

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

HEARING CHARTER

*Review of the Proposed National Aeronautics and Space Administration
Human Spaceflight Plan*

May 26, 2010
10 a.m. – 12 p. m.
2318 Rayburn House Office Building

I. Purpose

On May 26, 2010 at 10:00 a.m. the Committee on Science and Technology will hold a hearing on the proposed National Aeronautics and Space Administration (NASA) Human Spaceflight Plan. The purpose of the hearing is to continue the examination of the proposed NASA human spaceflight plan and to review issues related to the budget, cost, schedule and potential impacts of the plan.

The hearing will 1) examine the administration's proposed goals, strategies and plans for NASA's human spaceflight and exploration programs, including the revisions announced by the president on April 15, 2010; 2) the assumptions, basis, feasibility and sustainability of those plans within the FY 2011 budget plan and outyear funding plan; 3) the key challenges and risks involved in implementing the proposed change of course for NASA; and 4) what outstanding questions and issues need to be addressed, and what information is needed as Congress considers the proposed future direction for NASA's human spaceflight and exploration programs.

II. Scheduled Witnesses

Panel I:

Mr. Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration

Panel II:

Mr. Neil A. Armstrong
Commander, Apollo 11

Captain Eugene A. Cernan, USN (ret.)
Commander, Apollo 17

Mr. A. Thomas Young
Lockheed Martin (ret.)

Dr. John P. Holdren, Director of the Office of Science and Technology Policy, was invited to testify by the Committee but was unavailable due to another commitment.

III. Background and Issues

Background

Congress has been presented with the administration's proposal to make drastic changes to the United States human spaceflight and exploration program that has been authorized and funded by successive Congresses since 2005. Key components of the new plan presented by the president in February and later modified in the president's April 15th speech at the Kennedy Space Center include the following:

- The International Space Station (ISS) will be extended at least through 2020;
- An ISS crew rescue vehicle (potentially but not necessarily based on the Orion crew exploration vehicle design) will be developed and flying "within the next few years";
- There will be a human mission to an asteroid by 2025;
- Astronauts will orbit Mars by the mid-2030s;
- By 2015, NASA will have either finalized the design of a Heavy Lift Vehicle (HLV) and be ready to start building [per the president's April 15th speech], have done some design work on an HLV concept [per the OSTP Director's public statements], or have "defined" a Heavy Lift architecture [per NASA statements to staff]; NASA will also have either developed or started development of a new liquid hydrocarbon engine and have carried out fundamental research on heavy lift propulsion, and will have done all of the above for \$3.1 billion over the five-year period;
- NASA will support/fund the development of multiple [3-4, according to NASA] commercial crew transport services by 2016 at a total cost to NASA of \$6 billion; and
- NASA will invest \$7.8 billion in Flagship Technology Demonstrations, \$3 billion in Robotic Precursor mission, and \$4.9 billion on Space Technology over the next few years.

Mr. Norman Augustine, who chaired last year's Review of U.S. Human Spaceflight Plans Committee, has testified that the administration's proposed plan is closest to his panel's Option 5B—one of the "flexible path" options. According to the Augustine committee report, Option 5B *"employs an EELV-heritage commercial heavy-lift launcher and assumes a different (and significantly reduced) role for NASA...[and] would also entail substantial reductions in the NASA workforce and closure of facilities to obtain the expected cost reductions."*

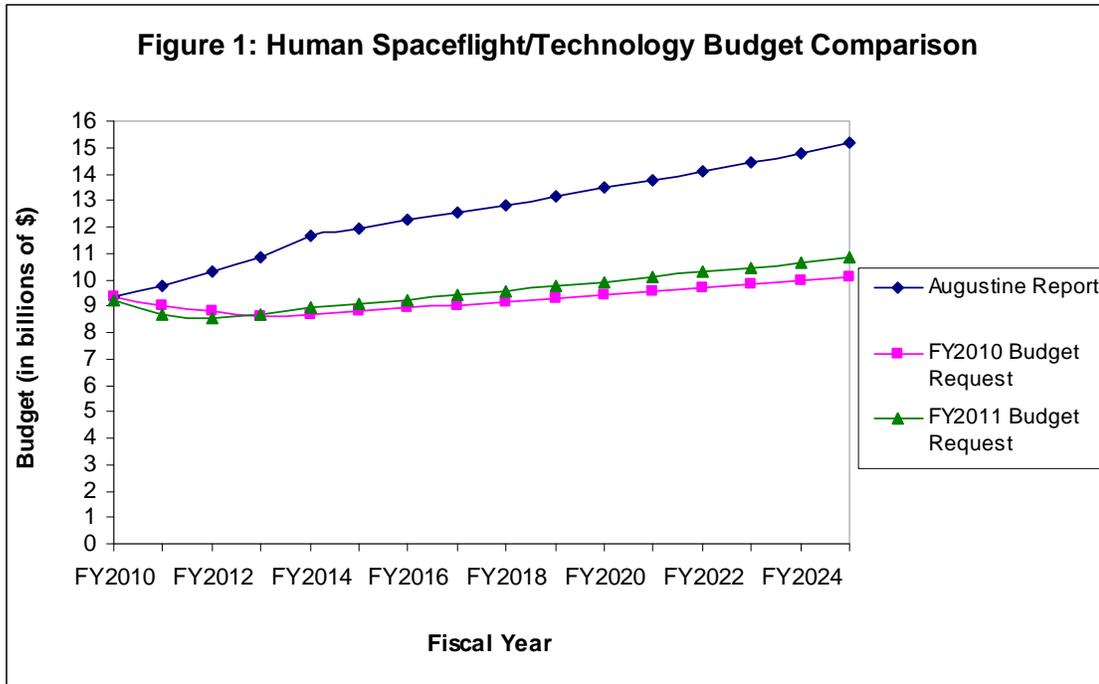
In announcing its proposals, the administration indicated that a new human spaceflight plan was needed because the exploration program of record was *"unexecutable"* under the projected budgets.

In the four months since the administration's proposed plan was announced, a number of significant issues have been raised that still have not been satisfactorily addressed by administration witnesses. A number of those issues are discussed in the following section.

Issues

1. No credible basis has been provided to date to support the claim that NASA can successfully execute the proposed plan within the FY 2011 and assumed outyear budget profile.

One of the most significant findings of last year's Augustine committee was that "*Human exploration beyond low Earth orbit is not viable under the FY 2010 budget guideline.*" Following the same methodology used by the Aerospace Corporation, staff of the Science and Technology Committee analyzed the FY 2011 budget request using the same budget categories used in the Aerospace analysis for the Augustine committee, namely, Shuttle, International Space Station (ISS), Exploration, Kennedy Space Center (KSC) modernization, and exploration-related technology. The staff analysis determined that the funding available for human spaceflight/exploration technology in the proposed FY 2011 budget plan is essentially the same as was available in the "not viable" FY 2010 budget guidance over the years FY 2010-2015. In addition, if one compares the FY 2011 budget plan and outyear funding profile with that of the Augustine committee's "Less Constrained" budget, it turns out the budget for the administration's proposed plan through 2025 [the date of the asteroid mission] is **\$47 billion lower** than the amount the Augustine committee determined would be needed to make any of its exploration options viable over that same period. Figure 1 below illustrates the mismatch between the Augustine committee's budget and both the "not viable" FY 2010 budget guidance and the proposed FY 2011 budget plan. [A spreadsheet comparing the various budgets is included in Appendix A on page 32].



The addition of an ISS crew rescue development program without a corresponding increase in the NASA budget would appear to further weaken the credibility of any assertion that the proposed plan is executable. In staff briefings, NASA personnel indicated that a preliminary estimate of the cost of developing a crew rescue vehicle is on the order of \$5-7 billion. Since the administration has stated the goal of flying the crew rescue vehicle “*within the next few years,*” it is reasonable to assume that several years of operations would also have to be budgeted for within the FY 2011-FY 2015 budget. Given the likely need to procure and fly two vehicles per year to the ISS, each on an Evolved Expendable Launch Vehicle (EELV), the annual operating cost could be estimated at \$1+ billion. Thus, the total cost over the five year period of the crew rescue vehicle development/operations program could approach \$10 billion. That is equivalent to a \$1-2 billion per year unfunded lien on the NASA budget. To put that shortfall into context, if one zeroed the FY 2011 funding for the Exploration Technology Demonstrations program, the Robotic Precursor program, and the KSC 21st Century Space Launch Complex initiative, it would only cover \$1.2 billion of the potential shortfall. To cover a \$2 billion shortfall, one would also have to eliminate the increased funding for Earth Science, Aeronautics, and Space Technology. To date, NASA has not identified the planned offsets for the cost of the crew rescue vehicle.

2. Lack of credible analysis or data and ensuing uncertainties contribute to increased risk of higher costs and longer delays than estimated and increased risk of unavailability of services.

One of the central elements of the administration’s plan is a proposal to rely on as-yet-to-be-developed “commercial crew” transport services to low Earth orbit and the ISS.

The administration's plan assumes that it will support the development and demonstration of up to 3-4 commercial crew systems at a cost of \$6 billion over the five-year period FY 2011-2015. [That funding is in addition to funding for launch infrastructure to facilitate commercial launches that is proposed as part of the "21st Century Space Launch Complex" initiative.] However, the basis of the \$6 billion estimate has not been provided to Congress, despite repeated requests. In addition, the administration has been unable to provide the percentage of private sector cost sharing assumed in its \$6 billion budget estimate. There are several grounds for questioning the credibility of the administration's estimate. The Aerospace Corporation, in its response to questions submitted by Space and Aeronautics Subcommittee Chairwoman Giffords, provided its independent analysis of the range of potential costs to develop a single crewed capsule/launch abort system of varying degrees of complexity/crew-carrying capacity. A chart provided by Aerospace that summarizes the analysis is included in Appendix A on page 21. For the presently envisioned 2-4 passenger commercial crew vehicles, the Aerospace analysis would suggest that the burden of proof needs to be put on the administration to demonstrate why the cost to the government has not been underestimated by at least a factor of two or more, even accounting for benefits to be accrued by following as yet unspecified "commercial practices" while still ensuring safety standards are met. The \$6 billion estimate is further called into question by NASA's preliminary estimate of the cost to develop a single "simple" crew rescue vehicle, with the crew rescue vehicle development cost estimate being essentially the same as what the administration estimates could fund the development of up to 3-4 different commercial crew transport vehicles with launch abort systems.

