be used to enhance our capabilities to acquire data relevant for the validation of tools for the entry, descent, and landing (EDL) phase of planetary re-entry, for enhanced research in combined-cycle approaches for hypersonic propulsion, and to support partnerships (specifically, for the HyBoLT/SOAREX/ALV–X1 partnership with ATK, and the X–51 partnership with the Air Force and DARPA). Through these partnerships, we intend to create databases for transition to turbulence in very high-speed flows and to solve key outstanding problems in supersonic combustion for hypersonic, air-breathing systems. Funds will also be used to enhance critical core competencies in advanced structural concepts, durability technologies, nondestructive evaluation methods and arc jet experimental techniques.

Subsonic Fixed Wing Project: $34.1 million

The goal of the Subsonic Fixed Wing project is to conduct long-term, cutting-edge research in the core competencies of the subsonic fixed wing regime to enable improved prediction methods and technologies for lower noise, lower emissions (including NO_X, CO_2, water vapor, volatiles, unburned hydrocarbons, particulate matter, and soot), and higher performance for subsonic aircraft. Funds from the budget augmentation will be used to enhance the results produced in collaboration with our NRA partner institutions by allowing for the proof-of-concept development and testing of a number of innovative ideas. We also intend to improve key facilities that can significantly strengthen the quality of acoustics and emissions/combustion experimental data in support of future concepts for significant reductions in noise and emissions. Furthermore, funds will be used to build and enhance new and existing partnerships to enable future improvements to the aircraft fleet (specifically, our X–48B/BWB partnership with AFRL and Boeing in pursuit of revolutionary aircraft concepts, our Ultra-High Bypass Ratio Fan partnership with Pratt & Whitney, and our Cruise Efficient Short Take-Off and Landing partnership with AFRL and Northrop-Grumman). The content of all of these partnerships is focused on the development of new aircraft concepts that can enable the 2–3X growth in the air transpor-

tation system with minimal environmental impact. Funds will also be used to enhance critical core competencies in combustion foundational research and system integration of aerodynamics and heat transfer in the propulsion flow path.

Subsonic Rotary Wing Project: $12.8 million

The goal of the Subsonic Rotary Wing project is to conduct long-term, cutting-edge research in the core competencies of the subsonic rotary wing regime to enable improved prediction methods and technologies for lower noise, lower emissions, and higher performance for rotary wing aircraft. Higher performance includes improved speed, range, payload capacity, propulsion efficiency, and control systems for safe operations. A number of necessary facility improvements will be made to enable the acquisition of additional data to assess the performance of key efforts in the project (gear spur, variable-speed transmission). The variable-speed transmission effort, a potentially revolutionary technology that can be used to increase the cruise speed of rotorcraft vehicles, will see significant benefits from this budget augmentation. In addition, funds will be used to enhance and develop external partnerships and to allow for additional data to be obtained during key tests planned for the coming months. For example, additional data will be gathered during the DARPA SMART rotor test to assess the ability of actively-controlled helicopter blades to reduce the noise from blade-vortex interactions during high-speed flight and descent. Funds will also be used to enhance critical core competencies in advanced control methods and cabin noise modeling and reduction.

Supersonics Project: $12.8 million

The goal of the Supersonics project is to conduct long-term, cutting-edge research in the core competencies of the supersonic regime to address the technical challenges for two supersonic vehicle classes: practical supersonic cruise aircraft and supersonic descent for High Mass Mars Entry Systems. Funds from the budget augmentation will be used to improve key facilities for the acquisition of acoustic data and the development of improved materials for high-temperature operation. Additional test opportunities will be made possible in the areas of sonic boom assessment and impact, noise suppression through advanced nozzle concept development, and aeroelastic predictive methodologies. Furthermore, funds will be used to enhance our ability to predict the supersonic deceleration phenomena of the EDL phase. Funds will also be used to enhance critical core competencies in high-temperature sensors, advanced inlet/nozzle concepts, aero-propulsive-servo-elasticity, composite structures, and lightweight multi-functional materials.

Aeronautics Test Program ($34.6 million)

Flight Operations and Test Infrastructure: $28.7 million

The budget augmentation will be used to ensure the strategic availability of critical capabilities at the Dryden Flight Research Center, which include Western Aeronautical Test Range (WATR), support aircraft (chase, pilot proficiency, and project support), testbed aircraft (directly participates in tests) and loads laboratory and simulators.

Aero Ground Test Facilities: $5.9 million

The budget augmentation will be used to upgrade the Unitary Wind Tunnel and Arcjet facility at Ames Research Center and the National Transonic Facility at the Langley Research Center to support NASA's missions over the long-term.

