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A REVIEW OF NASA'S SPACE LAUNCH SYSTEM

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

TUESDAY, JULY 12, 2011

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A REVIEW OF NASA'S SPACE LAUNCH SYSTEM

TUESDAY, JULY 12, 2011

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

The Committee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

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Subcommittee on Space and Aeronautics
A Review of NASA's Space Launch System

Tuesday, July 12, 2011
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness

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

HEARING CHARTER

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

A Review of NASA's Space Launch System

TUESDAY, JULY 12, 2011
10:00 A.M. TO 12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Hearing Purpose

The original intent of the hearing was to examine NASA's selection of a heavy-lift launch system ("Space Launch System") that will be used to launch future crew and cargo flights beyond low Earth orbit. Members would have had an opportunity to ask questions regarding cost, schedule, capabilities, and justification for the selected design. However, on July 7, a senior NASA official publicly stated that a final decision on SLS won't be announced until "late this summer." In light of NASA's continuing delays (the NASA Authorization Act of 2010 required a decision and report by mid-January 2011), the hearing will instead provide an opportunity for NASA to explain why it has failed to reach a decision, what analyses still need to be completed, and when the Space Launch System decisions will be forthcoming.

Witness

- **The Honorable Charles F. Bolden Jr.,** Administrator, National Aeronautics and Space Administration

Background

The Bush Administration and the NASA Authorization Acts of 2005 and 2008

In the aftermath of the Space Shuttle Columbia accident the Bush Administration proposed a new vision for space exploration, following the retirement of the Space Shuttle, which would extend human capabilities beyond low Earth orbit for the first time since 1972. In the NASA Authorization Act of 2005 Congress directed NASA to *"establish a program to develop a sustained human presence on the Moon, including a robust precursor program, to promote exploration, science, commerce, and United States preeminence in space, and as a stepping-stone to future exploration of Mars and other destinations."* [P.L. 109–155]

Subsequently, NASA created the Constellation program (consisting of the Ares 1 rocket and Orion crew capsule, the Ares 5 heavy lift launcher, and the Altair lunar lander) that was designed to accommodate this stepping-stone approach, and was Congressionally-authorized by the NASA Authorization Act of 2008 *"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]

The Obama Administration

In NASA's FY 2010 budget proposal the Obama Administration maintained the Congressionally-authorized policy of returning Americans to the Moon and noted that, *"Funds freed from the Shuttle's retirement will enable the Agency to support development of systems to deliver people and cargo to the International Space Station and the Moon," and, "The Agency will create a new chapter of this legacy as it works to return Americans to the Moon by 2020 as part of a robust human and robotic space exploration program."* Yet in spite of these assertions the Administration eliminated funding for continued development of the Altair lunar lander and the

Ares 5 heavy-lift launch vehicle, and cut more than $3 billion from NASA's five year Exploration Systems budget, relative to the FY 2009 budget request.

At the time of the FY 2010 budget proposal the Administration established an independent review committee chaired by retired Lockheed Martin executive Norman Augustine. The Review of Human Spaceflight Plans Committee delivered its final report in October 2009 with the overarching conclusion that *" Meaningful exploration beyond low-Earth orbit is not viable under the FY 2010 budget guideline" but that "Meaningful human exploration is possible under a less-constrained budget, increasing annual expenditures by approximately $3 billion in real purchasing power above the FY 2010 guidance."*

Despite the Augustine Committee's finding that the FY 2010 budget profile was insufficient for meaningful human space exploration, the next year the administration reduced the FY 2011 Exploration Systems budget to $4.3 billion, which was $1.8 billion below the FY 2010 runout plan. Hence, it appeared that *" Funds freed from the Shuttle's retirement." would not be provided by the Administration to "enable the Agency to support development of systems to deliver people and cargo to the International Space Station and the Moon."*

In NASA's FY 2011 budget request the Administration proposed canceling the Constellation program, claiming it was *" trying to recreate the glories of the past with the technologies of the past."* Then at a speech at the Kennedy Space Center on April 15th 2010, the President said 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.

On July 6, 2011 during a Twitterr Town Hall webcast, President Obama expressed his vision for exploration this way, *". . . let's ultimately get to Mars. A good pit stop is an asteroid. I haven't actually—we haven't identified the actual asteroid yet, in case people are wondering. But the point is, let's start stretching the boundaries so we're not doing the same thing over and over again. But rather, let's start thinking about what's the next horizon. What's the next frontier out there and you know, but in order to do that we're going to need some technological breakthroughs that we don't have yet."*

In lieu of *Constellation*, the Administration's FY 2011 budget sought to fund development of *"commercial crew"* transportation services (three or four, according to NASA), and postpone construction of human exploration systems for a least five years, instead pursuing additional propulsion research and technology development. Despite repeated requests by both the House Committee on Science, Space, and Technology, and the Senate Committee on Commerce, Science, and Transportation throughout 2010, NASA failed to provide a credible plan justifying their proposal. As a result, after extensive review and debate, Congress in its 2010 NASA Authorization Act reversed the Administration's approach and directed the agency to build upon the capabilities of the Shuttle and Constellation programs and immediately begin developing the SLS and MPCV.

The NASA Authorization Act of 2010 [P.L.111–267]

Last year Congress passed the NASA Authorization Act of 2010, which was signed by the President on October 11, 2010 [P.L.111–267]. The Act provided policy guidance and recommended funding levels for three years, and called for a National Academy *"review of the goals, core capabilities, and direction of human space flight, using the goals set forth in the National Aeronautics and Space Act of 1958, the NASA Authorization Act of 2005, and the NASA Authorization Act of 2008, the goals set forth in this Act, and goals set forth in any existing statement of space policy issued by the President."* The review is to be completed by next year.

Congress again reaffirmed the policy of the NASA Authorization Act of 2005 (42 U.S.C. 16761(a)), *"that the United States shall maintain an uninterrupted capability for human space flight and operations in low-Earth orbit, and beyond, as an essential instrument of national security and of the capacity to ensure continued United States participation and leadership in the exploration and utilization of space."* [§201(b)]

Section 202 (a) stated that, *"The long term goal of the human space flight and exploration efforts of NASA shall be to expand permanent human presence beyond low-Earth orbit and to do so, where practical, in a manner involving international partners."* Section 301(a)(1) stated, *"The extension of the human presence from low-Earth orbit to other regions of space beyond low-Earth orbit will enable missions to*

the surface of the Moon and missions to deep space destinations such as near-Earth asteroids and Mars."

Section 2(9) of the NASA Authorization Act of 2010 states, *"While commercial transportation systems have the promise to contribute valuable services, it is in the United States' national interest to maintain a government operated space transportation system for crew and cargo delivery to space."*

As a result, the Act provided **$10.8 billion** (through FY 2013) to continue developing a Shuttle- and Constellation-derived launch system (newly designated the Space Launch System and Multi-Purpose Crew Vehicle) that would also assure a national capability to access the International Space Station for the U.S. and our international partners in case commercial proposals fail to materialize or Russian Soyuz vehicles are unavailable. The Act also directed NASA to proceed immediately with its development with the goal of making the system operational by 2016.

Congress envisioned that the Space Launch System (SLS) and Multi Purpose Crew Vehicle (MPCV) would get maximum benefit from the more than $10.3 billion that had been spent (up to that time) on the *Constellation program.* Constellation had achieved a number of developmental milestones including the successful flight tests of the Ares 1–X and the Orion launch abort systems, and a ground demonstration of the new five-segment solid rocket motor that was to power the Ares 1 and Ares 5 launchers. The SLS and MPCV were to continue to focus on developing the advanced human safety features of the Orion project, and be capable of evolving into a heavy lift launch system that could eventually carry 130 tons to orbit to enable human exploration beyond Earth orbit.

NASA was directed to provide a report to Congress by January 9, 2011, describing the SLS and MPCV including *"... the assumptions, description, data, and analysis of the systems trades and resolution process, justification of trade decisions, the design factors which implement the essential system and vehicle capability requirements.the explanation and justification of any deviations from those requirements, the plan for utilization of existing contracts, civil service and contract workforce, supporting infrastructure utilization and modifications, and procurement strategy to expedite development activities through modification of existing contract vehicles, and the schedule of design and development milestones and related schedules leading to the accomplishment of operational goals established by this Act."* [Section 309]

In November 2010, NASA issued a series of small ($650,000) study contracts to 13 companies to provide industry inputs to the heavy lift studies. Initial responses were obtained in late February 2011 and final replies in late April 2011.

In January 2011, Administrator Bolden sent a letter to the Committee that said, *"Unfortunately, a 2016 first flight does not appear to be possible within projected FY 2011 and out year funding levels, although NASA is continuing to explore innovative procurement and development approaches to determine whether it can come closer to this goal."*

According to briefings by senior NASA officials in May 2011, the report is expected to include, 1) the basic framework for a "capability driven architecture" and concept of operations that provides the "strategic context for exploration of multiple destinations," 2) an analysis of the cost and benefits of proposed vehicle designs for the SLS and MPCV and alternatives, 3) analysis of the current Ares, Shuttle and Orion contracts for the applicability to the future development program, and 4) analysis of potential acquisitions approaches.

NASA has contracted with Booz Allen Hamilton to perform an independent cost assessment. The results were due in May 2011 for inclusion as part of the final report. In May 2011 senior NASA officials expressed confidence that the final report would be completed by June 20th, this was later changed to July 8th. NASA's report to Congress is now more than six months late. NASA is awaiting final approval from OMB.

Continuing delays have already resulted in the loss of thousands of highly skilled aerospace jobs, and threatens to do costly damage to the U.S. industrial base. On March 30, 2011 in testimony before the Space and Aeronautics Subcommittee hearing on *A Review of NASA's Exploration Program in Transition,* the Chairman of the Corporate Membership Committee of the American Institute of Aeronautics and Astronautics testified that, *"... the space industrial base is not FACING a crisis; we are IN a crisis. And we are losing a National Perishable Asset.our unique workforce."*

FY2011 Full Year Continuing Resolution

On April 15, 2011 a full year continuing resolution established spending levels for the balance of FY 2011. As noted in the table below, for the Space Launch System, amounts provided are slightly above authorized levels. Subsequently, on June 15th NASA provided Congress with an operating plan based on the continuing resolution (FY11 CR column below) and gave notice that *"(A)dditional information on NASA's progress in selecting an architecture and acquisition strategy will be provided to Congress in the Updated Report on MPCV and SLS in summer 2011."* Agency officials are now suggesting that the information won't be available until late summer at the earliest.

NASA FY12 Budget Req - Space Launch System & Multi Purpose Crew Vehicle

($ = million)

	FY11		FY12			FY13	
	Auth	CR	Auth	Budg Req	CJS Appro*	Auth	Budg Req
Space Launch Sys	1.631	1.786	2.650	1.690	1.985	2.640	**
Multi Purpose Crew Veh	1.120	1.196	1.400	0.916	1.063	1.400	**
Total	**$2.751**	**$2.982**	**$4.050**	**$2.606**	**$3.048**	**$2.640**	**$2.591****

*As approved by the CJS Subcommittee on July 7.

** Budget provided no breakout.

Recent FY 2012 Appropriation Activity

On July 7th the House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies reported an FY 2012 appropriations bill providing a total of $3.65 billion for Exploration Systems, that included the following provision: *" Provided, that not less than $1,063,000,000 shall be for the multipurpose crew vehicle to continue existing vehicle development activities to meet the requirements described in paragraph (a)(1) of section 303 of Public Law 111–267, and not less than $1,985,000,000 shall be for the heavy lift launch vehicle system which shall have a lift capability not less than 130 tons and which shall have an upper stage and other core elements developed simultaneously."*

Chairman HALL. Charlie, are you ready? Everybody ready down the road here? Committee on Science, Space, and Technology will come to order. Good morning. Welcome to today's hearing entitled, "A Review of NASA's Space Launch System." In front of you, of course, are the same packets contained in the written testimony, biography, and truth in testimony disclosure for today's witness, Administrator Charles F. Bolden.

And we will have opening statements. I recognize myself for five minutes for my opening statement.

Good morning, and today's hearing is entitled, "A Review of NASA's Space Launch System," and our witness is NASA Administrator Charlie Bolden.

As a preface to the formal portion of my statement, I want to first congratulate all the men and women at NASA and its contractors for the successful launch of STS–135. The Shuttle launch was viewed by tens of thousands of people on hand in Florida and millions more around the world, including a packed crowd in this hearing room, and it was a bittersweet moment to watch the last flight of the Shuttle Atlantis lift off from Kennedy Space Center.

General, your team did an outstanding job, and we all look forward to welcoming this crew safely home probably some time next week.

Several weeks ago as our Committee began planning for this hearing, we had every expectation that NASA would have announced its Space Launch System architecture well before today, with the goal that the Committee Members would have the opportunity to ask questions regarding cost, schedule, capabilities, and the like. Indications we had received from NASA throughout the spring clearly suggested that a decision would have been rendered prior to today. Sadly, such is not the case.

Nine months ago the President signed the NASA Authorization Act. Provisions in the bill clearly directed, clearly directed NASA to provide us with decisions to tell Congress of their decisions on the selection of the crew vehicle and the launch system design by January 9, 2011. That date was considered attainable given the previous investment and substantial progress made by NASA in vehicle engineering, design, and demonstrations that had already been achieved by the Constellation Program.

The Act also included the goal of reaching operational capability for the core elements not later than December 31, 2016, because that date seemed realistic for the now-canceled Constellation System, and it also reflected Congress' deep concern that we needed to have a back-up capability in place should commercial launch vehicles fail to materialize.

Instead, on January 15, Congress received a "preliminary report," that emphasized its selection of prototype vehicle designs but did not commit the agency to their construction. The report was careful to note, and I quote, "NASA hopes to finalize its acquisition decisions as early as spring of 2011, details that will be included in a follow-on report to Congress." We are well into summer, and no such report has been sent.

So today, 6 months later, and with the final space shuttle mission now underway, instead of an informed discussion on the attributes and trades on the selection of a Space Launch System, we

will be left with little more than an explanation of decision-making processes still to be completed.

Our letter of invitation asked you, Charlie, to describe the design of the launch system, how much it would cost, the budget profile, its performance, when it would be ready, and the types of missions it would enable. General Bolden, the fact that we do not have a final decision on the SLS and the supporting documents that the invitation letter requested represents almost an insult to this Committee and to Congress.

We will try our very best throughout this hearing to accommodate the agency's failure and the failure of the White House to answer congressional requests and to give us the information that we are entitled to have. But to be clear, this failure reflects poorly on the Administration and its space program. I can't help but feel that this Administration has let down the thousands of men and women who have devoted their careers to the space program as well as heroes such as Neil Armstrong, Mike Collins, Buzz Aldrin, Gene Cernan, Tom Stafford, and they go on and on and many, many others, known well to all of us, who risked their lives blazing the trail of space exploration and some who lost their lives and others who continue to maintain an unwavering dedication and devotion to the cause.

We have a record littered with requests by Congress for information over the last two years. We have waited for answers that have not come. We have pleaded for answers that have not come. We have done our best to be fair with you and with this President, who set out to delay the next step in our Nation's human space exploration program and by doing so has jeopardized the Space Station in the process.

It is a shame that for many of us that simply want to preserve, protect, and defend our leadership in space, that is all we ask for, that is what we want, that we see NASA paying for rides to the Space Station from countries that may not have our best interests at heart.

We have run out of patience. I realize and I believe that you are the person who has to bear the brunt of this President's bad decisions. I would like to believe you have told him what he ought to do, and I would like to believe that he didn't pay any attention to you. The White House has done you wrong. But nonetheless, you have to answer for these continued failures. I would like to point out today that this Committee reserves the right to open an investigation into these continued delays and join the investigation initiated by the Senate. It is a shame we have to even consider or be thinking about doing that.

Moving forward I think that it is important to note that we support all of the people engaged in developing the next heavy-lift vehicle as well as those who are working on the commercial cargo and crew contracts; people who are working every day to keep America at the forefront of human spaceflight. It is these engineers, these technicians and scientists who, despite the absence of good leadership from the White House, strive to dream big and carry on the legacy of those that came before us, before them and before us.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH HALL

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As a preface to the formal portion of my statement, I want to first congratulate all the men and women at NASA and its contractors for the successful launch of STS–135. The Shuttle launch was viewed by tens of thousands on hand in Florida and millions more around the world, including a packed crowd in this hearing room, and it was a bittersweet moment to watch the last flight of the Shuttle Atlantis lift off from Kennedy Space Center.

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Moving forward I think that it is important to note that we support all of the people engaged in developing the next heavy-lift vehicle as well as those working on the commercial cargo and crew contracts; people who are working every day to keep America at the forefront of human spaceflight. It is these engineers, technicians and scientists who, despite the absence of good leadership from this White House, strive to dream big and carry on the legacy of those that came before them.

I now recognize the Gentle-lady from Texas for her opening statement.

Chairman HALL. I now recognize the gentlelady from Texas for her opening statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman. Good morning, and let me welcome you, Administrator Bolden. I want to congratulate you and the entire Shuttle team on the truly spectacular launch of the Space Shuttle Atlantis. I watched video right here in this room last Friday, and I can assure you that the room was packed with enthusiastic supporters of all ages, and I know I speak for all of my colleagues when I say that we wish the crew of Atlantis a safe and successful mission.

As you know, you have been called to testify on NASA's plans to develop the vehicles that will enable future human exploration beyond low-Earth orbit, vehicles that have been authorized and funded by Congress. However, as you also know, and will testify today, that you still don't have an approved plan to share with us.

As a result, I expect that you will be on the receiving end of a lot of unhappiness and irritation expressed by many Members here today, and that includes me. It is unfortunate because the fault doesn't lie with you. It is my understanding that you have had a plan ready to announce for some time, but you haven't been able to get the final okay to make it public. And that said, it is now past time for a decision and a plan to be announced.

Three successful NASA Authorization Acts enacted by Democratic and Republican Congresses and Presidents alike over the past six years have directed NASA to undertake a program of human exploration beyond low-Earth orbit, and the most recent of those Authorization Acts directed NASA to move expeditiously to develop the heavy-lift launch vehicle and crew capsule needed to enable those exploration missions, as well as to provide back-up capability in support of the International Space Station.

In short, Congress is not asking NASA to build a rocket without a mission as some have claimed. Instead, we are asking NASA to build the system this Nation will need to carry out the exploration program authorized by successive Congresses and Presidents.

As I mentioned at the beginning of my remarks, the Shuttle Program is drawing to a close. There are many talented men and women who have worked on that program and on the now cancelled Constellation Program who want to continue to contribute to our Nation's leadership in space exploration, but they don't know what, if anything, is going to be there for them to work on in the coming years. There are impressionable young people, students, some of whom were here last week, looking with so much inspiration and hope in their eyes, but now we don't know whether there is even going to be a human spaceflight program when they get out of school. I even talked with some about their wishes of becoming an astronaut, and there are international partners who wonder why the United States appears to be adrift and ready to walk away from this global leadership in human spaceflight.

I suspect that this state of affairs pains you as much as it does me, but I have been around long enough to believe that we can do better, and I think that you believe that we can do better as well. So I hope that when this hearing is over, you will strongly convey to those in the Administration who are dithering that this is time to move forward and let NASA get on with the task that the Nation has asked to be undertaken.

I have been asked by many news outlets about the future, and sitting on this Committee they certainly expect me to know the answer, but I do not. At this critical juncture we need to move ahead expeditiously to build a Space Launch System and Multi-Purpose Crew Vehicle in a way that makes use of the human spaceflight skills and knowledge base that NASA has worked so hard to achieve over the years and to inspire the next generation of explorers, engineers, and scientists.

I firmly believe that if we lose this talent, it won't be just to another State or another agency. It will be to another country, and to those of my colleagues on the Majority side who are critical of the Administration's stewardship of NASA, I also hope that you will convey to your colleagues in Congress that NASA cannot do what we have asked it to do if its budget keeps getting cut. The proposed appropriations level for NASA is one that if enacted will simply add more stress to an agency and dedicated workforce that is already trying to do more with less. At the end of the day, this will put America on a path to relinquish its space leadership. I would hate for that to happen, and I don't believe that you want it to happen as well.

But we all need to recognize that votes on funding have consequences. Chairman Hall, I am so glad that you are supportive of this program, and I appreciate you calling this hearing today. Thank you, and I yield back the balance of my time.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Good morning, and welcome Administrator Bolden. I first want to congratulate you and the entire Shuttle team on the truly spectacular launch of the Space Shuttle Atlantis. I watched a video feed of that launch in this same hearing room last Friday, and I can assure you that the room was packed with enthusiastic viewers of all ages. I know I speak for all my colleagues when I say that we wish the crew of Atlantis a safe and successful mission.

Administrator Bolden, as you know, you have been called to testify on NASA's plans to develop the vehicles that will enable future human exploration beyond low-Earth orbit-vehicles that have been authorized and funded by Congress. However, as you also know-and will testify today-you still don't have an approved plan to share with us. As a result, I expect that you will be on the receiving end of a lot of unhappiness and irritation expressed by many Members here today. That's unfortunate, because the fault doesn't lie with you. It's my understanding that you have had a plan ready to announce for some time, but you haven't been able to get the final okay to make it public.

That said, it is now past time for a decision and a plan to be announced. Three successive NASA Authorization Acts-enacted by Democratic and Republican Congresses and Presidents alike over the past six years-have directed NASA to undertake a program of human exploration beyond low Earth orbit. And the most recent of those Authorization Acts directed NASA to move expeditiously to develop the heavy-lift launch vehicle and crew capsule needed to enable those exploration missions-as well as to provide backup capability in support of the International Space Station. In short, Congress is not asking NASA to build a rocket without a mission, as some have claimed. Instead, we are asking NASA to build the systems this na-

tion will need to carry out the exploration program authorized by successive Congresses and Presidents.

As I mentioned at the beginning of my remarks, the Shuttle program is drawing to a close. There are many talented men and women who have worked on that program and on the now-cancelled Constellation program who want to continue to contribute to our nation's leadership in space exploration-but they don't know what, if anything, is going to be there for them to work on in the coming years. There are impressionable young students-some of whom were in this hearing room last week to see the Shuttle lift off-who were inspired by the space program to study math and science, but who now don't know whether there is even going to be a human space flight program when they get out of school. And there are our international partners, who wonder why the United States appears to be adrift and ready to walk away from its global leadership in human space flight. Administrator Bolden, I suspect this state of affairs pains you as much as it pains me.

But I've been around long enough to believe that we can do better, and I think you believe that too. So I hope that when this hearing is over, you will strongly convey to those in the Administration who are dithering that it is time to move forward and let NASA get on with the tasks that the nation has asked it to undertake. At this critical juncture, we need to move ahead expeditiously to build the Space Launch System and Multi-Purpose Crew Vehicle in a way that makes use of the human spaceflight skills and knowledge-base NASA has worked so hard to achieve and that inspires the next generation of explorers, engineers, and scientists.

And to those of my colleagues on the Majority side who are critical of the Administration's stewardship of NASA, I also hope that you will convey to your colleagues in Congress that NASA cannot do what we are asking it to do if its budget keeps getting cut. The proposed House CJS appropriation level for NASA is one that, if enacted, will simply add more stress to an agency and dedicated workforce that is already trying to do "more with less", and at the end of the day will put America on a path to relinquish its space leadership. I would hate for that to happen, and I don't believe you would want it to happen either, but we all need to recognize that votes on funding have consequences.

Chairman Hall, I am glad that we are holding today's hearing, and I look forward to Administrator Bolden's testimony. Thank you, and I yield back the balance of my time.

Chairman HALL. And I thank you for your good opening remarks, and I agree with you on the budget cuts.

Now, I am going to take advantage of being the Chairman to make a statement. Some time many years ago when I was a Democrat, and I was a ranking Democrat, and I think Mr. Sensenbrenner might have been the Chairman then, the Republican Chairman, Al Gore, who was Vice-President, told us we had to cut the budget 25 percent. He told everyone that, and I talked to Al, and I said, I doubt seriously that the Chairman nor do I know how to cut the budget on people whose lives are in danger. Who could we get to help us?

And I think he suggested Administrator Goldin, I believe was the Administrator at that time, and we talked to him and told him we had to have a 25 percent cut. This is just my recollection. I can be wrong, because I am 88 years old, and I wake up every morning in kind of a new world sometimes, but I remember this conversation very well when we asked Mr. Goldin, and he said, yes, he would cut it.

Mr. Goldin did cut it, but he didn't cut it 25 percent. He cut it 34 percent. Really and truly. NASA hasn't been the same since that time. So you can have too dang many cuts, and I am like that senator that said don't tax me, tax that man behind the tree. They cut the wrong budget, and we are suffering from it today. We got to work together and try to work a way out of it.

I thank you, Ms. Johnson, for your statement.

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

And at this time——

Ms. JOHNSON. Mr. Chairman.

Chairman HALL. Yes.

Ms. JOHNSON. Before we proceed.

Chairman HALL. Go ahead. Sure.

Ms. JOHNSON. I would like to ask unanimous consent that Representative Sheila Jackson Lee be allowed to sit on the dais today and participate in questions. She hasn't arrived yet, but she made this request after our Committee Members finished their questions.

Chairman HALL. When she gets here, we will let her sit down.

Ms. JOHNSON. Thank you.

Chairman HALL. And let her ask questions.

Ms. JOHNSON. Thank you.

Chairman HALL. After our Members. Okay.