In its report, the Augustine committee concluded that: *"While there are many potential benefits of commercial services that transport crew to low Earth orbit, there are simply too many risks at the present time not to have a viable fallback option for risk mitigation."* However, the administration's proposed plan does not include any government backup option. In the absence of a government alternative, NASA would presumably have no choice but to cover any increased cost if it is to preserve its access to the low Earth orbit. Administrator Bolden, in testimony before Congress said *"I have to look at the possibility that the commercial sector may have difficulty, and we will do everything in my power to facilitate their success."*

In the absence of a significant non-NASA, truly commercial market, NASA would have to assume responsibility for ensuring the continued viability of at least two commercial companies [unless the government is willing to accept the existence of a commercial monopoly determining its crewed access to space]. However the existence of any significant non-NASA market has not been independently validated. Given that, it is instructive to note that at a recent Federal Aviation Administration Commercial Space Transportation Advisory Committee meeting, Administrator Bolden noted that destinations other than the ISS would be needed for the commercial providers in order to keep ISS commercial crew costs down, and that NASA might have to invest in creating them: *"We need a destination in low Earth orbit to which we can go", Bolden said. 'So that means that NASA and the commercial enterprises need to partner, maybe with DoD, maybe with the intelligence community. I don't know who. But we need to partner with a*

lot of people to develop a second orbital network of structures or something that act as a destination for people who want to make this commercial industry viable.” [Aerospace Daily, 5/20/10]. In addition, in an aviationweek.com article dated May 21, 2010, it was stated that “company reps agreed that even with a second destination...it will be hard to sustain a commercial market with the two annual ISS flights envisioned. ‘A market like that is probably not enough to sustain competition,’ says George Sowers, vice president for business development at ULA [United Launch Alliance]. ‘It could sustain two providers, if NASA’s willing to pay extra to have two. It’s kind of like EELV all over again.’”

Thus, if one accepts the administration’s assumption that commercial crew providers can be ready to provide operational crew transfer services to the ISS in 2016—a schedule estimate that has not been independently validated and was made without even first having determined what acquisition approach will be followed—all the would-be commercial providers can assume in terms of a NASA market is that they may split a total of 10 trips to the ISS before the end of the planned extension of the ISS in 2020. It is reasonable to assume that in the absence of other markets, those providers will expect NASA to assume the great majority of the risk and cost—whatever that cost might turn out to be.

3. Lack of detail and continued changes call into question the stability and sustainability of the proposed plan

A series of changes to the proposed plan raises questions about the stability of the plan and whether further changes will be forthcoming. The budget justification was provided to Congress one month after the FY 2011 budget release; few details were provided to support the magnitude of the changes being proposed.

On April 15, 2010, the president announced changes to the plan—a major one being the addition of a crew rescue vehicle to the human spaceflight portfolio—and one that represents a significant new requirement being levied on the FY 2011 NASA budget guideline. There were no details on what the change would entail, how it would be funded, and what the impact to other programs would be. In that same speech, the president announced that he was committed to “finalizing a [heavy lift] rocket design no later than 2015 and then begin to build it.” Yet, in subsequent discussions with NASA, Committee staff were told that primary emphasis was on the development of an engine for the first stage of a heavy launch vehicle and just the “definition of a heavy lift architecture” by 2015. Finally, the president added an explicit goal of carrying out the first human mission to a near-Earth asteroid by 2025.

With respect to the crew rescue vehicle program, Administrator Bolden said in his prepared statement for the April 22, 2010 hearing by Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies: “*Accommodating this effort within NASA’s budget will change the amounts requested for the programs described below* [technology development and demonstrations; heavy-lift and propulsion

research and development; robotic exploration precursor]. *An update to the NASA FY 2011 budget justification will be provided as soon as possible, but in the next few weeks.*”

On May 12, 2010, Administrator Bolden testified at a Senate Commerce, Science, and Transportation hearing that “*NASA expects to submit a revised FY 2011 budget request to Congress in the near future that will identify funding requirements for the restructured Orion crew capsule*”.

Given the number and significance of the changes being made to the initial proposed plan, the lack of details on the scope of programs and how they might change to support the addition of a crew rescue vehicle, the variations in the administration’s description of how heavy lift development will proceed, and the lack of an updated budget request that reflects the changes, it may be difficult for Congress to have confidence in the stability of the plan that it is being asked to support.

4. Proposed long-term exploration strategy lacks clarity and consistency

The Constellation Program was designed and congressionally-authorized with a stepping-stone approach in mind “*to ensure that activities in its lunar exploration program shall be designed and implemented in a manner that gives strong consideration to how those activities might also help meet the requirements of future activities beyond the Moon*” and a range of future destinations “*to expand human and robotic presence into the solar system, including the exploration and utilization of the Moon, near Earth asteroids, Lagrangian points, and eventually Mars and its moons.*” [P.L. 110-422]

However, in presenting his proposed new plan on April 15th, the president stated that with respect to the Moon, “*the simple fact is, we have been there before. There is a lot more of space to explore...*” He announced that the U.S. would send humans to an asteroid by 2025, followed by a human mission to orbit Mars by the mid 2030s.

Subsequent to that announcement, NASA continues to include the Moon as a destination but with no timetable, indicating a lunar landing would not occur until some time after the asteroid mission. Administrator Bolden’s May 12 prepared statement for the Senate Commerce Committee noted that “*under the new plan, we will...build a technological foundation for sustainable, beyond-LEO exploration, with more capable expeditions in lunar space, and human missions to near-Earth asteroids, the Moon, Lagrangian points, and, ultimately, Mars.*” In addition, Administrator Bolden’s prepared statement for the May 12 Senate hearing noted that the Exploration Robotic Precursors program would involve “*a lunar lander by 2015*” and the Enabling Technology Development and Demonstration program would involve activities “*that will lead to ground and flight demonstrations in lunar volatiles.*” It is not clear whether the Moon is or is not a significant part of the exploration strategy, and if so, what the purpose of lunar exploration would be under the president’s plan. If the Moon is not a near-term part of the exploration strategy, it is not apparent why programs to send landers to the Moon and demonstrations in lunar volatiles would be needed within the next five years.

Without a consistent outline of the logical progression for deep space exploration beyond low-Earth orbit authorized in law, how the knowledge from each mission would build on one another, and when a heavy-lift vehicle and crew capsule would be available to support deep space exploration, it is difficult for Congress to have a clear understanding of the plan it is being asked to support.

Implications for Congressional Consideration of the FY 2011 NASA Budget Request

Given the drastic changes being proposed by the administration, including cancellation of the current Constellation Program, the burden of proof has to rest with the administration to first demonstrate that its proposed plan is executable. That burden of proof includes providing compelling evidence that:

- 1) The proposed plan is executable within projected budgets;
- 2) The elements of the plan are sufficiently well defined and analyzed such that the risks of higher than estimated costs and schedule delays are minimized;
- 3) The plan is well thought-out and stable and has taken account of potential impacts on other sectors; and
- 4) The proposed long-term exploration strategy is clear and consistent.

If that burden of proof is met, Congress will still need to determine whether or not the measures proposed are in the best interest of the nation and of the nation's human spaceflight program. However, if the administration is unable to provide Congress with the confidence that its proposed plan is executable, Congress will then need to take steps to develop an alternative that is executable.

Appendix A of this hearing charter contains additional background on the questions and decisions for Congress that are raised by the administration's proposed plan.

APPENDIX A

Background: The Questions and Decisions for Congress on Human Spaceflight and the Proposed New Strategy

1. What Are the Priorities of the Goals and Objectives of the New Strategy That Congress is Being Asked to Support?

Various statements in the FY 2011 budget request and speeches by NASA and other officials state a range of goals and objectives making it difficult to discern the priorities of the goals being proposed for the U.S. human spaceflight program.

- The NASA Administrator's message in the NASA FY 2011 budget request stated "*As we invest in the most cutting-edge research and technology to enable human exploration beyond Earth, we will also work to cultivate an expanded space exploration industry through a commercial crew program that seeks to spur competition and innovation in American industry, ultimately resulting in commercial human spaceflight services. Once established, these services will not only allow astronauts to travel to the International Space Station, they will ultimately open space travel to many more people across the globe.*"
- In his April 15, 2010 remarks at Kennedy Space Center, the president stated: "*Our goal is the capacity for people to work and learn, operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite.*" He also said: "*Early in the next decade, a set of crewed flights will test and prove the systems required for exploration beyond low-Earth orbit. And by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the moon into deep space. We'll start by sending astronauts to an asteroid for the first time in history.*"

While various goals are being presented as part of the administration's proposed human spaceflight program, the realities of fiscal constraints within the U.S. government budget require that Congress understands the priorities for those goals. If the administration's goal is to send humans beyond low-Earth orbit, including to a near-Earth asteroid, as a starting point, by 2025, then a set of decisions must be made to support that goal. If the goal is to stimulate a space tourism and exploration industry, then certain questions must be asked and decisions must be made about the government's role in enabling the development of a new industry, and the advantages and disadvantages to the government and the taxpayer must be considered.

2. Should the Constellation Program be Canceled?

The Constellation Program consists of the Ares I crew launch vehicle and Orion crew exploration vehicle, the Ares V heavy-lift launch vehicle, associated ground systems and

lunar systems. Constellation is the architecture established to deliver Americans to the ISS and later to the Moon and other destinations in the solar system following the retirement of the Space Shuttle. The FY 2009 budget request for NASA stated that Constellation's Orion vehicle was also intended to serve as a back-up for commercial services being fostered to service the ISS: *"It [Orion] will be capable of ferrying up to six astronauts (plus additional cargo) to and from the International Space Station if commercial transport services are unavailable."* Constellation was authorized in both the NASA Authorization Act of 2005 [P.L. 109-155] and the NASA Authorization Act of 2008 [P.L. 110-422].

