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

External Perspectives on the FY 2010 NASA Budget Request and Related Issues

Thursday, June 18, 2009
10 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose:

On Thursday, June 18, 2009 at 10:00 a.m. the Subcommittee on Space and Aeronautics will hear from advisory and other stakeholder bodies on issues relevant to the National Aeronautics and Space Administration (NASA).

Witnesses:

Mr. John C. Marshall
Member
Aerospace Safety Advisory Panel (ASAP)

Dr. Kenneth M. Ford
Chair
NASA Advisory Council (NAC)

Mr. Robert M. Hanisee
Chair
Audit and Finance Committee
NASA Advisory Council (NAC)

Dr. Raymond S. Colladay
Chair
National Academies' Aeronautics and Space Engineering Board (ASEB)

Dr. Berrien Moore III
Member
National Academies' Space Studies Board (SSB)

Mr. J.P. Stevens
Vice President for Space Systems
Aerospace Industries Association (AIA)

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 projected civil service workforce for FY 09 is 17,900 employees. NASA has ten field Centers, including the Jet Propulsion Laboratory (JPL), a Federally Funded Research and Development Center (FFRDC). 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 (ISS). NASA is undertaking an exploration initiative with the goals of developing a new human space transportation system for both low Earth orbit and for missions beyond low Earth orbit, returning American astronauts to the Moon by 2020, and carrying out a broad program of human and robotic exploration of the solar system. NASA also maintains a space communications network that supports both NASA missions and other federal agency requirements. As of 2007, the most recent date for which complete data are available, about 82 % of NASA's budget was for contracted work. In addition, a number of NASA's scientific and human space flight activities involve collaboration with international participants.

The Committee held a hearing on May 19, 2009 at which time the NASA Acting Administrator, Mr. Christopher Scolese, presented NASA's FY 2010 budget request. Witnesses at today's hearing have been asked to identify the top priorities and issues that the Committee on Science and Technology should consider in upcoming multi-year NASA authorization legislation and any other matters they believe merit attention.

Budgetary Information

To put the FY 10 budget request into context, NASA has been tasked with flying the Shuttle safely until the end of the decade and then retiring the Shuttle fleet; completing assembly of, operating, and utilizing the International Space Station; completing the development of a new Crew Exploration Vehicle/Crew Launch Vehicle by 2015; returning American astronauts to the Moon by 2020; and conducting a variety of challenging science and aeronautics programs. The NASA Authorization Act of 2008 [P.L. 110-422] authorized an FY 09 funding level for NASA of $20.21 billion; the FY 09 NASA budget request was $17.61 billion and the appropriation for FY 09 was $17.78 billion. In addition, The American Recovery and Reinvestment Act [P.L. 111-5] included $1 billion for NASA's Earth science, aeronautics, exploration programs, cross-agency support, and Inspector General. Recovery Act funds are to be expended by September 30, 2010. P.L. 110-422 is a one-year authorization for NASA; the Science and Technology Committee is planning to move a multi-year reauthorization of NASA later this year.

President's FY 2010 Request

NASA's proposed budget for FY 10 is $18.7 billion, an increase of 5.1% over the enacted FY 09 appropriation for NASA. The FY 10 budget projection for NASA beyond FY 10 is essentially flat through FY 13. Attachment 1 summarizes the FY 10 budget request and its five-year funding plan.

Attachment 2 compares the NASA budget plan that accompanied the Vision for Space Exploration introduced by President Bush in 2004 with the actual funds requested for NASA. As can be seen, previous budget requests for NASA 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 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 $4 billion. The additional funding provided in the FY 09 appropriation and the FY 10 budget request help to redress that shortfall. However the FY 10 budget request does not project growth for the NASA budget beyond FY 10, and the disparity between the 2004 budget projections for FY 11-14 that the agency was planning against and the budgets that are now being proposed through FY 14 is shown in the chart. In addition, the impact of the budgetary shortfalls since 2004 has been exacerbated by the requirement to absorb the cost of the Shuttle's return-to-flight following the Columbia accident, the additional cost associated with the under budgeting of Shuttle transition and retirement that occurred in the FY 05 budget plan, and the under budgeting of ISS program support that also occurred in the FY 05 budget plan, which NASA indicates resulted in an unfunded lien against the agency's budgets of about $6.5 billion through FY 10.

House Appropriations Committee's Approval of CJS Subcommittee Recommendations

The Commerce, Justice, and Science (CJS) Subcommittee of the House Appropriations Committee held a markup of their fiscal year 2010 appropriations bill on June 4, 2009. The Subcommittee's funding recommendations for NASA in the bill were as follows:

Dollars in millions

	FY 09 Enacted	FY 10 Request	HAC/CJS FY 10 Markup	% Change between HAC/CJS FY 10 Markup and FY 10 Request
Science	4,503.0	4,477.2	4,496.1	+ 0.4
Aeronautics	500.0	507.0	501.0	-1.2
Exploration	3,505.5	3,963.1*	3,293.2	-16.9
Space operations	5,764.7	6,175.6	6,097.3	-1.3
Education	169.2	126.1	175.0	+38.8
Cross agency support	3,306.4	3,400.6	3,164.0	-6.9
Construction and environmental compliance	0.0	0.0	441.7	N/A (HAC Subcommittee addition)
Office of Inspector General	33.6	36.4	35.0	-3.8
TOTAL	17,782.4	18,686.0	18,203.3	-2.6

Source: HAC Website, June 4, 2009 and HS&T analysis

*According to the President's FY 2010 Budget Request for NASA, the Administration will update its request for Exploration following the human spaceflight review.