At this time I would like to introduce our witness, Charles F. Bolden, Jr., a friend of mine for a lot of years, a man I have admired and respected. Was appointed NASA administrator by President Obama and sworn in on July 17, 2009. He is an astronaut having flown on four Shuttle missions, including the mission that deployed the Hubble Space Telescope. Prior to being appointed administrator, Mr. Bolden served in the United States Marine Corps for 34 years. During his service he was an aviator, having flown 100 missions in South East Asia during the Vietnam War.

And he was a test pilot. He held a number of commands. Mr. Bolden retired from the Corps with the rank of major general. He is a true patriot. We are glad to have him before us here today, and we welcome you, Charlie.

STATEMENT OF CHARLES F. BOLDEN, JR., ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. BOLDEN. Mr. Chairman, thank you very much and Members of the Committee. I thank you all for the opportunity to appear here today to discuss the future of NASA's human spaceflight program, a future that I believe is very bright.

And before I continue with my formal comments, I do have to say you have the correct person here to cast blame. I want to make that very clear. I really appreciate everybody's continuing willingness to excuse me for our shortcomings, but it is really important for everybody on this Committee and everybody watching this hearing to understand that I am the leader of America's space program. I am the leader of the greatest space program in the world today, and so I am here in that capacity to testify and to try to be as honest and open as I can with you and answer as many questions as I can. I understand everybody's frustration, but you have the right guy here to criticize. It is not the President. It is me.

Our new system will stand on the shoulders of the successful Shuttle Program to which thousands of American men and women have contributed their passion and expertise to ensure America's preeminence in space exploration. I appear before you today 4 days after an historic milestone in America's spaceflight program; the

launch of Atlantis on the STS–135 mission, the final flight of the Shuttle Program.

The brave men and woman of STS–135 safely docked with the International Space Station on Sunday, joining the list of dozens of American astronauts who have been living and working in space continuously for the past decade aboard the orbiting outpost. The station is the pinnacle of our current achievement, a stepping stone to the rest of our solar system.

Some say that this final Shuttle mission will mark the end of America's 50 years of dominance in human spaceflight. As a former astronaut and the current NASA administrator, I am here to tell you that American leadership in space will continue for at least the next half century because we have laid the foundation for success, and as we say at NASA, failure is not an option.

The NASA Authorization Act of 2010 gave NASA a clear direction and in line with our 2011 Appropriations Bill, we are moving aggressively and enthusiastically to plan future exploration. We appreciate the significant bipartisan effort behind the law and look forward to working with you to shape a promising future for human spaceflight.

Our post-Shuttle human spaceflight plan also focuses on utilization and operation of the ISS, establishing a U.S. commercial cargo and crew capability to reach this national laboratory and making critical, prioritized investments in the technologies that will help us win the future.

We have to get out of the business of owning and operating low-Earth orbit transportation systems and hand that off to the private sector, exercising sufficient insight and oversight to ensure safety of our astronauts.

As you all know, our next generation human spaceflight, the Space Launch System, or SLS, and the Multi-Purpose Crew Vehicle or MPCV, will transport astronauts to multiple destinations beyond low-Earth orbit.

Our first goal is to target an asteroid by 2025. Our destinations could include cis-lunar space such as the Earth-Moon Lagrange points, the lunar surface, and eventually Mars and its moons.

I understand the interest of many Members of Congress, including Members of this Committee, in seeing that we move quickly. I share that interest and urgency as do the thousands of NASA employees and contractors who stand ready to build a new system, but we cannot rush a critical decision that will drive NASA's activities for several decades. We must be respectful stewards of taxpayer dollars.

As I have said time and time again, our new systems must be affordable, sustainable, and realistic. One of the most important lessons we learned from Constellation is that a Space Launch System will only be successful if multiple Congresses and multiple Administrations provide adequate funding.

In late May after careful analysis and deliberations by my senior management team, I accepted the Orion-based reference vehicle design first outlined in NASA's January, 2011 report to Congress as the agency's MPCV. Orion was already being built to meet the requirements of a deep-space vehicle, and our contract with Lockheed Martin Corporation maps well to our capsule requirements.

We have also been working expeditiously to complete assessments of SLS design options and develop a final integrated proposal for it and the MPCV Orion. Of course, we were constrained in this work to some degree by the 2010 Appropriations Law, which required us to continue funding Constellation Era contracts.

We are making progress towards selecting a technical design approach that will be evolvable over time to meet our goals and be consistent with the law. In parallel to technical decisions we are developing new ways of doing business to keep costs down and insure agility, efficiency, and sustainability. We are revising the management of our requirements, contracts, and projects and incorporating approaches to ensure affordability in the near term and over the long run.

To accomplish all this is required—all that is required to mount MPCV and SLS, NASA put together a series of teams to evaluate and compare various options and evaluate the risks, uncertainty and relative advantages and disadvantages of alternatives for this integrated system.

We have also sought input from industry and are considering an early flight program for SLS to make the most of what we know early on. We know that SLS must be capable of accessing many regions of space beyond LEO and be capable of lifting the MPCV. It also must be able to initially lift 70 to 100 metric tons to LEO while ultimately being evolvable to a lifting capacity of 130 metric tons or more.

The SLS must also have commonality of systems between core and upper stage and modularity of elements. The system should also be flexible and strengthen our industrial base. On June 20 I approved a specific design that our experts believe is the best technical path forward for SLS. That was an important step but not a final decision. Our experts, as well as an independent team from Booz Allen Hamilton, are now developing cost estimates. We need a credible path to preliminary design review or PDR on our best, most flexible approach based on budget assumptions and our best estimates on what its cost, what this cost and how it fits with projected budgets.

It would be irresponsible to proceed further until we at least have good estimates. I have shared that design with the Office of Management and Budget and others at the White House. Like me, they are eager to see the results of our cost estimates. We know that this program will likely cost tens of billions of dollars over many years, so this will likely be the most important decision I make as the NASA administrator, and I want to get it right.

We must first pin down the cost of specific technical design that I have proposed. Just as importantly we must then see how these costs fit into the larger NASA budget so that we can continue to do exceptional work in robotic exploration, science, and aeronautics.

Last week's House Subcommittee mark of our 2012 Appropriations Bill was another stark reminder that we are making this critical decision in exceptionally challenging fiscal times.

I commit that we will re-double our efforts to keep this Committee informed of our progress. While I would hope to have a final decision to announce this summer, the absolute need to make sure

our SLS program fits within our overall budget constraints suggests that it may take longer. While we are going through the process on that decision, we are continuing to make investments such as the following.

Assembly of the Orion Ground Test Article was recently completed, and it is being prepared for a series of ground-based, environmental tests to validate the Orion design and computer models.

The former Ares project has focused their development efforts on technologies and processes that could be utilized in the eventual SLS configuration, including vehicle avionics, J–2X engine testing, first stage motor testing, the developmental motor 3, and installation of upper-stage tooling applicable to large diameter tanks.

The J–2X engine is fully assembled and installed in the A–2 Test Stand at NASA's Stennis Space Center. The engine began a series of ten test firings on July 6.

Significant progress has been made in the modifications to Pad B at Launch Complex 39. There are new fiber optic cables replacing the copper wire, and by the way, we recovered $621,000 from scrap copper. New digital control systems for the pad utilities and a state-of-the-art lightning protection system that helped us clear the Shuttle during STS–135 processing. This has been done in continued preparation for a clean pad multi-user capability, including SLS.

Although NASA must still finalize an integrated test flight plan, based on the President's fiscal year 2012, budget request, NASA is currently targeting the first uncrewed SLS development flight for late 2017 to support a crewed mission by the early 2020s and a visit to an asteroid in 2025.

We look forward to working with the Congress as we finalize our strategy for achieving human spaceflight to many destinations in our solar system. I share your sense of urgency about moving forward but ask for your continued patience as we together build an affordable, sustainable, and realistic Space Launch System.

Mr. Chairman, I would be pleased to respond to any questions you or other Members of the Committee may have.

[The prepared statement of Mr. Bolden follows:]

PREPARED STATEMENT OF THE HONORABLE CHARLES F. BOLDEN JR., ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Chairman Hall and Members of the Committee, thank you for the opportunity to appear before you today to discuss the future of NASA's human spaceflight program, and in particular the progress NASA is making on developing the next-generation human spaceflight transportation systems known as the Space Launch System (SLS) and the Multi-Purpose Crew Vehicle (MPCV), as well as their associated mission and ground support elements and other programs.

With passage of the NASA Authorization Act of 2010 (P.L. 111–267) on October 11, 2010, NASA has a clear direction for our human spaceflight programs. NASA appreciates the significant effort made in advancing this important bipartisan legislation, and we look forward to working with you to shape a promising future for our Nation's human spaceflight programs. With the enactment of the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112–10), NASA is aggressively moving forward with our next-generation human spaceflight system development efforts as authorized.

The President's FY 2012 budget request continues to focus Agency efforts on a vigorous path of innovation and technological development leading to an array of challenging and inspiring missions to destinations with an incredible potential for discovery, increasing our knowledge of our solar system, developing technologies to improve life, expanding our presence in space, increasing space commerce, and en-

gaging the public. The request supports an aggressive launch rate of about 40 missions from FY 2011 through FY 2012, including U.S. and international flights to the International Space Station (ISS) as well as science missions flown to Earth orbit and beyond. Within the human spaceflight arena, our foremost priority is safely and productively conducting our current human spaceflight endeavor. The FY 2012 budget request also maintains a strong commitment to human spaceflight beyond low-Earth orbit (LEO) via a capability-driven architecture that will focus on increasingly complex missions as we develop the technical expertise to reach destinations ever deeper into our solar system. At present, as designated by the President, our initial destination for a human mission is a crewed flight to an asteroid by 2025, followed by a human mission to Mars in the mid-2030s. Our post-Shuttle human spaceflight plan also focuses on utilization and operation of the ISS and on establishing a U.S. commercial cargo and crew capability to reach this National Laboratory. It establishes critical priorities and invests in the technologies and excellent science, aeronautics research, and education programs that will help us win the future.

In terms of our next-generation human spaceflight system, the SLS and MPCV will be capable of transporting astronauts to multiple destinations beyond LEO. The capabilities provided by these two vehicle systems are necessary for all activities beyond LEO. While our plan calls for the initial destination for human flight beyond LEO to target an asteroid by 2025, other destinations could include cis-lunar space such as the Earth-Moon Lagrange points, the lunar surface, and eventually Mars and its moons. All of these places hold incredible information for us—information that we probably do not even know exists at this point. Compelling missions to advance exploration will be enabled by coupling these spacecraft systems with others needed for particular missions. This journey begins with the SLS and MPCV as the first important core elements of the evolutionary exploration approach to accomplishing a broad spectrum of missions.

To date, as NASA has reported to the Committee, the Agency has determined that the beyond-LEO version of the Orion Crew Exploration Vehicle is NASA's new MPCV, and as such, the current Orion contract with Lockheed Martin Corporation is being used through at least the development phase of the vehicle.

NASA has been working expeditiously to complete assessments of SLS design options and develop a final integrated proposal for MPCV/Orion and SLS. NASA has been conducting detailed technical analysis since the enactment of the NASA Authorization Act of 2010, and is working towards selecting a technical approach that will meet the intent of the SLS configuration described in the NASA Authorization of 2010 and enable the Nation to conduct a sustainable program of exploration. NASA's intent is that the design would evolve over time to meet the end goals of the SLS configuration in the Authorization Act. NASA is exploring strategic approaches that would be adaptable to modifications in annual funding and still make significant progress toward the end design. The SLS and MPCV teams are continuing to develop an integrated development plan that will be affordable in the near term and over the long run. In doing so, we are striving to design an evolvable and interoperable human spaceflight transportation system that will serve us for decades to come as we explore multiple compelling mission destinations. Due diligence will ensure the best value for the taxpayer with respect to cost, risk, schedule, performance, and impacts to critical NASA and industrial skills and capabilities in this multi-billion dollar endeavor.

While NASA has made significant progress to date on both the SLS and the MPCV, much work remains ahead for the Agency, as we finalize development plans and acquisition decisions per normal Agency processes for the SLS-decisions that must remain consistent with NASA's Strategic Plan and Agency commitments, as well as the NASA Authorization Act of 2010.

In a constrained budget environment, NASA knows how important it is to identify ways to make our programs and projects more efficient, so finding and incorporating these efficiencies remains a primary goal. We have embraced the challenge to deliver human spaceflight systems for lower cost, and the opportunity to become more efficient, innovative and agile in our programs. For example, we are revising the management of our requirements, contracts, and projects and incorporating approaches to ensure affordability in the near term and over the long run. This includes the use of focused insight/oversight, specifying to industry—where appropriate —what we need instead of how to build it, designing for cost-effective operations, increasing the use of common components and parts, and wisely consolidating infrastructure.

The remainder of my testimony will address progress made to date on the SLS and MPCV Programs, as well as outlining the work ahead of us in order to ensure

that we develop systems that reflect the NASA Authorization Act of 2010 using an affordable, sustainable and realistic approach.

However, before I explore those topics, I would like to take a moment to personally recognize the thousands of NASA civil servants and industry team Members who have worked selflessly for countless hours, often under difficult circumstances and in a turbulent environment, to make our human spaceflight programs and projects productive and successful. In the days ahead, these incredible and talented employees will continue to do whatever it takes to make sure that the United States remains the world's leader in human spaceflight. After all, they do not know how to commit to anything less. I would also like to thank the Committee for its continued strong support for NASA's human spaceflight programs and their value to the Nation, especially as we work hard to finalize details of a well-thought-out strategy for our next-generation human spaceflight programs.

An Integrated Launch System: A Work in Progress

Over the last several months, NASA has been evaluating options for developing an integrated and incremental development approach for the SLS, MPCV and the associated ground operations that will be capable of achieving progress in an incremental manner while also reflecting the goals and objectives of the NASA Authorization Act of 2010, the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112≥10), and in a sustainable manner.

In order to accomplish this task, NASA put together a series of teams to develop an Analysis of Alternatives (AoA) that would meet future human spaceflight goals established by law and by Administration policy. In general, an AoA is a study intended to aid decision making by comparing various options and illuminating the risk, uncertainty, and the relative advantages and disadvantages of alternatives being considered to satisfy a mission need.

The AoA process produced many important results that will help inform NASA's final decision for the architecture approach for SLS by evaluating various technical designs. This SLS process has also sought to incorporate input from industry via a broad area announcement which collected industry suggestions and comments that have proven to be very useful in the design development process. NASA's goal is to develop an SLS architecture that represents the best ideas from industry and NASA.

NASA is currently evaluating the potential options for future missions that could enable continued progress toward longer-duration, beyond-LEO destinations. NASA is strongly considering an early flight test program, not unlike that we are conducting with our commercial partners for the evolving LEO capability. Such a program has many benefits, such as earlier access to data that could inform future design iterations or be applied to other programs, etc. and could also mitigate gaps in the current NASA industrial base and workforce skills. If implemented, NASA believes that this early mission strategy could effectively utilize and evolve existing capability (workforce, hardware, and contracts) to begin the next human exploration venture quickly. Over the next months, NASA will continue to evaluate this type of integrated strategy, including cost and schedule, through normal Agency program formulation activities, and we will continue to keep Congress apprised of our progress. Final acquisition decisions for the SLS are expected in the next couple of months, and we will provide those to Congress as soon as they are available.

Very early on in this process, I directed that we complete an Independent Cost Assessment (ICA) of our integrated SLS/MPCV development approach—particularly in terms of the Agency's initial cost and schedule estimates for the SLS. This ICA work is ongoing. I want to have a sanity check on our cost and schedule estimates before we make a final commitment to what will be a critical, but expensive venture for our nation. NASA has contracted with the firm of Booz Allen Hamilton, Inc. to perform this work, and final results from the company are expected in late July/early August. To be clear, the ICA will only have the fidelity that reflects the maturity of the SLS architecture concepts described above. I have also chosen not to do comparative cost estimates of all the alternatives to enable the assessment to focus on some of the most promising alternatives. Since the SLS proposal is still considered to be in the pre-formulation phase, the initial assessment will be a rough order of magnitude (ROM), which is typical of pre-formulation planning that occurs before a decision is made to baseline and fund a program. Official baselining of a program occurs upon successful completion of the Preliminary Design Review, when system requirements are fully defined and system design concepts are mature. It is at this point that the Agency will commit to an established life cycle cost and schedule.

The MPCV Program

The NASA Authorization Act of 2010 directs that NASA develop an MPCV that continues the advanced development of the human safety features, designs, and systems in the Orion Project.

The MPCV will transport the crew from the Earth's surface to a nearby destination or staging point and return the crew safely back to the Earth's surface at the end of a mission. The MPCV will provide all services necessary to support a crew of up to four for up to 21-day missions (for very long beyond-LEO missions, such as exploration of near-Earth asteroids or other planetary bodies, additional elements—a space habitation module for example—will be included to provide long-duration deep space habitation capability).

Mounted on top of the SLS for launch and ascent, the MPCV will be capable of performing abort maneuvers to safely separate from the launch vehicle and return the crew to the Earth's surface. The MPCV will also be capable of performing in-space aborts if conditions require the immediate safe return of the crew. MPCV will include the necessary propulsive acceleration capability to rendezvous with other mission elements and return the flight crew from the destination to the Earth's surface. In-space operations, such as rendezvous and docking and extravehicular activities, will be performed with the MPCV in conjunction with other mission elements.

The NASA Authorization Act of 2010 requires that the MPCV be capable of efficient and timely evolution—something that has been in practice throughout the design process for the Orion vehicle. Continuing this process for MPCV will allow for an incremental or "block" development and mission capability approach. This will allow for early progress to be made on the fabrication of key design aspects, depending on available funding, while utilizing early testing to buy down risks associated with subsequent block configurations. Each test cycle will also provide an opportunity to on-ramp or off-ramp capabilities as the design evolves.

In late May, and after careful analysis and deliberations by a senior management team, I decided to accept the Orion-based reference vehicle design, first outlined in NASA's January 2011 report to Congress, as the Agency's MPCV. As part of my decision process, I determined that the Orion was already being built to meet the requirements of a deep-space vehicle and that the Agency's current Orion contractual partnership with Lockheed Martin Corporation maps well to the scope of the MPCV requirements outlined in the NASA Authorization Act of 2010. Therefore, the current contract will be used at least for the development phase of the MPCV.

Moving forward, work on the MPCV will focus only on the deep-space design. While the MPCV could be called upon to service the ISS—a backup requirement established by the NASA Authorization Act of 2010 —it should be well understood that utilizing the MPCV for routine ISS transportation would be a very inefficient and costly use of the MPCV deep-space capability. NASA is confident in the ability of our commercial and international partners to provide all currently foreseen support for the ISS. Therefore, there is no intention to conduct routine LEO missions with the MPCV.

It is important to point out that my decision regarding MPCV does not reflect a "business as usual" approach for the Agency. Over the last year, the NASA/Lockheed Martin team has shown exceptional creativity in finding ways to keep costs down by implementing new management techniques, technical solutions and innovation within the Orion Project. Since the NASA Authorization Act of 2010 was signed into law, the Orion government and industry team has assessed and implemented additional affordability initiatives that have reduced Design, Development, Test and Evaluation costs and enabled schedule acceleration. These initiatives include but are not limited to:

- Furthering the incremental approach to building and testing vehicle capabilities;
- Streamlining Government oversight and insight;
- Reducing formal deliverables and simplifying processes while retaining adequate rigor;
- Utilizing high fidelity engineering development units in lieu of flight-equivalent hardware in test facilities and labs;
- Consolidating test labs and re-use of test articles; and,
- Enhancing the approach for spacecraft processing by employing applicable Space Shuttle processes and certified Shuttle personnel.

Over the last year, NASA developed and executed plans for an incremental development approach for the Orion, due in large part to the constrained fiscal environment. This approach deferred work on some systems while focusing on core compo-

nents and systems that could be applicable to MPCV, with the aim of attempting to enable incremental test flights and subsequent upgrades to full operational capabilities as quickly as the budget profile allows. In doing so, NASA deliberately prioritized Constellation funds, including those for Orion, to maximize their use in support of transition to SLS and MPCV. Examples are listed below.

- Assembly of the Orion Ground Test Article (GTA) was recently completed, with the GTA being prepared for a series of ground-based environmental tests to validate the Orion design and computer models. The GTA is undergoing vibration and acoustic testing this summer, and will undergo drop testing at Langley Research Center Water Basin Facility in Virginia this fall. Data collected from GTA testing will be incorporated into MPCV development efforts so as to result in a safe, reliable and affordable human-rated crew capsule. Design work for the subsequent test article is also proceeding, including conducting periodic technical reviews. In FY 2012, testing on the GTA will be completed. Fabrication work and assembly work for the following test article will also be well underway.
- A new sensor technology has been developed that will allow easier, safer, and more affordable on-orbit rendezvous and docking to the ISS for future spacecraft, including the MPCV as well as commercial cargo and crew providers. The Orion Vision Navigation System (VNS) is an advanced Light Detection And Ranging (LiDAR) -based relative navigation sensor with performance specifications unmatched in today's relative navigation sensor market. The VNS uses cross-cutting technology that has been developed in partnership with commercial vendors and is applicable to future spacecraft requiring rendezvous and dockings, as well as terrestrial commercial applications. In May 2011, NASA tested the VNS system aboard STS–134. During this test, a prototype docking camera provided a resolution 16 times higher than the current Space Shuttle docking camera. Once completed, the VNS system should be able to provide rendezvous data to approaching vehicles as far away as three miles, which is three times the range of the current Shuttle navigation sensor.
- During the last year, progress continued on the construction and outfitting of Orion support facilities. NASA is now in the process of deciding how and when these facilities will be used by the MPCV Program.

NASA is hoping to be able to launch an initial uncrewed test flight of an integrated early version of the SLS and the MPCV as early as 2017.

The SLS Program

The SLS will be the Nation's first exploration-class, heavy-lift launch vehicle since the Saturn V and will serve as the critical next step beyond the Space Shuttle and three decades of LEO operations.

The NASA Authorization Act of 2010 directs that NASA develop an SLS that is capable of accessing cis-lunar space and other regions of space beyond LEO. The Act also states that the SLS must be capable of lifting the MPCV, and that the SLS must be able to initially lift 70–100 metric ton (mT) to LEO, while ultimately being evolvable to a lifting capacity of 130 mT or more. As such, the SLS flights will be capable of lifting the MPCV and other exploration flight elements into space for missions to the Moon, Lagrange points, asteroids, and ultimately to Mars. The MPCV design will be optimized for beyond-LEO exploration, and while contingency utilization for the ISS is a possibility, consistent with the Authorization Act of 2010, doing so would represent a highly inefficient vehicle usage.

In January 2011, NASA announced that it had chosen a Reference Vehicle Design for the SLS derived from Ares and Space Shuttle hardware. That concept vehicle utilized a LOX/LH2 core, five-segment solid rocket boosters, and a J–2X-based Upper Stage as the 130-mT version of the vehicle—evolvable from the 70–100-mT version. As envisioned, this Reference Vehicle Design would allow for use of existing Shuttle and Ares hardware assets in the near term, with the opportunity for later upgrades and/or competition for eventual upgrades in designs needed for affordable production. However, NASA has continued to study other alternative architectures as part of its due diligence. In so doing, NASA has identified several characteristics that the ultimate SLS design may include.

- **Evolvable development:** While our initial development efforts would focus on the 70–100-mT lift capability, in parallel, we would plan to capitalize on synergies between Core Stage and Upper-Stage design and manufacturing, thereby allowing us to develop some of the upper-range capabilities for an even-

tual 130-mT vehicle at the same time, as funding permits. Doing so is actually a fairly natural, evolvable progression in terms of developing these capabilities.

- **Commonality of systems:** The use of common elements (e.g., common propellants, common manufacturing, and common avionics and control systems) across the entire SLS can enable the same or similar equipment and manufacturing to be used for both systems. This makes more efficient use of the infrastructure and increases throughput through manufacturing. This ultimately can lower costs.
- **Modularity of Elements:** With the availability of three stages (Core, First, and Upper) to work with, NASA could structure each specific launch vehicle to achieve specific requirements such as thrust capability. Doing so would allow NASA to capitalize on cost savings. For example, if a specific mission did not need 130 mT in thrust capability, NASA could potentially save funds by not having to use booster stages on that mission. In addition, modularity offers the benefit of metering development costs commensurate with available funding levels.
- **Industrial Base:** We would work with the space launch community in general in an effort to help strengthen the overall industrial base.
- **Flexibility:** Although the SLS is expected to be costly to fly, it will have an unmatched payload capacity. The ability of the SLS to carry either the MPCV or large cargo also allows the SLS to carry robotic payloads for science or national security missions, although there are currently no requirements for such large payloads. The additional volume and lift capability could allow designers to either simplify the spacecraft by choosing to reduce deployments or eliminate the need for costly weight reductions;, to take advantage of the additional volume and lift capability to enable more capable missions; or to increase the duration and frequency of launch windows for planetary missions. To ensure that we have kept other agencies informed with our future plans for launch systems, we have provided periodic briefs on the progress of our SLS and MPCV deliberations to their senior leadership.

To be clear, as previously stated, much work remains ahead for the SLS team. We are working hard to finalize the analysis on the best option for venturing beyond LEO as quickly as possible and at the lowest near-term development cost.