Q4. During last year's committee hearings on the Decadal Survey for Aeronautics, many industry and academic witnesses expressed deep concern about NASA's plans to limit its R&D efforts to a basic level of development. They argued that such a policy could jeopardize the success of the Joint Planning and Development Office by halting development of promising air traffic management technologies at a level that FAA would be unable to adopt them into the next generation air transportation system. What steps are NASA and FAA taking to ensure this "technology gap" doesn't come into play?

A4. First, it is important to note that all three of the Aeronautics Research Mission Directorate (ARMD) research programs (Fundamental Aeronautics, Aviation Safety, and Airspace Systems) contribute directly and substantively to the Next Generation Air Transportation System (NextGen). Together, these programs address critical air traffic management, environmental, efficiency, and safety-related research challenges, all of which must be worked in order for the NextGen vision to be realized. The outputs of this focused commitment and investment will include advanced con-

cepts, algorithms, tools, methods, and technologies, and all of these products will be critical to the success of NGATS.

It should be evident from the clearly stated goals of the NextGen that a focus on fundamental, cutting-edge research is absolutely essential to the successful realization of the NextGen vision. The Vision 100 Century of Aviation Reauthorization Act (Public Law 108-176) clearly states that "The integrated plan shall be designed to ensure that the Next Generation Air Transportation System meets air transportation safety, security, mobility, efficiency, and capacity needs *beyond those currently included in the Federal Aviation Administration's operational evolution plan. . .*" (emphasis added). In other words, the NextGen vision is not simply an incremental advance on the existing system; it represents a true paradigm-shift from what we have today, and it requires a commitment to cutting-edge research across a breadth of aeronautical disciplines (from noise and emissions research to safety research to advanced mathematical optimization algorithms for airspace management, just to name a few). Such a commitment is precisely what NASA's new program is offering. Our return to fundamental, innovative research will increase the probability of development of the revolutionary technologies that will be required for the successful implementation of NextGen and will broaden the advanced technology development options.

While many have embraced NASA's return to the cutting-edge, and understand that such a focus is critical to the NextGen vision, some have raised concerns about "technology transition." According to Public Law 108–176, it is the responsibility of the Joint Planning and Development Office (JPDO) to facilitate "the transfer of technology from research programs such as the National Aeronautics and Space Administration program and the Department of Defense Advanced Research Projects Agency program to federal agencies with operational responsibilities and to the private sector." In other words, the responsibility for transition resides with the JPDO and all of its five member agencies. This responsibility is reinforced in the newly drafted JPDO MOU, which both NASA and the FAA have signed.

Transition of research into operational use is of course not a new challenge, nor is it particular to the FAA and NASA. One way to jeopardize successful transition, however, regardless of the agencies involved, is for the parties to become fixated on "technology maturity levels," or "technology readiness levels." The level of maturity to which a technology is developed is irrelevant if that technology does not enable the desired goals of the intended users. Successful transition requires the researchers and the users to engage closely from the very beginning on whatever is being developed or invented. The users must understand the assumptions and limitations that the researchers are operating under as they perform their research, and the researchers must understand how their assumptions will impact the usefulness of their technology or method. Successful transition relies upon a close working relationship among those who conduct the research and those who use its results, and the JPDO has been established precisely to address this challenge. NASA intends to work closely with all of the member agencies of the JPDO, including the FAA, throughout the entire technology development process to ensure that, to the greatest extent practicable, researchers and system operations personnel collaborate to make the technology development and transition as effective as possible. Figure 1 below illustrates our approach in the case of the transition of our airspace systems research to the FAA. This approach enables both NASA and the FAA to do what each does best according to its charter and mission in the best interest of the Nation.

Finally, it must be noted that the Enterprise Architecture and the Integrated Work Plan, the primary planning documents of the NextGen, are still being developed by the JPDO. Baseline versions for each of these documents are scheduled for completion during FY 2007. However, these documents will need to be vetted with the stakeholder community and will undoubtedly continue to evolve over the next few years. As these documents mature, gaps will most likely be identified in technology development, knowledge, schedule, or other areas, and NASA, the FAA, and the other JPDO member agencies (DOD, DHS, DOC) will work together to address those specific gaps as they impact NAS transitions and system implementation. In the interim, NASA will continue to work with the JPDO to refine its technical roadmaps and resource plans, which have been developed in substantial collaboration with the JPDO, as information regarding the JPDO plans becomes available.

Figure 1: Transition of Airspace Systems R&D from NASA to the FAA