In terms of differences with the President's request, the markup establishes a higher level of funding for Education and a new line item for Construction and environmental compliance. Exploration was recommended at a funding level approximately $670 million less than requested (16.9%). In total, the markup is about $483 million (2.6%) less than the FY 10 request, but 2.4 % higher than the level enacted for FY 09. The Chairman of the Commerce, Justice and Science Subcommittee said in his statement releasing the Subcommittee's FY 10 recommendations:

"For NASA, the bill provides a total of $18.2 billion, an increase of $421 million over last year's level. Investments have been made in Earth science to further the decadal surveys. The recommendation, however, acknowledges that the Administration has established a blue ribbon panel, led by Dr. Norm Augustine, to review the current vision for human space flight. Funds are provided in the bill to continue investments in human space flight at the same level as provided in fiscal year 2009. Reductions from the budget request should not be viewed as a diminution of my support or that of the Subcommittee in NASA's human space flight activities. Rather, the deferral is taken without prejudice; it is a pause, a time-out, to allow the President to establish his vision for human space exploration and to commit to realistic future funding levels to realize this vision.

The Subcommittee looks forward to receiving the findings of Dr. Augustine's panel and the recommendation of the Administration on the way forward. I do believe, however, in order to avoid continuing cost increases and further delays in the initial operating

capability of our Nation's next generation of human space flight architecture to follow the Shuttle's successful and impressive run, it is imperative that the Administration and Congress provide the necessary resources to meet that policy directive – in the annual President's budget and the annual Congressional budget process. When President Kennedy said we would put a man on the moon, the Nation followed – in spirit and with the resources to get the job done. We collectively should do no differently today."

The House Appropriations Committee approved the FY2010 Commerce, Justice and Science appropriations bill by voice vote with no changes on June 9, 2009. A floor vote is scheduled for June 17, 2009.

Aerospace Safety Advisory Panel

Since it was established in 1968 by Congress, the Aerospace Safety Advisory Panel (ASAP) has been evaluating NASA's safety performance and advising the agency on ways to improve that performance. The Panel, which is a FACA-chartered advisory body, consists of a maximum of nine members who are appointed by the NASA Administrator and is comprised of recognized safety, management, and engineering experts from industry, academia, and other government agencies.

The ASAP is a senior advisory committee that reports to the NASA Administrator and Congress. The Panel was established by Congress in the aftermath of the January 1967 Apollo 204 spacecraft fire. The Panel's statutory duties, as prescribed in Section 6 of the NASA Authorization Act of 1968, Public Law 90-67, 42 U.S.C. 2477 are as follows:

"The Panel shall review safety studies and operations plans that are referred to it and shall make reports thereon, shall advise the Administrator with respect to the hazards of proposed operations and with respect to the adequacy of proposed or existing safety standards, and shall perform such other duties as the Administrator may request."

The Panel was reauthorized in Section 106, Safety Management, Section 6, of the National Aeronautics and Space Administration Authorization Act of 2005, [P.L. 109-155].

The ASAP bases its advice on direct observation of NASA operations and decision-making. The Panel provides a report on an annual basis. In addition to examining NASA's management and culture related to safety, the report also examines NASA's compliance with the recommendations of the Columbia Accident Investigation Board (CAIB). The former NASA Administrator, Dr. Michael Griffin, also requested advice from the ASAP on technical authority, workforce and risk management practices.

ASAP 2008 Annual report

The transmittal letter accompanying the 2008 Annual report issued on April 15, 2009 stated that *"ASAP members believe that NASA and the new Administration stand at a critical crossroads for the Nation. Consequently, the ASAP decided to provide this brief,*

to-the-point letter report in lieu of the normal lengthier annual report issued by the Panel." While indicating that on balance, 2008 was a good year for NASA and that the ASAP is optimistic about the future of the Agency and its mission based on NASA's accomplishments in 2008, the Panel also recognized that "*this is a crucial time for NASA, the new Obama Administration, and the country. Important decisions lie ahead."* Issues the Panel identified in the report as critical were:

- **Proposed extension of the Space Shuttle Program**. The ASAP said in its report: *"To maximize safety, minimize wasted effort, and bolster employee morale, any further debate regarding the future of the Shuttle should be undertaken immediately and completed without further delay. From a safety standpoint, the ASAP strongly endorses the NASA position on not extending Shuttle operations beyond successful execution of the December 2008 manifest, completing the ISS. Continuing to fly the Shuttle not only would increase the risk to crews, but also could jeopardize the future U.S. Exploration program by squeezing available resources (and, in the worst case, support) for the Constellation program."*
- **Acceleration of the Constellation Program**. The ASAP in its report that it *"is not convinced that the Ares I and Orion initial operating capability (IOC) date can be improved appreciably by additional resources."*
- **Use of commercial transportation sources**. The report stated that "*There is no evidence that Commercial Orbital Transportation Services (COTS) vehicles will be completed in time to minimize the gap*".
- **Safety and reliability of Soyuz**. At its 2008 Second Quarterly meeting, the Panel expressed concern about the "*safety issues surrounding the Soyuz capsule and its associated recovery module*" following re-entry difficulties experienced by the Russian spacecraft. Although the ASAP said in its annual report that it continues to be concerned about the safety of the Russian Soyuz vehicle, the report also said that the Panel "*is satisfied that NASA is aware of and addressing the potential limitations involved in relying on Soyuz during the gap between Shuttle retirement and Constellation IOC"*.
- **Direction of Exploration**. The Panel suggested "*stability of policy and technical goals as particularly crucial for complex, expensive, safe, long-term programs and for cost-efficient, cost-effective, and safe mission plans and workers*". But the Panel also endorsed the standard management and engineering practice of "*periodically reviewing architecture and program plans (including design assumptions, new developments, changing requirements, emerging technologies, and their impact on decisions). Such reviews are particularly useful for programs such as Constellation that extend over many years and are subject to external reassessments of fundamental goals."*
- **Safety hardwired into Constellation.** The Panel's report said that **"***NASA has an important one-time opportunity to better interweave safety as a consistent and more powerful operating parameter by hardwiring safety into the fabric and procedures of the new flagship exploration program, Constellation. Accordingly, NASA should institutionalize safety programs, systems, processes, and reporting*."
- **Upgrading of NASA facilities and equipment.** The report said that: **"***During repeated visits to NASA Centers and Headquarters to hold quarterly and insight*

meetings, the ASAP has noted that deferred maintenance, modification, and upgrading of basic NASA infrastructure deserve higher priority."

- **Funding consistent with tasks and schedules**. The ASAP said in its report that it "*cannot overemphasize the high-priority need for Congress and the Administration to understand the impact on NASA of the interrelationship among cost, schedule, and risk (which is ignored only at great risk to safety)."*
- **Suitability of agency management approaches**. The Panel made observations on the governance structure, noting positive evolution of the "*new strategic management and governance model at Headquarters and at the NASA Centers*" and a "*new management emphasis on institutional requirements for safety, engineering, facilities, and personnel in the planning process*". However, the Panel expressed concern about the substance, application, and standardization of Human-Rating Requirements (HRR) across the agency. The report said that "*The new HRR standards move from validating compliance with mandatory failure tolerance requirements to an approach of designing to acceptable risk, but without any apparent clear and visible criteria for estimating "how safe is safe enough" for various mission categories*."
- **Workforce Development and Sustainment**. The Panel said that it supports *"continued attention to workforce planning, development, and sustainment to ensure that technically qualified personnel are available for NASA and its contractors so that these people can identify, manage, and control the complex safety risks of NASA programs."*
- **NASA culture that values the experience of safety and mission assurance**. While stating it was impressed with recent developments in NASA's safety culture evolution over the years, the Panel encouraged NASA to perform *"periodic internal and external measurements based on meaningful metrics"*.
- **Technical Standards Program focused on safety and risks**. The Panel stated that *"More robust technical performance standards are necessary to fill the void created by cancellation in the 1990s of numerous military standards and specifications."* Relative to the promulgation of lessons learned, the panel stated that "*NASA should improve its documentation and distribution system to capture and share lessons learned with all NASA Centers, mission directorates at NASA Headquarters, and, when appropriate, the private sector."*
- **CAIB Recommendations.** As mandated by the NASA Authorization Act of 2005, the ASAP is responsible for evaluating and reporting annually on NASA compliance with CAIB return-to-flight and continue-to-fly recommendations. The Panel said in its report that it "*is pleased with NASA's overall response*" and acknowledged that the Panel "*knows that the remaining three CAIB recommendations cannot be completely eliminated without major redesign. The Panel thus recommends that NASA use its formal risk acceptance process to make a decision on how to close out the remaining actions."*
- **Astronaut Health**. The Panel said that it had "*made a commitment to monitor the NASA Astronaut Health Care Systems Review and is satisfied with NASA's progress in responding to associated report recommendations*." The Panel noted that since its June 2007 report, NASA had undertaken several actions such as incorporating psychological evaluations as part of the future astronaut selection process.

In addition to its annual report, the Panel also submits Minutes with recommendations resulting from its quarterly meetings. For example, the Panel recommended, following its fourth quarter of 2008 meeting, that "*NASA obtain greater validation that the new Human-Rating Requirements Standard meets the safety requirements of a broad range of future human spaceflight programs by scheduling an external review by an independent "gray-beard" assessment panel.* "

NASA Advisory Council

NASA has had a long tradition of turning to knowledgeable experts for advice and guidance on major program and policy issues facing the agency. This tradition originated with NASA's predecessor organization, the National Advisory Committee for Aeronautics (NACA). With the creation of NASA in 1958, the NACA was abolished, but the tradition of turning to nongovernment sources for independent judgment and guidance survived. NASA established the NASA Advisory Council (NAC) to assist it with planning for its new and continuing responsibilities in aeronautics, space technology, space science and applications, and human space flight.