Currently, NASA has procurement teams mapping SLS requirements (those outlined in the NASA Authorization Act of 2010 and those we are currently developing). For the SLS, NASA is reviewing each element of Ares (First Stage, Upper Stage, Upper Stage J–2X engine, and avionics) and Shuttle Program contracts (Space Shuttle Main Engines, External Tank, SRB) to determine whether the new SLS requirements would be within scope of current contracts. At the same time, NASA is assessing SLS competition options, including the potential degree of competition.

Although NASA must still finalize an integrated test flight plan, based on the President's FY 2012 budget request, NASA is targeting that the first uncrewed SLS developmental flight or mission could take place in late 2017 to support a crewed mission by the early 2020s and a visit to an asteroid in 2025. This target date also depends on how quickly acquisition decisions are made so that physical development work can begin on SLS elements and integration processes.

NASA is strongly considering an early mission/test flight strategy that would include early flights that would begin with a lift capacity in the 70–100 mT range, sufficient to get out of LEO with meaningful mission content, with the first flight targeted for the end of 2017 and the second flight targeted for 2021. Therefore, the 70–100 mT flight configuration will offer early development of the Core Stage, continuation of the Orion-based design as the MPCV, an Upper Stage/kick motor capability that will enable a series of development missions/test flights beyond LEO, and use of existing solid rocket boosters.

Early test flights for the SLS, if carefully planned, could enable NASA to reduce development risk, drive innovation within the Agency and in private industry, and accomplish early exploration objectives. I have stressed to the SLS team that we must make every test flight count in a constrained budget environment; that is why the NASA teams are still working to develop an integrated SLS/MPCV test flight schedule that will be part of an overall incremental development approach consistent with anticipated cost constraints.

Moving forward on the SLS, one of NASA's greatest challenges will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and

affordable for the long term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements.

Additionally, the SLS Program will continue to examine ways to increase efficiency and agility to deliver an affordable and achievable heavy-lift system as soon as possible. Examples being considered in formulating SLS plans include the following:

- Consolidating infrastructure wisely;
- Using common parts and common designs across the Government to reduce costs;
- Ensuring requirements are appropriately specific and also that requirements applied to NASA crew launch vehicles are similar to those provided to our eventual commercial crew partners, thereby ensuring that NASA vehicles are not required to meet more substantial requirements than commercial crew vehicles and vice versa;
- Conducting insight/oversight activities of our contract partners in a smarter way, thereby using our resources more appropriately to focus on the high-risk items; and
- Ensuring that there are no unique configurations or developments that do not end up directly supporting the final system.

NASA has continued to make progress on developing a crew launch vehicle over the last year. Due to legal restrictions that have since been rescinded, NASA had been prevented from terminating any Constellation-related work. However, in the meantime, the Agency was able to prioritize Constellation work that had a high likelihood of feeding forward into the new SLS and MPCV Programs.

For example, during FY 2011, the former Ares Project worked closely with SLS planning team to focus their development efforts on technologies and processes that could be utilized in the eventual SLS configuration, including vehicle avionics, J–2X Engine testing, First Stage motor testing (Development Motor-3), and installation of Upper Stage tooling applicable to large-diameter tanks. At the same time, the former Ares Project deferred activities that were Ares-I-dependent, including a ground vibration test article and design of Upper Stage component hardware, such as the reaction control system.

The J–2X engine is an example of significant progress made during FY 2011 that could be directly applicable to the SLS Upper Stage engine. The J–2X engine is fully assembled and installed in the A–2 Test Stand at NASA's Stennis Space Center and has been readied for its first round of testing. The engine began a series of 10 test firings on July 6 and testing will occur over several months. Collected data will verify the engine functions as designed.

Conclusion

In conclusion, Americans and people worldwide have turned to NASA for inspiration throughout our history—our work gives people an opportunity to imagine what is barely possible, and we at NASA get to turn those dreams into real achievements for all humankind.

With the passage of the NASA Authorization Act of 2010, NASA has a clear direction and is making plans for moving the Agency forward. Today, we have a roadmap to even more historic achievements that will spur innovation, employ Americans in fulfilling jobs, and engage people around the world as we enter an exciting new era in space. NASA appreciates the significant effort that has gone into advancing this bipartisan legislation.

Let me assure you that NASA is committed to meeting the spaceflight goals of the Nation and fulfilling the requirements of the NASA Authorization Act of 2010. As such, we are committed to developing an affordable, sustainable, and realistic next-generation human spaceflight system that will enable human exploration, scientific discovery, broad commercial benefits, and inspirational missions that are in the best interests of the Nation. We look forward to working with you and other Members of Congress as we finalize our strategy for achieving human spaceflight to many destinations in our solar system.

Chairman Hall and Members of the Committee, I would like to conclude my remarks by thanking you again for your continued support for NASA and its human spaceflight programs. I would be pleased to respond to any questions you or the other Members of the Committee may have.

Chairman HALL. I thank you, and I tell the Members that we did not set a 5-minute request of you because of the importance of this meeting and the importance of the questions and the answers we ask.

Mr. BOLDEN. Thank you, Mr. Chairman.

Chairman HALL. We are at a crossroads trying to preserve our Space Station, and we are going to take all the time we really need. I would remind the Members of the Committee, though, that we are limited to five minutes, and try to stay within five minutes, and I will stay within my five minutes.

So the Chair recognizes himself for five minutes. Mr. Bolden, recently a senior NASA official, I think it was Ms. Garver, NASA Deputy Administrator, was talking about the agency's human spaceflight program. It was quoted in the press as saying, and I quote, exact quote, "We have a program, we have a budget, we have a destination. We are just putting finer points on the rocket design."

That was in the Washington Post, July 2, 2011, and I am trying to reconcile these comments with your testimony this morning, and it leaves me a little confused. Your testimony highlights work still to be done.

Let me reread her announcement. "We have a program. We have a budget, we have a destination. We are just putting fine points on the rocket design."

Your work is still to be done, including cost assessments. It will take a couple of months to complete probably. Yet another senior agency official suggests virtually all the decisions have been made except for a couple of minor tweaks to the rocket's design.

Can you reconcile these two views? You both just can't be right.

Mr. BOLDEN. Mr. Chairman, unfortunately we are all right, and I will try to explain that. We do have a program, and we have a very well-defined program right now for space exploration. It is a program that features a Space Launch System or a heavy-lift launch or heavy-lift rocket that will start at a 70 to 100 metric ton capability evolving to 130 to 150 metric tons. It has an MPCV which is already—the design for which has already been selected, and it has a ground launch system that we—I tried to point out some of the things that have already been done with that system at the Kennedy Space Center.

We have engines on the pad at Stennis that will be involved in this system. We have a budget because you all gave it to us in the form of the 2010 Authorization Act supplemented by the 2011 Appropriations Budget.

So with that budget and the President's 2012 proposal to you is what we are basing our program and our timelines on, and those timelines include what I gave to you. The President continually says that he has laid down the gauntlet for me. He has told me that he wants humans around an asteroid in 2025. I am going to put a satellite called DAWN around this—the Asteroid Vesta the end of this week as a precursor for sending humans there. Not that asteroid. We don't know what asteroid we are going to visit in 2025. It is too far out, but we will determine what that is. But we do have a program, we do have a plan. You have given us a budget, and I am very confident that we are going to be able to execute.

Chairman HALL. Well, our confidence is shaken some by the inaction, not just this year but last year. The NASA Authorization Act of 2010 directs NASA to design the Multi-Purpose Crew Vehicle to, "provide an alternative means of delivery of crew and cargo to the International Space Station in the event of other vehicles, whether commercial vehicles or partner-supplied vehicles, are unable to perform that function."

However, since your announcement last May I have heard conflicting reports about NASA's compliance with this requirement. So is the Multi-Purpose Crew Vehicle being designed as backup crew support for the Space Station?

Mr. BOLDEN. Mr. Chairman, it is not being designed as backup crew support, however, it is as a vehicle that is designed for deep-space exploration, it can function as a backup for crew rescue.

Chairman HALL. It is not being designed, but it is being designed.

Mr. BOLDEN. No, no, no, sir. You asked if it was being designed as a backup for low-Earth orbit operations, and my response is it is not being designed as such. Its design is as a deep-space exploration vehicle. What that means is when we go to deep space and return to Earth, having to go through its atmosphere, the energy that we have to absorb or dissipate, the speed at which we reenter, the pressures on the vehicle are much higher than they are on a low-Earth orbiting vehicle.

So if I design it for low-Earth orbit operations, it can't function in deep space. If I design it for deep space, it can function in low-Earth orbit, very inefficient, a waste of the government's money, but it will be able to do that. So it will have the capability of serving as a backup should it be needed.

I would not advise that, and if we have to use it that way, it means one of two things have happened. Either all the commercial entities have gone bankrupt and quit, or we have had an accident involving a commercial vehicle. Those are the only two reasons that I can foresee using Orion as a low-Earth operating vehicle, and I don't—I hope neither of those happens.

Chairman HALL. My time is up. I yield back and recognize Ms. Johnson for her five minutes.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

Mr. Bolden, I am still a little bit confused, but let me just ask this. How will the decision on the final SLS architecture affect the government and contractor aerospace workforce? Will we require more people? Will a lot of people be laid off, or will the decision stabilize the current workforce and potentially create new jobs? Or what is your projection?

Mr. BOLDEN. Congresswoman, the sooner we make the decision, the more I can say we will stabilize the workforce at whatever level it happens to be then. We are in the process of a seven-year, very well thought out transition plan from phasing out the Shuttle, which was decided by the previous Administration, not this one. My job is to execute a decision made by my predecessors, and I am on the verge of doing that next week when we land STS–135, and when people hear wheels stop, it will mean I have done my job.

And I will be a very happy camper because my pledge when I became the NASA Administrator was to safely fly out the Shuttle. That is not done yet. So I still have work to be done.

Once we put the next program into place, jobs will begin. We will begin to bring people back on at some rate. Right now we are trying to help people transition to other places in the aeronautics, in the aerospace workforce, and we are having success at that. We placed 1,000 workers with the Embraer down in Melbourne, Florida. We have put some other workers with an automobile company in Melbourne, Florida. That is work that NASA is trying to facilitate, but we don't do that.

I am trying to get people in Brevard County in the State of Florida to go out and recruit to bring businesses into the space coast. I am trying to get people around the country, in Houston, in Salt Lake City, other places, I need help, you know. My job is not to go out and recruit. I need for the states to do a little bit also.

Ms. JOHNSON. One other question. The Space Station has been a wonderful achievement. Are we going to leave all of that maintenance to Russia, or how are we going to handle it?

Mr. BOLDEN. Congresswoman, we have budgeted in all of the budgets that you all have approved for us and in the President's proposed budget for 2012, we have budgeted to fly the Space Station through 2020. We have done technical evaluations to determine if we can fly it longer, and we think we can. Americans will be in space operating at least through 2020.

So I need to clarify once and for all, I hope, we are not abandoning human spaceflight. We have a big job to do in operating the International Space Station for the next nine years at least. I just selected or just approved the assignment of American astronauts to fly on the International Space Station through 2015, 2016. We have more astronauts to be assigned, and in fact, they asked me, Houston asked if they could go out and recruit more astronauts to operate on the International Space Station because they anticipate they are not going to have enough.

So anybody who thinks we are abandoning human spaceflight, that is not the case. The kids you talked about who want to be astronauts, they are not going to make Shuttle because it is going, but they will walk on Mars, you know, provided we work together. I hope I am not the only optimist in the room. I have faith in American industry, and I know we can do this. So if it seems like I am naïve or Pollyannaish, I am not. I am just optimistic, and I have faith in American industry.

Ms. JOHNSON. Thank you. I am depending on you not to let me down.

Mr. BOLDEN. I won't.

Chairman HALL. The gentlelady's time has expired.

The Chair recognizes the gentleman from California, Mr. Rohrabacher, for five minutes.

Mr. ROHRABACHER. One thing is for sure. The United States Marine General is not Pollyanna.

Mr. BOLDEN. Thank you.

Mr. ROHRABACHER. All right. General, it is rather disconcerting to take a look at the NASA budget over the years. I have been here 22 years, and I have seen so many decisions that led to nothing

frankly, except the expenditure of billions of dollars, and I remember the X–33 Venture Project that there was big decisions made. We were going to do that over the DCX, and what we ended up with was spending a lot of money and getting nothing out of it. And there are other programs like that. And a number of these times that we have seen decisions made based on, frankly, pressure from Congress, not just decisions made by the Executive Branch.

Right now we are trying to make some fundamental decisions that will carry our country forward for over a long period of time. The Russians I understand have been using the Soyuz since 1966, and it still is a very viable system, transportation system. We have Delta, Atlas, EELVs. These rocket systems are still very capable of conducting space missions, are they not?

Mr. BOLDEN. Congressman, they are very capable, but I would point out the Soyuz spacecraft, which looks the same on the outside, the last two flights on Soyuz with our astronauts aboard have been new spacecraft for all intensive purposes. They have new avionics. One of the reasons we could not do a fly-around to take a picture of the stack when we had every vehicle known to man there was because we were not—we could not bring ourselves to be comfortable that a brand new vehicle could be backed off, flown around the stack and—to take photographs before we had had some more in-depth study.

So it is a new vehicle.

Mr. ROHRABACHER. And their approach has been to perfect it, perfect the vehicle.

Mr. BOLDEN. Their approach is unlike ours. We do revolutionary stuff.

Mr. ROHRABACHER. Right.

Mr. BOLDEN. They do evolutionary stuff.

Mr. ROHRABACHER. And sometimes evolutionary stuff may be actually more cost effective than doing revolutionary stuff that doesn't work.

Mr. BOLDEN. Congressman, I don't disagree with you, and if you look at the SLS and the MPCV, it is a hybrid of evolution and revolution.

Mr. ROHRABACHER. Okay. Let us just note that when we are—we are now being, you know, stampeded into building this mega new rocket rather than utilizing the systems that we have, you know, and trying to find a way to accomplish the same mission with the rockets that we do have. In other words, putting things into orbit and doing the work up there and then moving on rather than to keep doing everything in one big rocket.

If we spend money that might be done more cheaply by utilizing the systems we have, is this what—is the price that we are paying things like the telescopes and the cleaning up the space debris and maybe even some deep exploration projects, are we not spending money that should be going to some of those other goals in space?

Mr. BOLDEN. Congressman, I don't think so. If you look at the Hubble Space Telescope, I am partial you know, I cannot put—you can't put a dollar sign on the value of Hubble and what it has done for humankind and our understanding of our universe. We rewrite textbooks every day.

Mr. ROHRABACHER. Well, one dollar sign you can put on it, General, is if we spend all of our money on a huge vehicle that may or may not be absolutely necessary, the money won't be there for the—what is the modern version of the Hubble Telescope.

Mr. BOLDEN. Congressman, I am not going to go back and forth, but, you know, if I don't build a heavy-lift launch vehicle, we don't have an exploration program. This President has given us an opportunity to hit the restart button.

Mr. ROHRABACHER. No. You don't have a human exploration program.

Mr. BOLDEN. I am a big fan of human exploration.

Mr. ROHRABACHER. Well, I would suggest that we may want to explore with human beings in the far, in the distant future, but if insisting on exploring deep space with human beings eats up billions of dollars that we don't have for Hubble Telescopes and cleaning space debris, which is a vitally-important mission, that needs to be looked at. We are then chasing after goals that are so far in the distance that we are cutting out the things that we can do today.

Mr. BOLDEN. Congressman, in preparation for this hearing I listened this morning, I went to the web, the Kennedy Center, Kennedy Library website, and I listened to the debate, again, you have heard me tell this story, but between Kennedy and James Webb, a Marine, who was the NASA Administrator at the time, and this debate took place on September 16, 1963, and it was about where NASA should go because President Kennedy said, and I quote, "Space has lost a lot of its glamour," and he asked the NASA Administrator what we should do, and Administrator Webb said we should focus on science. And they argued. They literally yelled and screamed, and it came down to moon versus Mars versus science.

Guess who won? The President and we went to the moon.

Mr. ROHRABACHER. Well, and who knows what we would have done with the science in the meantime.

Mr. BOLDEN. We have done the science.

Chairman HALL. Would the gentleman yield? The gentleman from California yield to me?

Aren't you saying that continue to go the Station and keep our program there and plan those long voyages but not spend the money on them other than planning, and planning can cost whatever the Congress says we can spend? We can't go to the moon until our folks can go to the grocery store. That is just hard-cold facts, and kind of what you are saying is the economy is going to tell us when we can do that.

Mr. ROHRABACHER. We are right now at a point where we have to make tough decisions here at home, Mr. Chairman, and there are some things in space that are absolutely necessary for us to do, and by the way, I happen to believe space debris is one of them, although nobody seems to be paying attention to that.

And if we instead set our goals on spending money for goals that are 20 years down the line in terms of sending a man to Mars or something like that and ignore those absolute necessary costs that are right on us today, we are doing a big disservice to this generation and future generations because we won't accomplish those long-term goals.

Chairman HALL. The gentleman's time has expired.

The Chair recognizes the gentleman from Oregon, Mr. Wu.

Mr. WU. Thank you, Mr. Chairman, and thank you very much, Major General Bolden, for being here. I thank you for your 34 years of service in the Marine Corps and your very able service now as NASA Administrator and also congratulations on a very successful launch.

I find it very commendable that you are taking responsibility for many of the decisions that have been made in the last couple of years, but I think that we are all aware that just as President Kennedy prevailed in the discussions with Mr. Webb, that there is a President that you answer to just as your parallel space agency had, and Russia answers to someone in Moscow, and that his Chinese compatriot or colleague listens to someone at the head of the government in Beijing.

And I think that some of those decisions that have been made do go up a little bit higher in the chain, and I am not completely onboard with some of them. I see my job, part of it, I have been a passionate advocate for making sure that in the relationship of competition and cooperation between different countries, as I have said before, that the dominant language of space or that the language of space be English and not Russian or Chinese, just as the language of aviation is English.

I think it is very, very important that we continue to have that vision and so I don't want to encourage you to be anything other than a loyal soldier, but I do ask this of you; to either today or soon give me, give this Committee a high-end number, not what the Administration has asked for, not what the Congress has authorized, but what is a high-end number for what NASA needs to fully fund a deep-space human exploration program.

Because I am not sure that this Committee has seen that number yet, and it is not that we will ultimately be able to fund at that number, but it is very, very important to have that goal. Because just as you have taken responsibility, General, I think that it is incumbent upon us in the United States Congress to know that we are ultimately responsible for not fully funding space exploration at the levels that you all can use, and if you would care to comment on that or if you have a number in your head today, I am happy to hear it.

Mr. BOLDEN. Congressman, I don't have a number in my head today, and I will take it for the record, and I will be glad to get that to you, but you do point out several things.

Decisions with reference to our space program are in three baskets. There is technical, and I generally am the one that makes those. There are policy decisions, which generally go to the President, and he—and I act as one of his consultants, and then there are budget decisions, and you and the President work those in consultation as we are seeing over these past weeks.

Mr. WU. He hasn't asked me very recently, but I look forward to it.

Mr. BOLDEN. Well, I think you have some representatives with him, so my job is a little bit easier right now I think.

Mr. WU. Thank you very much. I yield back the balance of my time.

Chairman HALL. The gentleman's time, he yields back.

Recognize the older gentleman, Mr. Bartlett, for five minutes.

Mr. BARTLETT. Younger than you, though, sir. Thank you very much.

I am going to be the devil's advocate for a moment, and I want to put my context—my comments in context. I was involved a bit more than a half century ago in the first suborbital primate flight with Monkey Able and Monkey Baker. I was at Pensacola, Florida, then. I was involved with training of the first astronauts as they came to Pensacola for the slow rotation room in the human centrifuge, and when they came to the Navy Yard in Philadelphia for work with pressure suits and so forth.

There were three huge benefits to our country as a result of putting a man on the moon, and the first of these was national image. That was enormously important. Second of those was spin-offs, and you can point to a large number of spin-offs in the technology developed in putting a man on the moon. And the third and maybe the most important benefit to our country was that it captured the imagination of our people and inspired our young people to go into careers of math, science, and engineering.

I do not know how much that contributed to our winning the Cold War, but those millions of young people that were inspired to go into the science, math, and engineering, at least some of those were available to our military efforts that permitted us to bury the Soviet Union with our progress in armaments.

Help us make the argument, sir, that we need to continue funding these programs, because today if there are spin-offs, I don't hear of any of those, sir. And clearly nobody is capturing the imagination of our people, inspiring our young people to go into careers of science, math, and engineering, because this year the Chinese will graduate seven times as many engineers as we graduate. We face huge deficit problems in our country. Our deficit is a half trillion dollars more than all the money we vote to spend. We are laboring to try to come up with cuts that equal the deficit, but the cuts would be over ten years. The deficit is just this year. Even the Ryan budget doesn't balance for 25 years and balances then only if you assume what I think are unrealistic assumptions about cost growth because we are up against a world ceiling at 84 million barrels of oil a day.

Help us, sir, to go out to our constituents and convince them that we still ought to be spending money in spaceflight for humans.

Mr. BOLDEN. Congressman, I appreciate that, and I think we should be, and I can tell you that if you look at spin-offs, there are thousands still each year that come from space exploration.

Mr. BARTLETT. I don't know of those, sir, and I don't think—we are doing a terrible job of messaging this. You know, these are very dangerous missions. If one out of every 60 times I got in my car I died, I don't know how often I would get in my car, sir, but that is—we have had, what, 120 some missions. Two of them have ended up killing everybody on the mission. We have made this seem so darn ho hum that people hardly turn on their television anymore to watch these really spectacular things. We have done a very bad job of messaging this, have we not?

Mr. BOLDEN. We have done a great job of making it look easy——

Mr. BARTLETT. Yeah.

Mr. BOLDEN. —which is detrimental to——

Mr. BARTLETT. We have indeed, but that it is not easy, sir.

Mr. BOLDEN. It is not easy at all.

Mr. BARTLETT. One out of every 60 times you get in your car you die, how often would you get in your car? This is tough stuff, sir.

Mr. BOLDEN. It is.

Mr. BARTLETT. And we have made it seem very ho hum.

Mr. BOLDEN. But when you ask about spin-offs, if I just look at medical imaging, we have a young researcher out at Jet Propulsion Lab working on synthetic aperture radar for the Mars Lander. The technology there has now been parlayed into use for discovering breast tumors. Never expected to use it that way, and the list goes on and on of things like that.

We are working diligently in NASA to try to facilitate other agencies' ability to talk to young kids about the fun of math, science, engineering. We are really focused on STEM education and trying to instill a desire for young people to get into that type of work. We send people into schools, we downlink every, almost every day, conversations between astronauts on the International Space Station and students in some school around the country. We do that because we understand how critical it is to get our kids interested in science and math. We are failing as a Nation.

You know, I wish I could take the blame there alone but I can't. We are failing as a Nation in inspiring kids to want to get into science, engineering, and math. They all want to be business people, because they all want to become millionaires right away, and they can't do that. They want it bad, and they get it bad.

Mr. BARTLETT. You know, I have a lot of constituents who have lost their jobs, and if they haven't lost it, they know somebody who has, and I have a tough time selling to them that we need to spend billions putting a man—you know, I think we do, sir, because I think we need to have the best image in the world. I think we need to capture the imagination of people and inspire our young people, but, you know, you need to help us make this sale to the American people, because we have a tough time doing it.

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

Chairman HALL. The gentleman yields back.

The Chair recognizes the gentlelady from Ohio, Mrs. Fudge.

Ms. FUDGE. Thank you very much, Mr. Chairman, and thank you so much for being here, Mr. Bolden.

Two quick questions. Under the plan that is being devised, Mr. Administrator, will NASA Glenn and another entities maintain the same role and responsibilities they currently have with SLS as we did under Ares I and we were supposed to do under Ares V?

Mr. BOLDEN. Congresswoman, as I mentioned to you before, my plan right now is that the programs that—the tests that would be conducted at Glenn particularly for MPCV, Orion will still plan to be conducted there, so I don't—I see Glenn staying as strong and important as they have been in the development of future exploration systems.

Ms. FUDGE. Okay, and just to follow up on the MPCV, you received the letter, and we thank you for responding to the Ohio Delegation, and you stated that scheduling costs are now going to drive the MPCV testing as opposed to safety requirements which drove the testing before.

Could you please just clarify that for me?

Mr. BOLDEN. If I said that in a letter, then I misspoke. I hope I did not tell you that scheduling costs was going to out—override safety.

Ms. FUDGE. No, not override it but, well, I mean, you stated that the scheduling costs would drive how MPCV is tested, and this does represent a shift from Constellation because during—which safety requirements really drove testing. And if I—I may have read it incorrectly, Mr. Administrator.

Mr. BOLDEN. I hope so.

Ms. FUDGE. We can talk about it.

Mr. BOLDEN. Yes, ma'am, but safety is always paramount, and we do testing to try to enhance safety, enhance reliability, and the quality of our system. So you will not see a derogation or a degradation in our emphasis on safety.

If I talked about scheduling costs having an impact, it is because as we, as I alluded to earlier, the less money I have to put on a program means the longer it is going to take me to do that program unless I can significantly de-scope it to get it done in the timeframe that I originally identified for you. One of the reasons that I am being very cautious about bringing numbers to this Committee or to any other Committee of the Congress is because I don't want to end up where we were with Constellation. I don't want to bring you an un-executable program. I am very confident that the path on which we are presently proceeding I will be able to bring you a program that is affordable, sustainable, and makes sense. I am not there yet, to be quite honest.

