

THE NATIONAL AERONAUTICS AND SPACE  
ADMINISTRATION'S FISCAL YEAR 2012  
BUDGET REQUEST

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HEARING  
BEFORE THE  
SUBCOMMITTEE ON SPACE AND AERONAUTICS  
COMMITTEE ON SCIENCE, SPACE, AND  
TECHNOLOGY  
HOUSE OF REPRESENTATIVES  
ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

MARCH 2, 2011

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**THE NATIONAL AERONAUTICS AND SPACE  
ADMINISTRATION'S  
FISCAL YEAR 2012 BUDGET REQUEST**

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**WEDNESDAY, MARCH 2, 2011**

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

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

RALPH M. HALL, TEXAS  
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS  
RANKING MEMBER

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

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*The National Aeronautics and Space Administration Fiscal Year 2012  
Budget Request*

Wednesday, March 2, 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



**Witness**

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

**Background***Agency Overview*

NASA is the nation's primary civilian space and aeronautics research and development agency, carrying out a diverse set of missions and projects designed to expand our understanding of Earth, the Solar System, and the universe. NASA operates the Space Shuttle fleet, the International Space Station, and a number of satellites in orbit around Earth and throughout the solar system. It also undertakes activities in technology development and transfer, education, outreach, and participates in a number of interagency initiatives such as nanotechnology, information technology, climate change research, and the Next Generation Air Transportation (NextGen) program.

NASA was established by the National Aeronautics and Space Act of 1958 (P.L. 85-568) and was formed by merging the National Advisory Committee on Aeronautics (NACA) with selected space and aeronautics research projects from the defense department. In its first year, President Eisenhower requested \$125 million for NASA. Today, the agency's budget is more than \$18.7 billion (less than half of one percent of the federal budget), with about 83 percent of the total budget paid to commercial entities on a contract basis. NASA employs about 18,300 full time equivalent civil servants and another 43,000 contractors. In addition to its headquarters office in Washington, DC, NASA has nine field centers:

- Ames Research Center, Mountain View, CA
- Dryden Flight Research Center, Edwards Air Force Base, CA
- Glenn Research Center, Cleveland, OH
- Goddard Space Flight Center, Greenbelt, MD
- Johnson Space Center, Houston, TX
- Kennedy Space Center, Merritt Island, FL
- Langley Research Center, Hampton, VA
- Marshall Space Flight Center, Huntsville, AL
- Stennis Space Center, Bay St. Louis, MS

The Jet Propulsion Laboratory, located in Pasadena, CA, is a NASA-sponsored federally funded research and development center. NASA also owns the Wallops Flight Facility in Wallops Island, Virginia and the Michoud Assembly Facility east of New Orleans, Louisiana.

**FY2012 Budget Request**

NASA's budget request for FY 2012 is \$18.7 billion, the same amount appropriated by Congress for FY 2010 and continued thus far in FY 2011. The budget request also displays the succeeding four out-year budget assumptions (FY2013 - FY2016) to give Congress an indication of near-term spending plans for programs, projects and activities. The FY 2012 budget request assumes the same topline spending level through FY2016, but unlike previous budgets, NASA's FY2012 request qualified their out-year assumptions as 'notional.' However, NASA's 'notional' assumptions are significantly higher than those in OMB's FY2012 agency request (OMB's Blue Books) by an aggregate of \$2.33 Billion. In spite of this significant difference, NASA officials advised the Committee that they are using their higher out-year assumptions for planning purposes.

**NASA is proposing to modify its current account structure in two ways: (1) to divide "Aeronautics and Space Technology" into separate accounts; and (2) merge the "Space Operations" and "Exploration Systems" Directorates into one account. The latter may occur by this summer.**

*Key Highlights and Programs from the FY2012 Budget Proposal*

*Earth Science.* NASA's Earth Science programs seek approaches for providing sustained, simultaneous spaceborne climate measurements to advance knowledge of the Earth's atmosphere, oceans, sea ice, land surfaces, and the interaction of these elements in the ecosystem, including the impact of humans. Key elements include

flight programs to develop satellite observation missions; research analysis to understand the flight data; developing technologies for new measurement approaches; and advancing the use of Earth science measurements to inform environmental policy decisions.

- Compared to last year's budget, the FY2012 Earth Sciences request - \$1,797.4 million - is \$4.4 million less, a decrease of 0.2%.
- NASA operates 13 satellite missions making global observations and has seven missions in formulation or under development, with Glory, Aquarius, and NPOESS Preparatory Project (NPP) scheduled for launch in 2011.
- Delays start of the DESDynI and CLARREO missions.

*Astrophysics.* NASA's Astrophysics programs seek to discover how matter, energy, space and time behave under the extraordinary range of conditions within our universe; explore how the universe began and evolved; and characterize planetary systems orbiting other stars in a search for Earth-like planets. NASA operates 13 satellite missions including the Hubble Space Telescope, which has taken hundreds of thousands of astronomical images shedding light on many of the greatest mysteries of astronomy.

- Compared to last year's budget, the FY2012 Astrophysics request - \$682.7 million - is \$51.2 million higher, an 8.1% increase.
- NASA's successor to the Hubble Space Telescope is the James Webb Space Telescope (JWST). Last year, an external review panel determined that JWST will require up to \$1.5 billion in additional funding and at least another year before it will be ready for launch. In an effort to get the cost and schedule growth under control, JWST's program and project management was moved out of the Astrophysics management structure. NASA is currently conducting a 'bottoms-up' review to establish a new cost and schedule baseline that will be reflected in next year's budget request. The FY2012 budget request reduces JWST funding, ensuring that it will not meet the current launch date of 2014.

*Planetary Science.* NASA's Planetary Science program conducts robotic missions throughout our solar system to answer fundamental questions about its origins and evolution. Planetary science data supports NASA's longer term human exploration agenda including the use of robotic Mars rovers, (i.e. Spirit and Opportunity), and orbiters, (i.e., Odyssey and Mars Reconnaissance Orbiter) to map water and minerals on or near Mars surface. NASA's Near Earth Observation (NEO) program hunts for asteroids that are potential impact hazards to Earth.

- Compared to last year's budget, the FY2012 Planetary Science request - \$1540.7 million - is \$55 million higher, a 3.7% increase.
- NASA and the European Space Agency have established a joint program of office to coordinate future Mars missions beginning in 2016.
- Higher launch vehicle costs is severely impacting program, leading to reduced number of launches-per-decade unless lower-cost launchers become available.

*Heliophysics.* Heliophysics seeks to understand the Sun and its impact on the Earth's magnetosphere, ionosphere, and atmosphere. The extended solar environment extends beyond the orbit of Pluto, but here on Earth solar particles and fields effect high-altitude winds, radio and radar transmissions, the electrical power grid, and spacecraft electronics. NASA operates 14 heliophysics missions using 26 spacecraft including the Solar and Heliospheric Observatory (SOHO) and the Solar Terrestrial Relations Observatory (STEREO). Many Heliophysics missions have been extended beyond their original lifetimes, including the Voyager spacecraft launched in August 1977.

- Compared to last year's budget, the FY2012 Heliophysics request - \$622.3 million - is 19.6 million less, a 3.1% decrease.
- The United States may have to eliminate one or more instruments from the Solar Orbiter Collaboration - a joint mission with the European Space Agency - due to the high cost of a launch vehicle. Under the agreement, the US provides the launcher and several of the instruments. The mission is being led by the European Space Agency.