Today, the NAC, comprised of senior-level individuals from the private sector (e.g., academia, business, and retired government personnel), meets regularly to offer the NASA Administrator broad perspectives on agency program issues that the Administrator might not otherwise receive. The NAC consists of six committees, each chaired and populated exclusively by Council members. The six committees are:

- Aeronautics Committee
- Audit and Finance Committee
- Exploration Committee
- Human Capital Committee
- Science Committee
- Space Operations Committee

The NAC is composed of members appointed by the NASA Administrator; these members serve at the pleasure of the Administrator. The Council consists of approximately 25 to 35 members, renewable at the discretion of the NASA Administrator. Additionally, the National Academies' Chairs of the Aeronautics and Space Engineering Board and the Space Studies Board sit on the Council as ex-officio members.

The Council is considered "internal" in that it is chartered by NASA, its members are chosen by the agency, and it provides advice and counsel directly to the NASA Administrator. The Council operates under the Federal Advisory Committee Act (FACA) which allows access to government decision making processes, among other objectives. FACA sets requirements for Government-established groups that provide advice to the Government and that include non-Government employees.

Recent NAC Recommendations and Concerns

The NASA Advisory Council (NAC) meets on a quarterly basis and submits recommendations to the NASA Administrator shortly thereafter. The Council also conducts fact-finding meetings at different NASA facilities. Following its April 16, 2009 meeting, the Council made eight recommendations to NASA that the Council believed would be of assistance to NASA as the agency continues its implementation of its space exploration mission. The recommendations were:

- **Infusing new talent and knowledge into the NASA workforce**. The Council said that "*continued leadership in space science and exploration requires the constant infusion of new ideas and state-of-the-art knowledge provided by a vibrant and creative workforce. Therefore, NASA is encouraged to pursue avenues that will facilitate new hiring, particularly at the entry-level.*"
- **Assessing how NASA TV could be more effective and what is required to accomplish that goal**. The Council stated that "*The outcome of this study should include recommendations for the level and type of resources required to most effectively engage the public and disseminate NASA content.*"
- **Teaching and applying lessons learned to NASA's Human Spaceflight employees**. The Council said that "*To effectively transfer hard-won "lessons learned" to its human spaceflight work force, NASA is encouraged to institute recurring training for the workforce using a curriculum based on existing Safety and Mission Assurance materials. The training program should include lessons learned from the Apollo, Skylab, Mir, Shuttle, and ISS accidents, incidents, and close calls.*"
- **Documenting and Teaching of Human Spaceflight Lessons Learned**. The Council recommended that **"***A portion of the NASA training program should focus on lessons learned from the human spaceflight missions in order to retain historical knowledge, as many older employees will be retiring. NASA should document specific major operational lessons learned from human spaceflight programs. These lessons learned should be written /presented in a format to facilitate ease of training for the next generation of space workers.*"
- **Conducting a cost-benefit study of possible active methods for orbital debris removal**. The Council encouraged NASA **"***to conduct an in-house study of the current and projected orbital debris situation in order to evaluate the costs and benefits of developing a form of debris removal technology. The study should compare the costs of operating in the ever-expanding debris population with those of developing a selective debris removal method, and how those compare with long-term savings from actively reducing the threat of future collisions*."
- **Forming an Exoplanet Exploration Program Analysis Group under the NAC's Astrophysics Subcommittee**. NASA was encouraged to form such a group to conduct analyses at the request of the NAC's Science Committee, the NAC's Astrophysics Subcommittee, and NASA's Science Mission Directorate.
- **Developing a process for identifying non-science requirements and funding for Earth observations**. The Council encouraged NASA "*to work with OSTP and other agencies at the highest levels to define responsibilities and secure funding for Earth*

observations beyond those recommended by the NRC Decadal Survey to advance Earth System Science."

- **Conducting an independent study of space communications - requirements, capabilities, and architecture**. The Council encouraged NASA *"to contract for an independent study of space communications needs for science, exploration, and space operations. The report resulting from this study should include findings and recommendations that will assist NASA in planning a communications architecture that will enable the successful conduct of missions planned or conceivable through 2030. This study should result in recommendations that will assist NASA in development of more detailed, quantifiable requirements."*

Prior year recommendations from the NAC dealt with diverse issues, ranging from NASA's need to convene a workshop to provide external community input to the agency's formulation of the system-level program on Environmentally Responsible Aviation (recently unveiled as part of the FY 2010 budget request) to communicating lessons learned on large mission cost drivers to decadal survey committees. On that last recommendation, the Council was particularly concerned that "*in the last round of NRC decadal surveys, some high priority mission(s) ranked on the basis of an initial cost estimate turned out to be two to four times as expensive to develop. This leads to questions of whether those same rankings would have been assigned had more realistic cost estimates been available, and whether some different mix of missions might have been recommended to achieve the optimal science return within available funding constraints."* The Council concluded that *"the NRC decadal survey committees need to understand how early choices in mission concept design lead to cost growth so they can structure their recommendations to be more robust over time."*

The National Academies

The National Academy of Sciences (NAS) is a private, not-for-profit society of elected scholars in the areas of scientific and engineering research. The Academy is committed to science and technology research and its application to society. The NAS was chartered by Congress in 1861 to "*advise the federal government on scientific and technical matters*."