I am the one that asked, when I talk about my responsibility, to give me a sanity check, for example, when we started this whole thing, I told my team that I wanted independent cost assessments, ballpark figures, not detailed numbers because we don't ever know details. Another lesson we learned. You don't—I should not give you a hard number on cost and scheduling until I get what is called PDR, preliminary design review. If I give you a hard number before that stage, I can almost guarantee you I am wrong.

Congresswoman Edwards is shaking her head because she has been there, and she knows. So don't let me bring you a number that is a hard number on anything prior to us getting the PDR on any system, particularly multi-billion dollar system. If I come in and tell you that, then you throw me out because I am lying. Or I am really pulling it out of you know where. So I am not going to do that, and it frustrates everybody.

I am trying to get a ballpark figure right now, a random order of merit for what this program is going to cost, and I am just not there yet. I need to have—we have Booz Allen looking at the SLS, and we have a plan for them giving us a, you know, an independent assessment of whether we are in the ballpark. We may have missed something. I don't think so because preliminary word

is they think we—what we plan and the way we plan to approach it is pretty good.

But we have a ways to go before I can bring you hard numbers, so don't let me do that.

Ms. FUDGE. Is there anything else you would like to say? My questions are complete. I thank you for your answers, and I thank you for your service. It is always a pleasure to have you testify before this Committee. I know that your task is difficult.

Mr. BOLDEN. It is fun.

Ms. FUDGE. You call it fun. When I go home, I call it difficult.

Mr. BOLDEN. Nobody is shooting at me, and I don't have a 100-pound pack on my back.

Ms. FUDGE. Well, that is true.

Mr. BOLDEN. So this is fun.

Ms. FUDGE. Thank you so much, Mr. Administrator.

Mr. Chairman, I yield back.

Chairman HALL. The gentlelady yields back.

The Chair recognizes Mr. Fleischmann, the gentleman from Tennessee, for five minutes.

Mr. FLEISCHMANN. Thank you, Mr. Chairman. General, it is a privilege to be here today to hear this from you. I thank you. I also want to thank you. NASA personnel have come to my office and have already met with me to help bring me up to snuff on this. I am a lawyer by profession, but I really, really love this stuff, so I thank you for their visit and your presence here today.

I have a few questions, sir. You were talking, I think, about the human mission into deep space and mentioned Mars and perhaps some other locations, an asteroid. It seems to me that a lunar trip, a moon trip, might be a little bit easier, it has been done before. Where is that in the pecking order, and what is NASA's plans with regard to a lunar trip, sir?

Mr. BOLDEN. Under the flexible path approach that we intend to use, we have very hard destinations and set by the President, an asteroid in 2025, Mars in 2030, but there may be reasons, I anticipate there will probably be reasons to go back to the lunar surface for a period of, a short period of time just to make sure that we have everything we need before we head off to Mars.

You know, the moon is a couple of days away, and today with technology rovers that we have developed and tested in the desert over a number of years now, we can put a couple of astronauts on the surface of the moon and have them roam and range over the moon to do research or experimentation and then get them back, you know, in a couple of days. When somebody heads off to Mars, I can't turn them around and bring them back in a couple of days.

So it is unlikely that we will experience an Apollo 13 if we have that kind of failure on the way to Mars.

Mr. FLEISCHMANN. Yes, sir. Are there any other destinations? We talked about Mars, the moon, an asteroid. Anything else, sir?

Mr. BOLDEN. We talk about—things that we talk about with our industry, as a matter of fact, are what we call geosynchronous orbit as a stepping stone to going to some of these distant places for things like satellite repair. Those are technological developments. If you can get to geosynchronous orbit, then you can, you know, you can get to deep space.

So but we don't need a 130-metric-ton vehicle to do that. You could do that with a 70-metric-ton vehicle. You could do that with some of the vehicles that we have today, but they are not human rated, so, you know, there are a number of places.

Mr. FLEISCHMANN. Yes, sir. The President in his State of the Union was kind enough to mention ORNL, that is the lab in my district in Oak Ridge, fascinating place, and it is wonderful to represent the lab. Do you know of any role that they may have in deep space research, or is there any plans for our national labs to——

Mr. BOLDEN. Sir, let me take it for the record. I do not know personally of what Oak Ridge is doing. When I think about national labs, we are always collaborating with them in one way or another, and I am certain there is something, but I don't know, and I will get back to you.

Mr. FLEISCHMANN. Thank you. It is a pleasure. Thank you.

I yield back, Mr. Chairman.

Chairman HALL. The gentleman yields back.

The Chair recognizes Mr. McNerney, the gentleman from California, for five minutes.

Mr. MCNERNEY. Thank you, Mr. Chairman. I am over here. Good morning. Thank you for coming and testifying. I know you realize this wasn't going to be an easy session, and I appreciate your emotional attachment to the Space Shuttle Program. It means a lot.

I am a little confused about what was submitted by NASA to the OMB versus what was submitted to Booz Allen. Could you kind of go into that a little bit so we will get an understanding in the Committee here?

Mr. BOLDEN. What we submitted to OMB as a part of the decision making process was a decision memorandum from me that outlined the technical design of a vehicle that I would propose. Booz Allen is the consulting firm that I have asked to take a look at that technical proposal and tell me whether or not the schedule and cost that I have—that my folk have made is reasonable, whether it makes sense.

And they go, you know, so they are in work right now trying to help us determine an independent cost assessment.

Mr. MCNERNEY. So was what you submitted to OMB sufficient in terms of information for them to make an assessment of the cost?

Mr. BOLDEN. I would like to think so.

Mr. MCNERNEY. And have they——

Mr. BOLDEN. You would to ask——

Mr. MCNERNEY. —given you an estimate of when they will give you their numbers?

Mr. BOLDEN. Well, it is not, Congressman, it is not that—it is not just like that. We are working back and forth just as we work with the Committees, and we work with your staffs. We are actually coming up and briefing the staffs every time. Every time I make a preliminary decision, a technical decision, I generally try to have somebody come up here and sit with the staffs and tell them, you know, here is what we are doing or where we are going. I can't give you details because, as I said, every decision has three pieces to it; the policy, the budget, and the technical part.

Mr. MCNERNEY. So you don't and can't really give us an estimate of when OMB's numbers will be available?

Mr. BOLDEN. That was what I said in my testimony. As much as I would love to say I am going to do that by the end of this month or the end of next month, I am not comfortable making that commitment to you right now because I don't have the results of the independent cost assessment that I asked for.

Mr. MCNERNEY. Thank you. I am going to change directions a little bit.

Some folks criticize the SLS Program as a rocket to nowhere. Could you give us a roadmap of what we might accomplish with that hardware when it is available that would be noteworthy and make us proud?

Mr. BOLDEN. Early in the program even before we have a capability of putting humans on it, we are hopeful, and that is the 2017 timeframe that I mentioned before, we would like to use that to boost an early version of the MPCV into space and get it to speeds faster than it would be going when it came back from the International Space Station, for example, so that we can do the same thing that I required Elon Musk and SpaceX to do back last December, you know. Put his rocket, put his capsule into orbit, have it orbit Earth a few times, come back, and survive. That is what I required him to do before I would go any farther, and he did that.

I am now requiring me to put my MPCV, not into orbit, but put it somewhere, whether it goes around the moon and comes back, but I need it to accelerate, I need to accelerate it to a velocity that is equivalent of what it would be going when it comes back from the moon, from an asteroid, from Mars and be able to survive reentry and safe splashdown.

Mr. MCNERNEY. Well, those are good scientific goals, but they are not something that is going to sparked the imagination.

Mr. BOLDEN. Yes, they do, sir.

Mr. MCNERNEY. Well, I hope you are right.

Mr. BOLDEN. They spark the imagination of a young kid that wants to be an aeronautical engineer and figure out, you know, hypersonic—who wants to be involved in hypersonic research to determine whether a vehicle can survive reentry from speeds in excess of 17,500 miles an hour. If a kid is interested in that, that is pretty exciting.

Mr. MCNERNEY. What fraction of the population?

But, you know, there is always a certain tension between, as Mr. Rohrabacher explored there a minute ago, between manned and unmanned space programs, and I think you are probably biased in that from your experience.

Could you give us a little bit of, from your perspective, of what the advantage of human space exploration and expenditures are?

Mr. BOLDEN. Congressman, I wouldn't say I am biased. I would say I am informed, and my—what I have learned in my time is that, for example, when we went to the moon, the astronauts had been highly trained in geology. They knew exactly what rocks to look for. However, some of the more interesting rocks that they brought back were not ones they were sent to get because a robot, while it has capability of doing anything we tell it to do, and we can train them to do pretty good stuff, a robot does not have intel-

lect yet. A robot can't look around and see a piece of rock and say, boy, that is really interesting. They didn't tell me to bring this back, but I think I am going to take it anyway.

We have to have robotic precursors. You know, I am going to launch the Mars Science Laboratory to Mars in November. That is going to do an incredible amount of work. We are doing things with our international partners that are going to go ahead of humans. It will be some time before we are capable of putting humans on—in any of these places that I am sending precursors right now. I would not send a human to Vesta, for example, even if I could. That is why DAWN is going there in less than a week.

Mr. MCNERNEY. I think I have expired here.

Chairman HALL. The gentleman yield back.

Mr. MCNERNEY. I yield.

Chairman HALL. All right. The Chair at this time recognizes the Chairman of our Space and Aeronautics Subcommittee, Mr. Palazzo, from Mississippi, for five minutes.

Mr. PALAZZO. Thank you, Mr. Chairman. Thank you for your leadership. I also share your sentiments and concerns on SLS, the delays, but it was encouraging to see the American people focus on the final launch of Atlantis. It demonstrated that our Nation does love our space program, they love the American exceptionalism that it brings. I do think that the—a lot of the American people were left with a lot of questions, and that is what, where, when, and how, and hopefully with this Committee and others and along with NASA and the rest of Congress will be able to help find those answers with the Administrator.

Sir, you said many times that we need to test before we launch. What then is the agency's fiscal year 2012 test infrastructure plan?

Mr. BOLDEN. In fiscal year 2012, right now we will continue a lot of engine testing, both on commercial rocket engines as well as the engines that we are developing. As a part of my proposal on a heavy-lift system, America does not have the expertise that we once had in what is called LOX rocket fuel or LOX–RP propulsion systems.

So I have asked that we try to find money to begin development of a LOX–RP system. There are a lot of people that would love to see us use LOX–RP instead of LOX hydrogen. We don't have that capability anymore, and when we talk about stepping back for awhile and waiting for things to catch up, the reason we don't have the expertise is because when we got ready to build Shuttle, the Nation made a critical decision, and it decided it was going to go with LOX hydrogen as its focus, and we put LOX–RP aside. Russians do it very well, because they chose that system.

So those are some of the things I hope to do.

Mr. PALAZZO. Can you just elaborate on why it is important to test before you launch?

Mr. BOLDEN. Because you don't want to have something happen—it is sort of the way people put it. I would much rather be on the ground wishing I were in the air than in the air wishing I were on the ground. When I test on the ground, as we did with the AJ–26, we have had incredible success testing the AJ–26 for aero jet and orbital. We had a mishap with the AJ–26 engine. I would much rather have that occur and find out that there is some-

thing wrong than have it occur on the test—on the launch platform at Wallops where the Nation has a significant investment in the infrastructure there.

You know, so it is really important that we test things to see if we can wring out all the potential problems before we put it on a vehicle or try to put it in space.

Mr. PALAZZO. I have a question regarding the fiscal year '11, operating plan that was recently sent to Congress. The three-page spreadsheet noted as enclosure one indicates that the Multi-Purpose Crew Vehicle and the Space Launch System are due to receive amounts that are quite close to amounts stipulated in the continuing resolution, but details provided in enclosure two suggests that resources will be moved out of the Space Launch System line to other projects and activities.

It is unclear to me even being a CPA exactly where and how much money is actually moving from SLS to support activities and other accounts. So for the record I request that NASA provide a detailed accounting of exactly how much money will be expended on development of SLS hardware, how many money is being moved to other accounts, the distribution of funding by center, the names of those accounts and for what purpose, and how much money is planned to be rolled into fiscal year 2012.

Would you please provide this information?

Mr. BOLDEN. Sir, I will take that for the record and provide it. As a precursor, however, what you are talking about is ground systems for SLS, and unlike Constellation where we had separate programs, in the SLS the ground systems are rolled into the program, so the cost is in SLS, not any separate program the way it was with Constellation.

Mr. PALAZZO. But you will provide that?

Mr. BOLDEN. But we will provide the information that you requested.

Mr. PALAZZO. All right, because, you know, of course, I make that request, Mr. Administrator, just because, you know, we have to capture America's imagination, and we also need to ensure the public support and Congressional support, and we need to be able to back that up, and it must be earned.

And I do have a little bit of time left. I would just like to—why an asteroid?

Mr. BOLDEN. Well, why an asteroid? Asteroids tell us a lot about Earth, tell us about our own Earth, but the most important reason an asteroid is because one of these days, I will go back to what my friend, Mr. Rohrabacher, talks about, and we do need to be aware of the fact that one of these days one of these rocks that is orbiting the sun that we don't know a lot about is going to come perilously close to Earth, and one of these days it may actually hit Earth. And you all laugh when I tell you about it, but I don't want any of us to be dinosaurs, because I think we all know that if an asteroid makes it through our atmosphere of any significant size and impacts Earth, then it is going to be a dark day, and it could spell the end of civilization as we know it in the greatest, to the greatest extent.

So when people talk about near-Earth objects and needing to understand what they are and what they can do, they are not crazy.

They are people who just have a concern about the planet, as do I. In the National Space Policy one of my charges with the Secretary of Defense is to determine how we protect the planet against near-Earth objects, how we protect the planet against things.

We live in a big universe, and some people live under the big sky theory or the big space theory that there is a lot of stuff out there but none of it will ever hit us. You have heard more in the last two weeks about near misses on the International Space Station than you have probably heard in your life, and that is just because people are becoming aware as we wind down the Space Shuttle Program, you know, that there are threats to the International Space Station, there are threats to anything we put in orbit because there is a lot of stuff out there.

Mr. PALAZZO. Well, thank you, and I yield back what time I don't have left.

Chairman HALL. The gentleman yields back his time.

For your information, 10 or 15 years ago we had a hearing on asteroids, and we found out for the first time that sometime in the '80s, mid '80s, an asteroid just missed Earth by about 15 minutes, and no one knew it until it was here and gone. Go back and read that, and you will get some information on it.

Thank you. At this time I think I want to recognize Mrs. Edwards. Yeah. I am going to. For five minutes.

Ms. EDWARDS. Thank you, Mr. Chairman. I am not really sure what to make of that. I will say thank you, Administrator Bolden, and I just want to share with you. I was, over the 4th of July holiday I was out at Assateague, just camped out under the stars with five year old, ten year old, you know, six year olds, and we were looking up at the sky, and we were looking at the constellations, and we were just chatting, this group of young people who were so excited to be able to see out there in all of its wonder. And one of the little boys said, I want to go out there. That is what I want to do. That is who I want to be, and without any prompting at all, and it made me think as we then approached the last launch of the Shuttle Program, that there is so much more to do.

And I know that you share that passion, and I do, too, and so when you say to this Committee that we are not abandoning our human spaceflight program, I want that to be true to those young people who were looking up at the stars, and not just because of the sheer joy of being out in space, but because our space exploration program tells us something about ourselves, it helps us to see ourselves and our relative place in this universe in a very different kind of way.

And so I am concerned, and I think the timeliness of this hearing is really appropriate, in another part of the Capitol, the House Appropriations Committee right now I think is considering the 2012 appropriations budget for NASA. So it is appropriate that we are talking about this program and the fiscal responsibilities that we share for it, but at the same time that same Committee is looking at the elimination of the James Webb Space Telescope, and that is the next area of exploration for us that like the Hubble will tell us so much about our universe.

And so on the one hand we have some who argue for the continuation of human spaceflight, but on the other hand, others say, well,

we should invest more in things that are not part of the human spaceflight program but that are science, and we can't have it every way. I think that we—I happen to be one of those who believe that we need multiple legs of a stool to investigate our universe.

So I understand that you approved the decision on the SLS design and you are basically ready to go and your plan was delivered to OMB. Can you tell me which engineers, scientists, aerospace people over at OMB are holding up their decision to get it over here and over to you so that you can begin work?

Mr. BOLDEN. Congresswoman, I wouldn't say anybody is holding up a decision. I would say they are evaluating just as we always do in this deliberative process, and there are engineers at OMB, by the way. They are pretty smart people. I hate to say that, but there are.

Ms. EDWARDS. I guess my point, though, is that there was a promise that we would have, you know, something that was a workable plan that you could move forward on and so that there was some certainty and stability both within the agency and in the private sector. We were told that would be the spring, and then it was later in the spring, and then it was closer to the launch of the Atlantis, and now we are hearing perhaps, I don't know, some time this summer.

And we are months and months away from the report of the Augustine Committee, where we knew that it was time to construct or some thought a different direction. There have been multiple hearings here on Capitol Hill. We have looked at an authorization.

I mean, when are we go going to be ready to go?

Mr. BOLDEN. Congresswoman, I hope I can bring you something with all deliberate speed, but with all deliberate speed in this town sometimes is not as fast as we would like. I would say if you compare the delivery of the decision, the ultimate decision on MPCV, that was relatively fast in the grand scheme of the way that we generally operate with major programs like that, and I think while everyone is impatient and thinks we are not moving on SLS, we have made incredible progress. You know, we are almost there. We are getting there, but in the course of starting this effort to today, our budget has, I think as everybody in this Committee recognizes, it has constantly deteriorated. When we started this, the President's 2011 budget, I would have been at $20 billion next year. We are not going to be there, and so we have had to go back, and I have had to de-scope, I have had to put—I put a ceiling on my technical team that put them under a lot of pressure. There are some of them sitting in this room right now who wish that Congressman Wu's request that somebody could find me all the money in the world because they are really working hard to try to find a way to live within our means, to live within the 2012 proposed budget of the President, which has already been, if you look at the House proposal I got to go back again to the drawing board and figure out what to do.

So we are working with all deliberate speed, but when things keep changing, then we have to go back and make adjustments. Otherwise I can't bring you an affordable, sustainable, realistic program.

Ms. EDWARDS. Thank you, Mr. Chairman, and I hope we can bring the Administrator back because five minutes is just not long enough.

Mr. BOLDEN. Congresswoman——

Ms. EDWARDS. Thank you, Mr. Chairman. I think I have to yield.

Mr. BOLDEN. Oh. Okay. I thought you were going to let me talk about James Webb. Okay.

Chairman HALL. The gentlelady finally yields back. Good questions, though, and we always appreciate you. You are a good Member.

The Chair at this time recognizes Mr. Cravaack for five minutes.

Mr. CRAVAACK. Thank you, Mr. Chair.

Major General, it is refreshing, sir, to have you here today and with your military perspective with coming in and saying it is not the President, it is me, the buck ends with me, and I just can't tell you how much I appreciate that, sir, and you are bringing that military perspective to the table.

I also appreciate your need for good information in means good information out. So I understand your diligence on what you are trying to do to ensure that we have the right answers to the questions that we are bringing you up here today and making sure that you don't arbitrarily misguide us on what your vision is. So I commend you for that, sir, and I definitely appreciate that as well.

One of the big things I think a lot of us are asking themselves in the back of the mind in these critical financial straits we are in is the return on the investment of going into space. And I still remember as a young kid watching the launch. I am a pilot as well. Wendy Lawrence is a classmate of mine from the Naval Academy, Brent Jett, both classmates. So I understand space, and I understand the need to go into space, but in this critical situation I am looking for that return on investment.

And in your statement you mentioned that you had been working with other agencies, and they are interested in the SLS Program. I was wondering what is your relationship with the DOD, and is the DOD interested in the SLS Program and what it can bring to bear for them?

Mr. BOLDEN. I had a discussion with a representative from DOD this morning to make sure I did not overstep or over-speak, and so while I would not say that they have definitive plans for SLS, what they are most impressed with and what they are encouraging us to press on and make a decision soon is because of its importance to the Nation's space industrial base.

That is not trivial. You know, we are seeing our space industrial base erode, sometimes slowly, sometimes more rapidly, and that is important for me and for DOD and for the entire national security establishment because the people that are affected worse are the sub-tier subcontractors. The primes have lots of stuff to do, but it is the sub-tier people that we are concerned about. People that make instruments, for example, or make strain gages, or circuit breakers.

Mr. CRAVAACK. So what do you think is the chief threat to our national security in space right now?

Mr. BOLDEN. Our economy.

Mr. CRAVAACK. Interesting.

Mr. BOLDEN. I agree with my classmate Mike Mullen, the chairman. National—our economy is the biggest threat to the Nation right now. We have got to—one of the reasons that I struggle every day is because I know what I want to do, and I know what my agency can do, but I am realistic, and you know, although we represent less than half of a percent of the federal budget, we have got to take our share of cuts like everybody else. I hate to say that, but I want to do it smartly, and I want to be able to, you know, for people to feel proud of what we do.

Mr. CRAVAACK. I appreciate that, sir, and I want to support you any way I can. Thirty-four years in the Corps, I would follow you anywhere, sir, but——

Mr. BOLDEN. Thank you for your service.

Mr. CRAVAACK. —you know, based on your assessment, how can Congress help you to overcome your challenges? I understand the economy, I understand the nature of making sure you get the right money, but how can we best help you in achieving these goals, because I do believe that in the national security interest that these goals need to be achieved.

Mr. BOLDEN. It goes without saying that a firm, consistent budget is always helpful. The biggest thing, you know, I have—I can't fix a problem that started eight years ago and persisted over eight years. I don't care how much you give me, you know. We in the Administration, this Congress, the American people, we all stood back and watched the Constellation Program just die a slow death, you know. I can't correct that. I would love to. President Obama can't correct that. But he set us on a course right now that I think is the right course. I support the course we are on, you know, or I would be gone. I could be with my grandkids. People don't like it when I say that, but, you know, there are other things I could do, but I love this. I love what I do, and I love my people.

You know, we have got tough choices to make, and as a Nation, but what I tell people is as long as I am the NASA Administrator, we are not going to back down from human spaceflight. Now, I may not be able to do it the way I want to do it, but we will find a way to do it, and it will be safe and efficient and we will live within our means, but we cannot forsake science, and I spend pennies on aeronautics. So, you know, I am always torn because I—if you give me $100 million for aeronautics tomorrow, let me tell you, if you want to see return on investment, I can do that, but I don't even have time to talk about aeronautics because, you know, everybody is focused on SLS and stuff like that.

Mr. CRAVAACK. Well, sir, thank you very much for your service and thank your grandkids for us because we are glad you are here, and I yield back, sir.

Chairman HALL. The gentleman yields back his time.

The Chair now recognizes Mrs. Wilson, the gentlelady from Florida, for five minutes.

Ms. WILSON. Thank you, Mr. Chair. Welcome. Good morning. How are you?

Mr. BOLDEN. Doing fine. Thank you.

Ms. WILSON. It is good to see you.

Mr. BOLDEN. Always good to be here.

Ms. WILSON. I don't know if you remember but back in, it might have been '92 or '93, you were in Miami with a bunch of school kids at Miami Northwestern Senior High School.

Mr. BOLDEN. My aunt was the librarian.

Ms. WILSON. Yes.

Mr. BOLDEN. Yes.

Ms. WILSON. And——

Mr. BOLDEN. I do remember.

Ms. WILSON. I was a school board member sitting next to you and then the next day we were on the front page of the newspaper. So being a principal from Florida and because of the proximity, space travel is very relevant in the school districts of Florida, and our children have always been excited since they take multiple field trips all the time to Cape Kennedy.

And I just wanted to find out, will there be any international collaboration with spaceflights, and how have you set that up, and what can we look forward to with the Russians and, you know, everyone else being involved in this, and how do we explain this to the kids in our schools?

Mr. BOLDEN. International collaboration is critical to everything that we do, particularly when we talk about long-term plans for exploration, for deep-space exploration. No nation, no single nation can explore deep space alone. So it is going to require international collaboration. All of our partners, our international partners in the International Space Station, there are five big agencies. The European Space Agency has 19 members, so I don't envy them. They are all struggling as we are financially right now, trying to decide how do we put collaborative programs together to do Mars exploration as precursors for human missions there. And we are all working to that end.

We all collaborate on education because we all suffer the same problem. It is not—this is not an American calamity, the lack of interest in STEM-related courses on the part of school children. It is a world-wide issue.

You know, when the Congressman talked about the thousands of people going into engineering in China, well, they got billions more people than we have, so it is not surprising that they have more going into engineering. They have a bigger pool from which to draw. It is not that more kids are interested in engineering. It is the numbers are much more massive, and they are doing things.

So, yeah, we have got to work hard.

Ms. WILSON. Thank you. Specifically, talk to me a little bit about Russia. You know, we hear Russia, we know the old Russia. What is the new Russia?

Mr. BOLDEN. The new Russia is an incredibly valuable partner for us. They are a major partner on the International Space Station. I would say if you want to say how does Space Station exist today, it exists today because of our collaboration with the Russians. The first two elements of what is now the International Space Station were Russian because their components were ready before we were. When we lost Columbia on February 1, 2003, we didn't have a way to get American astronauts to the International Space Station, and we didn't want to de-person it, de-man it. The Russians were there, and with Soyuz they took our crews for al-

most three years while we went back and worked on making Shuttle available.