*Aeronautics Research.* NASA's Aeronautics research programs provide direct and indirect benefit to the public. Fundamental research in traditional aeronautical disciplines and relevant emerging fields enable revolutionary changes which lead to a safer, more environmentally friendly and more efficient national air transportation system to benefit the flying public. Aeronautics research is conducted through five programs: Aviation Safety; Airspace Systems; Fundamental Aeronautics; Integrated

Systems Research; and the Aeronautics Test Program. NASA's Aeronautics research is a significant contributor to the FAA's Next Generation Air Transportation System (NextGen) program.

- Compared to last year's budget, the FY2012 Aeronautics request - \$569.4 million - is \$10.2 million less, a 1.8% decrease.

*Space Technology.* For FY2012, NASA is proposing to create a new budget line for Space Technology (in last year's budget request, it was combined with Aeronautics Research). The program consists of technology development and innovation projects that are broadly applicable to the Agency's future missions in science and exploration while providing space technologies that can improve the capabilities and lower the cost of other government agencies and commercial space activities. It is managed by the Office of Chief Technologist, who reports directly to the Administrator. Space Technology has three programs: Early Stage Innovation; Game Changing Technology; and Crosscutting Capability Demonstrations.

- Compared to last year's budget, the FY2012 Space Technology request - \$1,024.2 million - is \$452 million higher, a 79% increase. Note, however, that last year's request was never enacted.
- The Space Technology program also absorbs existing programs, including the Innovative Partnership Program, portions of the Exploration Technology Program, and the Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) Programs.

Exploration Systems and Human Spaceflight. See the section Human Space Flight and the NASA Authorization Act of 2010 below for a fuller explanation of changes and issues.

*Space Operations.* The Space Operations Mission Directorate (SOMD) manages the Space Shuttle program; oversees the operation of the International Space Station, including payloads on the ISS; provides launch services for other NASA directorates, mainly for Space Science missions; manages the Space Communication and Navigation (SCaN) program, providing communications between Earth and missions in space (Shuttle, ISS, and deep space science missions); through the Human Space Flight Operations program, provides training for NASA astronauts and supports their health and safety; develops future space launch complex upgrades; and manages rocket testing capabilities through the Rocket Propulsion Test program.

- Compared to last year's budget, the FY2012 Space Operations request - \$4,346.9 million - is \$540.9 million less, an 11.1% decrease. This largely reflects the pending retirement of Shuttle.
- STS-133 Space Shuttle Discovery is currently at the International Space Station. NASA must safely fly the two remaining Space Shuttle missions while preparing for the Shuttle's retirement later this year.
- NASA will support utilization of the International Space Station through at least 2020.
- The FY2012 budget request includes \$548 million in pension liability for the Shuttle's prime contractor United Space Alliance.

*Education.* NASA's education programs are designed to increase the number of students who are proficient in, and choose to major in, and pursue careers in STEM fields. NASA works through mutually beneficial relationships with over 500 colleges and universities, hundreds of K-12 schools and districts, and over 400 museums and science centers to provide education experiences.

- Compared to last year's budget, the FY2012 Education request - \$138.4 million - is \$7.4 million less, a 5.1% decrease.

*Cross Agency Support.* Cross Agency Support (CAS) is comprised of two themes, Center Management and Operations, and Agency Management and Operations. Together they manage all nine NASA centers and their personnel; agency acquisitions; financial management; maintenance and operation of facilities; ensure safety and mission success; sustain Agency-wide critical capabilities; and information technology.

- Compared to last year's budget, the FY2012 CAS request - \$3,192.0 million - is \$80.6 million higher, a 2.6% increase.

*Construction and Environmental Compliance and Restoration.* The Construction and Environmental Compliance and Restoration (CECR) account provides for design and execution of facility construction and revitalization projects, demolition projects, and environmental and restoration activities. The Environmental Compliance and Restoration program is to clean up pollutants from past activities.

- Compared to last year's budget, the FY2012 request - \$450.4 million - is \$53.1 million higher, a 13.4% increase.

- The FY2012 request supports cleanup of the Santa Susana Field Laboratory (CA), in preparation for dispositioning the property. Inspector General. Supports auditors, investigators, and analysts to prevent and detect fraud, waste and abuse and mismanagement.
- Compared to last year's budget, the FY2012 request—\$37.5 million—is \$500 thousand higher, a 1.4% increase.

*Human Space Flight and the NASA Authorization Act of 2010*

Last year Congress passed the NASA Authorization Act of 2010, which was signed by the President on October 11th (P.L.111-267). The Act provided policy guidance and recommended funding levels agreed to by the Congress. Yet the Administration's FY2012 budget request diverges significantly from the Authorization Act in a number of ways in the area of human spaceflight. Much of the Act was in direct response to the Administration's FY2011 request to cancel development of the Constellation Program (consisting of a new launch system, Ares 1 and Ares 5; and the Orion crew capsule) as the successor to the Space Shuttle, which will be retired from service later this year.

In lieu of Constellation, the Administration's FY2011 budget sought \$6 billion to fund development of multiple commercial crew transport services (three or four, according to NASA), arguing that emerging commercial companies had the capability to safely design, build and operate launch systems and crew capsules to carry astronauts to and from low-Earth orbit. Despite repeated requests by the Committee throughout 2010, NASA failed to provide a credible plan or the basis for its \$6 billion estimate to Congress. As a result, Congress in its 2010 NASA Authorization Act strongly disagreed with the Administration's proposal.

Instead, the Act provided \$10.8 billion (through 2013) for continued development of a Shuttle- and Constellation-derived launch system (newly designated the Space Launch System and Multi-Purpose Crew Vehicle) that would assure a backup capability to access the International Space Station for the U.S. and our international partners in case commercial proposals fail to materialize. The Act also directed NASA to proceed immediately with its development with the goal of making the system operational by 2016.

The Space Launch System (SLS) and Multi-Purpose Crew Vehicle (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 missions beyond Earth orbit. Congress envisioned that the SLS and MPCV would get maximum benefit from the more than \$10.3 billion that had previously been spent on the Constellation system. During the previous 18 months, major Constellation components achieved a number of milestones including successful flight tests of the Ares 1-X and the Orion launch abort systems, and a ground demonstration of a five-segment solid rocket motor that was to have powered the Ares 1.

In the area of commercial crew the Authorization Act provided \$1.3 billion over three years to "continue or expand activities and agreements initiated in FY2010 that reduce risk, develop technologies, and lead to other advancements that will help determine the most effective and efficient means of advancing the development of commercial crew services."

The following table compares the policy and funding guidance that Congress established in the NASA Authorization Act with the Administration's FY2012 budget request. Over the next two years (FY2012 - FY2013) the Administration's request underfunds development of the Multi-Purpose Crew Vehicle and Space Launch System/Heavy Lift Launch Vehicle by more than \$2.4 billion, a 31 percent decline. In the area of Commercial Spaceflight the Administration significantly augmented amounts already authorized for commercial Cargo Resupply Services and Commercial Crew.

Although NASA is seeking to fund development of multiple commercial crew systems, NASA will not own the systems and will shoulder additional costs to "rent seats" on a per mission basis. NASA has inserted a new line in the FY2012 budget called Mission Operations Sustainment that will be used to pay the per seat rental if and when a new commercial crew industry has been established. Despite repeated requests to NASA to provide the cost basis or assumptions used to estimate the future cost for commercial seat rental, NASA did not provide that information to the Committee. As a result the table below assumes that \$415 million requested in FY2013 will be necessary for seat rentals, which is roughly similar to the cost to rent seats on the Russian Soyuz.