NASA provided the Committee the following status information for the Constellation Program, as of May 2010:

"The following are some of the Orion Project's key achievements:

- *The Orion PDR [Preliminary Design Review] was conducted during the summer of 2009, and completed in August 2009. The PDR was an extensive review of Orion's detailed subsystems and integrated systems designs to date. The PDR board unanimously recommended proceeding with detailed designs toward Critical Design Review (CDR) in February 2011.*

- *In 2009, NASA conducted preliminary capsule recovery tests at both the Navy's Carderock facility in Maryland and in the ocean near Kennedy Space Center (KSC) in Florida. Using a mockup of the Orion capsule, these Post-landing Orion Recover Tests involved search and rescue teams simulating stabilization and recovery of the Orion capsule in a variety of sea state conditions. Results were intended to lead to design features for both the spacecraft and recovery equipment, as well as contributing to development of the final recovery procedures.*

- *Fabrication of the Orion Ground Test Article crew module is progressing at the Michoud Assembly Facility in Louisiana. Completion is estimated for the fall of 2010, followed by completion of the service module and launch abort system ground test article, currently scheduled for 2011. NASA is using a friction stir welding technique on this ground test article, and is hoping to demonstrate the longest continuous friction stir weld ever attempted.*

- *NASA performed its first developmental flight test of the Orion Launch Abort System (LAS) at the White Sands Missile Range, New Mexico. The Pad Abort-1 test, successfully conducted May 6, 2010, was the first integrated firing of all three motors in a real flight environment. Orion's Launch Abort System (LAS) includes three newly designed solid rocket motors: 1) abort motor, 2) jettison motor, and 3) attitude control motor. Each motor contributes substantially to the state of the art in solid rocket propulsion technology. All of these motors have been successfully demonstrated in full-scale static firings on the ground individually.*

- *Orion project successfully conducted a Software PDR.*
- *The Orion project successfully completed a formal Integrated Baseline Review to assess the adequacy of the integrated project baseline (cost, schedule, risk, and technical) following the system PDR.*

The following are some of the Ares I Project's key achievements:

- *Having completed its PDR in 2008, the Ares I Project is now working toward its CDR, which is scheduled for September 2011.*
- *In September 2009, NASA and ATK conducted the first successful test of the Ares I's five-segment development motor in Promontory, Utah. Beyond validating the basic performance characteristics of the stage, the test has enhanced modeling and understanding of key attributes that have historically been very difficult to predict analytically such as erosive burning, thrust oscillations and thrust tail off. The next static test, DM-2, is currently scheduled for September 2010.*
- *In October 2009, the Ares I-X test flight took place at Kennedy Space Center in Florida. Data from more than 700 on-board sensors showed that the vehicle was effectively controlled and stable in flight. Thrust oscillation frequencies and magnitude data from the Ares I-X flight also were consistent with measurements from recent Shuttle flights that were instrumented, leading us to conclude that the oscillation vibration on the Ares I would be within the bounds that the Ares I is currently being designed to. In the end, this test flight provided tremendous insight into the aerodynamic, acoustic, structural, vibration and thermal forces that Ares I would be expected to experience.*
- *J-2X Test Hardware Status: Having passed its CDR in 2008, development and verification testing at the component and subsystem level continues. Current planning includes a fully assembled engine, minus the full nozzle extension, to be available the end of calendar year 2010, followed by receipt of an additional developmental engine in 2011. Static fire testing for engines is currently slated to begin in the February-March 2011 time frame.*

The following are some of the recent infrastructure achievements for the Constellation Program:

- *The Operations and Checkout building at KSC was completed in January 2009, marking activation of High Bay Facility. When outfitted, the O&C will support final assembly of the Orion spacecraft.*
- *The final 600-foot Lightning Protection Tower at KSC's Pad B was completed in February 2009. This was where the Ares I-X test flight launched from in October*

2009.

- *Workers at KSC topped out the tenth and final segment of the new mobile launcher (ML) after it was lifted by crane and lowered onto the ninth segment in January 2010. When completed, the tower will be 345 feet tall and have multiple platforms for personnel access. Its base was made lighter than Space Shuttle mobile launcher platforms so the crawler-transporter can pick up the heavier load of the tower and a taller rocket.*

- *A-3 Test Stand at Stennis Space Center in Mississippi: Construction of the long duration altitude test stand for the J-2X engine is nearly 75 percent complete. When completed in 2013, the A-3 facility will provide a unique critical capability to simulate environments at greater than 100,000 ft altitude necessary to demonstrate altitude starting and perform full-duration hot-fire testing.*

- *Space Environmental Test Facility (SET) at Glenn Research Center's Plum Brook Station in Ohio: Construction started in 2007 and is about 75 percent complete. SET is planned for conducting qualification testing of the fully integrated Orion spacecraft, including vibration, acoustics, and EMI testing.*

- *Fabrication of the Orion Crew Module mockup for Neutral Buoyancy Laboratory testing and training events. These events are targeted at both the in-space EVA aspects on the outside of the vehicle as well as for internal cabin mobility within a simulated space gravity environment.*

- *Fabrication of a partial gravity testing and training facility (Advanced Reduced Gravity Off-Load System). This facility allows for simulations of a non-Earth surface gravity environment (lunar, Mars, etc) for both shirt-sleeve and spacesuit testing and training.*

As of May 2010, NASA reported that it had spent a total of \$10.3 billion on Constellation.

In addition, the Constellation Program has contributed a number of new technology developments and innovations. A partial list was provided by Mr. Douglas Cook, NASA Associate Administrator for the Exploration Systems Mission Directorate, at a March 24, 2010 hearing of the Space and Aeronautics Subcommittee on "Proposed Changes to NASA's Exploration Programs: What's Known, What's Not, and What are the Issues for Congress?":

- *"Automated rendezvous and docking is one that we are working on the Orion. In the upper stage we are making further progress on the technology of friction stir welding. We are working on composite structures. We have made some advances in lightning protection on space vehicles, advanced batteries. We are using solar arrays on the spacecraft. We are making advances in guidance, navigation, and control and other avionic software that will be possible. We have actually...advanced development*

work out at Ames...in...advanced thermal protection systems for spacecraft. We are working on closed life support, and we...are actually charting some new territory in modeling of the environments and characteristics of the spacecraft during launch and entry through new modeling techniques and software.”

The FY 2011 budget proposes to cancel Constellation and includes \$1.9 billion in FY 2011 and \$600 million in FY 2012 to fund:

- Termination and liability for existing contracts (including severance pay);
- Closeout costs of content and property disposition;
- Costs to render safe facilities no longer in use, mothballed, or targeted for demolition;
- Potential environmental remediation of agency direct and support contractor facilities no longer in use; and
- Coverage for transitional civil servants as new programs are being initiated.

The April 15, 2010 speech by the president proposed restructuring the Orion crew capsule that was an element of the Constellation Program to focus on providing crew escape capability for the International Space Station by means of an “Orion Lite”. A Fact Sheet issued by the Office of Science and Technology Policy described the rationale for the scaled-down Orion as “*providing stand-by emergency escape capabilities for astronauts on the Space Station. We will be able to launch this vehicle within the next few years, creating an American crew escape capability that will increase the safety of our crews on the Space Station, reduce our dependence on foreign providers, and simplify requirements for other commercial crew providers.*” According to the revised plan, this effort will also “*help establish a technological foundation for future exploration spacecraft needed for human missions beyond low Earth orbit.*” Last week, NASA officials informed Committee staff that NASA is in discussions with OMB and OSTP on several options for pursuing a crew rescue vehicle. Those options include 1) restructuring Orion to be developed as a crew rescue vehicle, and 2) initiating a competition that would be open to new concepts for a crew rescue vehicle. A decision to pursue the latter option would necessitate cancelling the Orion contract and incurring contract termination costs, while also starting a new contract competition and development program.

Congressional Direction on Limitations on the Use of FY 2010 Appropriations

In the Statement of Managers accompanying the FY 2010 Consolidated Appropriations Act, “*The conferees note that the Constellation program is the program for which funds have been authorized and appropriated over the last four years, and upon which the pending budget request is based. Accordingly, it is premature for the conferees to advocate or initiate significant changes to the current program absent a bona fide proposal from the Administration and subsequent assessment, consideration and enactment by Congress.*” The Statement of Managers also states that “*Funds are not provided herein to initiate any new program, project or activity, not otherwise contemplated within the budget request and approved by Congress, consistent with section 505 of this Act, unless otherwise approved by the Congress in a subsequent*

appropriations Act. Funds are also not provided herein to cancel, terminate or significantly modify contracts related to the spacecraft architecture of the current program, unless such changes or modifications have been considered in subsequent appropriations Acts.” Similar language was included in the Act itself. According to NASA, the Constellation Program is currently proceeding per the enacted FY 2010 appropriation.

According to NASA, all work that is currently under contract for Constellation will continue. The Administrator has instructed the Constellation Program to refrain from initiating new work not currently under contract, and also to refrain from expanding the scope of any work that currently is under contract. As of March 11, 2010, NASA had canceled five planned procurements, including planned studies: the Exploration Ground Launch Services (EGLS) solicitation at the Kennedy Space Center (KSC); the Vehicle Assembly Building High Bay modification solicitation at KSC; the Water Basin construction solicitation at the Langley Research Center; the Altair Conceptual Design Contracts solicitation at the Johnson Space Center; and the Ares V heavy-lift design trades solicitation at the Marshall Space Flight Center.

In testimony to the Committee on Science and Technology on February 25, 2010, Administrator Bolden stated that: *“in...a letter that I sent recently to 27 members of the House who questioned what we were doing with the Constellation Program...I told them...we were in compliance with the direction of the 2010 Appropriations Act and that I have directed no cancellations or terminations and that we intended to comply with the law.”*

Members of Congress have continued to express concern over NASA’s actions regarding the legislative direction in the FY 2010 Appropriations for NASA. In a May 10, 2010 letter to the Director of the Office of Management and Budget, Senator Barbara Mikulski, chair of the Senate Commerce, Justice, Science and Related Agencies Appropriations Subcommittee that funds NASA wrote:

- *“I am advised that NASA has undertaken a series of steps to direct industry to retain certain funds made available in fiscal year 2010 to cover prospective termination costs so as not to potentially violate the terms of the Antideficiency Act (31 U.S.C. 1341). I am deeply troubled by this approach as it effectively seeks to terminate Constellation activities in apparent violation of the terms of the Omnibus provision.”*
- In addition, Senator Mikulski wrote: *“I urge you, in conjunction with the Vice President and the President’s Chief of Staff, to immediately devise a path forward to avoid cancelling contracts in fiscal year 2010 and to avoid invoking termination liability set asides from existing contract dollars and activities on the Constellation Program.”*
- *“I further urgently request that you review NASA’s budgeting practices regarding termination liability to articulate a clear and appropriate standard to deal fairly with industry, provide a schedule to implement this standard and identify the fiscal reserves required to effectively comply with this standard.”*

Senator Richard Shelby, ranking member of the Commerce, Justice, Science and Related Agencies Appropriations Subcommittee, took the step of co-signing a provision to H.R. 4899, the Supplemental Appropriations Act, 2010:

- *“Provided further, That notwithstanding any other provision of law or regulation, funds made available for Constellation in fiscal year 2010 for ‘National Aeronautics and Space Administration Exploration’ and from previous appropriations for ‘National Aeronautics and Space Administration Exploration’ shall be available to fund continued performance of Constellation contracts, and performance of such Constellation contracts may not be terminated for convenience by the National Aeronautics and Space Administration in fiscal year 2010.”*

At issue is the appearance that NASA’s actions on Constellation contracts may not be following directions in law and the implications that those actions have for progress on the Constellation Program—the current program of record that has been authorized by Congress and for which Congress has appropriated FY 2010 funds for implementation.