In 1964, the National Academy of Engineering, a body of renown engineers who are elected to be members, was established under the charter of the NAS, and shares the work with the NAS in advising the federal government. In addition, the NAS, in 1970, established the Institute of Medicine, which is a body of elected, distinguished experts in medicine, health and health policy, to advise the government and "*upon its own initiative, to identify issues of medical care, research, and education*." In 1916, the NAS organized the National Research Council, "*to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government*." "*…the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities*." The NAS, NAE, IOM, and NRC are collectively referred to as The National Academies.

A primary function of the National Academies is to convene "*committees of experts in all areas of scientific and technological endeavor. These experts serve pro bono to address critical national issues and to give advice to the federal government and the public*."

The National Research Council is organized into thematic discipline areas. Within the Division on Engineering and Physical Sciences, the Space Studies Board (SSB) and the Aeronautics and Space Engineering Board (ASEB) oversee ad-hoc committees of experts that prepare reports and provide other information on research, technical and policy areas related to space and aeronautics, and provide advice to the Federal government in these areas. The Federal government funds approximately 85 percent of the work of the NRC through individual contracts and grants, according to the National Academies. Individuals representing the SSB and ASEB will testify at the hearing.

Space Studies Board

The Space Studies Board (SSB) was established in 1958 and consists of members from academia, private industry, and not-for-profit organizations with expertise in space science, policy, engineering, and other related fields. The Board "*oversees advisory studies and program assessments, facilitates international research coordination, and promotes communications on space science and science policy between the research community, the federal government, and the interested public*." Among its consensus-based studies are the SSB-led "decadal surveys" which provide recommendations, with extensive input from the interested community, on priority missions and research activities to be pursued in the areas of planetary science, solar and space physics, and Earth science and other research objectives. The SSB is also the U.S. national committee to the Committee on Space Research of the International Council of Science, a multidisciplinary scientific entity that promotes the international exchange of scientific results, information, and discussion on scientific research in space.

The Board is currently undertaking the following activities:

- A decadal survey on biological and physical sciences in space, in cooperation with the Aeronautics and Space Engineering Board;
- A planetary science decadal survey;
- NASA's suborbital research capabilities;
- Astro2010 astronomy and astrophysics decadal survey, in cooperation with the Board on Physics and Astronomy;
- A review of near-Earth object surveys and hazard mitigation strategies, in cooperation with the Aeronautics and Space Engineering Board;
- Development of a workshop report on future international space cooperation and competition in a globalizing world;
- A study of the role and scope of mission-enabling activities in NASA's space and Earth science missions; and
- A study on the rationale and goals of the U.S. civil space program, in cooperation with the Aeronautics and Space Engineering Board.

Recently published SSB reports include:

- ***An Assessment of Planetary Protection Requirements for Mars Sample Return Missions***

  NASA requested that the NRC review the findings of an earlier report on planetary protection for a Mars Sample Return mission and to update the recommendations in light of scientific understanding of Mars and advances in relevant technologies.

- ***A Performance Assessment of NASA's Heliophysics Program***

  The 2005 NASA Authorization Act directed NASA to arrange for the National Academies to review the performance of each of the NASA Science Mission Directorate divisions every five years. This Assessment of NASA's Heliophysics Program reviewed the extent to which NASA's heliophysics division aligned with previous NRC advice, especially the decadal survey report, *The Sun to the Earth—and Beyond: A Decadal Research Strategy in Solar and Space Physics*.

  The report noted that "*Unfortunately, very little of the recommended NASA program priorities from the decadal survey's Integrated Research Strategy will be realized during the period (2004-2013) covered by the survey. Mission cost growth, reordering of survey mission priorities, and unrealized budget assumptions have delayed or deferred nearly all of the NASA spacecraft missions recommended in the survey. As a result, the status of the Integrated Research Strategy going forward is in jeopardy, and the loss of synergistic capabilities in space will constitute a serious impediment to future progress*."

- ***Severe Space Weather Events: Understanding Societal and Economic Impacts Workshop Report***

  The report summarized a public workshop held in May 2008 that included presentations and discussions on the "*nation's current and future ability to manage the effects of space weather events and their societal and economic impacts*."

- ***Launching Science: Science Opportunities Provided by NASA's Constellation System***

  The report was requested by NASA. The executive summary notes: "*The committee was impressed with the scientific potential of the many proposals that it evaluated. However, the committee notes that the Constellation System has been justified by NASA and selected in order to enable human exploration beyond low Earth orbit—not to enable science missions. Virtually all of the science mission concepts that could take advantage of Constellation's unique capabilities are likely to be prohibitively expensive*."