**Comparing the NASA Authorization Act of 2010 (P.L. 111-267) with the FY2012  
Budget Request**

(millions of \$)	FY10 enacted / FY11 C.R. *	Auth. FY12	Budget Request FY12	Request vs. Auth. FY12	Auth. FY13	Budget Request FY13	Request vs. Auth. FY13	Auth. Total FY12-13	Budget Request Total FY12-13	Request vs. Auth. FY12-13	Request vs. Auth. FY12-13
<b>Human Exploration Capabilities</b>	<b>3,287</b>	<b>4,050</b>	<b>2,810</b>	<b>(1,240)</b>	<b>4,050</b>	<b>2,810</b>	<b>(1,240)</b>	<b>8,100</b>	<b>5,620</b>	<b>(2,480)</b>	<b>--31%</b>
<i>MPCV</i>	<i>1,435</i>	<i>1,400</i>	<i>1,010</i>	<i>(390)</i>	<i>1,400</i>						
<i>SLS/HLLV</i>	<i>1,387</i>	<i>2,650</i>	<i>1,800</i>	<i>(850)</i>	<i>2,640</i>						
<i>Integr'n &amp; Ops</i>	<i>465</i>										
<b>Commercial Spaceflight Capabilities</b>	<b>1,066</b>	<b>1,295</b>	<b>1,645</b>	<b>350</b>	<b>1,301</b>	<b>2,066</b>	<b>765</b>	<b>2,596</b>	<b>3,711</b>	<b>1,115</b>	<b>+43%</b>
<i>COTS</i>	<i>^300</i>										
<i>CRS (Cargo)</i>	<i>516</i>	<i>795</i>	<i>795</i>	<i>0</i>	<i>801</i>	<i>801</i>	<i>0</i>	<i>1,596</i>	<i>1,596</i>		
<i>Comm Crew</i>	<i>**250</i>	<i>500</i>	<i>850</i>	<i>350</i>	<i>500</i>	<i>850</i>	<i>350</i>	<i>1,000</i>	<i>1,700</i>	<i>700</i>	
<i>Mission Ops Sustainment</i>					<i>0</i>	<i>415</i>	<i>415</i>	<i>0</i>	<i>415</i>	<i>415</i>	

\*Values are reference only. Under the CR some numbers may vary slightly.

^ \$39 million in FY2010 and \$33 million in Q1 FY2011

\*\* Senate Appropriations committee bill as reported (S.3636) and House-passed full year continuing resolution (H.R.3082 as amended), not enacted. Approx \$50 million obligated for CDev2

Last year NASA used \$50 million from the American Recovery and Reinvestment Act to fund five study proposals called Commercial Crew Development (CCDev 2). NASA initiated a second request for proposals (CCDev 2) and plans to award funding once the FY2011 appropriation is finalized. CCDev 2 currently has no budget allocation so these funds will further reduce the amount available for Human Exploration Capabilities but is not reflected in the above chart.

Chairman HALL. All right. The Committee on Science, Space and Technology will come to order, and I say to you good morning and thank you for being here. Charlie, I think it is a good morning. I know you are a good guy and likeable and admired here, and for some of the things I say about the Administration, I am not talking about you directly. But you are a big guy, and I know you are going to handle it.

I welcome all of you here to the hearing entitled the National Aeronautics and Space Administration Fiscal Year 2012 Budget Request. In front of you are packets containing the written testimony, biography and Truth in Testimony Disclosure for today's witness, Administrator Charles F. Bolden.

I recognize myself for five minutes for an opening statement.

I want to thank Administrator Bolden for appearing before our Committee today. There are a number of significant issues facing our Nation's space program, and I look forward to a frank and open discussion on the issues.

I am concerned that the future of our space program is in very serious jeopardy and has been since the President ran a line through the word Constellation. With the retirement of the Space Shuttle, NASA faces a critical period and needs to focus its limited resources to sustain our leadership in space.

As everyone knows we are in a challenging budget environment. In times like these it is more important than ever for NASA to have credible, realistic plans that can be understood and can be defended. It must execute the programs it has with efficiency and thrift and work closely, I think, with the Congress to abide by congressional legislation. It is my personal opinion that someone over at the White House seems to have very little interest in working with the Congress. The President made a speech to the Nation just last January told all of us that we had not only to work together, and that is a good speech, we should work together, that we even had to sit together that night. His speech was great. It was just two years too late. When the speech was shorter two years ago, I counted the words in the January speech, 5,602 words. Two years ago the words seemed to have narrowed down to two words, we won, with no real cooperation sought from the Republican side.

In the area of human spaceflight, I am concerned about having assured access to the International Space Station for the United States and our international partners so it can live up to its promise as a vital research laboratory. That is why Congress several years ago authorized a follow-on system called Constellation. The Constellation program was guided by the safety recommendations of the Columbia Accident Investigation Board. Its goals and designs were well understood and endorsed by successive Republican and Democratic Congressmen working together. I am sure you have heard that from many of us.

Yet last year the President, without warning, cancelled Constellation in favor of a commercial crew proposal that assumed spending at least \$6 billion over five years on the development and demonstration of up to three or four privately owned and operated commercial crew systems with no or very few details.

Despite repeated requests from former Chairman Gordon and myself, NASA never provided the basis for its cost estimates or a

credible plan showing how the needs of the United States and our international partners could be met at a lower cost or on a faster development cycle than Constellation.

So last year, after intense and often contentious debate Congress passed the NASA Authorization Act of 2010. The bill was a product of compromise, and no one got everything they wanted. But the Act contained policy elements and funding guidelines that could allow the space program to move forward.

Specifically the Act provided \$10.8 billion over three years for the newly-designated Multi-Purpose Crew Vehicle and Space Launch System to assure the capability to supply and support the International Space Station for the United States and our international partners in case commercial proposals fail to materialize.

The Act also urged NASA to capitalize on investments already made in the Constellation program in order to save money, maintain a skilled workforce and minimize further development delays.

With regard to Commercial Crew, the Act authorized \$1.3 billion over three years for activities that, as the authorization bill states, "reduce risk, develop technologies, and lead to advancements that will help determine the most effective and efficient means of advancing the development of commercial crew services." Commercial crew was not ignored, but to be perfectly clear, it was not and is not Congress' first priority. Our first priority is to continue with the development of the Space Launch System and Multi-Purpose Crew Vehicle.

Yet the Administration's fiscal year 2012 budget proposal completely flips the priorities of the Act, significantly increasing Commercial Crew funding while making deep cuts to the Human Exploration Capabilities accounts which Congress clearly intended to serve as our assured access to space.

Members of this Committee have been some of NASA's most ardent supporters in the House, and we take the NASA Authorization Act, all of us take it very seriously. We expect NASA to make good faith efforts to abide by the policy direction and funding limitations in the law and to cease its efforts to delay resumption of full development of an assured access system. The new budget proposal disregards, yes, ignores, our authorization law.

Knowing that we face a very difficult budget environment for years to come, it is more important than ever that NASA have credible plans, execute them well, and work closely with Congress to abide by the legislative direction.

We would like to work together with you to maintain our human spaceflight program.

In order to do this, NASA should embrace the policy direction that has been agreed to, which would help reduce the surprise, frustration and anger from those who have been your greatest supporters.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH HALL

I want to thank Administrator Bolden for appearing before our Committee today. There are a number of significant issues facing our nation's space program, and I look forward to a frank and open discussion on the issues.

I am concerned that the future of our space program is in serious jeopardy. With the retirement of the Space Shuttle, NASA faces a critical period and needs to focus its limited resources to sustain our leadership in space.

As everyone knows we are in a challenging budget environment. In times like these it is more important than ever for NASA to have credible, realistic plans that can be understood and defended. It must execute the programs it has with efficiency and thrift, and work closely with the Congress to abide by legislation.