Justification and Analytical Basis for Cancellation

- In a September 15, 2009 hearing on the results of the Review of U.S. Human Space Flight Plans Committee, Chairman Gordon asked of the Review’s Chair, Mr. Norman Augustine, *“we do have a program that has been authorized we have spent billions of dollars on. ...So are you prepared to say that one or all of the other options are substantially better than Constellation and worth having a major turn now?”*
 - Mr. Augustine responded *“I think it would be our view just what you said, that there should be a compelling reason to change an existing program, and we believe that the existing program, given adequate funds, is executable and would carry out its objectives.”*
- In the Committee’s February 25, 2010 hearing on NASA’s Fiscal Year 2011 Budget Request, Chairman Gordon noted: *“the justification from moving from Constellation to a different approach is expense, and so if we—if it is not going to be less expensive, then there has to be a better explanation [of]... why this move.”*
- Since the FY 2011 budget release, additional details on the justification for the proposal to cancel rather than modify or restructure the Constellation program have not been provided. In addition, the actual cost to terminate the program is still not known.
- To understand the factual analysis that informed the Augustine committee, Subcommittee on Space and Aeronautics Chairwoman, Gabrielle Giffords sent a series of questions to the Aerospace Corporation, which was tasked to support the Augustine committee in its review. Regarding a full assessment of Constellation cost and schedule, Aerospace stated *“Aerospace did not perform a traditional parametric or grass-roots Independent Cost Estimate (ICE) for the Constellation Program or its major elements...Aerospace was tasked to perform a high-level schedule assessment of Constellation.”*

Issues Related to the Proposal to Include a Crew Rescue Vehicle

In addition, in light of the change on April 15th that now includes a crew rescue vehicle (which could involve restructuring the Orion vehicle), the Congress will need to understand a number of issues including: what that vehicle will be, the acquisition approach that NASA will follow (restructuring the Orion contract or pursuing a new vehicle competition and development program), how NASA plans to address the cost and schedule for the rescue vehicle, the impacts of those costs on other NASA programs, and the plan and timeline for moving forward with a deep space crew exploration capsule.

Issues Related to Proposal to Include a Crew Rescue Vehicle

- *What are the details of a crew rescue vehicle, including how many crew it will accommodate and how will the program be modified to meet the proposed timeline of “the next few years”?*
- *What, if any, supporting infrastructure is needed for a crew rescue vehicle and what will it cost?*
- *What are the timeline and plans for deciding on and developing a crew capsule to explore destinations beyond low-Earth orbit and what costs are assumed for that development?*
- *What are the implications of the decision on a crew rescue vehicle on the civil servant and contractor workforce, as well as on the space industrial base?*
- *If the addition of a NASA-funded crew rescue vehicle has reduced the capabilities that commercial crew systems will have to provide, will the \$6 billion commercial crew budget be reduced accordingly? If not, why not?*

To date, NASA has not provided this information to Congress.

- In his prepared statement for the April 22, 2010 Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies, NASA Administrator Bolden said: *“Accommodating this effort within NASA’s budget will change the amounts requested for the programs described below [technology development and demonstration; heavy-lift and propulsion research and development; robotic exploration precursor]. An update to the NASA budget justification will be provided as soon as possible, but in the next few weeks.”*
- On May 12, 2010, Administrator Bolden testified at a Senate Commerce, Science, and Transportation hearing that *“NASA expects to submit a revised FY 2011 budget request to Congress in the near future that will identify funding requirements for the restructured Orion crew capsule.”* In addition, Mr. Bolden stated during the hearing that the Orion variant will launch on an Evolved Expendable Launch Vehicle (EELV), however there are no details on what the EELV would cost, whether design changes would be required, when the vehicle could be available and how it would be funded within the FY 2011 budget plan for NASA.
- Prior to the April 15, 2010 announcement about Orion, Administrator Bolden was quoted in a March 30, 2010 article in Aviation Week and Space Technology as expressing his interest in a “common crew capsule” during a Senate Appropriations

Hearing held on March 23, 2010. *“For his part, Bolden says he favors development of a ‘common crew module’ that could fly on several different commercial launch vehicles.”* According to the article Mr. Bolden also stated: *“I would like to help the commercial entities design a single crew module, because it’s good for us to train,”* he says. *“You don’t have to train crews for multiple crew modules, and that can be used interchangeably on any launch vehicle.”* It is not clear whether NASA has discussed this option with potential commercial crew providers, whether they have any interest in such an approach, and whether it is consistent with a “commercial” approach to crew transfer.

3. Is the Proposed ISS Extension Program Funded and Organized to Accommodate the Extension?

The NASA Authorization Act of 2008 [P.L. 110-422] states that *“The Administrator shall take all necessary steps to ensure that the International Space Station remains a viable and productive facility capable of potential United States utilization through at least 2020.”*

The NASA FY 2011 budget request includes the proposal to extend use of the ISS beyond 2016, likely through 2020 or beyond, in order to utilize the orbiting facility as a basic research facility and a test bed for exploration technology development and demonstrations. NASA is requesting \$2.78 billion in its proposed FY 2011 budget to support these efforts and to initiate activities to increase ISS functionality. Under the revised April 15th plan there are no changes to extension of the ISS, however the revised plan restructures Orion to *“provide stand-by emergency escape capabilities for the Space Station.”* There are several issues on the research and contingency plans to support enhanced utilization and an extension of the ISS that have yet to be defined.

Issues That Need to Be Addressed on ISS Extension

- The proposed FY 2011 budget plan does not make clear how much of the increase will be used to support enhanced ISS utilization. Although the budget proposes \$50 million a year for ISS research as part of the budget for ISS operations, there are no details on what the budget would support. NASA has indicated to Committee staff that the content of the ISS research budget has not yet been defined.
- In addition, the budget request does not identify the proposed budget for microgravity research as mandated in Section 204 of the NASA Authorization Act of 2005 [P.L. 109-155] : *“Beginning with fiscal year 2006, the Administrator shall allocate at least 15 percent of the funds budgeted for ISS research to ground-based, free-flyer, and ISS life and microgravity science research that is not directly related to supporting the human exploration program.”* Congress will need to understand the extent to which the budget request will support congressionally-mandated research and enhanced utilization of the ISS.

- Multiple users and stakeholders are discussed with respect to ISS utilization, including universities and basic researchers, NASA mission programs, commercial and private entities as well as other Federal agencies that are partners in the ISS National Laboratory. In his prepared statement to the Senate Committee on Commerce, Science, and Transportation in a hearing on U.S. Human Spaceflight held on May 12, 2010, Administrator Bolden stated that *“NASA will initiate an independent organization, as recommended by the Augustine Committee and the National Research Council that will support the space station research community.”* Congress will need further details to understand how the priorities for utilization resources will be established among these users and stakeholders, the roles and responsibilities of this proposed independent organization and how it will be selected and funded.
- The NASA Authorization Act of 2008 directed NASA to develop a contingency plan for cargo transportation to and from the ISS should the commercial cargo services be delayed, unavailable for extended periods, or experience a failure. NASA’s “Logistics Contingency Plan for the International Space Station” transmitted to the Committee in response to the 2008 Authorization direction does not provide a clear contingency plan. The report stated that: *“Cargo vehicles require 2-3 years of lead time for production and processing, and international partner vehicles have a production schedule based on current predicted needs. There is no plan to have additional vehicles in production to cover for delays in commercial cargo services. However, actual cargo manifesting can be adjusted closer to the planned flight dates. Therefore, the primary contingency plan is to closely monitor on-orbit systems and cargo demands and adjust as needed. This may include not having to fly spares as soon as currently predicted, or reducing utilization to meet an emerging need.”*

While the proposed FY 2011 budget plan includes an extension of the ISS to 2020, Congress continues to lack several details and plans that are needed to ensure that the infrastructure, plans, and resources would be in place to support the ISS extension and utilization.

4. Should Congress Support the Proposal to Develop and then Rely on Commercial Cargo and Crew Capability as the Nation’s Access to Low Earth Orbit?

The proposed plan in the FY 2011 budget does not include a U.S. government capability to launch American astronauts and to deliver cargo to the ISS. NASA plans to rely on commercially provided cargo transportation services for ISS resupply starting in the 2011 timeframe using its Commercial Resupply Services (CRS) contract. NASA is currently funding two partners in the Commercial Orbital Transportation Services (COTS) Program to develop and demonstrate commercial cargo delivery capability to the ISS—Space Exploration Technologies Corporation and Orbital Sciences Corporation.

When the Space Shuttle is retired, NASA anticipates that crew access to the ISS will be provided by acquiring seats on Russian Soyuz spacecraft until the 2016 timeframe.

Under the president's proposal, the agency plans to cease using Soyuz spacecraft at that time and anticipates using commercially-provided crew transport services instead. Funding in FY 2011 for ISS cargo/crew is about \$857 million; a total of \$5.77 billion is projected for the period of FY 2011 through FY 2015. The FY 2011 budget requests an additional \$312 million—a 62% increase in the cost of the COTS program—to expedite ISS cargo development and to help ensure mission success. According to NASA's budget justification, *"The Commercial Crew Program will provide \$6 billion over the next five years to support the development of commercial crew transportation providers to whom NASA could competitively award a crew transportation services contract..."* The revised April 15th plan makes no changes to the plan to rely on the use of commercial services to deliver cargo and crew to and from the ISS, although in adding a crew rescue vehicle, the revised April 15th plan eliminates the crew rescue requirement for potential commercial crew providers.

Does Congress Have the Analytical Basis to Support a Decision on Commercial Crew?

In her opening statement for the March 24, 2010 Subcommittee on Space and Aeronautics hearing on NASA's human spaceflight programs, Chairwoman Giffords summarized the status of a series of issues examined at a series of Committee and subcommittee hearings held:

"The clock is ticking. It is now almost two months since the Administration's FY 2011 budget request for NASA was submitted to Congress, and there are still too many unanswered questions surrounding it."

"In place of good explanations and solid rationales for such sweeping and frankly puzzling changes, we have been given a combination of unpersuasive arguments and 'we're working on the details' responses."