- ***Ensuring the Climate Record from the NPOESS and GOES-R Spacecraft: Elements of a Strategy to Recover Measurement Capabilities Lost in Program Restructuring***

  The study was requested by NASA and NOAA to "*prioritize capabilities, especially those related to climate research, that were lost or placed at risk following recent changes to NPOESS and the GOES-R series of polar and geostationary environmental monitoring satellites*."

- ***United States Civil Space Policy: Summary of a Workshop***

  The workshop participants considered the goals, purposes and priorities of U.S. civil space including *"key changes and developments since 2003; how space exploration fits in a broader national and international context; sustainability factors, including affordability, public interest, and political will; definitions, metrics, and decision criteria for program portfolio mix and balance; roles of government in Earth observations from space; and requirements and gaps in capabilities and infrastructure."*

- ***Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity***

  NASA requested that the NRC conduct a study "to *provide criteria and guiding principles for determining the list of candidate missions*" for the next competition for a New Frontiers mission. The New Frontiers Program to compete principal-investigator-led science missions to explore the solar system with a cost cap of $750 million, according to the report.

- ***Space Science and the International Traffic in Arms Regulations: Summary of a Workshop***

  NASA requested that the NRC "*organize a workshop on the implications of ITAR for space science. The purpose of the workshop was to reopen a discussion among State Department regulators and policymakers, academic researchers and faculty, ITAR officials, NASA officials, and other interested parties to explore concerns about ITAR's effects on space science activities*."

  The NRC summarized the workshop presentations and discussions in a report. The workshop summary noted that "*Over the long term…many believe that a clean-slate approach is needed to fix the fundamental disconnect between ITAR as it is being applied to space science research and the needs of the U.S. space science community as it endeavors to maintain world leadership. The United States has many space-related policy priorities in addition to national security, including space leadership, university excellence, and international partnerships. As emphasized at the workshop, all these national goals need to be considered jointly in the development of a system for controlling the export of space-related hardware and technology that is*

effective at protecting national security, but that does not inadvertently harm the other policy priorities."

Aeronautics and Space Engineering Board

Established in 1967, the Aeronautics and Space Engineering Board (ASEB) is comprised of individuals from academia, private industry, and not-for-profit organizations with expertise in aeronautics, aviation, space systems and engineering, and policy. The ASEB "*oversees ad hoc committees that recommend priorities and procedures for achieving aerospace engineering objectives, and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance*."

The ASEB is currently undertaking the following activities:

- A decadal survey on biological and physical sciences in space, in cooperation with the Space Studies Board;
- A review of Near-Earth Object Surveys and Hazard Mitigation Strategies, in cooperation with the Space Studies Board;
- A study on the rationale and goals of the U.S. civil space program, in cooperation with the Space Studies Board;
- An independent assessment of NASA's National Aviation Operations Monitoring Service (NAOMS) Project, and
- A review of the NASA Institute for Advanced Concepts.

Recently published ASEB reports include:

- ***Radioisotope Power Systems: An Imperative for Maintaining U.S. Leadership in Space Exploration***.

  The study was conducted in response to House Report 110-240 of the Commerce, Justice, Science and Related Agencies Appropriations Bill, 2008 and assessed NASA's program in radioisotope power systems technology and its ability to meet NASA's near-term and future mission needs and plans.

  According to the report, "*Reestablishing domestic production of ^{238}Pu will be expensive (the cost will likely exceed $150 million). Previous proposals to make this investment have not been enacted, and cost seems to be the major impediment. However, regardless of why these proposals have been rejected, the day of reckoning has arrived. NASA is already making mission-limiting decisions based on the short supply of ^{238}Pu*."

- ***A Constrained Space Exploration Technology Program: A Review of NASA's Exploration Technology Development Program***
  In response to Congressional direction in the report of the Science, State, Justice, and Commerce fiscal year 2007 appropriations, NASA arranged for an NRC assessment of NASA's Exploration Technology Development Program (ETDP) "*to determine how well the program is aligned with the stated objectives of the Vision for Space Exploration (VSE), identify gaps, and assess the quality of the research*." Although the bill did not become law, NASA proceeded with the request for the study.

  As noted in the executive summary, "*A fundamental concern…is that the ETDP is currently focused on the short-term challenges of the VSE and is addressing the near-term technologies needed to meet these challenges. Although it is clear that much of this focus results from the constraints on the program, the committee is concerned that the short-term approach characteristic of the current ETDP will have long-term consequences and result in compromised long-term decisions. Extensibility to longer lunar missions and to human exploration of Mars is at risk in the current research portfolio*."

- ***NASA Aeronautics Research: An Assessment***

  NASA requested the study in response to the NASA Authorization Act of 2005, which directed that NASA arrange for an NRC assessment of the NASA aeronautics research portfolio in the context of the recommendations of the NRC Decadal Survey of Civil Aeronautics, NASA's aeronautics research requirements, and the ability of the nation's research workforce and facilities to address the priority research challenges and requirements for civil aeronautics.