In the area of human spaceflight, I am concerned about having assured access to the International Space Station for the U.S. and our international partners so it can live up to its promise as vital research laboratory. That is why Congress, several years ago, authorized a follow-on system called Constellation. The Constellation program was guided by the safety recommendations of the Columbia Accident Investigation Board. Its goals and design were well understood and endorsed by successive Republican and Democratic Congresses.

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Commercial crew was not ignored, but to be perfectly clear, it was not - and is not - Congress' first priority.

Yet the Administration's FY2012 budget proposal completely flips the priorities of the Act, significantly increasing Commercial Crew funding while making deep cuts to the Human Exploration Capabilities accounts which Congress clearly intended to serve as our assured access to space.

Members of this Committee have been some of NASA's most ardent supporters in the House and we take the NASA Authorization Act very seriously. We expect NASA to make good faith efforts to abide by the policy direction and funding limitations in the law, and to cease its efforts to delay resumption of full development of an assured access system.

Knowing that we face a very difficult budget environment for years to come, it is more important than ever that NASA have credible plans, execute them well, and work closely with Congress to abide by legislative direction.

We want to work together with you to maintain our human spaceflight program.

In order to do this, NASA should embrace the policy direction that has been agreed to, which would help reduce the surprise, frustration and anger from those who have been your greatest supporters.

Chairman HALL. I now recognize Mrs. Johnson for her opening remarks.

Ms. JOHNSON. Thank you very much, Mr. Chairman. Welcome back to the Committee, Administrator Bolden.

I want to congratulate you and your agency on STS-133, and I understand that the mission has been very productive to date, and I look forward to the crew's safe return to Earth next week.

I had another appointment, so I missed it, and I kept telling the people going, I might not miss it because it might not go up that day but it did.

Today is the Congress' first opportunity to review the President's fiscal year 2012 budget request for NASA. This budget request is coming over in a very challenging budgetary environment with the appropriations for fiscal year 2011 still undecided even though we are now 5 months into that year. I can only imagine the challenges that you are facing in trying to plan and carry out the challenging activities that the nation has asked you to undertake when the budgetary sands keep shifting.

I hope that we are able to resolve our current appropriations impasse soon, but I also hope that an agreement doesn't come at the expense of critical investments this Nation needs to make to prepare for the future. I consider NASA to be one of those critical investments.

One only has to look at all the advances, new technologies and inspiration that NASA has delivered over the years to realize that the people of NASA are one of our Nation's vital resources and we need to support them and their important missions in space and Earth science, aeronautics and human spaceflight and exploration. I could spend my entire time listing just some of the fruits of our past investments in NASA that have become embedded in our daily lives whether they be as broad in scope as global satellite communications or as specific as smoke detectors, cordless power tools, digital mammography, body imaging and firefighter breathing systems.

Other nations increasingly are recognizing the benefits a strong and active space program can deliver, and as a result, we see them being willing to make the necessary investments to build their space capabilities. However, I am worried that we here in America are forgetting how important these R&D investments are to our future and how critical this skilled workforce is to our future competitiveness.

I am a great admirer of you, Mr. Bolden, and the inspirational leadership that you bring to NASA. I am also a supporter of the President who wishes you to be successful in this policy initiative. However, I have to say that I am disappointed in the budget request that is before us today, especially in light of all the work that Congress undertook last year to forge a constructive path forward for the Nation's space program.

While last year's Authorization Act was by no means a perfect bill, it did clearly articulate Congress' intent that NASA pursue a meaningful human spaceflight and exploration program that builds on all the work that has been done over the past five years. I had thought the Administration agreed with the compromise that was enacted into law, but I am afraid I do not see it reflected in the proposed NASA budget request. The request cuts NASA's overall budget plan and its human exploration budget even further than before, delays the development of the next generation vehicles and eliminates any concrete destinations or milestones beyond the International Space Station.

This is an unfortunate situation for a number of reasons, but its most damaging impact will be on both our existing, highly skilled workforce and on the young people who are inspired by NASA to dream of careers in science and technology. The start-stop approach to finding funding goals that we have seen over the past

several years can only cause us to lose the best and brightest of both groups, and they will never be replaced. It will not be easy. We are really not getting them ready, so we cannot afford to lose the ones we have.

I know that you have great sympathy for the budget and the pressures that NASA is facing, as do we. That is why I am hoping and expecting that the Administration would provide some constancy of funding and direction to the Agency, and I am afraid that I don't see it in the budget that has been submitted to Congress.

So where do we go from here? I think that the most constructive approach for all of us here is to consider the budget request that you will present today as the beginning of a discussion, not the end. We are going to need you to tell us what you can do with your budget, not what you can't do. We need to know about spaceflight goals that have been set forth in successive NASA authorization acts. We want to know what is possible. We need to know not just what you cannot do. Make no mistake about it. This is a critical period for NASA. Our leadership and preeminence in space and aeronautics is at stake. Resting on our laurels from prior accomplishments is not an option. Sustained investments in research, technology and development must be made, not just for our sake, but for our Nation's sake. Without this sustained investment in the years ahead, NASA will be hard-pressed to foster the innovation needed to inspire young generations to pursue scientific and technical careers, and that would be a bad sign for our Nation.

I want to work with you, Administrator Bolden, and with Chairman Hall to ensure that NASA continues to instill pride and to inspire by pushing back the frontiers of knowledge through exploring and living in space, advancing science and engineering and developing innovative technologies.

I want to again welcome you, and I hope that we can work together to see that we have a more positive NASA program. I yield back. Thank you, Mr. Chairman.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you Chairman Hall, and welcome back to the Committee, Administrator Bolden. I want to congratulate you and your agency on the successful launch of STS-133. I understand that the mission has been very productive to date, and I look forward to the crew's safe return to Earth next week.

Today is the Congress's first opportunity to review the president's Fiscal Year 2012 budget request for NASA. This budget request is coming over in a very challenging budgetary environment, with the appropriations for FY 2011 still undecided even though we are now five months into that year. I can only imagine the challenges you are facing, Mr. Administrator, in trying to plan and carry out the challenging activities that the nation has asked you to undertake when the budgetary sands keep shifting under you.

I hope that we are able to resolve our current appropriations impasse soon, but I also hope that an agreement doesn't come at the expense of the critical investments this nation needs to make to prepare for the future. I consider NASA to be one of those critical investments.

One only has to look at all of the advances, new technologies, and inspiration that NASA has delivered over the years to realize that the people of NASA are one of our nation's vital resources, and we need to support them and their important missions in space and Earth science, aeronautics, and human space flight and exploration. I could spend my entire time today listing just some of the fruits of our past investments in NASA that have become embedded in our daily life, whether they be as broad in scope as global satellite communications or as specific as smoke de-

tectors, cordless power tools, digital mammography, body imaging, and firefighter breathing systems.

Other nations increasingly are recognizing the benefits a strong and active space program can deliver, and as a result we see them being willing to make the necessary investments to build their space capabilities. However, I am worried that we here in America are forgetting how important these R&D investments are to our future, and how critical this skilled workforce is to our future competitiveness.

Mr. Bolden, I am a great admirer of you and the inspirational leadership you bring to NASA. I am also a supporter of the president who wishes him to be successful in his policy initiatives. However, I have to say that I am disappointed in the budget request that is before us today, especially in light of all the work that Congress undertook last year to forge a constructive path forward for the nation's space program.