For instance, the commercial crew proposal is lacking all of the basic information that a would-be investor would demand before committing funds to a project. For example:

- *What's the proposed cost to the government to develop these systems?*
- *How much, if any, of the development cost will be shared by the companies?*
- *How much will it cost NASA to buy these services?*
- *What else will NASA have to provide to make—and keep—the companies' operations viable?*
- *When can we credibly expect these services to be operationally available and will they meet our expectation of what is safe enough?*
- *What recourse will NASA have if the companies fail to meet safety standards, cost, schedule and performance?*
- *Finally, is there any significant non-NASA market for these services; is it a viable one; and is it one we should use scarce tax dollars to promote?"*

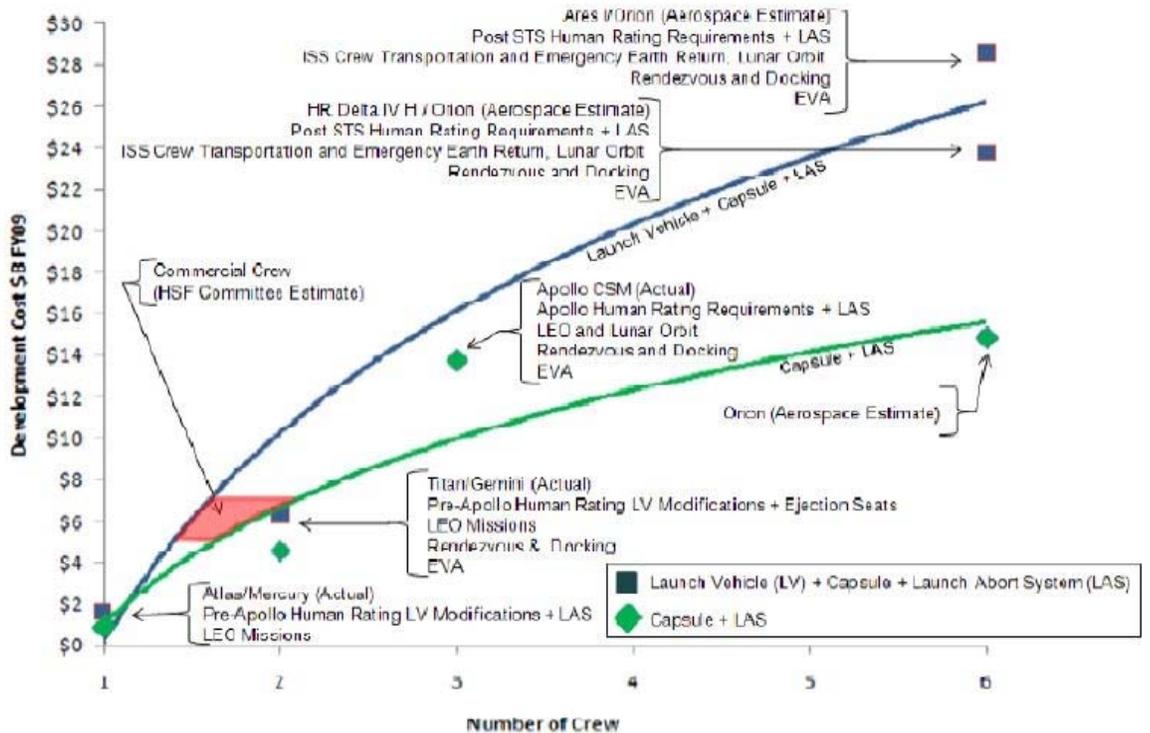
It is now two months after the March hearing, the Committee still lacks critical details and information about the plan.

- It is unclear what the government is buying for the proposed \$6 billion to foster the development of commercial crew capability—a capsule, a launch vehicle, or both? The FY 2011 budget request states that “*Unlike the COTS program, which exclusively funded entirely new and integrated systems (launch vehicles plus capsules), this program will also be open to a broad range of commercial proposals including, but not limited to: human-rating existing launch vehicles, developing spacecraft for delivering crew to the ISS that can be launched on multiple launch vehicles, or developing new high-reliability rocket systems.*”
- NASA has provided no information as to whether the \$6 billion requested is the government’s total share needed to complete the proposed commercial crew demonstrations or whether additional government support would be required for developing commercial crew capability. This information is purportedly to be informed by responses to a Request for Information, which was released on May 21, 2010.
 - However, this issue takes on greater significance in light of comments reported in a recent issue of Space News by the director of business development for United Launch Alliance (ULA), one of the potential commercial crew transport providers. The April 5, 2010 article says that “*As NASA devises its strategy for fostering development of a commercial successor to the space shuttle, the nation’s primary rocket builder is cautioning the agency not to count on industry for a substantial upfront investment in an endeavor rife with uncertainty.*”
- In response to Chairwoman Giffords’ request noted earlier, the Aerospace Corporation stated that it was given the cost to assume in its affordability analyses for developing multiple commercial crew systems; it did not independently develop that cost.
- Details on the basis for the budget estimate of \$6 billion for developing commercial crew capability are still needed.
 - The Augustine committee report estimated the DDT&E cost to NASA would be \$3 billion and would involve two commercial competitors and a government-provided rocket. The Aerospace Corporation’s responses to Chairwoman Giffords stated that: “*Aerospace did not independently develop the basis for the \$3B initial estimate. The Committee did not ask Aerospace to independently verify the \$3 billion figure. In fact, no verification could be performed given the Committee’s statement that this dollar amount was simply NASA’s portion of the total cost.*” The Aerospace responses also noted that “*The Committee’s final estimate of the cost of the program to NASA was approximately \$5 billion. It was assumed that additional private investment funding would be required to complete the DDT&E.*”
 - NASA officials told Committee staff that NASA plans to use the \$6 billion to support developing commercial crew capability in 3-4 companies.
 - The Aerospace Corporation’s responses to Chairwoman Giffords further indicate the approximate cost estimate proposed by the Augustine committee is consistent with the historical cost of developing a single crew transportation system to carry 1-2 crew (Figure A.1, page 21). However, Aerospace’s analysis suggests that for a crew of 4, development costs for a crew capsule and a launch abort system

could be substantially higher. When adding a launch vehicle, the costs could increase even more. Aerospace notes that “*Gemini is the closest historical program to the commercial crew capsule. While we have chosen to plot development cost vs. crew size, the complexity of the system is a function of human-rating requirements, destination and capability.*”

- o Indeed, the data plotted in the Aerospace responses give serious grounds for concern that the Augustine committee’s assumed cost estimate may understate the actual costs of developing commercial crew by at least a factor of two or more, especially when the additional cost of providing a “suitable version of an existing booster,” e.g., human-rating an EELV, is added—something that Aerospace has independently estimated could cost up to an additional \$11 billion, depending on the capsule/launch abort system chosen, if ground infrastructure costs are included. It goes without saying that given NASA’s constrained budget, the impact of any such cost growth in the proposed commercial crew program would have to be absorbed by NASA’s other programs.
- o Given the lack of independent analysis provided to Congress to justify the \$6 billion estimate and the Aerospace Corporation’s own analysis of potential commercial crew development costs, the credibility of NASA’s proposal remains to be demonstrated.

Figure A.1.



Source: Aerospace Corporation, Responses to Questions from Rep. Gabrielle Giffords, March 23, 2010

- In addition to the development cost, NASA has provided no independently derived estimates of the potential cost of procuring crew transportation services. According to the Aerospace Corporation, *“The Committee provided the commercial crew transportation assumptions that assumed a price of \$200M FY09 per flight at a rate of 2 flights per year. Using a historical cost growth factor for operational systems, Aerospace increased the cost per flight to \$250M FY09. The Committee did not define the crew capacity of the commercial crew vehicle. Based on the 2 Gemini-class crew module discussed above....the cost per seat would be on the order of \$125M FY09 but would vary with crew size.”*
- The timeline for the availability of commercial crew is also in question. The Aerospace Corporation did not independently develop or verify the 2016 estimate for the availability of the commercial crew capability. In fact, Aerospace was told to assume a date of 2016 for when a commercial capability would become available. Aerospace said that *“The Committee provided the schedule estimate for the commercial crew scenario as an input assumption, which was then used for the subsequent affordability analyses.”* Aerospace also said that it *“has not performed any analysis or assessment of the length of time it would take to develop, demonstrate, and contract for an operational commercial crew transport service.”*
- Information on when the government will need to contract for crew services to meet an anticipated commercial crew timeframe and the cost of crew services is needed to evaluate the government’s complete plan and cost for getting American astronauts to the ISS on commercial vehicles.
 - Aerospace raised questions related to the acquisition steps the government would need to follow to develop and procure commercial crew transport services—steps which Aerospace stated *“typically take on the order of many months,”* but the Augustine committee did not request any analysis of the impact of those steps on the cost or schedule for commercial crew—and there is no indication that the impact of those steps was considered when the Administration’s plan was formulated. Indeed, Aerospace said in response to one of Chairwoman Giffords’ questions that *“This is a critical question. While we raised these questions in the development of our work for the Committee, we were not tasked to develop this analysis. Subsequent to the release of the Committee Report, we have met with the NASA Administrator and key staff to discuss these issues. To our knowledge, NASA is currently evaluating these steps. Based on Aerospace’s prior experiences on a wide range of government acquisition activities, the acquisition-related steps are numerous, and include such steps as described in the Question 4 above. These steps typically take on the order of many months.”*
- Details on how development of a crew rescue vehicle for the ISS would *“simplify requirements for other commercial crew providers”* need to be understood in terms of, for example, any changes in the potential cost and schedule estimate for developing commercial crew capability. For example, will the simplification involve a consequent reduction in the \$6 billion allocated for developing commercial crew capability?
- Details on which sector—government or commercial—would fund the needed supporting infrastructure, including mission control, have not been provided.

- In addition, details about programs that would support the commercial crew capability and a commercial space market are also needed. For example, the proposed FY 2011 budget also requests \$428.6 million in FY 2011 and \$1.9 billion over five years for a 21st Century Space Launch Complex, in part to attract new customers, including potential commercial crew companies, to the Florida space range. NASA has not provided the requirements for the proposed complex, a detailed plan for the initiative, or a rationale for the funding requested. In addition, the administration has not provided a break-out of how the money would be spent. The requirements for the proposed Complex will be derived from a Request for Information that NASA plans to issue in the near term, according to NASA officials who briefed Committee staff on the status of planning for the Complex. Although NASA officials indicate that detailed planning for the proposed Complex would involve interaction with the U.S. Air Force, which operates the Cape Canaveral Air Station, the Air Force is currently in the process of analyzing its launch enterprise strategy for which it has requested \$51 million in FY 2011 for launch modernization at Cape Canaveral and Vandenberg—a funding level that is almost an order-of-magnitude less than is being proposed just for the Cape in NASA’s FY 2011 budget request. Without details on the requirements for the Space Launch Complex, a detailed plan, a rationale for the level of funds requested and further information on how the money would be spent, it will be difficult for Congress to evaluate the credibility or urgency of the 21st Century Space Launch Complex initiative.