- ***Managing Space Radiation Risk in the New Era of Space Exploration***

  NASA requested that the NRC "*evaluate the radiation shielding requirements for lunar missions and to recommend a strategic plan for developing the radiation mitigation capabilities needed to enable the planned lunar mission architecture*."

  As noted in the executive summary of the report, "*The committee finds that the lack of knowledge about the biological effects of and responses to space radiation is the single most important factor limiting the prediction of radiation risk associated with human space exploration*."

- ***Assessing the Research and Development Plan for the Next Generation Air Transportation System: A Workshop***

  Upon request by the Federal Aviation Administration's Joint Planning and Development Office (JPDO), the National Academies held a workshop "*to gather observations on the research and development aspects of the baseline Integrated Work Plan for the Next Generation Air Transportation System (NextGen) being prepared by JPDO….*"

- ***Wake Turbulence: An Obstacle to Increased Air Traffic Capacity***

  The study was conducted pursuant to direction in the NASA Authorization Act of 2005 [P.L. 109-155] for NASA to enter into an arrangement with the National Research Council to assess the issue of wake vortex hazard, which has the potential to affect air traffic capacity.

  The authoring committee of the report found "*that the wake vortex problem does present a real impediment to increased traffic capacity, something reflected in most of the documentation that has been drafted to date by the JPDO* [Joint Planning and Development Office]…. *However, although the need to address wake vortex issues is clearly acknowledged, the research required to provide the required solutions is not yet underway*."

<u>Aerospace Industries Association</u>

The Aerospace Industries Association (AIA), founded in 1919 as the Aeronautical Chamber of Commerce, represents about 300 aerospace manufacturing companies and suppliers across all segments of the industry, including commercial aviation and avionics, manned and unmanned defense systems, space technologies, and satellite communications, and the 657,000 skilled workers who develop and manufacture aerospace and aviation systems.

Over the last year, AIA has provided witness testimony on such topics and issues as NextGen air transportation initiative, export controls, NASA and NOAA programs, and STEM education and the aerospace workforce to various House and Senate committees.

In January 2009, the AIA prepared a report, "*The Role of Space in Addressing America's National Priorities*" to provide the new administration and Congress with information on "*the major issues facing our aerospace industry*." The report recommended the development of a national space strategy "*that links national policy with needs, programs and resources*" and that coordinates space across national security, civil and commercial domains.

In addition, the report provided the following recommendations pertaining to civil and commercial space:

- "*Our space capabilities should be coordinated, at the highest level, as a singular enterprise.*"
- "*The administration should provide and support a national budget that reflects both robust and stable funding across space functions to prevent disruptions to the planned lifecycle of critical, multi-year space programs.*"

Workforce and the Economy

- *"The U.S. government should work to create opportunities for our current workforce, and make science and education a national priority to ensure a strong future workforce."*
- *"The administration and Congress should work to create a more favorable business environment for the U.S. aerospace industry."*

Space Exploration

- *"Both the U.S. Space Exploration Policy and the Constellation Program should be treated as national priorities and given the funding and support needed to keep development on its current schedule and to minimize the impending gap in U.S. human spaceflight."*
- *"The International Space Station should be fully utilized as a national laboratory."*
- *"The NASA science program should receive the funding necessary to provide a wide suite of robotic missions and other research."*

Earth Observation

- *"The U.S. government should immediately address existing and growing gaps in climate measurements and weather satellite coverage."*
- *"The administration should establish, fund and implement a U.S. Earth Observation architecture as a national priority."*

National Security Space (as it relates to civil and commercial areas)

- *"Space protection and space situational awareness programs should become a funded national priority."*
- *"The U.S. government should undergo a careful review of critical space technologies to evaluate which technologies should be controlled under the State Department ITAR process and which are truly commercial and could be controlled under the Commerce Department process. This review must be followed with meaningful and careful legislation that would ensure the right technologies are controlled the right way."*

Astronomy and Astrophysics Advisory Committee

The National Science Foundation Authorization Act of 2002 [P.L. 107-368] as amended, directed the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE) to establish the Astronomy and Astrophysics Advisory Committee (AAAC) to

"*assess, and make recommendations regarding, the coordination of astronomy and astrophysics programs of the Foundation and the National Aeronautics and Space Administration and the Department of Energy*" and to

"*assess, and make recommendations regarding, the status of the activities of the Foundation and the National Aeronautics and Space Administration, and the Department*

of Energy as they relate to the recommendations contained in the National Research Council's 2000 report, entitled 'Astronomy and Astrophysics in the New Millennium" and the recommendations contained in subsequent National Research Council reports of a similar nature".

The AAAC is directed to submit a report every year to the NSF, NASA, and DOE and to relevant Congressional committees. According to its March 15, 2009 report, the AAAC found that interagency cooperation among DOE, NASA, and NSF is strong at the scientist-to-scientist level, the programmatic level, and among small and large projects and facilities. The Committee also found that many of the high-priority projects recommended in the 2000 National Academies Decadal Survey for astronomy and astrophysics have not been implemented.