While last year's Authorization Act was by no means a perfect bill, it did clearly articulate Congress's intent that NASA pursue a meaningful human space flight and exploration program that builds on all of the work that has been done over the past five years. I had thought that the Administration agreed with the compromise that was enacted into law, but I am afraid that I do not see it reflected in the proposed NASA budget request. The request cuts NASA's overall budget plan and its human exploration budget even further than before, delays the development of the next generation vehicles, and eliminates any concrete destinations or milestones beyond the International Space Station.

That is an unfortunate situation for a number of reasons, but its most damaging impact will be on both our existing highly skilled workforce and on the young people who have been inspired by NASA to dream of careers in science and technology. The start-stop approach to funding and goals that we have seen over the past several years can only cause us to lose the best and brightest of both groups, and they are not going to be easily replaced.

Mr. Bolden, you know that I have great sympathy for the budgetary and other pressures NASA is facing. That is why I was hoping and expecting that the Administration would provide some constancy of funding and direction to the agency, but I'm afraid that I don't see it in the budget that has been submitted to Congress.

So where do we go from here? I think that the most constructive approach for all of us here is to consider the budget request that you will present today as the beginning of the discussion, not the end. We are going to need you to tell us what you can do with your budget to meet the human spaceflight goals that have been set forth in successive NASA Authorization Acts—not simply tell us what you can't do. And if additional resources are needed to realize those goals, we need to know that too.

Make no mistake about it, this is a critical period for NASA. Our leadership and preeminence in space and aeronautics is at stake. Resting on our laurels from prior accomplishments is not an option. Sustained investments in research, technology, and development must be made. Without this sustained investment in the years ahead, NASA will be hard-pressed to foster innovation needed to inspire our younger generations to pursue scientific and technical careers. That would be a shame.

I want to work with you, Administrator Bolden, and you, Chairman Hall, to ensure that NASA continues to instill pride and to inspire by pushing back the frontiers of knowledge through exploring and living in space, advancing science and engineering, and developing innovative technologies.

With that, I again want to welcome you to today's hearing, Administrator Bolden, and I yield back the balance of my time.

Chairman HALL. Thank you, Ms. Johnson, for a great opening statement, and if there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

Chairman HALL. At this time I would like to and am proud to introduce the witness. Charles F. Bolden Jr., was appointed NASA Administrator by President Obama and was 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 Southeast Asia during the

Vietnam War. He was a test pilot. He held a number of commands. Mr. Bolden retired from the Corps with a rank of Major General.

He is a true patriot, and we are very proud to have him here today. He is also a friend of mine, admired by many. I observed him just several weeks ago as he nurtured the care of those that had lost others in carrying out the space program out at the cemetery here. I was with him last Thursday as he welcomed everybody for a great day and a day of pride that we launched successfully, and he is a true patriot, and we are very glad to have him before us today.

I recognize you, sir, for five minutes, but we would be more lenient with you since I had to read all these things to you here. If you need more time, you take it.

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

Mr. BOLDEN. Chairman Hall, Ranking Member Johnson, Members of this Committee, thank you very much. And Chairman and Ranking Member, let me congratulate both of you on your new leadership roles. I want to thank you and all the Members of the Committee for the longstanding support that all of you have given to NASA.

We have a common passion for space exploration and the benefits it brings our Nation. As you take on your new responsibilities, I look forward to continuing our work together in the same collegial fashion as we have in the past. And I would like to take the liberty of also thanking you, Chairman Hall, for getting space back into the name of this Committee. It was missing for many years, and it is now back in the name. So I do appreciate that.

With your permission, Mr. Chairman, I would like to show a very short video clip that we brought with us, if that is okay.

Chairman HALL. And who would object?

[Video]

Mr. BOLDEN. Thank you for the time to show that video, Mr. Chairman. Not a day goes by that I don't think and pray about Gabby. All of us in the NASA family continue to pray for her speedy and full recovery.

The International Space Station is our anchor for future exploration, and our crew members aboard ISS are truly serving on the frontiers of human experience. We are delighted that with the authorization bill passed and signed into law last fall, the station will continue as a global resource for another 10 years.

It is my privilege today to discuss the President's fiscal year 2012 budget request of \$18.7 billion for NASA. Despite the commitment to fiscal restraint, I am pleased that we are proposing to hold funding at the level appropriated in 2010, which of course, continues to be our spending level under the continuing resolution. This budget request continues the agency's focus on a reinvigorated path of innovation and technological discovery, leading to an array of challenging destinations and missions that engage the public.

The Authorization Act of 2010 gave NASA a clear direction. We're moving forward to implement the details of that Act with this fiscal year 2012 budget. The President's budget for NASA

funds all major elements of the Act while supporting a diverse portfolio of key programs.

Because these are tough fiscal times, we also had to make some difficult choices. Reductions were necessary in some areas so we can invest in the future while living within our means. This budget maintains a strong commitment to human spaceflight and the development of new technologies. It invests in the excellent science, aeronautics research and education programs that will help us win the future. It carries out programs of innovation to support long-term job growth and a dynamic economy that will help us out-innovate, out-educate and out-build all others in the world.

[Chart]

Along with our budget proposal, last week we published our 2011 strategic plan. NASA's core mission in support of this vision that is on the chart remains fundamentally the same as it has since its inception in 1958. Just this past week, we launched STS-133 on the Shuttle Discovery, one of the final three Shuttle flights to the ISS. Along with supplies that will support the station's scientific research and technology demonstrations, Discovery has also delivered a robotic crew member, Robonaut 2, R2. The Glory Earth Science Mission will launch from California this week on a mission to help us better understand Earth, its atmosphere and the variables affecting our climate. Our space program continues to venture in ways that will have long-term benefits, and there are many more milestones in the very near term.

Yesterday, we announced three new program offices to carry out our future work. NASA brings good jobs and bolsters the economy and communities across this Nation.

[Chart]

This chart shows at a very high level the scope of our activities for fiscal year 2012. Our priorities in human spaceflight in the fiscal year 2012 budget request are to maintain safe access for American astronauts to low Earth orbit as we fully utilize the International Space Station; facilitate safe, reliable and cost-effective U.S.-provided commercial access to low Earth orbit for American astronauts and their supplies as soon as possible; begin to lay the groundwork for expanding human presence into deep space, the moon, asteroids and eventually Mars through the development of a powerful, evolvable heavy-lift rocket and multipurpose capsule; and pursue technology development to carry humans farther into the solar system. These initiatives will enable America to retain its position as a leader in space exploration for generations to come.

At the same time, in our other endeavors, our priorities are to extend our reach with robots and scientific observatories to learn more about our home planet and the solar system and peer beyond it to the origins of the universe; pursue ground-breaking research into the next generation of aviation technologies; and carry out dynamic education programs that help develop the next generation of science, technology, engineering and mathematics professionals. That is a lot, but NASA thrives on doing big things. We have vastly increased human knowledge, and our discoveries and technologies have improved life on Earth.

There has been some concern that NASA is abandoning human spaceflight. This simply is not true.

[Chart]

These charts illustrate the percentage of NASA's budget that supports human spaceflight. As you can see, it is a substantial portion, 44 percent in this chart. If I remove the cost of facilities and other support, it is 57 percent of our budget.

[Chart]

Here is human spaceflight broken out with its slice of the pie alone. We devote some resources in closing out the Shuttle program. As the centerpiece of human spaceflight and the critical anchor for our future deep space exploration, the International Space Station gets the largest portion of funds. The next generation of vehicles, the evolvable heavy-lift rocket and the multipurpose crew vehicle, received 39 percent of our human spaceflight budget. Our continuing efforts to facilitate commercial access to space receive a significant boost but still represent almost the smallest piece of our human spaceflight pie.