And since that time they have been the primary provider of transportation for our crews to and from the International Space Station. So, you know, they are still a very good partner.

But we also have incredible international partners in the Europeans and the Japanese and the Canadians. The Canadians have great expertise in robotics. You are going to see us do some time soon, we are going to do a refueling exercise, robotic refueling on the International Space Station. The thing that is going to do it is going to be Dexter, and Dexter is a Canadian-built robot.

So, you know, international collaboration is critical.

Ms. WILSON. Just one little follow up. We keep hearing about Russia and aggression from Russia, and I am just wondering has there been any thought placed as to what happens if this aggression becomes intolerable? How will that affect the Space Station? Is it so entwined that we need their support forever?

Mr. BOLDEN. If I do my job and when I was in the military, if my counterparts there do their job, we won't have the problem that you perceive, but, you know, as long as we continue to work collaboratively with the Russians on the International Space Station, hopefully, you know, we will play an inadvertent diplomatic role.

You know, the Russians during the end of the Cold War, I believe, came about partially because of the collaboration that we had with the Soviet Union in the Apollo-Soyuz test project. When I talk to my dear friend, Sergei Krikalev, with whom I flew on Shuttle, my last flight, Sergei, you know, went to space his first flight as a citizen of the Soviet Union from Stalingrad and came back to Earth as a citizen of Russia from St. Petersburg. So things change.

Ms. WILSON. Thank you. I believe I am over.

Thank you, Mr. Chair.

Chairman HALL. Gentlelady is over.

The Chair recognizes Mo Brooks, gentleman from Alabama, for five minutes. And Ms. Wilson, you were pretty well on time. Thank you for that.

Mr. BROOKS. Thank you, Mr. Chairman.

I would like to focus on something that came out of the Commerce, Justice, and Science and Related Agencies Appropriations Subcommittee last week. Are you familiar with the vote that they had on either Wednesday or Thursday concerning the NASA budget?

Mr. BOLDEN. I am painfully familiar.

Mr. BROOKS. And as I understand it, NASA would be cut roughly 1.6 billion, a little bit more than that; James Webb Space Telescope—if I understand correctly from media reports—would be zeroed out. Overall, in your judgment, what would be the impact on NASA if the CJS Subcommittee proposal for NASA becomes governing law?

Mr. BOLDEN. Congressman, I try to make a point of not dealing in conjecture. So I will say a couple of things. One is all my planning right now is based on the 2010 Authorization Act as supported by the 2011 Full Year Continuing Resolution looking to the President's 2012 budget proposal. If what you say happened, it goes without saying that my efforts to keep the gap between the end of

the shuttle era and an American capability to take humans to orbit, if not close it, as I think we are starting to do, I would not be able to do that. The gap between the end of shuttle and another American capability to take humans to the International Space Station would increase and it is untold how much that would increase.

If I had to sacrifice science, which I would not choose to do, you know, something like the James Webb Space Telescope that—when we started Hubble, dark energy didn't exist. At least we didn't know about it. When we launched Hubble, there was no such thing as extrasolar planets. So those kinds of discoveries would probably go lacking unless some other nation stepped forward and did it.

Mr. BROOKS. Are you familiar enough with the CJS proposal to be able to itemize for us the impact it has on specific NASA programs?

Mr. BOLDEN. Yes, sir.

Mr. BROOKS. Other than James Webb we know would be zeroed out. But if you would, please, illuminate us.

Mr. BOLDEN. So I will take it for the record and bring it back to you, but there—it is across the board.

Mr. BROOKS. For the fiscal year 2011 budget, Congress proposed $1.8 billion for the Space Launch Systems program. How much of a role is a Marshall Space Flight Center supposed to play in the SLS?

Mr. BOLDEN. Sir, Marshall is critical. Marshall is where I house the program office for the SLS. The SLS program is at the Marshall Space Flight Center. They will lead the development of the heavy-lift launch vehicle and its ground system is in coordination with the Kennedy Space Center. They will integrate the vehicle or be a part of the integration of the SLS with the MPCV that heads the program office for the—at Johnson Space Center so——

Mr. BROOKS. Out of that 1.8 billion, how much does Marshall need in order to fulfill the mission as you envision with respect to SLS?

Mr. BOLDEN. Robert Lightfoot was telling me he would tell me more. I—you know——

Mr. BROOKS. More than what?

Mr. BOLDEN. More than any number I give him. But of the 1.8 billion—the 1.8 billion, again, is for the entire SLS system, which includes ground systems, everything else, and I will have to get back to you. I will get to you for the record. While the SLS program office manages all that money, all of the money is not spent or obligated in and around, you know, Huntsville. It goes all over the country so—but I—we can get you a breakdown on what is going to be in Huntsville and what is going to be in Florida and what is going to be in Mississippi and other places.

Mr. BROOKS. Well, you shared with us the critical nature of the Marshall Space Flight Center and SLS program. Are you in a position today to tell me exactly how much of that 1.8 billion is scheduled to be spent on Marshall efforts?

Mr. BOLDEN. Congressman, I am not in a position to tell you specifically how it is going to be broken out, but as the program office—with program management responsibility at Marshall, they will manage all of the money that is designated in the line item

for the SLS. So if it is 1.8 billion, it is all managed out of the SLS program office at Marshall.

Mr. BROOKS. My staff has been receiving information that out of 1.8 billion it might be as little as 65 million that would, in fact, be spent at Marshall on the development of their part of the SLS system. Do you have any insight that you can share with us on whether that is right or wrong?

Mr. BOLDEN. Congressman, I doubt that that is correct. I think that is a misunderstanding, but I will take it for the record and get back to you.

Mr. BROOKS. If you would, I would very much appreciate it.

Thank you, Mr. Chairman.

Chairman HALL. The gentleman's time has expired. The Chair recognizes the gentlelady from California, Ms. Lofgren.

Ms. LOFGREN. Well, thank you, Mr. Chairman, and thank you, Mr. Bolden, for being here today and for your lifetime of service to our country. It is really something that we all admire and we are grateful both to you and to your grandchildren for continuing to serve us.

We are in a dicey time economically. We know that. We have a need to get our budgets in order. We know that as a country. We are having a disagreement on how to do that now, but we will do that. We will accommodate that. And I believe that there is every reason to believe we will continue to have a vigorous science program in this country because otherwise we won't even have a future economically. And in that science budget, I certainly include NASA.

As you probably know, I come from Silicon Valley and there is a lot of innovation going on there all of the time. And so my question for you is how can, in a strategic sense, we design with the capacity to incorporate innovations that are already underway but are not yet ready for implementation? For example, there is an article in Aerospace America in February of this year that outlines a program that I have been following now for several years, which is a paraffin-based fuel that has been developed with the help of NASA Ames, Stanford University, and the Space Propulsion Group, and they are about to launch within the next couple of years with this new paraffin-based fuel. What the article indicates is that this fuel is going to lower the cost of a whole variety of systems. It is not going to be suitable just for replacement of boosters. They are going to be suitable for building in upper stages a wide variety of applications, and it is going to affect the lower cost. The design is different because of the burn rate and the capacity. I know that SpaceX is—I know they are not necessarily in Silicon Valley per se—is also doing some innovative things.

So I guess the question is generic. How does the government, which tends to be—I don't mean this as criticism; it is just the nature of government—a little more stodgy I guess than the private sector, incorporate these innovations without holding up the design overall?

Mr. BOLDEN. That makes plenty of sense and that is exactly what we are trying to do. We—I have a chief technologist, Dr. Bobby Braun, who is a Professor at Georgia Tech and, you know, still spends time there, but his task or his challenge from me is to

make sure that we don't miss out on technological development, technological innovations, capabilities that are out there. Congressman Clarke, I reminded or I pointed out to him the last time I was here that he and the citizens of Detroit should be very proud of the fact that they produced Robonaut 2, R2. That is innovation in the field of robotics. It is now—R2 is now on the International Space Station and will live there for the life of the International Space Station. And that came from a collaboration between General Motors and the Johnson Space Center. We are always looking for innovative ways to do things.

Ms. LOFGREN. Well, specifically, are you taking a look at the paraffin-based fuel issue? I know there has been testing with the Air Force, as well as at NASA Ames as part of the planning for this?

Mr. BOLDEN. We at NASA are not looking at alternative fuels because that is not what we do. What we look at and what I am certain Ames is probably doing—I am not familiar with the specific one that you mentioned—but what most of my research centers like Ames, Langley, Glenn do is they take emerging technologies and try to help industry develop systems that can use that. So when you talk about paraffin-based fuel——

Ms. LOFGREN. Well, SpaceX is going to use it on their next launch but——

Mr. BOLDEN. I don't know. You know——

Ms. LOFGREN. Well, that—according to the article. But could I just do this——

Mr. BOLDEN. I don't think so. If they are, you know, I——

Ms. LOFGREN. I am just reading what the report said in Aerospace America.

Mr. BOLDEN. They use a LOX/RP engine and so I don't know.

Ms. LOFGREN. Well, could I ask you this? Would you look into this paraffin-based issue for me and get back to me on it?

Mr. BOLDEN. Yes, ma'am. We will.

Ms. LOFGREN. I appreciate that very much.

Mr. BOLDEN. We will. Thank you.

Ms. LOFGREN. I yield back, Mr. Chairman.

Chairman HALL. The gentlelady yields back.

The Chair recognizes the gentlelady from Florida, Ms. Adams, for five minutes.

Mrs. ADAMS. Thank you, Mr. Chairman.

Good morning, actually. It is still morning, Administrator Bolden. And I, too, want to thank you for your service to our country.

You know, I want to reiterate something that you and I have just spoken about I am sure several times. I always say it every time and that is my problem isn't that we cancel constellation. I understand why that happened. My problem is that we didn't have a viable plan set forth when we did so. And in doing so, we lose our preeminence. We lose some ability if not a lot of ability. And I heard my colleague talk about the spinoffs. Well, I have the 2010 Spinoff book sitting on my desk in my office prominently displayed so that people can see the innovation, the creation, and the advancements, and the jobs created from this program. So when I sit and listen, I hear you say comments like "the sooner we make a decision." You are right. The sooner we make a decision.

You—we go back and forth about affordable, sustainable, and it has to make sense, but we still haven't made a decision so we don't know if it is affordable, sustainable, and it makes sense. The deliberate speed of this town, well, then why the deliberate speed to end without an Option B? I understand budget priorities. I understand all of this, but I also understand that this is the first time in decades—decades that the United States has no way to get American astronauts flying on American rockets built by American engineers and scientists into outer space. And it concerns me that NASA seems okay with that. That is where I am on this. I—you know, what is the intention of the Administration to assist our constituents with imminent layoffs as a reflection of the poor planning after the Constellation cancellation.

You realize that we have over nine percent unemployment and we have more and more layoffs coming in Central Florida where I represent. And I heard you say that you are working with the communities and the State and I commend you for that.

I would like to know what are you doing with them? Because I have been speaking with them also. I know of the two programs you referenced in that, but we still have a lot more people going to lose their jobs in an economy that is flailing and an unemployment rate that is 9., what, 2, three percent. Each day I hear of more unemployment. So I just need to know, when can we see the plan? When will we see that plan? When will NASA follow through with last year's authorization bill?

Mr. BOLDEN. Congresswoman, we are carrying out the provisions of last year's authorization bill each day. And I tried to mention some of that in my remarks.

A couple of things. You know, we are proceeding—if you look at the timelines that I have given you, a capability of putting humans in space aboard an American spacecraft by the 2015, 2016 timeframe, if you look at where we were with Constellation at the time that the recommendation went to the President to terminate Constellation, we were looking at 2016, 2017, maybe 2018. So somehow, we are actually ahead of when we would have been with Constellation in terms of getting beyond low Earth orbit. We at least now have a vision that would enable us to go not only back to the moon with a system that can get us down to the surface but to other places. We could not do that with Constellation.

We have made significant changes. In Constellation, we are going to be relying on two vehicles to get crew—a separate vehicle for crew and a separate vehicle for cargo. Every time you introduce another system, that is more risk. And while, you know, some people say, well, it is safer for the crew, that was a step that we didn't necessarily need to take. And so when you look at the SLS, it is a system that carries crew and cargo. So we went from two vehicles required for a mission to one vehicle required.

You know, as I said before, the decision that I am working under now was made more than eight years ago. It was a decision made by the prior administration.

Mrs. ADAMS. Again, the SLS, we are still waiting for that information, and that is why we are having this hearing today.

Mr. BOLDEN. Yes, Congresswoman. I understand that.

Mrs. ADAMS. And so when can we truly expect—several people have asked that question and we kind of have a vague—can you give us a clear timeframe, something—I mean you say it is at OMB. Can we have that same information? Can the Committee have that information? When can we expect to see something?

Mr. BOLDEN. Congresswoman, there are things that I can share with this Committee, and I would gladly do that to let you know where we are. And we will make arrangements to do that.

Mrs. ADAMS. Could you do that, please?

Mr. BOLDEN. But I would say, because some of it is proprietary to the companies involved, then it is not stuff that can be shared publicly. It should not be in the New York Times. But we will work to get that to the Committee.

But you mentioned the fact that for the first time in decades we have no capability. I would have to remind you that between Apollo and Shuttle, you know, the last time we flew an Apollo spacecraft with humans on it was the mid- to late 1970s and we didn't fly Shuttle until '81. And that was with a plan. It took us longer than we thought. You know, we were down for two years after Columbia, down for two years after Shuttle. Had it not been for the Russians, we would have not had a capability to get humans in space. So we are looking at a redundant capability of putting humans in space. With Russians, we hope to have a couple of American companies that will be able to do that so that we are not caught again where, when we lose a vehicle, we don't have an American capability to get to space.

So we have been here before, unfortunately. It is not the first time. But we are trying to get us to the point where we have the capability to do this.

Mrs. ADAMS. Thank you.

Mr. BOLDEN. Yes, ma'am.

Mrs. ADAMS. I yield back.

Chairman HALL. The gentlelady makes a good point and yields back.

The Chair now recognizes Ms. Sewell from Alabama for five minutes.

Ms. SEWELL. Thank you, Mr. Chairman.

Welcome. It is great to see you again, Mr. Administrator.

My question is really about the timeline, the budget for SLS. The proposed budget for fiscal year 2012, as you indicated, is 1.8 billion. And as you know, the Marshall Space Center in Huntsville, Alabama, is likely to be very important in creating those components. And so my question is is it realistic—is the fiscal year 2012 amount, 1.8 billion, sufficient to fully fund SLS and the heavy-lift vehicle? And I know that the timeline has moved a bit, that it was 2016; it is now 2017. I really want you to talk a little bit about the achievability of the timeline.

Mr. BOLDEN. Congresswoman, if I can go back and just make one adjustment. The time—the 2016 time was the time that you all told me you wanted to have a capability to do that. And at the time, I expressed some concern as to whether I could do that given the budget climate.

Ms. SEWELL. Um-hum.

Mr. BOLDEN. The budget climate has deteriorated since we had that initial conversation. So 2017 for an initial capability to fly the vehicle, that is not human-rated. That—we are still talking about, you know, late this decade, early '20s, before we have a human-rated vehicle, but we think we are going to be able to do that. Is the budget sufficient? When we made the recommendation on what should be in the budget to the President, I did not take the largest amount. I took the minimum that I thought we could do the program. I took the minimum that I thought we could do commercial crew and cargo, and that has caused quite a bit of consternation that I have discussed with this Committee and the Science Committee and the Appropriations Committee before that, you know, I would love to have more money for commercial crew to give me some assurance that we can facilitate their success. It is not there, so I—what I did was I took what I figured was the minimum amount that would get me to a viable commercial capability, the minimum amount that I thought would get me to a viable space launch system and MPCV, and that is what you see in the 2012 budget. So given that level of funding, we can do what we said we can do.

Ms. SEWELL. How will that affect Marshall's Space Center? How does the bottom line——

Mr. BOLDEN. If everything goes as planned, Marshall will have some robust activity coming up. They are anxious to get back into building rockets and doing that kind of thing. They recently had a shell-buckling test——

Ms. SEWELL. Um-hum.

Mr. BOLDEN. —that excited everybody there because it showed us that we overbilled, that—it showed our commercial partners that perhaps they overdesign and overbill because we found that, you know, things are stronger than we really think they are.

Ms. SEWELL. Right. I wanted to move a little bit to talking about components in the SLS. Some have argued that the development of new components is more expensive and time-consuming than using existing components for SLS. With the tight NASA budget, it is cost-efficient to have a competition on the boosters' phase of the SLS as some individuals have recently suggested? And would this potential competition impact cost and the schedule?

Mr. BOLDEN. One of the things that we have recommended that I can share in the design, if you will, of the new SLS, in an effort to try to speed things along and utilize as much as we can of existing technology while preserving the space industrial base for some time is a desire to utilize existing solid rocket boosters——

Ms. SEWELL. Right.

Mr. BOLDEN. —until we can hold a competition, which I have directed—we try to do as soon as possible—where all comers can compete to include a LOX/RP capability. And I have said before I want to find the money to seed money for American manufacturers to at least take the risk at producing LOX/RP engines for a booster. So the eventual booster for the final SLS could be solids, could be liquids of two forms—LOX/hydrogen, LOX/RP—or if there is paraffin-based, I mean it might be that. It is going to full and open competition if I can do what I would like to do.

Ms. SEWELL. Thank you very much. I yield back the balance of my time.

Chairman HALL. The gentlelady yields back. The Chair recognizes Dr. Harris, the gentleman from Maryland.

Mr. HARRIS. Thank you very much. And thank you very much, General Bolden, for all the service you have given to the country over a long and illustrious career now capped heading an agency that I think is going to have some very difficult decisions to make.

First of all, I want to thank the Agency for everything they are doing at Wallops Island. It is a big boon to the economy of the First Congressional District of Maryland, which is only about 10 miles away or so from it.

Let me just follow up with a question that Chairman Hall asked at the beginning and which I think I am getting the handle on. In the 2010 authorization, NASA was instructed to take the MPCV and use it as a backup vehicle to get to the International Space Station, but your testimony today is that that is really probably not going to be ready until around 2020, is that correct, for man flight?

Mr. BOLDEN. Congressman, it is—you know, the date that the MPCV is ready for a human flight will be sometime between probably 2017 and 2020.

Mr. HARRIS. Well, 2017 is when the unmanned flight——

Mr. BOLDEN. That is when we plan to fly an unmanned flight——

Mr. HARRIS. Unmanned. So realistically, it is about 2020. So—and my understanding is the International Space Station is really only projected right now to be used through 2020. I mean it can go until 2028 or so, but only to 2020. So realistically, the MPCV really will never be a backup vehicle.

Mr. BOLDEN. If we go beyond—there are a number of ifs——

Mr. HARRIS. Yeah, if we go beyond——

Mr. BOLDEN. —that I usually—well, I mean——

Mr. HARRIS. We don't go beyond 2020. Realistically, it won't be a realistic backup.

Mr. BOLDEN. Well, that is probably safe to say that.

Mr. HARRIS. That is what I imagined. So the Russians now—we kind of depend upon the Russians for all our manned space flights it looks like until a commercial alternative—and what is the—is it realistic that we will have a commercial alternative to delivering our astronauts to the space station for 2020?

Mr. BOLDEN. It is realistic that we will have a capability by 2015.

Mr. HARRIS. By 2015. So it looks like for a four-year window or so we are going to depend upon the Russians?

Mr. BOLDEN. Yes, sir.

Mr. HARRIS. And my understanding—I think I read it somewhere—they are kind of charging us a whole lot more than they used to on that——

Mr. BOLDEN. No, sir. They are actually not.

Mr. HARRIS. Right. Okay.

Mr. BOLDEN. The latest contract that we signed with the Russians was essentially what we had signed before plus inflation. And yet, the thing that I try to keep people—to help people understand it is not just for a ride. It is for training because our crewmembers

fly as crewmembers of the Soyuz Spacecraft. Generally, an American will be the flight engineer. We have never had an American fly as a commander of a Soyuz, but they do the flight engineer duties. They—one of the reasons we want to bring the capability of sending humans to space on an American-made vehicle is just to reduce the amount of time that I lose an astronaut to Russia for training.

Mr. HARRIS. Sure.

Mr. BOLDEN. You know, that is one of the things that is unattractive, if you will, to a young astronaut with a family is having to spend two years of their time back and forth to Russia. You know, that is—it is not attractive.

Mr. HARRIS. Absolutely. No, thank you very much on that.

But with, again, with regards to the MPCV, it looks like we are not going to be able to fulfill that, you know, the requirement of the 2010 law to use—actually have that available as a backup. We will depend upon the commercial rockets and, of course, the Russians as backups it looks like.

Mr. BOLDEN. My hope is that we will have more than one commercial—more than one American-made capability to take humans to space by the 2015/2016 time frame.

Mr. HARRIS. Okay.

Mr. BOLDEN. Which would give us three alternatives.

Mr. HARRIS. Well, thank you very much. And again, thank you for your service.

I yield back.

Mr. BOLDEN. Thank you. Thank you.

Chairman HALL. The gentleman yields back.

I say to the very patient Ms. Jackson Lee, if you can wait five more minutes, the Chair is going to recognize Mr. Clarke for five minutes.

Mr. CLARKE. Thank you, Mr. Chair.

I would like to yield a minute of my time to the good gentleman from Oregon, Mr. Wu.

Mr. WU. I thank the gentleman from Michigan.

Dr. Bolden, I just want to piggyback on two things, one is the paraffin engine as mentioned by Ms. Lofgren. I met with Brian Cantwell, the head of Aeronautics and Astronautics years ago and, you know, his claim is that they have solved a lot of the problems associated with paraffin technology. I brought this to the attention of your predecessor and he went right to those problems and, you know, I just encourage you to personally take some interest in this because what is momentum to one person is inertia to another.

The other item is what you mentioned about people wanting to become millionaires. And I would hope—not NASA but somebody else—kind of take a look at how many people proportionately become millionaires when they want to become an investment banker and anybody else because just as it is kind of seductive to try to become the next Tiger Woods or a basketball player or whatever, we need to start drawing people into things like science and engineering just as NASA drew the best and brightest back in the '50s and '60s. And I would really like to see that again. And I just want to throw that out.

And I thank you, Mr. Clarke. I appreciate it.

Mr. CLARKE. You are welcome.

Administrator Bolden, I just wanted to follow up on a question that was posed by the gentlelady from Maryland, Ms. Edwards, regarding the James Webb Space Telescope. In light of some of the facts here, there could be huge job losses throughout 22 States, maybe 8,000 scientist jobs at risk here. Can you comment on the appropriateness of cancelling the support of the Webb Telescope?

Mr. BOLDEN. Congressman, I have tried to explain what I think is the importance of James Webb in terms of opening new horizons far greater than we got from Hubble. I would only say that for about the same cost as Hubble in real year dollars, we will bring James Webb into operation. You know, it is—we have made significant changes in management in the program, changes at the Goddard Space Flight Center. Our contractor has done the same. Seventy-five percent of the hardware has already been delivered, and it is in the President's 2012 budget. So I guess the only other comment I could make was that it is a valuable commodity in NASA's stable of science projects.

Mr. CLARKE. I yield back.

Chairman HALL. The gentleman yields back.

I hate to tell Ms. Jackson Lee but I have to follow the rules.

Chairman Smith, I recognize you for 5 quick minutes.

Mr. SMITH. Thank you, Mr. Chairman.

Let me follow up, Mr. Bolden, on your last comments about the James Webb Space Telescope. Isn't the real problem here that OMB has not given your Agency flexibility when it comes to the budget? It sort of straight-lined the James Webb telescope rather than give you all the flexibility to maybe frontload it since 75 percent of the development has been done?

Mr. BOLDEN. Congressman, we are still in process of developing our re-plan for James Webb, which would include a revision to what we think is needed in the budget. When we helped develop the 2012 budget, that is where we were marching with Webb at the time.

Mr. SMITH. But you support full funding?

Mr. BOLDEN. I will support the funding that we will bring forward in our re-plan, which I have had an opportunity to see and which we have pre-briefed to our source—to our SRB, our outside review board.

Mr. SMITH. And would it help you if OMB gave you more flexibility?

Mr. BOLDEN. Congressman, I always have a certain amount of flexibility. I go back to the decision-making process. You know, I have to go to them for consideration of issues pertaining to the budget that I don't have a full grasp of.

Mr. SMITH. I would never admit that, but we will hope you can do the best you can for the——

Mr. BOLDEN. Yes, sir. I am doing—I will do the best I can.

Mr. SMITH. Okay.

Mr. BOLDEN. I will.

Mr. SMITH. Second question is this: there have been two independent assessments, I understand, of the Agency's morale and trust in its organizational leadership. Can you give this Committee the results of those assessments that have been done?

Mr. BOLDEN. I am not sure of which ones you speak, so I will take it for the record and get it back——

Mr. SMITH. Okay.

Mr. BOLDEN. —but I can tell you when I travel around the Agency, most recently on the afternoon of the launch last Friday——

Mr. SMITH. Right.

Mr. BOLDEN. —at a cookout at the Kennedy Space Center where I had an opportunity to circulate among the workforce——

Mr. SMITH. Yeah.

Mr. BOLDEN. —many of whom will not be working several weeks from now, they were upbeat. Their attitude was very positive and they——

Mr. SMITH. Mr. Bolden, I am sure that is the case. That is also anecdotal.