Another policy issue to be addressed in considering the proposal to turn U.S. astronaut transportation over to the private sector is the extent of the government’s role in supporting and sustaining a “commercial” market.

In his opening statement at the Committee’s February 25, 2010 hearing on NASA’s Fiscal Year Budget Request, Chairman Gordon posed the following questions:

- *“Do you have concrete evidence that you can provide us that shows that there will be sufficient non-NASA commercial crew transport markets to keep these companies viable, or is NASA going to be on the hook to do whatever it takes to keep them in business since NASA will have no other means of getting into orbit?” “That is, will NASA’s actions make these companies “too important to fail” despite the lack of any significant existing markets for their proposed services—with all of the implications for the American taxpayer inherent in that phrase?”*
 - In response, Administrator Bolden stated: that *“unfortunately, it is not—we at NASA have not done any market surveys nor have...I offered to do that or asked to do it, so I am depending upon surveys and information that has come from the industry themselves.”*

According to an unofficial transcript of a hearing that reviewed NASA’s human spaceflight plans held by the Senate Committee on Commerce, Science, and Transportation on May 12, 2010, NASA Administrator Bolden stated:

- *“I have always said, I will do everything in my power to facilitate the success of the commercial entities in access to low-Earth orbit. I have to have that.”* He also said, *“You know, I have to look at the possibility that the commercial sector may have difficulty, and we will do everything in my power to facilitate their success.”*
- Captain Eugene Cernan testified at that same hearing that Mr. Bolden discussed with him his concern about when commercial crew capability might become available, had said that NASA might have to subsidize them, and that *“it may be a bailout like GM and Chrysler; as a matter of fact, it may be the largest bailout in history,”* according to the unofficial transcript of the hearing.

Does Congress Have the Facts and Analysis to Have Confidence in the Safety of Proposed Commercial Crew Services?

The Subcommittee on Space and Aeronautics examined several issues related to safety and human spaceflight in its December 2009 hearing, “Ensuring the Safety of Human Space Flight.” The hearing made clear that establishing and enforcing safety standards for the transport of crew on commercially provided orbital crew transportation services is in many ways uncharted territory. A process has yet to be advanced by the government on how the “airworthiness” of commercial spaceflight vehicles used to transport government passengers will be “certified.” Several issues need to be addressed in order for Congress to have the data and analysis of how safety will be ensured in proposed commercial human spaceflight systems.

In her opening statement at that hearing, Chairwoman Giffords said:

- *“As several of the witnesses at today’s hearing will testify, the Constellation program strove to respond to the recommendations of the Columbia Accident Investigation Board in the design of Ares and Orion.*
- *The result is a system that is calculated to be significantly safer than the Space Shuttle, and 2 to 3 times safer than the alternative approaches considered by NASA.*
- *Given that, I think the burden of proof has to be put on those who would deviate from Constellation program to demonstrate that their alternative crew transportation systems will be at least as safe, if not safer than the Ares/Orion system.”*

Addressing the latter issue that Chairwoman Giffords raised involves several questions and issues:

- *What will be required to verify commercial providers’ compliance with future government-developed safety standards for human spaceflight?*
- *Commercial companies are currently developing launch systems that would potentially be used to carry crew. What are the implications of implementing safety standards after a vehicle has been designed and developed?*

- *What is needed to develop and implement new safety processes, testing and verification procedures?*
- *What is involved in establishing a new regulatory regime for certification?*
- *What training and familiarization with non-NASA crewed spacecraft and launch vehicles would astronauts flying on such non-NASA spacecraft and launch vehicles need in order to deal with off-nominal conditions, contingency operations and emergencies?*
- *What contingencies would be in place should commercial crew providers experience delays, failures, or be unavailable for an extended period of time?*
- *How will any differences in safety risk among potential crew transportation systems be addressed, even if those systems meet safety standards?*

Mr. John Marshall, a member of the Aerospace Safety Advisory Panel who testified at the hearing made a comment in his prepared statement: *“there is no cookie-cutter approach to safety in space.”* Mr. Marshall articulated in his prepared statement several challenges that need to be addressed in ensuring the safety of NASA astronauts on commercial crew transportation providers to low-Earth orbit:

- *“Establishing detailed safety requirements that NASA deems essential to safe flight. These must be in a clear and enforceable form that can be placed on contract(s) and tested for compliance.*
- *...establishing minimum acceptable safety levels to guide system designs and set the baseline for both NASA and their contractors as to what is ‘safe enough’ is critical.*
- *Even with clear safety requirements and levels, much of the inherent safety of complex systems like spacecraft depends upon the design choices and decisions where risks are weighed against performance, costs, and of course, schedules. An open and effective system has been developed within NASA to accomplish this. A similar process needs to be institutionalized by any commercial provider as well, whereby all potential hazards are properly vetted by both government and contractors. This will not be easy and may require more than the ‘hands off’ approach envisions by some.*
- *Establishing disciplined program and process-related checks and balances so that NASA can verify that the contractor has evidence of compliance with the launch vehicle design requirements in the as-built vehicle and successful completion of the activities necessary to demonstrate mission readiness.”*

In discussions about safety, there have been repeated references to NASA’s oversight of safety for any commercial crew system. Accordingly, in testimony to the Senate Committee on Commerce, Science, and Transportation’s May 12, 2010 hearing on the future of U.S. human spaceflight, Dr. John Holdren, Director of the Office of Science and Technology Policy said, *“Safety will remain under the oversight of NASA. This gentleman on my left was in charge of safety for the Astronaut Corps when he was an astronaut. He knows how important that is. While Charlie Bolden is Administrator of NASA, there’s going to be no shortfall in the oversight of the private sector in delivering astronauts to Earth orbit in terms of safety. I just wanted to make that one point because*

it has come up from time to time.” What “oversight” means in terms of NASA’s role and the costs to accomplish the oversight have not been discussed and needs to be understood.

5. Should Congress Support NASA’s Advanced Technology Initiatives?

According to NASA, the agency’s Exploration Systems Mission Directorate (ESMD) will manage activities aimed at advancing technologies needed to expand human exploration opportunities, reduce mission costs, and contribute NASA innovation to broader national challenges and applications, will be funded in and managed by ESMD. ESMD’s Exploration Technology and Demonstrations activities are proposed to be funded at \$652.4 million in FY 2011; a total of \$7.82 billion is projected for the period of FY 2011 through FY 2015 to develop and carry out flagship technology projects.

ESMD will also lead research and development (R&D) activities related to space launch propulsion technologies. The agency proposes in its budget justification that this propulsion R&D effort include development of a U.S. first-stage hydrocarbon engine for potential use in future heavy lift (and other) launch systems, as well as basic research in areas such as new propellants, advanced propulsion materials manufacturing techniques, combustion processes and engine health monitoring. The proposed FY 2011 funding level for heavy lift and propulsion technology is \$559 million; a total of \$3.1 billion is projected for the period of FY 2011 through FY 2015. The April 15th plan included a decision date for a heavy lift vehicle by 2015. The issues related to heavy lift are described in a later section of the charter.

In addition, the FY 2011 budget request proposes a program of robotic precursor missions to send spacecraft to *“to candidate destinations for human exploration such as the Moon, Mars and its moons, Lagrange points, and nearby asteroids to scout targets for future human activities, and identify hazards and resources that will determine the future course of expanding human civilization into space.”* The FY 2011 budget plan proposes an investment of \$125 million in FY 2011 and a total of about \$3 billion for FY 2011- 2015 on the robotic precursor program. The revised April 15th plan makes no changes to the proposed robotic precursor mission program.

Issues Related to Advanced Technology Initiatives

- In his testimony to the Senate Commerce, Science and Transportation Committee hearing on May 12, 2010, Administrator Bolden provided a list of the initial technology development projects that will be pursued as part of the advanced technology programs as well as list of the dates by which those projects will be completed. His prepared statement, however, cautions that the initial plans may change: *“Please note these are preliminary ESMD plans that may need to be modified following finalization of Agency plans regarding the restructuring of the Orion crew capsule.”*

- A recently released pre-publication version of a report by the National Academies, *Capabilities for the Future: An Assessment of NASA Laboratories for Basic Research* stated that “*The fundamental research community at NASA has been severely impacted by the budget reductions that are responsible for this decrease in laboratory capabilities, and as a result NASA’s ability to support even NASA’s future goals is in serious jeopardy.*” The study found that “*Over 80 percent of NASA facilities are more than 40 years old and need significant maintenance and upgrades to preserve safety and continuity of operations for critical missions.*” The report further stated that “*Deferred maintenance grew from \$1.77 billion to \$2.46 billion from 2004 to 2009, presenting a staggering repair and maintenance bill for the future.*” In addition, “*The equipment and facilities at NASA’s fundamental research laboratories are inferior to those...at comparable laboratories at DOE, at top-tier universities, and at many corporate research institutions.*” The president’s budget request does not appear to contain specific funds to deal with the facilities issues raised in the National Academies report.
- In his prepared statement to the Subcommittee on Space and Aeronautics’ hearing held on March 24, 2010, Mr. A. Thomas Young, Lockheed Martin (ret.), stated: “*The technology program identified in the proposed budget lacks definition and focus.*”

Congress needs the details on the basis and justification for the funding levels proposed for the technology programs, an understanding of the priorities for the programs and how they relate to the overall strategy and the implications of the need to fund a crew rescue vehicle on the technology initiatives. To date, this information has not been provided.

6. Should Congress Support the Plan to Make a Decision on a Heavy-Lift Vehicle by 2015?

The Constellation Program includes the Ares V cargo launch vehicle which, according to the FY 2010 budget request for NASA, “*is designed to provide the heavy-lift capability for the Constellation architecture. The vehicle consists of a 6-engine core stage, two five-and-half segment solid rocket boosters, and an Earth departure stage (EDS) powered by a restartable J-2X engine. The EDS serves as the vehicle’s second stage, and is key to injecting the lunar lander and EDS stack into the low Earth orbit staging for rendezvous and dock with Orion. After the EDS performs the trans-lunar injection burn for the lander and Orion, it will be jettisoned.*”

The proposed human spaceflight plan does not include development of a heavy-lift vehicle. Instead the plan focuses on research and development in heavy-lift capabilities that would inform a decision on a launch vehicle. This is a point of departure from the Augustine committee report—often referenced as a key input into the proposed new plan—which included the importance of a heavy-lift launch vehicle among its principal findings. Mr. Augustine noted in testimony to the Senate Committee on Science, Transportation, and Commerce on May 12, 2010 that a key difference between the Augustine committee’s Option 5B and the administration’s plan is that: “*One is that our*

option went ahead with the development of the heavy-lift launch vehicle right away, rather than wait up to 5 years.”