I want to commend the NASA workforce, both civil servants and contractors, across the Nation for their dedication to our missions during this time of transition and change. These workers are our greatest assets, and they make us all proud. They fully understand the risks of our exploration and welcome the challenge. They will be the ones making tomorrow happen.

These are exciting and dynamic times at NASA. The challenges ahead are significant, but the opportunities are great. We have to achieve big things that will create a measurable impact on our economy, our world and our way of life.

I thank you for the time to make my statement, and I look forward to your questions, Mr. Chairman.

[The prepared statement of Mr. Bolden follows:]

PREPARED STATEMENT OF THE HONORABLE CHARLES F. BOLDEN, JR.

Mr. Chairman and Members of the Committee, today it is my privilege to discuss the President's FY 2012 budget request of \$18.7 billion for NASA. This request continues the Agency's focus on a reinvigorated path of innovation and technological discovery leading to an array of challenging destinations and missions that increases our knowledge, develop technologies to improve life, to expand our presence in space for knowledge and commerce, and that will engage the public. With the President's signing of the NASA Authorization Act of 2010 (P.L. 111-267) on October 11, 2010, NASA has a clear direction and is moving forward. NASA appreciates the significant effort that advanced this important bipartisan legislation, particularly efforts by the leadership and Members of this Committee. This is a time of opportunity for NASA to shape a promising future for the Nation's space program.

Because these are tough fiscal times, tough choices had to be made. But the proposed FY 2012 budget funds all major elements of the Authorization Act, supporting a diverse portfolio of programs, while making difficult choices to fund key priorities and reduce other areas in order to invest in the future. A chart summarizing the President's FY 2012 budget request for NASA is enclosed as Enclosure 1.

We have an incredible balance of human space flight, science, aeronautics and technology development. Within the human space flight arena, our foremost priority is our current human spaceflight endeavor—the International Space Station—and the safety and viability of the astronauts aboard it. The request also maintains a strong commitment to human spaceflight beyond low Earth orbit. It establishes critical priorities and invests in the technologies and excellent science, aeronautics research, and education programs that will help us win the future. The request supports an aggressive launch rate over the next two years with about 40 U.S. and international missions to the ISS, for science, and to support other agencies.

At its core, NASA's mission remains fundamentally the same as it always has been and supports our new vision: "To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind." This statement is from the new multi-year 2011 NASA Strategic Plan accompanying the FY 2012

budget request, which all of NASA's Mission Directorates, Mission Support Offices and Centers helped to develop, and reflects NASA's proposed direction and priorities.

Our human spaceflight priorities in the FY 2012 budget request are to:

- safely fly the last Space Shuttle flights this year and maintain safe access for humans to low-Earth orbit as we fully utilize the International Space Station;
- facilitate safe, reliable, and cost-effective U.S.-provided commercial access to low-Earth orbit first for cargo and then for crew as quickly as possible;
- begin to lay the ground work for expanding human presence into deep space—the Moon, asteroids, eventually Mars—through development of a powerful, evolvable heavy-lift rocket and multi-purpose crew capsule; and
- pursue technology development that is needed to carry humans farther into the solar system. Taken together, these human spaceflight initiatives will enable America to retain its position as a leader in space exploration for generations to come.

At the same time, we will extend our reach with robots and scientific observatories to expand our knowledge of the universe beyond our own planet. We will continue the vital work to expand our abilities to observe our planet Earth and make that data available for decision makers. We will also continue our groundbreaking research into the next generation of aviation technologies. Finally, we will make the most of all of NASA's technological breakthroughs to improve life here at home.

With the FY 2012 budget, NASA will carry out research, technology and innovation programs that support long-term job growth and economic competitiveness and build upon our Nation's position as a technology leader. We will educate the next generation of technology leaders through vital programs in science, technology, engineering, and mathematics education. And we will build the future through those investments in American industry to create a new job-producing engine for the U.S. economy.

This year we honor the legacy of President John F. Kennedy who 50 years ago set the United States on a path that resulted in a national effort to produce an unprecedented achievement. Now, we step forward along a similar path, engaged in a wide range of activities in human spaceflight, technology development, science, and aeronautics—a path characterized by engagement of an expanded commercial space sector and technology development to mature the capabilities required by increasingly challenging missions designed to make discoveries and reach new destinations.

NASA's Science Mission Directorate (SMD) continues to rewrite textbooks and make headlines around the world. Across disciplines and geographic regions worldwide, NASA aims to achieve a deep scientific understanding of Earth, other planets and solar system bodies, our star system in its entirety, and the universe beyond. The Agency is laying the foundation for the robotic and human expeditions of the future while meeting today's needs for scientific information to address national concerns about global change, space weather, and education.

- The Mars Science Laboratory will launch later this year and arrive at Mars in August 2012. It will be the largest rover ever to reach the Red Planet and will search for evidence of both past and present life.
- The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will launch in early 2012 and become the first focusing hard X-ray telescope to orbit Earth.
- Research and analysis programs will use data from an array of sources, including spacecraft, sounding rockets, balloons, and payloads on the ISS. We will continue to evaluate the vast amounts of data we receive from dozens of ongoing missions supported by this budget.
- A continued focus on Earth Science sees us continuing development of the Orbiting Carbon Observatory-2 (OCO-2) for launch in 2013 and other initiatives to collect data about our home planet across the spectrum.
- The budget reflects the scientific priorities for astrophysics as expressed in the recent Decadal Survey of the National Academy of Sciences. The budget supports small-, medium-, and large-scale activities recommended by the Decadal Survey.
- The Radiation Belt Storm Probe mission will launch next year, and development of other smaller missions and instruments to study the Sun will get underway here on the ground.

With the appointment of a new Chief Scientist, NASA will pursue an integrated, strategic approach to its scientific work across Mission Directorates and programs.

As we continue our work to consolidate the Exploration Systems and Space Operations Mission Directorates (ESMD and SOMD), both groups will support our current human spaceflight programs and continue work on technologies to expand our future capabilities.

- We will safely fly out the Space Shuttle in 2011, including STS-135 if funds are available, and then proceed with the disposition of most Space Shuttle assets after the retirement of the fleet. The Shuttle program accomplished many outstanding things for this Nation, and in 2012 we look forward to moving our retired Orbiters to museums and science centers across the country to inspire the next generation of explorers.
- Completing assembly of the U.S. segment of the ISS will be the crowning achievement of the Space Shuttle's nearly 30-year history. The ISS will serve as a fully functional and permanently crewed research laboratory and technology test bed, providing a critical stepping stone for exploration and future international cooperation, as well as an invaluable National Laboratory for non-NASA and nongovernmental users. During FY 2011, NASA will award a cooperative agreement to an independent non-profit organization (NPO) with responsibility to further develop national uses of the ISS. The NPO will oversee all ISS research involving organizations other than NASA, and transfer current NASA biological and physical research to the NPO in future years.
- In 2012, we will make progress in developing a new Space Launch System (SLS), an evolvable heavy-lift rocket that will be the first step on our eventual journeys to destinations beyond LEO.
- We will continue work on a Multi Purpose Crew Vehicle (MPCV) that will build on the human safety features, designs, and systems of the Orion Crew Exploration Vehicle. As with the SLS, acquisition strategy decisions will be finalized by this summer.
- NASA will continue to expand commercial access to space and work with our partners to achieve milestones in the Commercial Orbital Transportation Services (COTS) Program, the Commercial Resupply Services (CRS) effort, and an expanded Commercial Crew Development (CCDev) program. As we direct resources toward developing these capabilities, we not only create multiple means for accessing LEO, we also facilitate commercial uses of space, help lower costs, and spark an engine for long-term job growth. While the request is above the authorized level for 2012, NASA believes the amount is critical, combined with significant corporate investments, to ensure that we will have one or more companies that can transport American astronauts to the ISS. With retirement of the Space Shuttle in 2011, this is a top Agency priority.
- Most importantly, NASA recognizes that these programmatic changes will continue to personally affect thousands of NASA civil servants and contractors who have worked countless hours, often under difficult circumstances, to make our human spaceflight, science, and aeronautics programs and projects successful. I commend the investment that these dedicated Americans have made and will continue to make in our Nation's space and aeronautics programs. These are tremendously exciting and dynamic times for the U.S. space program. NASA will strive to utilize our workforce in a manner that will ensure that the Nation maintains NASA's greatest asset—the skilled civil servants and contractors—while working to increase the efficiency and cost-effectiveness in all of its operations.
- The 21st Century Space Launch Complex program will focus on upgrades to the Florida launch range, expanding capabilities to support SLS, MPCV, commercial cargo/launch services providers, and transforming KSC into a modern facility that benefits all range users. The program will re-plan its activities based on available FY 2011 funding to align with 2010 NASA Authorization's focus areas, including cross organizational coordination between 21st CSLC, Launch Services, and Commercial Crew activities.