Mr. BOLDEN. Yeah.

Mr. SMITH. These assessments, one was done by the former senior engineer for the Hubble Space Telescope, Charlie Pellerin, and another by the management consulting firm McKinsey. Are you familiar with those assessments, those studies?

Mr. BOLDEN. I contracted for the one for McKinsey and Charlie Pellerin used to—I mean still works for us, I think, so I will—as I said, I will take it for the record and bring you the results of those——

Mr. SMITH. You will give me some results for those assessments? Okay. Thank you, Mr. Bolden.

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

Chairman HALL. All right. The Chair is really pleased to recognize the gentlelady from Houston, Texas, Mrs. Jackson Lee for 5 or 6 minutes.

Ms. JACKSON LEE. Mr. Chairman, let me thank you and the Ranking Member, Ms. Johnson, for your kindness in indulging me on a Committee that I had the privilege of serving on for 12 years and still have a great affection and respect for the work that is done by this great Committee. And, of course, one of its jurisdictional responsibility is NASA.

Before I dive into my questions, Mr. Administrator, let me thank you for your keen hospitality for a very emotional and moving experience on last Friday as Atlantis pushed past all doubts, all weather threats, and did what we expected her to do, which is to launch beautifully, and to the men and women that are now in space and utilizing the space station. We wish them well as they by-step space junk and do the great work that they have done over the years.

I also would like to personally thank Mr. Glenn Posey. I have never seen a human being work as hard as he did and Karl Stehmer, who was excellent in his work. And these are the kinds of personnel that don't say no and recognize the importance of a Member who is able to see firsthand the work of NASA. And Members who were there, I know, appreciated their kindness.

Let me follow the line of questioning of my good friend, Congressman Bartlett, as a strong advocate of human space exploration. I can't cite the tenure that he has but I am really concerned the next generation of physicists and astronauts of many training, whether

it is medicine, but just those who aspire to believe that it is important for men and women to go into space.

I am concerned about the messaging in what we have said. And you made a very valid point. We have been down conspicuously in our recent times with the Columbia and Challenger and either use another vehicle or we are not actually going into space. This should be characterized as that. My understanding is we are in this position because we did not fully fund Constellation when we had every opportunity to do so. And so now we are in a period where we are looking at the Space Launch System, but the message is not getting to the American people that we are still vibrant, we are still engaged. Tell me what NASA Johnson—Houston's role is now going to be with the Space Launch System and, if any, the MPCV. We are told that there are four contractors in Houston, and what is their role in filling the gap? Because we will expect thousands of layoffs in the Fall that are going to come about. They are mostly contractors. But what will be Houston's role as we go forward?

And let me ask this other question. I have legislation. We are still in pain about the choice of the shuttle, and my legislation is a compromise. It indicates a loaner to be a partner to the other anchored iconic city or area that was leading in space that was Florida. There is no competition to Houston's role in the beginning of our space history. It is deserving—it would finish the historical story, but I think my effort—it doesn't have to even be legislation—of loaning—and I know there is some talk about the remains of—or the remains of some of the tragedies that occurred. I don't want to speak for or against that. I welcome that thought. But I am talking about an actual shuttle being loaned to the Houston Space Johnson area.

If you can go forward on the first question of Houston's role now upcoming and then on the space shuttle loaner program.

Mr. BOLDEN. Congresswoman, thank you very much.

Ms. JACKSON LEE. And thank you for your long and ongoing service.

Mr. BOLDEN. Thank you. And I appreciate your specific mention of the employees, particularly, again Posey and Karl Stehmer who, unfortunately, is in the room when you said that. So I have no idea what that is going to cost me.

Ms. JACKSON LEE. I will put some funding in the budget for it.

Mr. BOLDEN. They are two people who represent the 17,000 plus people in the civil service portion of NASA and then the almost 40,000 contractors who are incredibly dedicated, who are motivated and come to work every day because they love what they do.

When you ask about JSC, JSC will continue to play a critical role in everything that has to do with human space flight. They have the program office for the MPCV. They will be working cooperatively with the Kennedy Space Center that will have the program office for commercial crew. Astronauts will continue to train at the Johnson Space Center, train and live in Houston for the foreseeable future. As I mentioned, we just recently named additional crews for the International Space Station. They will train and work out of Houston. And the development of the MPCV, its test profile and everything else, its integration to the SLS will be headquartered down in——

Ms. JACKSON LEE. So will we see the ramping-up of employees that are now losing jobs?

Mr. BOLDEN. Over time it is our hope that you will see everything bottom out and you will see a ramp-up in jobs back in all of our space communities. What I think you will also see over time is that as we are able to successfully facilitate the success of commercial space entities, you will see that those companies become represented in the Houston area, in the space coast area, in other areas around the country. You know, we signed an agreement down at the Kennedy Space Center last week with Mark Sirangelo, the CEO of Sierra Nevada to utilize the engineering expertise of the Kennedy Space Center. He had signed one with Johnson Space Center, with Ames, and with Langley. And that is what we are looking for is more cooperation between—among the commercial entities and our——

Ms. JACKSON LEE. We are looking for jobs and people with expertise——

Mr. BOLDEN. Exactly.

Ms. JACKSON LEE. —so that we can——

Mr. BOLDEN. Exactly.

Ms. JACKSON LEE. —continue to be leaders in science and technology.

Mr. BOLDEN. There are three things that I tell people all the time and I promise this Committee. One is that the United States will maintain its leadership in exploration. The second one is that we will do everything in our power to facilitate the success of an American capability of taking humans to space on American-built rockets using American innovation. That is critical for us. And then the third thing is that we are going to do deep space exploration. Given the President's 2012 budget, we have a timeline on which we are going to do that that I talked about in my comments. If we get less funding, we will still do that but the time may stretch out.

Ms. JACKSON LEE. A loaner vehicle?

Mr. BOLDEN. I don't really have a comment on that, Congresswoman. I am waiting—you know, we have a plan in place and we intend to carry out that plan, but——

Ms. JACKSON LEE. Mr. Chairman, I will just end on this note. I am continuing to press for Houston's historical position in space to be rewarded and respected. And so I will continue to reach the President and anyone else to say that we need a shuttle, however it can be placed appropriately. And I thank you for letting me press this issue and I will press it again with you in the coming weeks.

Thank you. I yield back.

Chairman HALL. Thank you. And thank you for your patience. And thank you for coming back to the Committee that you served long years on.

Ms. Johnson and I have agreed to give Mr. Rohrabacher 1 minute additional.

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

Chairman HALL. Have 10 seconds that is gone.

Mr. ROHRABACHER. Okay. Let me just note that I am for human presence and enterprise and utilization and even human settlement in space. I am not so sure about human exploration versus robotic exploration.

But the question I have for you that I wanted to make sure we got this down, the development costs of actually achieving a refueling capability, which would give us further capabilities in space, how does that match up with the cost—the new cost of developing a new huge rocket? Could we—is it about the same, is it less, or what is the——

Mr. BOLDEN. Congressman, I will have to take that for the record because that is a study that I am certain is somewhere, you know, over in the headquarters building, but I am not aware of that. I have not asked for that information, but I will get it to you.

Mr. ROHRABACHER. I would appreciate that because it does go right to the heart of the matter of what strategy we will have, of whether you have to launch right from the Earth with everything or whether or not we should start developing the capabilities of refueling and then going on with further missions that wouldn't necessarily require a huge rocket that requires that much fuel.

Mr. BOLDEN. I don't have the answer and I will get it for the record. But I will tell you in the ongoing evaluation that I asked in coming to the conclusion that I did on the SLS, we looked at multiple scenarios, one of which was, you know, flight-to-Earth orbit or what we call an Earth-orbit rendezvous. And it turned out that that was not as economical nor as reliable as the single flight, beyond-Earth orbit rendezvous, the way that we envision it now.

Mr. ROHRABACHER. Thank you very much.

Mr. BOLDEN. But I will get you the information.

Mr. ROHRABACHER. Yes, sir.

Chairman HALL. Gentleman has a promise. Gentleman's time is up.

Mrs. Johnson has asked for a minute.

Ms. JOHNSON. Thank you, Mr. Chairman.

I simply want to thank the Administrator and also express my appreciation for this program and all it has done for the Nation and the world and for every possible person involved. And I don't see this, though I am troubled about the ending of a program, but rather the launching of new horizons and horizons that we will all see as much benefit as we have seen in the past of our shuttle system. And I want to thank you again for being here, for being persistent, and you deserve a break. Thank you.

Mr. BOLDEN. Thank you, Congresswoman.

Mr. WU. And Mr. Chairman, I am not going to ask for a minute, but I want to thank you——

Chairman HALL. Please don't.

Mr. WU. But I want to thank you anyway——

Chairman HALL. No, you have a minute.

Mr. WU. No, no. I want to thank you anyway because I know you would have given it to me. Thank you.

Chairman HALL. I thank Mr. Bolden for your very valuable testimony.

Mr. BOLDEN. Congressman, may I have 30 seconds?

Chairman HALL. I have a closing statement here that I have to make.

Mr. BOLDEN. May I ask for 30 seconds before your closing statement?

Chairman HALL. Sure. Yes, sir.

Mr. BOLDEN. And, you know, we have—I have said a lot about who is responsible for what, and I am ultimately responsible to the President, but, you know, I have served in the Space Agency under five Presidents, starting with President Reagan, and I think people need to look at what our present President has done in terms of support for the space program. You know, I did not—I can't remember—and certainly this happened—a President who has taken the personal interest in the program the way that President Obama has. When he and his family came to the Cape after we did not launch STS–134 and spent quite a bit of time with the crew, the families, the workers there, I mean, and we had cancelled already that day, that spoke volumes. The commendatory message that he sent to our employees Friday afternoon after the launch of STS–135 and continued his promise and his challenge to us to send humans to an asteroid in Mars is more than I can remember from any of the total of five Presidents for whom I have worked. So I do like to give credit where credit is due.

Chairman HALL. I thank you. I don't agree with you, but I do thank you.

General Bolden, I would just implore you to get a final decision out as soon as you can, tomorrow, maybe, day after, whenever you can. But Congress takes a real high priority on closing the gap and having a backup system, and given all that has been achieved under the Constellation program, good or bad, mistakes were made and all that I know, but it shouldn't take a year's worth of deliberations to come up with an architecture that at some time, in some respects resemble components of Constellation or whatever follows Constellation. We have a workforce, we have an industrial base that is critical to our Nation's security and economic well being, and their future is being heavily impacted by NASA's indecision.

And whoever wrote this for me also said I hope you will take that message back to the White House. I am not saying I hope you take that message back to the White House because you opened your statement saying the buck stopped with you. I don't really truly agree with that, but I do say to you because of your service and because of your outstanding—your heroic service to this country, the years you gave, you put your life in the hands of battling the enemy and people have admired you. Three times you were strapped to one of our spacecrafts, didn't know for sure—positive that you were going to get back—four times. People admire you and almost worship you and you have always been capable of friendship, and I think that is the reason that we have tried to be factual with our questions here, not mean or unkind, but trying to extract—and not asking, we are begging for information.

As Mrs. Adams said, who represents an area that she is fearful, you know, and anxious and asking you when, when? And you said if you look at this or look at that or if you look at the Constellation, I just urge you to look at Congress and what Congress has asked you to do already——

Mr. BOLDEN. Yes, sir.

Chairman HALL. —and has been agreed by both sides. Help us. And thank you for your time.

Mr. BOLDEN. Thank you, sir.

Chairman HALL. And at this time, we do close out—Members of the Committee will have additional questions for you, Mr. Bolden. I will ask you to respond to them. And the record will remain open for two weeks for additional comments from Members. And we thank you.

Mr. BOLDEN. Congressman, thank you very much.

[Whereupon, at 12:22 p.m., the committee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Questions For the Record For The Honorable Charles F. Bolden, Jr.

July 12, 2011 Hearing on

A Review of NASA's Space Launch System

From Chairman Ralph Hall

1. **The NASA Authorization Act of 2010 directs NASA to design the Multi-Purpose Crew Vehicle to "provide an alternative means of delivery of crew and cargo to the International Space Station, in the event other vehicles, whether commercial vehicles or partner-supplied vehicles, are unable to perform that function." NASA leadership has made a number of conflicting statements about NASA's compliance with this requirement. Is the SLS and MPCV being designed to provide back-up crew support for the International Space Station?**

A: The Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle (MPCV) are expected to execute the system's first launch in 2017 and be crew capable in 2021. The SLS is a heavy lift launch vehicle and has payload capability far and above that which is necessary to support ISS crew rotation and resupply activities; therefore, launching an SLS for ISS-related activities would be a highly inefficient use of the system that is simply not cost-effective. However, in an emergency, the SLS could be used for Low Earth Orbit (LEO) operations. In addition, the Orion MPCV is a crew vehicle that is primarily designed for deep space exploration and, if needed for an emergency, could function as a backup vehicle for the International Space Station (ISS) crew. The current Orion design is specifically designed and tailored for deep space exploration and a high-speed reentry to Earth, which includes systems that are not necessary for LEO missions. Launching the Orion MPCV capsule for use in LEO would also be an inefficient use of a robust system intended for other purposes.

2. **Administrator Bolden states in his testimony, "The MPCV will transport the crew from the Earth's surface to a nearby destination or staging point and return the crew safely back to the Earth's surface at the end of the mission." This is confusing since the MPCV is designed to be the deep space vehicle for beyond Earth orbit. Why did your testimony say only "from the Earth's surface to a nearby destination or staging point...?"**

A: As noted in the Administrator's testimony, "The MPCV will provide all services necessary to support a crew of up to four for up to 21-day missions (for very long beyond-LEO missions, such as exploration of near-Earth asteroids or other planetary bodies, additional elements – a space habitation module for example – will be included to provide long-duration deep space habitation capability)." The "staging point" cited earlier refers to that location where the Orion MPCV will rendezvous with other modules that may be required for a particular deep-space exploration mission. This could include High Earth Orbit, a Lagrange Point (Example: Earth-Moon L1 or L2), or another location.

3. **Administrator Bolden states that NASA's initial destination for a human mission to deep space will be an asteroid by the year 2025, followed by a human mission to Mars in the mid-2030s. The moon, however, is portrayed as a possible 'other' destination, but no associated timeline is offered. A lunar trip could be far less risky, especially as a first flight to test new deep space hardware, whereas a trip to an asteroid could take a month or longer.**

    a. **Just where does the moon fit within NASA's exploration plans, and why is it being given such a low priority?**

A: NASA regards the Moon as one of several viable destinations for human exploration as part of a capability-driven approach. Lunar circumnavigation and flights to Earth-Moon Lagrange points hold near-term promise as compelling test locations for the SLS, Orion MPCV, and other key emerging systems. The Moon could be used as a test bed for technology development to further our deep-space exploration goals. Given the recent scientific discoveries on the Moon, it also holds great scientific, economic, and security potential. Human lunar surface missions would require the development of a lander.

    b. **Does this mean that no missions are planned beyond low Earth orbit prior to 2025?**

A: NASA's plans for Orion and SLS include a system test flight in 2017, and a crewed test flight in 2021, called Exploration Mission 1 and 2, respectively (EM-1 and EM-2). Both of these missions will go beyond low Earth orbit. The prospects for the conduct of a crewed deep space flight prior to an asteroid rendezvous mission will be defined as the Agency moves forward with the development of SLS and Orion MPCV.

    c. **What plans does NASA have for utilization of the SLS & MPCV in the years leading up to 2025?**

A: NASA's plans for Orion and SLS include a system test flight in 2017, and a crewed test flight in 2021, called Exploration Mission 1 and 2, respectively (EM-1 and EM-2). Both of these missions will go beyond low Earth orbit. The prospects for the conduct of a crewed deep space flight prior to an asteroid rendezvous mission will be defined as the Agency moves forward with the development of SLS and Orion MPCV.

    d. **What destinations other than an asteroid are being considered?**

A: The SLS and Orion MPCV are being designed to provide capabilities for a variety of deep space missions to multiple destinations, including the Moon, asteroids, the moons of Mars, and ultimately the surface of Mars. Besides near-Earth asteroid rendezvous flights, these systems could be used to support circum-lunar navigations and flights to Earth-Moon Lagrange points. Lagrange points are gravitationally stable regions created by the interaction of the gravity fields of any two large masses; an object placed a Lagrange point will tend to stay in place for a long time. These could therefore be excellent locations in which to place habitation modules to study long-duration expeditions away from LEO, conduct developmental systems tests, enable tele-

robotic operations, and execute science activities. Beyond this initial capability, SLS and Orion MPCV could support eventual missions to the moons of Mars -- Deimos and Phobos -- and the surface of Mars itself, with incremental upgrades.

e. When will NASA specify the asteroid to be visited?

A: NASA is currently studying various potential destinations, one of them being an asteroid. However, it is premature to identify a specific asteroid at this time. Currently, there are very few known asteroids that meet the filter criteria for a human exploration mission. However, new asteroids are being found at an regular pace and the specific asteroid NASA will visit will be chosen later following more extensive target surveys, and once architecture studies have been completed, and as the SLS and Orion MPCV are being developed.

4. **Substantial funding for the development of the SLS and MPCV has been authorized in both the 2011 CR and the House CJS subcommittee mark for FY2012 to enable NASA to develop the SLS and MPCV without delays, with the goal of making the core elements of SLS and MPCV operational by 2016 to provide an alternative means of crew transportation to the ISS. Yet, in your testimony you say that NASA is targeting the first uncrewed SLS developmental flight in late 2017 even though the MPCV could be ready for test flights as early as 2013. What is NASA doing to foster earlier test flights of the MPCV as the law directs to support operational capabilities closer to 2016 and to provide backup capability for ISS servicing?**

A: NASA is moving out with the development of the SLS, having announced the basic architecture of the system on September 14, 2011, and followed up in September, October, and December with the release of several synopses designed to support the development of different components of the system, including:

- SLS Stages Acquisition (posted 9-28-11)
- SLS Core Stage Engines (posted 9-28-11)
- SLS Advanced Development Request for Information (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and Risk Reduction (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction notification of intention to issue a Draft NASA Research Announcement (NRA) on or about in the December 12, 2011 (posted 12-1-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction activity synopsis announcing an Industry Day on December 15, 2011 (posted 12-1-11)

In addition, NASA has adjusted its flight test approach with the addition of an early Orion MPCV test flight called Exploration Flight Test 1 (EFT-1) in 2014. EFT-1 is intended to facilitate timely and robust testing of critical Orion spacecraft systems that address 10 of the 16 highest risks to crew survivability and exploration mission failure by providing information needed to influence the spacecraft design regarding safety.

The NASA Authorization Act of 2010 (P.L. 111-267, October 11, 2010) directed the Agency to develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capability to destinations beyond low-Earth orbit. In general, it can take anywhere from 6-8 years to develop a heavy lift launch vehicle, however NASA is expediting that process by utilizing as much existing hardware as possible. In developing the SLS, the Act directed the Administrator to utilize, to the extent practicable, existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle Program (SSP), Orion, and Ares I projects. This includes SSP-derived components and Ares components that draw extensively on SSP heritage propulsion systems, including liquid fuel engines, cryogenic stages, and solid rocket motors. As a result, the Agency will initiate the development of the SLS with SSP and Ares derived assets.

For example, for the SLS large cryogenic Stages (Core Stage and Upper Stage), NASA intends to modify the existing Ares I Upper Stage contract with Boeing. The Ares I Upper Stage has similar functionality as the SLS Core and Upper Stage elements, and much of the Ares I Design, Development, Test & Evaluation (DDT&E) especially at the component level is applicable to SLS requirements. NASA will establish a new baseline to meet the exploration missions, consisting of an SLS Core and Upper Stage that will include common design features and be produced with common tooling, procedures, and techniques to obtain Core and Upper Stage synergies.

For the SLS Core Stage Engines, NASA will use existing RS-25 Space Shuttle Main Engines (SSMEs) for the core lift capabilities. The RS-25 effort is for the acquisition of storage, adaptation, and reacceptance of existing RS-25 Core Stage Engines required for four or five early missions of the SLS (depending upon final manifest needs), which includes moving and storing the residual inventory of fifteen flight engines, two development engines, and associated ground support equipment.

NASA is moving ahead with development of the Orion Multi-Purpose Crew Vehicle (MPCV). In November of 2011, NASA announced plans to conduct Exploration Flight Test-1 (EFT-1), an uncrewed, two-orbit, high apogee, high-energy-entry, low-inclination test mission that is targeted for flight in FY 2014. This early exploration flight test is critical to providing early data to influence design decisions and serving as a pathfinder to validate innovative new approaches to space systems development that will reduce the cost of exploration missions. The EFT-1 utilizes an early production variant of the Orion spacecraft that will be integrated on a Lockheed Martin-procured, commercially available heavy-class launch vehicle. This launch vehicle will require performance capability to launch a mass of approximately 18 metric tons to provide the energy and guidance capability to achieve reentry conditions required to validate Orion's heat shield performance. The flight test will provide an opportunity to significantly inform critical design by operating the integrated spacecraft hardware and software in flight environments that cannot be duplicated by ground testing.

While the Agency is planning to use the SLS/MPCV for back-up crew transportation capability for the International Space Station (ISS), vehicles designed to support deep space missions are not optimized for LEO operations and are thus not cost-effective or efficient. The primary means of ferrying U.S., Canadian, European, and Japanese astronauts to and from ISS – as well

as providing rescue capabilities – will be U.S. commercial crew transportation services. NASA hopes to support more than one such service, so that there is redundant capability in the event that one-provider experiences an anomaly leading to a flight delay.

5. **The 2010 NASA Authorization Act directs NASA to minimize modification and development of ground infrastructure and maximize use of existing vehicle and mission operations processes. Can you please explain what steps NASA is taking to identify cost savings measures through the use of existing ground infrastructure, flight hardware, and proven processes?**

A: Moving forward on the SLS, one of NASA's greatest challenges will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. The Agency must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments.

NASA is currently assessing a number of potential opportunities for reducing the institutional costs associated with developing, producing, and operating SLS. For example:

- Stennis Space Center (SSC) -- NASA continues to partner with other federal Government and commercial customers to maximize utilization of the rocket test facilities at SSC. United Launch Alliance and the U.S. Air Force already utilize test stand capabilities there, including the B1 test stand for RS-68 testing and the E-Complex for component and small-thrust testing. NASA is currently considering other potential opportunities for sharing capabilities. In addition, NASA is continuing to bring the A-3 test stand, which is under construction, to a level that is safe to put in extended standby until a future use is identified. NASA does not require A-3 for near-term altitude testing of SLS engines.

- Kennedy Space Center (KSC) -- As part of the broader Ground Systems Development and Operations (GSDO) Program, the 21st Century Space Launch Complex initiative to recapitalize the launch capabilities at KSC continues to seek additional users and innovative uses for KSC infrastructure and capabilities, including SLS, in an effort to increase operational efficiency and reduce the launch costs for all customers. Discussions with potential Government and commercial users were initiated in FY 2010 and continue today. As one example, on October 31, 2011, NASA announced a partnership with Space Florida to exclusively occupy, use and modify KSC's Orbiter Processing Facility-3 (OPF-3), the Space Shuttle Main Engine Processing Facility and Processing Control Center. Space Florida is leasing OPF-3 to the Boeing Company to integrate and test the company's Crew Space Transportation (CST-100) spacecraft, creating up to 550 jobs along the Space Coast.

In addition to prudent consolidation of infrastructure, the SLS Program will continue to examine ways to increase efficiency and agility to deliver an affordable and achievable heavy-lift system as soon as possible. Examples being considered in formulating SLS plans include the following:

- Using common parts and common designs across the Government to reduce costs;

- Ensuring requirements are appropriately specific and also that requirements applied to NASA crew launch vehicles are similar to those provided to industry for planned commercial crew systems, thereby ensuring that NASA vehicles are not required to meet more substantial requirements than commercial crew vehicles, and vice versa;

- Conducting insight/oversight activities of the Agency's contract partners in a smarter way, thereby using NASA's resources more appropriately to focus on the high-risk items; and

- Ensuring that there are no unique configurations or developments that do not end up directly supporting the final system.

From Ranking Member Eddie Bernice Johnson

1. **How will NASA use the Booz Allen results? What, if anything, could change regarding the technical decision on the SLS, the testing program, and notional timeline for the SLS and integrated architecture as a result of the Booz Allen analysis? Please provide examples of how the cost assessment information could change the technical decision on SLS or the integrated architecture going forward.**

A: NASA appreciates the work of Booz Allen Hamilton on the Independent Cost Assessment (ICA) for the Space Launch System (SLS), Orion Multi-Purpose Crew Vehicle (MPCV), and the Exploration Ground Systems (formerly named 21st Century Ground Systems). The ICA recommendations provide advice on the effective and efficient implementation of NASA's programs given the technical and architectural decisions that have been made. The recommendations do not drive technical or architectural changes for the programs. NASA has implemented the following ICA recommendations:

- *Programs should consistently use most recent NASA New Start Inflation Tables in developing their estimates:* The current NASA New Start Inflation Table was sent to the Program Planning & Control offices of all programs. Programs were instructed to use these inflation assumptions in formulating budget submits.

- *Program estimates should be aligned to Cost Element Structure/Work Breakdown Structure, and mapped to the program schedule:* Lower level WBS elements have now been defined for each program, and NASA is using a bottom-up analysis by program WBS in formulating future budgets. Mapping to the Integrated Master Schedule is forward work.