To demonstrate a concrete timetable and commitment for expanding human exploration further into space, the president announced in his April 15, 2010 remarks that, in addition to investing in heavy-lift technologies, NASA would “*finalize a rocket design no later than 2015 and then begin to build it. That’s at least two years earlier than previously planned....*” The Office of Science and Technology Fact Sheet on the president’s April 15th address stated that “*This new rocket would eventually lift future deep-space spacecraft to enable humans to expand our reach toward Mars and the rest of the Solar System. This new rocket would take advantage of the new technology investments proposed in the budget – primarily a \$3.1 billion investment over five years on heavy-lift R&D.*” That Fact Sheet calls out “*development of a U.S. first-stage hydrocarbon engine for potential use in future heavy lift (and other) launch systems.*”

While the date of 2015 has been proposed as a decision point on the heavy-lift vehicle, it is not clear what that decision point means.

- In his prepared statement for the May 12, 2010 Senate Commerce, Science and Transportation hearing on U.S. human spaceflight plans, Dr. John Holdren, director of the Office of Science and Technology Policy, stated: “*The President also directed in his speech that NASA be in a position to select a heavy-lift rocket design by no later than 2015 for its future mission beyond Earth’s orbit.*” Dr. Holdren’s statement went on to say that “*It is currently anticipated that this decision would set the general configuration of the vehicle, as well as target performance levels and other attributes. A more detailed and mature design for this vehicle likely would need to be completed following this initial decision, as part of a subsequent development effort.*”
- In his prepared statement for the Senate hearing, Mr. Bolden said, “*the President specifically recognized the need for a heavy lift launch capability to carry humans beyond LEO by requiring a decision a vehicle design no later than 2015. Such a decision would include setting performance goals, identifying lift capability and selecting the general vehicle design – work that will ultimately lay the path for launching a spacecraft for crewed missions into deep space.*”

By 2015, will NASA be in the position of building a vehicle, having completed most of the design and development process, or will NASA be in the position of just having defined which type of vehicle to design and develop? What is the return on the \$3.1 billion investment that Congress is being asked to support? These potentially different decision milestones in 2015 will have significant implications for the timeline of developing a heavy-lift vehicle to support exploration beyond low-Earth orbit and to achieve the administration’s goal of human travel to a near-Earth asteroid by 2025.

What Additional Information Does the Congress Need Regarding the Proposed Heavy Lift Launch Vehicle?

NASA's May 2010 Request for Information on "Heavy Lift Launch System and Propulsion Technology" requests that industry "*Provide information regarding your potential launch or space transportation architectures (expendable, reusable, or a hybrid system) that could meet multiple customer needs (e.g., NASA, DoD, and Commercial).*" The Request for Information raises a number of questions: What is NASA's strategy for developing heavy-lift capability? Will DOD co-fund the development? Will the system be designed to meet multiple agency requirements, and if so, what are the advantages and disadvantages to this approach? How does the involvement of other agencies and the commercial sector affect the timeline and process for moving forward on a heavy-lift architecture?

In addition, according to NASA's planning timeline, NASA would fund development leading to a hydrocarbon engine demonstration that would occur in the 2015 timeframe; an operational hydrocarbon engine would be available in the early 2020s. NASA has not provided a rationale for completing an engine development program in parallel with developing a heavy-lift launch architecture that may or may not use that engine. Important questions remain regarding how an engine research and development program will proceed and when a heavy-lift vehicle would be available to support crewed missions beyond low-Earth orbit. NASA has explained that prior to sending a crewed mission to an asteroid in 2025, several crewed precursor flights would be needed including cislunar and circumlunar missions. Without supporting details to establish when the required spacecraft, heavy lift vehicle and other required systems will be in place, the timeline for achieving a human mission to an asteroid must remain uncertain.

Congress needs to understand:

- *When will a heavy-lift vehicle need to be ready, including an operational new engine if one is used, in order to support initial circumlunar and cislunar missions in preparation for a crewed mission to an asteroid in 2025? Is NASA's plan viable?*
- *What are the estimated costs of developing a new engine and how do they compare to the anticipated long-term cost savings for that engine? How does it compare to the cost of pursuing evolvable heavy lift capabilities using the Constellation architecture approach?*
- *When will a crew exploration vehicle for travel beyond low-Earth orbit need to be ready to support initial circumlunar and cislunar missions proposed to take place prior to 2025? When does a decision on that vehicle and subsequent development need to take place to support that timeline? Is NASA's plan viable?*
- *Will the success or failure of heavy lift research and development and other advanced technologies, such as in-space refueling, dictate where and when human exploration missions can be conducted?*
- *Will the heavy lift vehicle be a government or commercially-provided system?*

7. To What Extent Can the Plan that Congress is Being Asked to Support Be Executed Within the Proposed Budget?

Among its principal conclusions the Augustine Committee found that:

- The current U.S. human spaceflight program is on an “*unsustainable trajectory*,”
- “*Human exploration beyond low-Earth orbit is not viable under the FY2010 budget guideline*,” and
- “*Meaningful human exploration is possible under a less-constrained budget, increasing annual expenditures by approximately \$3 billion in real purchasing power above the FY2010 guidance.*”

The goal of a sustainable human spaceflight program is stated as a recurring theme of the FY 2011 budget request: “*The Exploration Systems Mission Directorate (ESMD) will lead the Nation on a course of discovery and innovation that will provide the technologies, capabilities and infrastructure required for sustainable, affordable human presence in space.*” Following the president’s remarks on revisions to his proposed human spaceflight strategy, Presidential Science Advisor, Dr. John Holdren characterized the president’s new plan as “*more flexible, more practical, more productive, and more affordable, but also more visionary*” than the existing plan.

According to Mr. Augustine, who spoke at the April 15th Kennedy Space Center event, the overall portfolio of the proposed plan is “very close to” the Augustine committee’s proposed option 5B. As described in the Augustine committee report, option 5B “*employs an EELV-heritage commercial heavy-lift launcher and assumes a different (and significantly reduced) role for NASA. It has an advantage of potentially lower operational costs, but requires significant restructuring of NASA....The choice between NASA and EELV heritage is driven by potentially lower development and operations cost (favoring EELV-heritage systems) is driven by potentially lower development and operations cost (favoring the EELV-heritage systems) vs. continuity of NASA’s system design, development and mission assurance knowledge and experience, which would provide higher probability of successful and predictable developments (favoring NASA systems). EELV-heritage launch systems, due to their lower payload performance, would require significantly greater launch and mission complexity to achieve the same total mass in orbit. The EELV option would also entail substantial reductions in the NASA workforce and closure of facilities necessary to obtain the expected cost reductions.*”

It is worth noting that DOD is reported to be developing plans for replacing its existing EELVs due to escalating costs of the EELV program. Furthermore, in the near term, DOD has expressed concern about the impact producing a human-rated EELV might have on the Air Force. In a recent interview in Defense News, the Air Force’s Deputy Undersecretary for Space Programs said:

“If some commercial company or companies want to use the EELV for human access to the space station, we’d have to look very closely at changes to the rockets’ design in order to accommodate people. And any of those changes we’d have to manage very

closely so that they don't ripple in to the Air Force design, which has been very successful with 31 successes out of 31 attempts. My view is, if it works, don't fix it."

When it analyzed the integrated options described in its report, including option 5B, the Augustine committee used two budget scenarios: the FY2010 budget request for human spaceflight, as directed within the Augustine committee's charter, and a "*less-constrained planning budget*" that increased "*from the FY 2010 budget number to a sum \$3 billion higher in 2014, and then rose at an expected inflation rate of 2.4 percent thereafter*".

Table 1, below, shows the year by year budget figures projected for the Augustine committee's less constrained scenario, the FY 2010 budget request, extended with inflation (as prepared by the Aerospace Corporation for the Augustine committee), and the FY 2011 budget request, also extended with inflation. The budget figures for the Augustine committee's less constrained scenario and the FY 2010 budget request include the Space Shuttle, ISS, total Exploration budgets, and Exploration infrastructure sustainment at KSC. The FY 2011 budget column includes the same elements, the 21st Century Launch Complex and half of the Space Technology Program (minus the Innovative Partnership Program budget), with the assumption that half of Space Technology investments will be devoted to Science. What becomes clear from Table 1 is the growing gap between what the Augustine committee found was necessary for "*meaningful human exploration*" and what is requested within the FY 2010 and FY 2011 budgets for NASA's human spaceflight programs and exploration technology development as one looks at the outyear budget totals. While the overall FY 2011 NASA budget includes a \$6 billion increase over five years above the FY 2010 budget, Table 1 shows a significant gap between the Augustine committee's less constrained scenario and the FY 2010 and FY 2011 budget projections for human spaceflight/ technology programs. Under the administration's FY 2011 budget request, the new strategy proposed for human spaceflight, while similar to the Augustine committee's Option 5B, would be funded at a level that falls almost \$11 billion below the Augustine committee's projected resource need for that content within the first five years (from FY 2010-FY 2015) of implementation. That gap grows to \$27 billion over 10 years and by FY 2025, the FY 2011 budget guidance falls \$47 billion short of what the Augustine committee determined would be necessary for a meaningful exploration program.

As part of its conclusions, the Augustine committee found that there was no "*reasonable exploration program (e.g., with different heavy-lift vehicles, or a different exploration destination)* [that] *would fit within the FY 2010 budget guidance.*" In addition, in the chapter on "Concluding Observations" the Augustine committee states that "*Perhaps the greatest contributor to risk in the space program, both human and financial, is seeking to accomplish extraordinarily difficult tasks with resources inconsistent with the demands on those tasks.*" Mr. Augustine echoed this guidance in his testimony on May 12, 2010 to the Senate Committee on Commerce, Science, and Transportation: "*The most important request I would make to this Committee on behalf of my colleagues on the Human Space Flight Committee was that whatever program is approved, that its goals match the budget. Otherwise, I think we'll all be back here 10 years from now having this same discussion.*" The comparisons shown in Table 1 do not provide grounds for

confidence that the proposed FY11 strategy is sustainable, affordable and matched to the resources requested for it.