NASA's Aeronautics Research Mission Directorate (ARMD) continues to improve the safety, efficiency and environmental friendliness of air travel.

- our work continues to address the challenge of meeting the growing technology and capacity needs of the Next Generation air travel system, or "NextGen," in coordination with the FAA and other stakeholders in airspace efficiency.

- NASA's work on green aviation technologies that improve fuel efficiency and reduce noise continues apace.
- We also continue to work with industry to develop the concepts and technologies for the aircraft of tomorrow. The Agency's fundamental and integrated systems research and testing will continue to generate improvements and economic impacts felt by the general flying public as well as the aeronautics community.

The establishment last year of the Office of the Chief Technologist (OCT) enabled NASA to begin moving toward the technological breakthroughs needed to meet our Nation's space exploration goals, while building our Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. By investing in high payoff, disruptive technology that industry cannot tackle today, NASA matures the technology required for our future missions in science and exploration while improving the capabilities and lowering the cost of other government agencies and commercial activities.

- In OCT's cross-cutting role, NASA recently developed draft space technology roadmaps, which define pathways to advance the Nation's capabilities in space and establish a foundation for the Agency's future investments in technology and innovation. NASA is working collaboratively with the National Research Council (NRC) to refine these roadmaps. The final product will establish a mechanism for prioritizing NASA's technology investments, and will support the initial Space Technology Policy Congress requested in the NASA Authorization Act.
- As leader of the Space Technology Program, OCT will sponsor a portfolio of both competitive and strategically-guided technology investments, bringing the agency a wide range of mission-focused and transformative technologies that will enable revolutionary approaches to achieving NASA's current and future missions.
- In FY 2012, a significant portion of the Exploration Technology Development Program is moved from ESMD to Space Technology. These efforts focus on developing the long-range, exploration-specific technologies to enable NASA's deep space human exploration future. The integration of Exploration Technology activities with Space Technology creates one robust space technology budget line, and eliminates the potential for overlap had NASA's space technology investments been split among two accounts. ESMD will continue to set the prioritized requirements for these efforts and will serve as the primary customer of Space Technology's Exploration-specific activities.
- continues to manage SBIR and STTR, and integrates technology transfer efforts ensure NASA technologies are infused into commercial applications, develops technology partnerships, and facilitates emerging commercial space activities

Recognizing that our work must continuously inspire not only the public at large but also students at all levels, NASA's Education programs this year focus on widening the pipeline of students pursuing coursework in science, technology, engineering and mathematics (STEM). As President Obama has said, "Our future depends on reaffirming America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in math, science, technology, and engineering."

- The FY 2012 request for NASA's Office of Education capitalizes on the excitement of NASA's mission through innovative approaches that inspire educator and student interest and proficiency in STEM disciplines. NASA's education program in FY 2012 and beyond will focus and strengthen the Agency's tradition of investing in the Nation's education programs and supporting the country's educators who play a key role in inspiring, encouraging, and nurturing the young minds of today, who will manage and lead the Nation's laboratories and research centers of tomorrow.
- Among NASA's Education activities will be a continued Summer of Innovation, building on the successful model piloted with four states this past year.

All of these activities place NASA in the forefront of a bright future for America, where we challenge ourselves and create a global space enterprise with positive ramifications across the world. The FY 2012 budget request provides the resources for NASA to innovate and make discoveries on many fronts, and we look forward to implementing it. See Enclosure 2 for a more detail summary of each activity.

## CONCLUSION

As we enter the second half-century of human spaceflight, the Nation can look back upon NASA's accomplishments with pride, but we can also look forward with anticipation to many more achievements to come. The NASA Authorization Act of 2010 (P.L. 111-267) has provided us with clear direction that enables the Agency to conduct important research on the ISS, develop new launch vehicle and crew transportation capabilities to go beyond the bounds of LEO, utilize a dazzling array of spacecraft to study the depths of the cosmos while taking the measure of our home planet, improve aviation systems and safety, develop new technologies that will have applications to both space exploration and life on Earth, and inspire the teachers and students of our country. In developing and executing the challenging missions that only NASA can do, we contribute new knowledge and technologies that enhance the nation's ability to compete on the global stage and help to secure a more prosperous future.

These are tough fiscal times, calling for tough choices. The President's FY 2012 budget request makes those choices and helps advance all of these bold aims, and we look forward to working with the Committee on its implementation.

Mr. Chairman, thank you for your support and that of this Committee. I would be pleased to respond to any questions you or the other Members of the Committee may have.

## BIOGRAPHY OF THE HONORABLE CHARLES F. BOLDEN, JR.

Nominated by President Barack Obama and confirmed by the U.S. Senate, retired Marine Corps Major General Charles Frank Bolden, Jr., began his duties as the twelfth Administrator of the National Aeronautics and Space Administration on July 17, 2009. As Administrator, he leads the NASA team and manages its resources to advance the agency's missions and goals.

Bolden's confirmation marks the beginning of his second stint with the nation's space agency. His 34-year career with the Marine Corps included 14 years as a member of NASA's Astronaut Office. After joining the office in 1980, he traveled to orbit four times aboard the space shuttle between 1986 and 1994, commanding two of the missions. His flights included deployment of the Hubble Space Telescope and the first joint U.S.-Russian shuttle mission, which featured a cosmonaut as a member of his crew. Prior to Bolden's nomination for the NASA Administrator's job, he was employed as the Chief Executive Officer of JACKandPANTHER LLC, a small business enterprise providing leadership, military and aerospace consulting, and motivational speaking.