- *There should be a common practice across programs for generating cost and schedule estimates, a full program life cycle cost estimate should be initiated upon approval of the SLS architecture:* Each program is performing a bottom up estimate in support of its yearly budget formulation process that will be supported by a detailed Basis of Estimate (BOE), documenting the content, assumptions, and estimating methodology. NASA will develop a plan to complete an independent cost estimate (ICE) for each program in accordance with its policy for Program Management, likely associated with KDP-C.

- *NASA should develop an integrated schedule across the three programs:* A Program-to-Program Schedules Working Group has been established and have developed a tri-program integrated master schedule (IMS). The working group maintains configuration control and provides analysis of the IMS.

- *A quantitative risk analysis (QRA) or sensitivity analysis should be performed on all three programs, and reserves positions should be established based on the risk analysis findings:* Programs have initiated QRA analysis to look at how risks and risk mitigation costs might manifest over time. The analysis will be updated and refined throughout the normal program maturation and budget formulation processes.

The Agency will continue to carefully consider the remainder of the ICA's findings and recommendations as it proceeds to implement these efforts during its program formulation activities.

2. **In response to a question from Congresswoman Sewell on the budget and timeline for the Space Launch System, you noted that "what I figured was the minimum amount that I thought would get me to a viable SLS and Multi-Purpose Crew Vehicle (MPCV), and that is what you see in the 2012 budget. So given that level of funding, we can do what we said we can do." House Appropriators have proposed a bill that includes levels that are higher than the FY 2012 request for the SLS and MPCV. What would any additional funding, above that requested for FY 2012, mean for the SLS program and notional timeline that you described in your prepared statement?**

A: The Consolidated and Further Continuing Appropriations Act of 2012 (P.L. 112-55) supports a balanced portfolio for NASA across its human spaceflight, science, and aeronautics missions. Within human spaceflight, the Act provides for funding key systems that will enable NASA's next missions beyond Low Earth Orbit (LEO), including the SLS and Orion MPCV, while at the same time ensuring the continued utilization of the International Space Station (ISS) through commercial cargo and crew providers. Now that Station is fully assembled and ready for full utilization of its three major international science labs, it is critical that the U.S. adequately fund Station support, in part because research conducted on ISS will help enable and enhance the safety of future missions beyond LEO using SLS and MPCV.

3. **The NASA Authorization Act of 2010 directs NASA to "*extend or modify existing vehicle development and associated contracts necessary*" to begin development of the SLS. What needs to happen in order to extend or modify these contracts and when do you estimate that process will be completed so that contractors can begin work on an SLS vehicle?**

A: NASA currently has procurement teams mapping SLS requirements (those outlined in the NASA Authorization Act of 2010 and those we are currently developing). For the SLS, NASA is reviewing each element of Ares (First Stage, Upper Stage, Upper Stage J-2X engine, and Avionics) and Shuttle Program contracts (Space Shuttle Main Engines, External Tank, Solid Rocket Booster) to determine whether the new SLS requirements would be within scope of current contracts. We are in the process of documenting within scope actions (First Stage (for early Booster needs), Avionics and J-2X) and have issued synopses for planned non-competed actions (Core/Upper Stage and RS-25 Engines). We are working expeditiously to finalize the contractual actions to ensure that SLS requirements are under contract as soon as possible. In parallel, NASA is planning on two near-term competed actions.

4. **What internal cost analyses/assessments are being or have been carried out on the SLS and integrated architecture and by what internal office? Please provide the Committee with a copy of those internal analyses/assessments by August 30, 2011.**

A: There have been several efforts, which were either internal cost assessments or activities, which significantly informed NASA by verifying cost data and identifying methods that could reduce costs. One major activity was the Booz Allen Hamilton Independent Cost Assessment (ICA). The outcome from the ICA provided NASA with recommended corrective actions. There were other internal studies performed that fed into the ICA activity. However, many of those documents are pre-decisional materials used to make the final SLS decision, culminating in the SLS procurement strategy meeting that approved the contract actions to begin development of the SLS.

5. **What outyear budget levels are you assuming for NASA in order to achieve the President's stated objective to "target an asteroid by 2025"?**

A: NASA is assuming out-year budget levels commensurate with an evolvable, capability-driven, multi-destination exploration architecture that will support NASA in achieving a target of reaching an asteroid by 2025. The FY 2012 Appropriation starts NASA on the path to enable near-term objectives to be met, including the Exploration Flight Test (EFT-1) and Ascent Abort (AA-2) test flights. These test flights will inform the ongoing flight and ground systems design efforts leading to the first un-crewed test flight of the Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle (Orion MPCV) in FY2017.

6. **I understand from your statement that NASA is considering carrying science payloads using the eventual SLS heavy launcher.**

   a. **Do you see this as an opportunity to gain additional flight experience on the eventual SLS?**

A: The SLS will be able to lift a substantial payload into space. Payloads could range from the crewed Orion MPCV or other human-rated modules designed to conduct deep space missions, to an uncrewed, large science payload, which could be placed into deep space or Earth orbit. The launch vehicle will be designed to accommodate a variety of missions, and every launch of the SLS will provide NASA with valuable flight experience.

   b. **What science missions might be candidates?**

A: As Administrator Bolden stated in his written testimony, "The ability of the SLS to carry either the MPCV or large cargo also allows the SLS to carry robotic payloads for science or national security missions, although there are currently no requirements for such large payloads." Science mission size and weight are driven by such factors as telescope aperture, destination, radiation environment, instrumentation complexity, or requirements to land on other planetary bodies. Thus, mission size and cost are strongly correlated. As a result, science missions that could make effective use of the lift capability of the SLS would be very costly—and are beyond the current ability of the NASA Science Mission Directorate to afford. This was borne out in a study by the National Research Council on the subject of science mission utilization of heavy lift launch vehicle (see Launching Science: Science Opportunities Provided by NASA's Constellation System, NRC 2008). The current set of decadal surveys of the National Academy of Sciences identifies no science missions that require a heavy lift launch vehicle. The next round

of decadal surveys in the space sciences, to be conducted early next decade, will be conducted in an era when SLS is flying, and will be better able to take that capability into account, including any potential opportunities to fly science missions as secondary payloads.

7. **As you know, changing the requirements of a development program tends to drive-up its costs. Mr. Doug Cooke of NASA recently testified before our Space and Aeronautics Subcommittee that "*As Constellation contracts were revised to include new technical requirements and IOC [initial operational capability] dates, costs grew. For every year IOC moved to the right, approximately $3 billion more was added to the costs of the Program*".**

    a. **How will NASA ensure that its system requirements and targeted dates for initial operational capability of the SLS remain stable throughout the development process?**

A: The funding level for SLS and the Orion MPCV requested in the President's FY 2013 budget request supports an initial test flight of the system by the end of 2017, with an initial crewed test flight in 2021. The availability of these systems is, of course, contingent upon the availability of appropriated funds. It is very important that NASA receive the requested funding levels in order to keep the development, testing, and eventual operation of these systems on track. Another factor that will contribute to program stability, both in terms of technical requirements and schedule milestones, is the increased performance margin of the SLS/Orion stack over the Ares I/Orion combination. SLS is a much more powerful launch vehicle than Ares I, and will offer significantly more performance margin. Even if the mass of the launcher and/or spacecraft increase during development, the extra performance margin will enable the Programs to absorb that mass increase (by reducing this margin) while still meeting system performance requirements. This will allow NASA to baseline these requirements early on with much higher confidence that they will remain stable during development. This strategy is consistent with, and indeed central to, the exploration program's emphasis on "design to cost" rather than "design for performance."

Also as part of a "design to cost" philosophy, NASA is incorporating inputs from industry in how the Government/contractor relationship can be improved to stabilize requirements and reduce development and operations costs. The Broad Agency Announcement (BAA) NNM10ZDA001K which was released on July 29, 2010, to solicit proposals for Heavy-Lift and Propulsion Technology Systems Analysis and Trade Studies (SATS) from industry July 29, 2010, sought technical solutions in support of heavy-lift system concepts and system architectures, and to identify propulsion technology gaps to support NASA's goals. NASA's intent was to gather unique and innovative options, technologies, and concepts to incorporate any new ideas into Government models and analyses, and to use the information for future planning and potential acquisition.

    b. **What new steps is NASA taking to maintain discipline on system requirements for the SLS?**

A: The Exploration Systems Division has set up a comprehensive and rigorous system for establishing top-level (level 1) systems requirements consistent with the architecture mission and key stakeholder demands for the SLS, MPCV, and EGS. The major program (SLS, MPCV, EGS) requirements are maintained in a level 1 (top level) requirements document that is reviewed and approved at the highest level in the Agency. The current Cross-Program System Requirements Review (CP-SRR), SLS System Requirements Review/System Design Review (SRR/SDR), and Orion MPCV Critical Design Review (CDR) are all part of the rigorous approach to maintaining discipline for SLS and integrated requirements. All of the more detailed program requirements are approved at the appropriate lowest level in a timely fashion with an integral assessment of cost and schedule impacts stemming from their implementation as part of a "design to cost and schedule program approach." Moreover, the architecture has reasonable performance margins for the envisioned SLS/Orion missions and NASA will have more opportunities to stabilize requirements early on while incorporating design and operability features that will reduce costs, even at the risk of slightly reducing overall performance margin. That means performance requirements can be baselined early on with much higher confidence. This strategy is consistent with, and indeed central to, the exploration program's emphasis on "design to cost" rather than "design for performance."

Also as part of a "design to cost" philosophy, NASA is incorporating inputs from industry in how the Government/contractor relationship can be improved to stabilize requirements and reduce development and operations costs. The Broad Agency Announcement (BAA) NNM10ZDA001K which was released on July 29, 2010, to solicit proposals for Heavy-Lift and Propulsion Technology Systems Analysis and Trade Studies (SATS) from industry July 29, 2010, sought technical solutions in support of heavy-lift system concepts and system architectures, and to identify propulsion technology gaps to support NASA's goals. NASA's intent was to gather unique and innovative options, technologies, and concepts to incorporate any new ideas into Government models and analyses, and to use the information for future planning and potential acquisition.

The competition produced cost pricing that was below historical averages and NASA's cost model calculations. Innovations resulting from the BAAs were then incorporated into the SLS, MPCV, and Ground Operations Requirements Analysis Cycles (RACs). One key finding of the Analysis of Alternatives (AoA) was that cost and risk assessments did not identify distinct discriminators among the alternatives. Another finding was that management and business approaches drive cost more than do technical solutions. NASA is looking to embed those approaches through the ongoing and future RAC cycles to reduce costs and make key decisions earlier.

From Rep. Randy Neugebauer

1. **Administrator Bolden, what is the earliest we can expect a mission beyond low Earth orbit using the Space Launch System or Multi-Purpose Crew Vehicle?**

A: At this time, NASA's plans for the Orion Multi-Purpose Crew Vehicle (MPCV) and Space Launch System (SLS) include a system test flight in 2017, and a crewed test flight in 2021. When looking beyond near-Earth space and LEO, several missions and target destinations are being considered as part of NASA's capability-driven, multi-destination exploration plan. These include Earth's closest solar system neighbors: the Earth-Moon Lagrange points and cis-lunar space, asteroids, the Moon, the moons of Mars, and Mars. Initially, Earth-Moon Lagrange points and a circum-lunar orbit mission are most viable as part of the test build-up approach. Near Earth Asteroids (NEAs) provide the opportunity to send humans beyond the solar orbit of Earth while holding compelling science and planetary defense knowledge-building potential. In addition to possible scientific prospects, missions to NEAs would afford astronauts the experience applicable to deeper-space missions that would eventually contribute to establishing a permanent human presence beyond Earth. Currently, there are a few asteroids which could be visited by the SLS and Orion MPCV in the timeframe under consideration, new asteroids are regularly being discovered, and NASA is assessing options for further asteroid target surveys. The prospects for the conduct of a crewed deep space flight with the system prior to an asteroid rendezvous mission will be defined as the Agency moves forward with the development of SLS and Orion MPCV.

   a. **Will that be the initial and primary utilization of these programs?**

A: The SLS and Orion MPCV are being designed to provide capabilities for a variety of deep space missions to multiple destinations, including the Moon, asteroids, the moons of Mars, and ultimately the surface of Mars. Besides near-Earth asteroid rendezvous flights, these systems could be used to support circum-lunar navigations and flights to Earth-Moon Lagrange points. Lagrange points are gravitationally stable regions created by the interaction of the gravity fields of any two large masses; an object placed a Lagrange point will tend to stay in place for a long time. These could therefore be excellent locations in which to place habitation modules to study long-duration expeditions away from LEO, conduct developmental systems tests, enable tele-robotic operations, and execute science activities. Beyond this initial capability, SLS and Orion MPCV could support eventual missions to the moons of Mars -- Deimos and Phobos -- and the surface of Mars itself, with incremental upgrades.

However, in an emergency, the SLS could also be used for Low Earth Orbit (LEO) operations. In addition, the Orion MPCV is a crew vehicle that is primarily designed for deep space exploration and, if need be for an emergency, can function as a backup vehicle for the International Space Station (ISS) crew. Launching the Orion MPCV capsule for use in LEO would also be an inefficient use of a robust system designed for other purposes.

   b. **If not, what focus do you intend to prescribe for the programs prior to missions beyond low Earth orbit?**

A: Please see response to question #1a; the primary purpose of the SLS and Orion MPCV is to conduct crewed deep space missions of exploration beyond LEO. Such missions will be preceded by at least two test flights.

From Rep. Mo Brooks

1. **Section 304 of the Authorization Act was clear that SLS was "to the extent practicable...[use] existing contracts, investments, workforce and industrial base and capabilities from the ....Ares 1 projects...." Section 302 makes it clear that the goal is an SLS operational capability by 2016.**

    a. **How much money has been transferred to MSFC for the SLS program in FY 2011?**

A: In the FY 2011, NASA was transitioning its human spaceflight efforts based on direction in the FY 2011 Full Year Continuing Appropriation (P.L. 112-10). The SLS Program Office at MSFC is responsible for managing the SLS budget. For FY 2011, the total budget for heavy lift related activities that would become SLS in FY 2012 were funded at $1.8 billion (of which the vehicle development specific activities were funded at $1.3 billion). As such, the Program Office determines which Centers the funding is distributed to, depending on SLS work assigned to each Center. The subsequent Centers then use that funding to manage the contracts for which they are responsible. Since FY 2011 was a transition year the MSFC program manager was not as involved in this process as is the case now that the program has been established.

    b. **Which existing Ares contracts do you intend to modify for the purposes of SLS development?**

A: Please see table below.

CURRENT CONTRACTS	MAJOR CHANGE TO CONTRACTS	SLS CONTRACTS
Upper Stage, and Instrument Unit Avionics (IUA)	Combine through an Undefinitized Contract Action (UCA)	Cryogenic Stages with Imbedded Avionics
First Stage Booster	In-Scope Modification via UCA	Qualify and Build 2 Flight Sets
J2-X, and RS-25	Combine via UCA	Qualify J2-X and Initiate RS-25 Activity

2. **It is my understanding that NASA has capped the SLS budget at $1.2B per year in its internal planning. Please explain why you are artificially constraining SLS to a much lower funding level than Congress has directed.**

A: The President's Budget Request for FY 2013 would fund the SLS at $1.885 billion, which includes $1.34 billion for the SLS plus $404.5 million for Exploration Ground Systems (EGS), which had previously been carried under the SLS line, in addition to $140.4M of SLS and EGS related construction of facilities. The President's Budget Request for FY 2013 provides an appropriately balanced portfolio within a budget-constrained environment for NASA across its human spaceflight, science, and aeronautics missions. Within human spaceflight, the request provides for funding key systems that will enable NASA's next missions beyond Low Earth

Orbit (LEO), including the SLS and Orion MPCV, while at the same time ensuring the continued utilization of the International Space Station (ISS) through commercial cargo and crew providers. Now that Station is fully assembled and ready for full utilization of its three major international science labs, it is critical that the U.S. adequately fund International Space Station support, in part because microgravity research conducted on ISS will help enable and enhance the safety of future missions beyond LEO using SLS and MPCV.

3. **NASA's operating plan calls for the redirection of $500.2M from SLS launch vehicle development to the 21st Century Launch Complex, and to an unrelated "ground operations" activity at Kennedy Space Center. $500M is more than the amount spent in FY2009 on KSC ground operations – the year in which NASA flew the Ares IX test rocket, was assembling the new mobile launch platform for the Ares I and was closing on the final design review for the Ares launch system - in other words, substantial work was underway at MSFC and KSC. Now, NASA has delayed by at least 2 years the first flight of any exploration launch system, laid off thousands of workers and has yet to finalize the design for the SLS itself.**

    a. **What is the justification for reprogramming $500M at KSC in 2011?**
    b. **What specific activities to you intend to fund with this money?**
    c. **What is the "ground operations" activity?**
    d. **Have those projects, been shared with the SLS Program Manager, and with the Director of MSFC?**
    e. **Is any of the work planned for the $340 million Shuttle transition-related work?**

A: Please see responses, below.

a) The planned work at KSC is essential to enable the first launch of SLS in 2017, as detailed below.

b) Monies from the SLS Program will go to KSC to fund specific activities that are required for the launch vehicle to make the planned December 2017 launch. SLS funding is intended for three major activities: 1) Crawler-Transporter life-extension upgrades, 2) Vehicle Assembly Building (VAB) facility and system upgrades and 3) Pad 39B structural studies to ensure that the proper margins exist to launch the SLS vehicle. There are a number of significantly smaller items funded, which are critical to SLS launch preparations.

c) Ground operations includes the design, development, testing, and operation of those systems required to receive, assemble, test, launch, and recover SLS and Orion flight hardware.

d) All KSC activities and tasks that are funded by SLS monies are coordinated with the SLS Program. The SLS Program Manager must authorize each expenditure and is providing regular updates to the Director of Marshall Space Flight Center (MSFC) regarding planned acquisitions and the progress of any KSC work.

e) None of the SLS funding is planned to support any of the $340 million Space Shuttle transition-related work.

4. **NASA was nearly a year late making an SLS announcement, yet NASA has publicly announced its detailed plans for commercial crew and MPCV. In fact, the designs for commercial and MPCV have been announced, the contractors have been selected, and funds for these activities have been provided. Yet MSFC continues to layoff personnel. This is unacceptable. Why have you moved out on funding contracts for commercial crew and MPCV, and not taken action on SLS work?**

A: NASA is moving out with the development of the SLS, having announced the basic architecture of the system on September 14, 2011, and followed up in September, October, and December with the release of several synopses designed to support the development of different components of the system, including:

- SLS Stages Acquisition (posted 9-28-11)
- SLS Core Stage Engines (posted 9-28-11)
- SLS Advanced Development Request for Information (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and Risk Reduction (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction notification of intention to issue a Draft NASA Research Announcement (NRA) on or about in the December 12, 2011 (posted 12-1-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction activity synopsis announcing an Industry Day on December 15, 2011 (posted 12-1-11)

The NASA Authorization Act of 2010 (P.L. 111-267, October 11, 2010) directed the Agency to develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capability to destinations beyond low-Earth orbit. In developing the SLS, the Act directed the Administrator to utilize to the extent practicable existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle Program (SSP), Orion, and Ares I projects. This includes SSP-derived components and Ares components that draw extensively on SSP heritage propulsion systems, including liquid fuel engines, cryogenic stages, and solid rocket motors. As a result, the Agency will initiate the development of the SLS with SSP and Ares derived assets.

For example, for the SLS large cryogenic Stages (Core Stage and Upper Stage), NASA intends to modify the existing Ares I Upper Stage contract with Boeing. The Ares I Upper Stage has the same functionality as the SLS Core and Upper Stage elements, and much of the Ares I Design, Development, Test & Evaluation (DDT&E) especially at the component level is applicable to SLS requirements. NASA will establish a new baseline to meet the exploration missions, consisting of an SLS Core and Upper Stage that will include common design features and be produced with common tooling, procedures, and techniques to obtain Core and Upper Stage synergies.

For the SLS Core Stage Engines, NASA will use existing RS-25 Space Shuttle Main Engines (SSMEs) for the core lift capabilities. The RS-25 effort is for the acquisition of storage, adaptation, and reacceptance of existing RS-25 Core Stage Engines required for four or five early missions of the SLS (depending upon final manifest needs), which includes moving and storing the residual inventory of fifteen flight engines, two development engines, and associated ground support equipment.

The Agency greatly appreciates the efforts and talents of our aerospace contractor and civil service workforce, and is working to ensure that their critical skills and capabilities are not lost as we develop the systems required to take our astronauts beyond LEO.

5. **Please provide the Committee a detailed accounting of where all of the $1.8B in fiscal year 2011 funds have been and are going to be spent. This accounting must include, by center, funding obligated per contract (name of each contract shall also be provided) and costs for civil servants and infrastructure.**

A: Please see Attachment A.

6. **How do you plan to address the concerns raised in the June 30, 2011 Inspector General's report on Commercial Crew? Specifically, what are you criteria for selecting the acquisition approach?**

A: When the Inspector General's (IG) report on Commercial Crew was issued on June 30, 2011, NASA was still in the process of finalizing its strategy for procuring commercial crew transportation services. As indicated in the IG report, NASA was in the process of finalizing this strategy for presentation to Congress by late summer 2011. On September 16, 2011, the NASA Procurement System Review (PSR) report was delivered to the Committee on Science, Space and Technology, and other Committees. In developing this report, NASA conducted a comprehensive review of current Government procurement and acquisition practices and processes to determine the most cost-effective means of procuring commercial crew transportation capabilities, as required by the Authorization Act of 2010.

In their report, the IG recognized the challenges associated with the alternative strategies that were being considered for the next phase of Commercial Crew, specifically whether to use Space Act Agreements or FAR-based procurements. While the IG report did not recommend either approach, it did acknowledge that, "In selecting procurement mechanisms, among the options, NASA must balance its role as a supporter of commercial partners with its responsibility to ensure that commercially developed vehicles are safe for NASA astronauts, meet the Agency's needs, and provide a viable domestic alternative to the Soyuz vehicle."

The PSR details the Agency's procurement strategy for Commercial Crew and addresses the concerns raised by the IG's report of June 30, 2011. As detailed in sections 4.0 of the PSR, the Agency has determined that the appropriate procurement strategy for the transportation services phase of Commercial Crew is to transition away from use of Space Act Agreements, which are used to stimulate industry development activities, to use full and open competition under FAR-based contracts for the full design and development of crew transportation services. The PSR

fully explains NASA's basis for proceeding with issuance of a Fixed Price Contract for the Commercial Crew Integrated Design Contract (CCIDC).

7. **Can commercial launches be done from infrastructure which receives funds from the $1.8 billion appropriated to the SLS system? If so, what portion of the infrastructure funds is being provided from your commercial space funding?**

A: The $1.8 billion that was appropriated to the SLS system will be used to directly support SLS design and hardware. However, NASA realizes that when manufacturing, testing and launch facilities can be designed such that multiple users can use the infrastructure, such as a clean launch pad concept, the overall recurring costs are shared, thus reducing NASA's long-term system costs. Currently at KSC the launch pad, VAB, and some servicing buildings are being evaluated for dual-use. The Michoud Assembly Facility (MAF) is and will continue to be a multi-user facility. Stennis Space Center's (SSC's) engine test capability will continue to be available to the commercial community, as well. The amount of infrastructure that can be used by the commercial launch community will depend on the final design, but it is one of the elements that is being considered. None of the $1.8 billion of SLS funds is being used to directly support commercial launches.

From Rep. Lamar Smith

NASA deputy administrator Lori Garver was quoted in the Washington Post in July 2011 saying, "We have brought the program back from the brink. We inherited a program that was in disarray." She was clearly blaming the Bush Administration in her remarks.

1. **Do you agree with her characterization?**

A: The Deputy Administrator was reflecting the discussions initiated after the Augustine Committee outlined a new direction for human exploration that included the development of advanced in-space capabilities and pursuing a stepping stone approach to exploring the Moon, near Earth asteroids, and Mars and its moons. This set in motion a realignment of programs set forth by the Administration in the FY 2011 Budget request that then culminated in the bipartisan Authorization Act of FY 2010, which NASA is now implementing.

2. **Is it true that President Obama's first budget proposal to the Congress for NASA in early 2009 diverted over $3 billion for FY 2011-2013 from NASA's Exploration budget profile compared to Bush Administration projections?**

A: In the FY 2010 request, the Exploration budget increased from $3.3 billion in 2008 to $4 billion in 2009 and 2010 and grew to $5.5 billion a year from 2011 through 2014. This provided more money up front than in the final Bush Administration request, but less money in the outyears. At the time it was noted that the outyear budget plan as it affects the Exploration architecture would be fully assessed in August 2009 upon the completion of the Review of U.S. Human Space Flight Plans.

3. **If you tally the Obama Administration's current budget profile for NASA over the next five years (FY2012- 2014) for the International Space Station and Exploration accounts, there's nearly $3 billion less each year for NASA's manned spaceflight than what the Bush Administration projected. With such deep budget cuts to manned spaceflight under President Obama, why does Deputy Administrator Garver blame the Bush Administration for disarray when President Obama's own budget cut NASA's manned spaceflight programs so deeply?**

A: While the Agency's previous human space exploration program was facing cost and schedule challenges, the current NASA budget -- which has built on the NASA Authorization Act of 2010 -- prioritizes urgent needs for a sustainable long-term program. This includes extending ISS operations and utilization to at least 2020, supporting the development of commercial systems for cargo and crew transportation to and from low Earth orbit (LEO), and developing the next generation Orion Multi-Purpose Crew Vehicle and Space Launch System, which will take U.S. astronauts beyond LEO on missions of deep space exploration.