Table 1. Comparison of Budgets for Human Spaceflight/Technology

| (all in millions of \$) | Augustine Report (Less Constrained Options) | Change From Previous Year (Augustine) | FY2010 Budget | Change From Previous Year (FY10) | FY2011 Budget | Change From Previous Year (FY11) |
|-------------------------|---|---------------------------------------|---------------|----------------------------------|---------------|----------------------------------|
| Assumed Inflation (%) | 2.40 | | 1.40 | | 1.80 | |
| FY2010 | 9,387.20 | | 9,387.20 | | 9,236.20 | |
| FY2011 | 9,774.00 | 386.80 | 9,024.00 | -363.20 | 8,647.90 | -588.30 |
| FY2012 | 10,317.00 | 543.00 | 8,816.00 | -208.00 | 8,557.10 | -90.80 |
| FY2013 | 10,867.00 | 550.00 | 8,617.00 | -199.00 | 8,681.30 | 124.20 |
| FY2014 | 11,681.00 | 814.00 | 8,681.00 | 64.00 | 8,978.20 | 296.90 |
| FY2015 | 11,961.00 | 280.00 | 8,802.00 | 121.00 | 9,067.10 | 88.90 |
| FY2016 | 12,248.00 | 287.00 | 8,925.23 | 123.23 | 9,230.31 | 163.21 |
| FY2017 | 12,542.00 | 294.00 | 9,050.18 | 124.95 | 9,396.45 | 166.15 |
| FY2018 | 12,843.01 | 301.01 | 9,176.88 | 126.70 | 9,565.59 | 169.14 |
| FY2019 | 13,152.00 | 308.99 | 9,305.36 | 128.48 | 9,737.77 | 172.18 |
| FY2020 | 13,467.65 | 315.65 | 9,435.64 | 130.28 | 9,913.05 | 175.28 |
| FY2021 | 13,790.87 | 323.22 | 9,567.73 | 132.10 | 10,091.48 | 178.43 |
| FY2022 | 14,121.85 | 330.98 | 9,701.68 | 133.95 | 10,273.13 | 181.65 |
| FY2023 | 14,460.78 | 338.92 | 9,837.51 | 135.82 | 10,458.05 | 184.92 |
| FY2024 | 14,807.84 | 347.06 | 9,975.23 | 137.73 | 10,646.29 | 188.24 |
| FY2025 | 15,163.22 | 355.39 | 10,114.88 | 139.65 | 10,837.93 | 191.63 |

| | | | | | | |
|---------------------------------|------------|--|------------|--|------------|--|
| Aggregate FY2010 Through FY2015 | 63,987.20 | | 53,327.20 | | 53,167.80 | |
| Aggregate FY2010 Through FY2020 | 128,239.86 | | 99,220.49 | | 101,010.97 | |
| Aggregate FY2010 Through FY2025 | 200,584.42 | | 148,417.53 | | 153,317.85 | |

| | Through FY2015 | Through FY2020 | Through FY2025 | | | |
|--|----------------|----------------|----------------|--|--|--|
| Difference in Aggregates Augustine -FY10 Budget | 10,660.00 | 29,019.37 | 52,166.89 | | | |
| Difference in Aggregates Augustine -FY11 Budget | 10,819.40 | 27,228.89 | 47,266.56 | | | |
| Difference in Aggregates FY10 Budget - FY11 Budget | 159.40 | -1,790.48 | -4,900.33 | | | |

Sources: The Aerospace Corporation, NASA, and “The Economic Assumptions Underlying the Fiscal 2011 Budget, Christina D. Romer, Chair, President’s Council of Economic Advisers, February 1, 2010.”

8. What Will Be the Impacts to the Human Spaceflight Workforce and Industrial Base Under the Proposed Human Spaceflight Strategy?

The retirement of the Space Shuttle and the proposed direction for NASA will have major implications for the U.S. aerospace workforce and space industrial base. In conceiving the Constellation Program, NASA integrated measures to facilitate the transition of the Space Shuttle workforce to Constellation; the industrial base was also considered. In implementing Constellation, NASA had established a bridge so that a number of Shuttle and Space Station employees could devote a portion of their time to developing experience and skills that are relevant to the Constellation Program and that will facilitate their eventual transition to Constellation.

The proposed new direction for NASA's human spaceflight programs raises new issues and questions about the critical skills and knowledge of human spaceflight operations that will need to be sustained over time, the ability to attract new talent to the aerospace workforce and the potential state of the U.S. space industrial base. In particular, what are the critical workforce skills and industrial capabilities that need to be preserved as national assets, and what are the most effective ways to preserve those assets? What would any significant cutback or change in direction from the current Constellation Program mean for the aerospace workforce and space industrial base? These issues and questions were examined in a Committee on Science and Technology hearing on December 10, 2009 on *Decisions on the Future Direction and Funding for NASA: What Will They Mean for the U.S. Aerospace Workforce and Industrial Base?*

As Subcommittee on Space and Aeronautics Chairwoman Giffords stated in her opening remarks:

- *“Make no mistake about it. The decisions we collectively make about the future of our space program will have a lasting impact on our workforce, our industrial base, and our standing in the world.*
- *As a result, I want our witnesses to give us their views on what we need to consider when making those decisions so that the outcome will inspire our best and brightest to pursue careers in aerospace—careers that will be vital to our future competitiveness, national security, and quality of life.”*

Witnesses at that hearing commented on the link between the NASA workforce and industrial base and national security, how long-term experience affects the success of human spaceflight and the need for continued, engaging participation in inspiring programs to maintain and pass on that experience to the next generation.

Mr. A. Thomas Young, Lockheed Martin (ret.) stated:

- *“...spaceflight is not a typical technological activity. Because of the special characteristics of spaceflight...a workforce is required that has the culture and capabilities aligned with these characteristics. A workforce with the necessary intellectual strengths and possibly even more important, the experience and longevity to establish the sensitivity as to what is required for spaceflight success. Today in*

government, universities and industry we have such a workforce. It has evolved over decades of extraordinary successes and tragic failures. ...It is truly a national treasure. Without a challenging and meaningful space program, this national capability will atrophy.”

Ms. Marion Blakey, President and Chief Executive Officer of the Aerospace Industries Association stated:

- *“NASA is linked to the health of our industrial base. ...we must also view these jobs as a national resource critical to our nation’s technological capability and our national security. Aerospace talent lost to other industries may be unrecoverable; new workers may take years to train. Additionally, if we lose certain facilities that manufacture high-tech technologies, it may take years and additional resources to bring them back.”*
- *“this decision [on human spaceflight], has a genuine impact on our national security because you must remember that some of these particularly smaller companies with unique capabilities and technologies...in fact also support that fragile national security supply chain.”*

Dr. Richard Aubrecht, Moog Inc. stated:

- *“The people that we had that did the Space Shuttle and did the Apollo program, they are about to retire, and the thing we are looking for the Constellation to be is the transition to the next generation of people and to do the mentoring...It goes from person to person. It is not in the drawings.”*

Although the administration has proposed a number of steps to address workforce issues, the following section illustrates the immature status of some of those proposals and an overall lack of clarity to date on how the workforce initiatives will work in an integrated fashion.

How Many New Jobs Will the Proposed Human Spaceflight Plan Create?

The president’s revised plan for NASA *“leads to more than 2,500 additional jobs in Florida’s Kennedy Space Center area by 2012”* and *“Jumpstarts a new commercial space transportation industry to provide safe and efficient crew and cargo transportation to the Space Station...projected to create over 10,000 jobs nationally,”* according to the OSTP Fact Sheet.

In addition, *“the Administration is launching a \$40 million, multi-agency initiative to help the Space Coast transform its economy and prepare its workers for the opportunities of tomorrow,”* according to an OSTP Fact Sheet on Florida’s Space Workers and the New Approach to Human Spaceflight. Accordingly, in his remarks at the Kennedy Space Center on April 15th, the president proposed *“a \$40 million initiative-led by a high-level team from the White House, NASA, and other agencies- to develop a plan for regional economic growth and job creation.”* He directed the plan to be delivered to him by

August 15, 2010. In his prepared statement for the May 12, 2010 Senate Commerce, Science and Transportation Committee hearing on NASA's human spaceflight plans, Mr. Bolden stated that *"The \$40 million for this initiative will be taken from the funds requested for Constellation transition in the original FY2011 Presidential budget request."*

On May 3, 2010, The White House established a Task Force on Space Industry Workforce and Economic Development *"to develop, in collaboration with local stakeholders, an interagency action plan to facilitate economic development strategies and plans along the Space Coast and to provide training and other opportunities for affected aerospace workers so they are equipped to contribute to new developments in America's space program and related industries. The Secretary of Commerce and the Administrator of NASA shall serve as Co-Chairs of the Task Force."* The program *"shall be implemented consistent with applicable law and subject to the availability of appropriations."*

As part of its functions, the Task Force is directed to *"provide leadership and coordination of Federal Government resources to facilitate workforce and economic development opportunities for aerospace communities and workers affected by new developments in America's space exploration program."* In addition, the Task Force is directed to develop a plan that, among other things, *"recommends how best to invest \$40 million in transition assistance funding to ensure robust workforce and economic development in those communities within Florida affected by transitions in America's space exploration program"*. No similar initiatives or funds have been announced for other regions affected by the cancellation of Constellation.

NASA has not provided details on the rationale for the estimated jobs to be created, the types of jobs that will be created, and the extent to which the new jobs at the Kennedy Space Center will help offset the workforce decline that will follow the Space Shuttle retirement. An April 13, 2010 *New York Times* article notes that a senior administration official pointed to a study conducted by the Tauri Group, a consulting firm, and financed by the Commercial Spaceflight Federation, as the source of the estimated 10,000 jobs to be created by the commercial space transportation industry. It is not clear whether NASA or the administration has independently verified this estimate as part of its projected level of jobs to be created through commercial crew and cargo programs.

In addition, the proposed new strategy—specifically the cancellation of the Constellation Program—reportedly could have significant implications for the health of the solid rocket motor industrial base, which also supports ballistic missile programs. At a February 25, 2010 Committee on Science and Technology hearing on "NASA's Fiscal Year 2011 Budget Request and Issues," the Committee requested that the Administrator provide details on the extent to which NASA consulted the Department of Defense on the FY 2011 budget plan and the implications it will have on the industrial base and with whom in the Defense Department NASA consulted. NASA has not yet provided those details.

Questions and Information Needed to Inform Congress' Decision

- *To what extent do the projected commercial-sector jobs preserve the critical U.S. knowledge base of human spaceflight operations?*
- *What types of jobs would the new positions involve and at what skill levels? To what extent would those commercial-sector jobs help mitigate the projected job losses to be experienced by the retirement of the Space Shuttle and the proposed cancellation of the Constellation program?*
- *What assumptions, if any, have been made about the geographical locations of the projected new commercial-sector jobs?*
- *Is the Space Industry and Workforce Economic Development initiative expected to require funding beyond FY 2011, and if so how much?*
- *Which agency(ies) will be in charge of implementing this plan?*