The Committee made the following recommendations in its March 15, 2009 report:

- *"In the interest of astronomical research, agencies should be encouraged to continue coordinating activities where the science or technology demands it, and furthermore, to map out more clearly the scientific and technological complementarities that might be the basis for future missions/projects. We emphasize coordination, which may, but not necessarily, take the form of joint projects. We emphasize coordination, which may, but not necessarily, take the form of joint projects. Taking advantage of unique skill sets amongst agencies and throughout the world, coordinated access to northern and southern hemispheres of the sky, ground and space access—all important aspects of a vigorous science program."*
- *"Robust cost estimates, including full life-cycle costs and external analyses of the budgets, as well as strategic planning for large facilities are a necessity, and should be an integral part of any prioritization and implementation process."*
- *"Assessment of the cooperation within projects involving federal plus international and private partners is now needed, in addition to that of inter-agency projects. Some of these projects have started since the time the AAAC was chartered."*

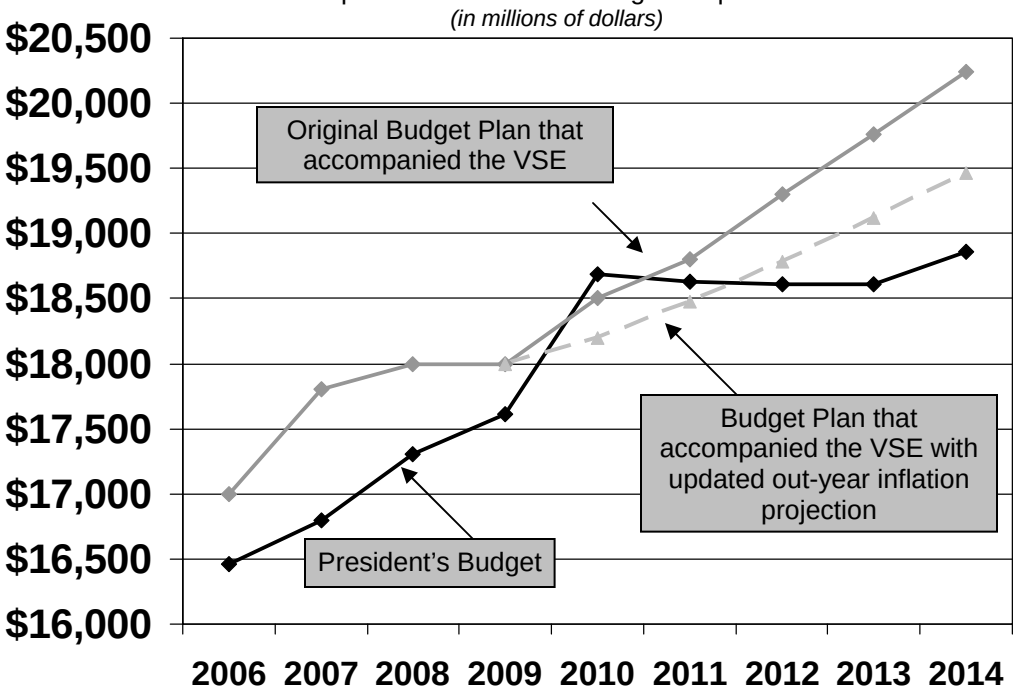
Attachment 1

NASA's FY 2010 Budget Request

Budget Authority ($M)	FY 2008	FY 2009	Recovery Act	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Science	**4,733.2**	**4,503.0**	**400.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,379.6	325.0	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6		1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,206.2	75.0	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6		605.0	672.6	720.5	742.7	762.6
Aeronautics	**511.4**	**500.0**	**150.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Exploration	**3,299.4**	**3,505.5**	**400.0**	**3963.1***	**6076.6***	**6028.5***	**5966.5***	**6195.3***
Constellation Systems	2,675.9	3,033.1	400.0	3,505.4	5,543.3	5,472.0	5,407.6	5,602.6
Advanced Capabilities	623.5	472.3		457.7	533.3	556.5	558.9	592.7
Space Operations	**5,427.2**	**5,764.7**	**0.0**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7		3,157.1	382.8	87.8	0.0	0.0
International Space Station	1,685.5	2,060.2		2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support (SFS)	446.2	722.8		751.5	732.7	745.9	749.7	748.9
Education	**146.8**	**169.2**	**0.0**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Cross-Agency Support	**3,251.4**	**3,306.4**	**50.0**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	2,011.7	2,024.0		2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Operations	834.1	921.2		961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	293.7	50.0	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5		0.0	0.0	0.0	0.0	0.0
Inspector General	**32.6**	**33.6**	**2.0**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
NASA FY 2010	**17,401.9**	**17,782.4**	**1,002.0**	**18,686.0**	**18,631.0**	**18,613.0**	**18,607.0**	**18,858.0**
Year to Year Change		*2.2%*		*5.1%*	*-0.3%*	*-0.1%*	*0.0%*	*1.3%*

*Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results.

Attachment 2

Comparison of Budget Plan that accompanied the VSE (Vision for Space Exploration) in 2004 with actual/planned President's Budget Requests for NASA

(in millions of dollars)