4. **Since you became NASA Administrator, have you asked the White House Office of Management and Budget and White House Office of Science & Technology Policy for the flexibility to shift funding in NASA's Science budget to keep the James Webb Space Telescope on track?**

A: NASA assessed the JWST cost and schedule profiles as recommended in the report of the Independent Comprehensive Review Panel, chaired by John Casani. NASA actively and independently developed a new baseline estimate for JWST and shared the results with the Administration. NASA established a new baseline cost and schedule for JWST and included this new baseline in its FY2013 budget request.

5. **Did the White House deny your requests? If so, why?**

A: The Administration was kept informed as to the outcome and implications of the replan and worked with NASA to explore possible scenarios. Final decisions resulting in a new cost and schedule baseline for JWST are reflected in the FY 2013 budget request.

6. **Do you believe that it is fair to say that the primary management problem facing the James Webb Space Telescope is that the OMB has not given the agency the budget flexibility it needs at this critical time in its development, when 75 percent of the development is already complete, in production, and undergoing testing?**

A: Management and budgeting problems facing JWST as outlined in the report of the Independent Comprehensive Review Panel, chaired by John Casani have been addressed in the replan. Changes in the reporting structures both at NASA headquarters and Goddard Space Flight Center have improved communications and have resulted in over a year of excellent performance (Jan 2011 to the present) since initiating the changes. It will be vital to the continuation of this success that the adequate levels of reserves be maintained in the program as this was a noted shortcoming in how the program was previously budgeted.

7. **Is it true that NASA has adopted a design for the future heavy-lift Space Launch System that utilizes an expendable version of the Space Shuttle Main Engine (SSME) as opposed to leveraging the Air Force's development of the RS-68 engine?**

A: The NASA Authorization Act of 2010 (P.L. 111-267, October 11, 2010) directed the Agency to develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capability to destinations beyond low-Earth orbit. In developing the SLS, the Act directed the Administrator to utilize to the extent practicable existing contracts, investments, workforce, industrial base, and capabilities from the SSP, Orion, and Ares I projects. This includes SSP-derived components and Ares components that draw extensively on SSP heritage propulsion systems, including liquid fuel engines, cryogenic stages, and solid rocket motors. As a result, the Agency will initiate the development of the SLS with SSP and Ares derived assets.

The SLS will utilize existing RS-25 Space Shuttle Main Engines (SSMEs) for the core lift capabilities. The RS-25 effort is for the acquisition of storage, adaptation, and reacceptance of existing RS-25 Core Stage Engines required for four or five early missions of the SLS (depending upon final manifest needs), which includes moving and storing the residual inventory of fifteen flight engines, two development engines, and associated ground support equipment.

The Government estimate for the time required to replace the RS-25 Core Stage engines with another alternative is nine years for development (includes two years to obtain and transfer the necessary property plus six to seven years for development and fabrication) plus one year for stage and vehicle integration. Therefore, the schedule for an initial SLS launch would slip from 2017 to no earlier than 2021. This schedule does meet the 2010 Authorization Act intent or the Government schedule for a first launch in 2017. The choice of the RS-25 and its associated performance is also tightly coupled with the tank diameters and other design characteristics of the SLS Core Stage. A set of approved and tested engines must be delivered for integration into the Core Stage by the summer of 2016 to meet the current SLS manifest. Thus, no other engine besides the RS-25 can fulfill the SLS architecture requirements while meeting the SLS manifest.

8. **If so, the cost analysis previously provided to this Committee during the previous administration showed that this approach with the SSME costs less in the short-term to develop, but costs many billions of dollars more over the life of the program. Please provide the justification and rationale for your choice of the SSME over the RS-68 engine.**

A: The SLS development planning calls for using existing SSME engines for the initial capability. NASA is planning on developing an expendable version of the SSME which would have lower manufacturing costs but still provide the engine performance needed, particularly specific impulse in a vacuum environment. NASA has a current inventory of SSME engines, which it has decided to use based on Space Shuttle performance, reducing initial design costs, and being a good steward of taxpayer monies since the hardware has already been paid for. The SSME is currently considered a human-rated system. The RS-68 engine would require a significant amount of design changes and system upgrades to meet the intent of NASA's human-rating requirements. As also described in the response to Question 7, an RS-68 upgrade program would require significant development funds, which would increase the overall SLS Program cost and could result in significant launch slips due to funding limitations.

9. **Knowing your deep concern for safety in the dangerous business of human spaceflight, could you describe the lessons learned from the Space Shuttle *Columbia* and *Challenger* accident investigation reports that are applicable to certifying new privately-owned launch and crew vehicles to carry NASA astronauts to the International Space Station?**

A: NASA's Commercial Crew Program (CCP) and engineering culture have placed a strong emphasis on and a firm appreciation for the value of lessons learned. NASA and the CCP are resolute in their commitment to learn from the tragic losses of the crews of *Apollo 1* (AS-204), *Challenger* (STS-51L) and *Columbia* (STS-107) as we continue the safe pursuit of human

spaceflight. The recommendations from the accident investigation reports resulting from the Apollo, Challenger, and Columbia accidents that are the most applicable to our certification efforts generally fall into two main categories: (1) recommendations that relate to the specific design of the flight hardware, and (2) recommendations that relate to management of NASA's program activities. The following paragraphs provide a summary of the common themes and referenced recommendations that are noted from each of the accident investigation reports.

In the case of those that relate to the specific design of the flight hardware, the recommendations called for independent oversight of design, test and certification where an independent team reviews and evaluates certification requirements, and provides technical oversight of the verification. (Reference: *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendation I.) The recommendations also state that NASA and its contractors, or "commercial providers," should conduct hazard analyses and criticality reviews of items that must be improved prior to flight to ensure mission success and flight safety. (Reference: *Apollo 204 Accident Report of the Committee on Aeronautical and Space Sciences, United States Senate;* and, *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendations III and IX.) Some recommendations relate to improvements of systems design to maximize the opportunities for safe launch abort, crew escape and landing. (Reference: *Report of Apollo 204 Review Board*, recommendation following Finding #4; *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendations VI and VII; and *The Columbia Accident Investigation Board Report*, Vol. 1, Ch. 11, recommendation R3.3-3.) Other recommendations are specifically relevant to the unique designs of Apollo and the Space Shuttle system.

For recommendations that relate to management of NASA's program activities, the commissions recommended that NASA establish safety advisory panels, an independent safety organization, and an independent technical engineering authority that is responsible for technical requirements, waivers, and a disciplined, systematic approach to identifying, analyzing, and controlling hazards throughout the life cycle of the system. (Reference: *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendations II and IV; and *The Columbia Accident Investigation Board Report*, Vol. 1, Ch. 11, recommendations R7.5-1, R7.5-2, and R9.1-1.) The recommendations also called for robust Flight Readiness Reviews and Mission Management Teams, astronauts in management positions, and cultural and communications changes. (Reference: *Report of Apollo 204 Review Board*, recommendation following Finding 11; *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendations II and V; and *The Columbia Accident Investigation Board Report*, Vol. 1, Ch. 11, Recommendation R6.3-1.) Finally, the recommendations called for a flight rate (including performance capabilities and schedule) consistent with available resources. (Reference: *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Recommendation VIII; and *The Columbia Accident Investigation Board Report*, Vol. 1, Ch. 11, recommendation R6.2-1.)

Report of Apollo 204 Review Board:
http://www.hq.nasa.gov/office/pao/History/Apollo204/find.html

Report of the Presidential Commission on the Space Shuttle Challenger Accident:
http://history.nasa.gov/rogersrep/v6index.htm

The Columbia Accident Investigation Board Report, Vol. 1, Ch. 11:
http://history.nasa.gov/columbia/Troxell/Columbia%20Web%20Site/CAIB/CAIB%20Website/CAIB%20Report/Volume%201/Part%203/chapter11.pdf

10. How do these reports inform NASA's minimum requirements and standards for flight tests and certification before NASA astronauts fly onboard these privately-owned vehicles?

A: Prior to the development of requirements for the Commercial Crew Program (CCP), NASA personnel involved in CCP took a two-day course from NASA's Academy of Program/Project & Engineering Leadership on *Space Systems Development: Lessons Learned.* The lessons learned during this course, and from NASA's past experiences, were applied by CCP management and technical experts as they developed NASA's minimum requirements and standards for flight tests and certification, as well as the management approach for CCP activities.

NASA's approach to program requirements for the CCP is formulated specifically to establish a program set of requirements to implement the lessons learned throughout the Agency's history. In particular, there are two principles CCP considers essential to facilitating commercial industry's ability to develop safe, reliable and cost-effective crew transportation capabilities:

1. Establishment of an appropriate set of high-level NASA program requirements necessary to define needed system capabilities, performance, and crew safety attributes; and

2. Disciplined technical leadership to establish and maintain a culture and processes that ensure that safety-related requirements are met, and to rigorously manage NASA requirements changes once baselined.

NASA is committed to managing the requirements, standards, and processes for crew transportation system (CTS) certification to ensure that commercial missions are held to the same safety standards as Government missions. NASA will be responsible for defining, managing, reviewing and approving certification plans and verification closure of requirements related to CCP missions as part of this new implementation approach.

To implement the lessons learned from Apollo, Challenger and Columbia relative to the independent oversight of design, test and certification, CCP will map program processes to the Agency's programmatic guidelines for all NASA spaceflight programs (NASA Procedural Requirements 7120.5, *NASA Space Flight Program and Project Management Requirements*). These processes will include independent review of the key milestones and major technical risks to crew safety. NASA CTS certification is the process of evaluating and assuring that the proposed commercial provider's CTS design and implementation can safely conduct the required crew transportation mission. NASA CTS certification includes evaluation of design features and capabilities that accommodate human interaction with the CTS to enhance overall safety and mission success. NASA, through the CTS certification process, is fully accountable for the safety of the NASA crew on CCP missions.

NASA CTS certification is an integral part of all CCP activities, including integrated design; development, test, evaluation, and verification; program management and control; flight readiness certification; launch, landing, recovery, and mission operations; sustaining engineering; and maintenance/upgrades. To ensure safety, CTS certification will validate technical and performance requirements, verify compliance with requirements at the subsystem, process and safety product level, validate that the CTS operates in the appropriate environments, and identify any potential residual risk to NASA. As such, NASA CTS certification will enable NASA approval of design features and capabilities to enable safe recovery of the crew from hazardous situations, which implements the lesson learned on systems designed to maximize the opportunities for safe launch abort, crew escape and landing. CCP has also incorporated safety and reliability goals for crew survival and mission assurance which are consistent with Agency human rating requirements.

Prior to certification, the commercial provider will be required to provide a safety and reliability plan, which describes how safety and reliability analytical methodologies are integrated into the design process and are used to identify and eliminate or control catastrophic hazards, as well as to balance risks and trades. This plan will address hazards, failure modes and effects, and the probabilistic safety analysis processes. NASA will review the safety and reliability products, assess the commercial provider's determination of risk likelihood and consequence, and evaluate whether the design decisions and hazard controls put in place by the commercial provider are sufficient to ensure crew safety and mission success. NASA also requires the commercial providers to have provisions for a sound risk management system into which the Agency will have insight, and those risks will map into the Program's oversight risk management system along with the other viable programmatic risks. In addition to CTS certification, NASA will verify that key performance parameters are trended, evaluated, and understood. These requirements implement the lesson learned that NASA and its contractors should conduct continuous hazard analyses and criticality reviews to ensure continued focus on flight safety and mission success.

NASA will ensure that safety and good engineering practices are utilized by the commercial providers by defining appropriate standards and specifications from NASA's history to be used in the design and development of crew transportation systems. In order to implement this approach, NASA will identify the skill mix and disciplines, including astronauts and flight crew personnel, that are needed to follow the design, development and verification of an integrated end-to-end system and operations concept. NASA also plans to bring additional technical expertise from within the Agency, as required and when requested, for complex technical issue resolution. The approach will evolve as the designs and relationships mature, and during implementation, as the Agency transitions through the program acquisition phases. The intent of the approach is to minimize technical risk and cost impacts to the Agency's and the commercial provider, while leveraging NASA's human spaceflight technical expertise and lessons learned whenever it is needed.

During the certification process, approval authority for all program requirement changes, commercial provider implementation of the program requirements, certification plans and verifications of certification activities will reside with the NASA Program Manager for CCP. The Program Manager will receive support for oversight activities from the Deputy Program

Manager, an astronaut and former Director of the Flight Crew Operations Directorate; the CCP Systems Engineering and Requirements organization; program system offices; NASA Engineering, Safety and Mission Assurance, Health and Medical; Astronaut Office; and International Space Station (ISS) Program. As NASA has defined and matured its requirements for commercial crew transportation systems, the Astronaut Office, independent technical authorities, and other NASA human spaceflight programs participated in the development and approval of requirements and standards. Due to the participation of the Astronaut Office and the independent technical authorities in approvals and in the CTS certification process, CCP oversight decisions will have the benefit of the checks and balances established by NASA's governance model. The processes for developing and approving satisfaction of requirements and standards demonstrate how CCP implements and incorporates the recommendations from the accident investigation reports related to an independent safety organization, an independent technical engineering authority, and astronauts in management positions.

Although the Commercial Crew Program is in the early phase of design and development, CCP has generated its framework for instituting the recommendations of the accident investigation reports related to robust Flight Readiness Reviews (FRR) and Mission Management Teams. Under CCP, the FRR process will evaluate CTS production and operation progress, technical issues and requirement deviations/waivers, and the closure of any actions, prior to granting authority-to-proceed to the next mission preparation phase. The purpose of the FRR is to evaluate readiness of all personnel, elements, and assets to support the launch and execution of the mission. The process will verify that all risks and hazards, including past flight anomalies, have been identified, credibly assessed, and characterized, and mitigation efforts have been implemented or residual risks have been accepted prior to proceeding to the next phase. Authority-to-proceed into launch countdown initiates the Mission Management Process. The CTS Mission Management Process is the controlling framework for conducting CTS Operations, nominal and contingency, effective from FRR through crew recovery. The Mission Management Process oversees the execution of operations, ensures the CTS is operated within established operational limits, and enables timely identification and resolution of potential impacts to crew health and safety and mission success.

Finally, all CCP activities will be subject to evaluation by various organizations independent of and funded separately from CCP, including the Safety and Mission Assurance independent technical authority, the NASA Space Flight Safety Panel, which is chaired by a member of the Astronaut Office, and the NASA Aerospace Safety Advisory Panel, which was established after the Apollo accident investigation. The Commercial Crew Program will adhere to the recommendations of the accident investigation reports related to the establishment of these organizations through open dialogue and cooperation during independent assessment and evaluation of CCP activities.

11. **Members of Congress have received many disturbing reports that FY 2011 funding of $1.8 billion for the Space Launch System is not being spent as Congress authorized. Further, due to the Obama Administration's indecision, NASA has not initiated contracts on the SLS with industry at a time when many engineers and technicians who worked on the Space Shuttle are now facing unemployment.**

a. **How much of the $1.8 billion does NASA plan to have obligated on contract by the end of FY 2011?**

b. **Please provide how much of the $1.8 billion for SLS has been obligated by contract name as well as the costs for civil servants and other overhead costs.**

A: Please see Attachment A.

12. Is the NASA chief financial officer applying the same level of overhead rate to SLS appropriated funds as the overhead rates for other NASA programs? If not, why?

A: The CFO does not apply an overhead rate to projects and programs. As per the NASA Space Flight Program and Project Management Requirements – NID 7120.5 D; Each program and project shall have a Decision Authority who is the Agency's responsible individual who determines whether and how the program or project proceeds through the life cycle and the ***key program or project cost***, schedule, and content parameters that govern the remaining life cycle activities. For programs and Category 1 projects, the Decision Authority is the NASA Associate Administrator. This authority may be delegated to the MDAA for Category 1 projects. For Category 2 and 3 projects, the Decision Authority is the MDAA. These project authorities may be delegated to a Center Director. All delegations are documented and approved in the applicable authority document (PCA or Project Plan) depending on which Decision Authority is delegating.

A significant portion of NASA's acquisitions are developed in-house. The costs of labor dedicated to direct program or project activities (both civil servant and contractor) are budgeted within the relevant program or project. Construction of facilities (CoF) of developing or modifying facilities to meet the requirements of a specific program or project are shown in the program or project's out-year estimates, but are included in the Cross-Agency Support account for the budget year. This 'modified full cost' approach ensures that NASA can make the most cost effective acquisition decisions while not burdening programs or projects with overhead costs.

From Rep. Jerry Costello

1. **How does the technical design that NASA has proposed for SLS measure up against the recommendations from the Columbia Accident Investigation Board (CAIB) and the Astronaut Office that a Shuttle replacement have at least a Loss of Crew probability of 1 in 1,000 missions?**

The combined Orion MPCV, Space Launch System (SLS), and Exploration Ground Systems (EGS) efforts will fully meet the intent of the Columbia Accident Investigation Board (CAIB) with respect to crew escape and abort capability. The current Concept of Operations is that both the flight and ground crew will be able to rapidly escape the launch tower if selected failures were detected prior to closing the Orion hatch. If a failure were to occur on the pad or during ascent, the combined systems would automatically send abort commands. Preliminary analysis shows that there is a high rate of survivability, but these models and analyses need to be refined prior to releasing any estimates.

The current estimate for the Loss of Crew (LOC) is under evaluation and NASA has considered many configurations and operational options to reduce the risk of LOC. NASA will establish an Agency minimum threshold for a LOC requirement for the programs. Accordingly, the SLS, MPCV, and EGS will establish a program requirement for LOC, consistent with program capability, that when combined must meet or exceed the minimum Agency requirement. Further, the programs will continue to evolve and improve LOC capability throughout the program lifecycle.

2. **What is the role of NASA's Office of Safety and Mission Assurance in ensuring the safety of the Multi-Purpose Crew Vehicle (MPCV) and the eventual SLS?**

A: For the MPCV and the SLS, the role of the Office of Safety and Mission Assurance (OSMA) is in full compliance with NPD 1000.0A, NASA Governance and Strategic Management Handbook and NASA NPR 7120.5, NASA Program and Project Management Processes and Requirements. Each of the Programs has a Chief Safety Officer (CSO) that is delegated the Safety and Mission Assurance Technical Authority responsibility. These CSOs report independently through the Center SMA Director, the Center Director, and then to the Chief, OSMA. In addition, there is a Cross-Program Integration CSO, who is responsible for coordinating the efforts of the Programs across the Exploration Systems Division, including MPCV and SLS. The Integration CSO also reports independently through the Center SMA Director, the Center Director, and then to the Chief, OSMA. Finally, the Chief, OSMA, is supported by his staff of experienced SMA personnel who interface with Exploration Systems Division at Headquarters, as well as directly with the MPCV and SLS safety and mission assurance personnel and the CSOs working the programs. Based on these interfaces the OSMA staff advise the Chief S&MA, on applicable requirements, policies, and issues."

3. **How will NASA ensure the safety of both the SLS and MPCV in light of the proposed 70% reduction in oversight?**

    a. **What oversight activities is NASA proposing to eliminate?**

b. What's involved for contractors and NASA in using different approaches to insight and oversight?

A: In a constrained budget environment, NASA knows how important it is to identify ways to make the Agency's programs and projects more efficient, so finding and incorporating these efficiencies remains a primary goal. NASA has embraced the challenge to deliver human spaceflight systems for lower cost, and the opportunity to become more efficient, innovative and agile in its programs. For example, NASA is revising the management of requirements, contracts, and projects and incorporating approaches to ensure affordability in the near term and over the long run. This includes the use of focused insight/oversight, specifying to industry – where appropriate – what the Agency needs instead of how to build it, designing for cost-effective operations, increasing the use of common components and parts, and wisely consolidating infrastructure.

An example of tangible results is the reform of the Government insight and oversight model in the Orion project. The Orion MPCV program has made substantial reductions in oversight through a comprehensive and systematic approach based on metering of insight commensurate with risk, rigorous management controls and cultural training, establishing co-located Government contractor teams, and focusing on near-term test flight missions. This approach deployed the Government workforce to emphasize the engineering insight that comes from focused, in-line, co-located contributions to design and testing, and to deemphasize dedicated oversight management.

The net result of the rebalancing of resources toward hardware procurement and spacecraft production has been the ability to accelerate first test article delivery under a dramatically smaller budget. Government performance of in-line tasks was increased. This refocused Government resources toward tasks directly contributing to design and testing efforts, further enhanced Government insight, and fostered a more integrated Government and industry team. Through this process, the Government gains significant insight into the contractor's vehicle system and has early insight into any issues or concerns that could impact vehicle safety. The focused insight allows the Government to make recommendations to the industry partner and the Government oversight team to improve the vehicle design or correct a known issue/defect. Final oversight decisions will be performed by the NASA. The Agency's commitment to safety is unwavering.

4. Please describe how NASA is using existing Constellation contracts to work on elements it will need for the new launch system and how these contracts may build on past work and maintain the aerospace workforce. If NASA is not using these contracts, please explain the financial impact of terminating them.

A: NASA is moving out with the development of the SLS, having announced the basic architecture of the system on September 14, 2011, and followed up in September, October, and December with the release of several synopses designed to support the development of different components of the system, including:

- SLS Stages Acquisition (posted 9-28-11)

- SLS Core Stage Engines (posted 9-28-11)
- SLS Advanced Development Request for Information (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and Risk Reduction (posted 10-7-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction notification of intention to issue a Draft NASA Research Announcement (NRA) on or about in the December 12, 2011 (posted 12-1-11)
- SLS Advanced Booster Engineering Demonstration and/or Risk Reduction activity synopsis announcing an Industry Day on December 15, 2011 (posted 12-1-11)

The NASA Authorization Act of 2010 (P.L. 111-267, October 11, 2010) directed the Agency to develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capability to destinations beyond low-Earth orbit. In developing the SLS, the Act directed the Administrator to utilize to the extent practicable existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle Program (SSP), Orion, and Ares I projects. This includes SSP-derived components and Ares components that draw extensively on SSP heritage propulsion systems, including liquid fuel engines, cryogenic stages, and solid rocket motors. As a result, the Agency will initiate the development of the SLS with SSP and Ares derived assets.

For example, for the SLS large cryogenic Stages (Core Stage and Upper Stage), NASA intends to modify the existing Ares I Upper Stage contract with Boeing. The Ares I Upper Stage has the same functionality as the SLS Core and Upper Stage elements, and much of the Ares I Design, Development, Test & Evaluation (DDT&E) especially at the component level is applicable to SLS requirements. NASA will establish a new baseline to meet the exploration missions, consisting of an SLS Core and Upper Stage that will include common design features and be produced with common tooling, procedures, and techniques to obtain Core and Upper Stage synergies.

For the SLS Core Stage Engines, NASA will use existing RS-25 Space Shuttle Main Engines (SSMEs) for the core lift capabilities. The RS-25 effort is for the acquisition of storage, adaptation, and reacceptance of existing RS-25 Core Stage Engines required for four or five early missions of the SLS (depending upon final manifest needs), which includes moving and storing the residual inventory of fifteen flight engines, two development engines, and associated ground support equipment.

The Agency greatly appreciates the efforts and talents of our aerospace contractor and civil service workforce, and is working to ensure that their critical skills and capabilities are not lost as we develop the systems required to take our astronauts beyond LEO.

5. **What are the human exploration missions NASA intends to undertake with the new exploration system? What goals or milestones is NASA considering to measure the program's success as it moves beyond LEO?**

A: The SLS and Orion MPCV are being designed to provide capabilities for a variety of deep space missions to multiple destinations, including the Moon, asteroids, the moons of Mars, and ultimately the surface of Mars. Besides near-Earth asteroid rendezvous flights, these systems

could be used to support circum-lunar navigations and flights to Earth-Moon Lagrange points. Lagrange points are gravitationally stable regions created by the interaction of the gravity fields of any two large masses; an object placed a Lagrange point will tend to stay in place for a long time. These could therefore be excellent locations in which to place habitation modules to study long-duration expeditions away from LEO, conduct developmental systems tests, enable tele-robotic operations, and execute science activities. Beyond this initial capability, SLS and Orion MPCV could support eventual missions to the moons of Mars -- Deimos and Phobos -- and the surface of Mars itself, with incremental upgrades.

6. **During debate on the 2010 NASA Authorization Act, Congresswoman Giffords expressed serious concerns about NASA's ability to achieve its goals at the authorized funding levels. In view of her concerns, please describe how you plan to develop an integrated exploration system under the constrained funding levels available over the next few years.**

A: The funding level for SLS, Orion MPCV, and EGS efforts requested in the President's FY 2013 budget request supports an initial test flight of the system by the end of 2017, with an initial crewed test flight in 2021. The Agency has placed these efforts under the Exploration Systems Division of the Human Exploration and Operations Mission Directorate to ensure that they move forward in an integrated fashion, in terms of both cost and schedule planning. The ultimate availability of these systems is, of course, contingent upon the availability of appropriated funds. It is very important that NASA receive the requested funding levels in order to keep the development, testing, and eventual operation of these systems on track.

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