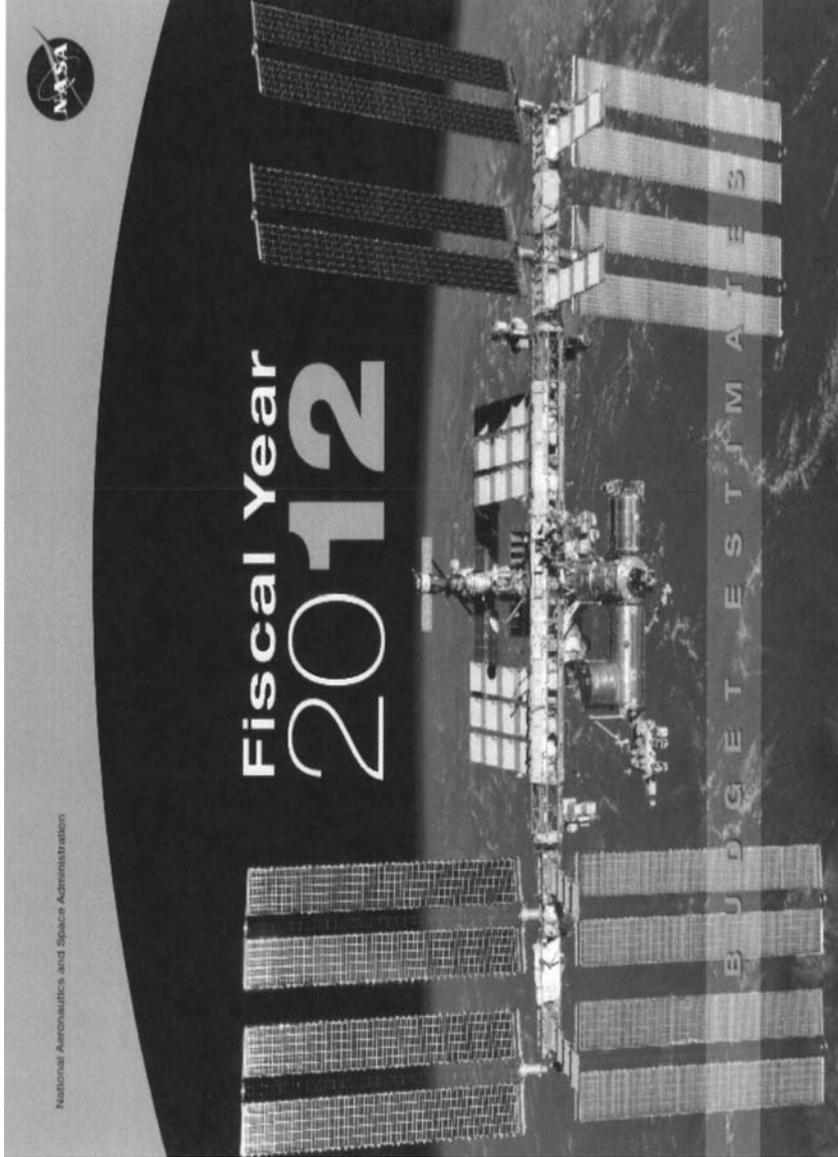
A resident of Houston, Bolden was born Aug. 19, 1946, in Columbia, S.C. He graduated from C. A. Johnson High School in 1964 and received an appointment to the U.S. Naval Academy. Bolden earned a bachelor of science degree in electrical science in 1968 and was commissioned as a second lieutenant in the Marine Corps. After completing flight training in 1970, he became a naval aviator. Bolden flew more than 100 combat missions in North and South Vietnam, Laos, and Cambodia, while stationed in Namphong, Thailand, from 1972–1973.

After returning to the U.S., Bolden served in a variety of positions in the Marine Corps in California and earned a master of science degree in systems management from the University of Southern California in 1977. Following graduation, he was assigned to the Naval Test Pilot School at Patuxent River, Md., and completed his training in 1979. While working at the Naval Air Test Center's Systems Engineering and Strike Aircraft Test Directorates, he tested a variety of ground attack aircraft until his selection as an astronaut candidate in 1980.

Bolden's NASA astronaut career included technical assignments as the Astronaut Office Safety Officer; Technical Assistant to the Director of Flight Crew Operations; Special Assistant to the Director of the Johnson Space Center; Chief of the Safety Division at Johnson (overseeing safety efforts for the return to flight after the 1986 Challenger accident); lead astronaut for vehicle test and checkout at the Kennedy Space Center; and Assistant Deputy Administrator at NASA Headquarters. After his final space shuttle flight in 1994, he left the agency to return to active duty the operating forces in the Marine Corps as the Deputy Commandant of Midshipmen at the U.S. Naval Academy.

Bolden was assigned as the Deputy Commanding General of the 1st Marine Expeditionary Force in the Pacific in 1997. During the first half of 1998, he served as Commanding General of the 1st Marine Expeditionary Force Forward in support of Operation Desert Thunder in Kuwait. Bolden was promoted to his final rank of major general in July 1998 and named Deputy Commander of U.S. Forces in Japan. He later served as the Commanding General of the 3rd Marine Aircraft Wing at Marine Corps Air Station Miramar in San Diego, Calif., from 2000 until 2002, before retiring from the Marine Corps in 2003. Bolden's many military decorations include the Defense Superior Service Medal and the Distinguished Flying Cross. He was inducted into the U.S. Astronaut Hall of Fame in May 2006.

Bolden is married to the former Alexis (Jackie) Walker of Columbia, S.C. The couple has two children: Anthony Che, a lieutenant colonel in the Marine Corps who is married to the former Penelope McDougal of Sydney, Australia, and Kelly Michelle, a medical doctor now serving a fellowship in plastic surgery.





*NASA's Vision from the 2011 Strategic Plan:*

*To reach for new heights*

*and*

*reveal the unknown*

*so that*

*what we do and learn*

*will*

*benefit all humankind*



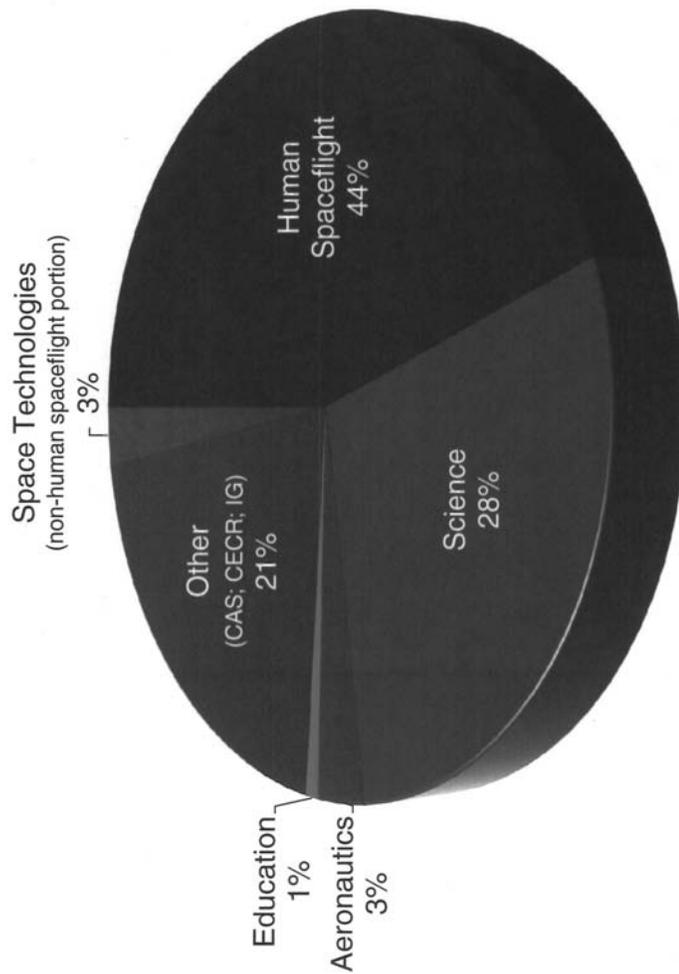
## FY 2012 Budget Request

Budget Authority (\$M)	FY 2012
Science	5,017
Aeronautics	569
Space Technology	1,024
Exploration Systems	3,949
Space Operations	4,347
Education	138
Cross-Agency Support	3,192
CoF and ECR	450
Inspector General	38
<b>NASA FY 2012</b>	<b>18,724</b>

The FY 2012 Budget provides \$18.7 billion in 2012 for NASA to support a diverse portfolio of programs even in austere times.

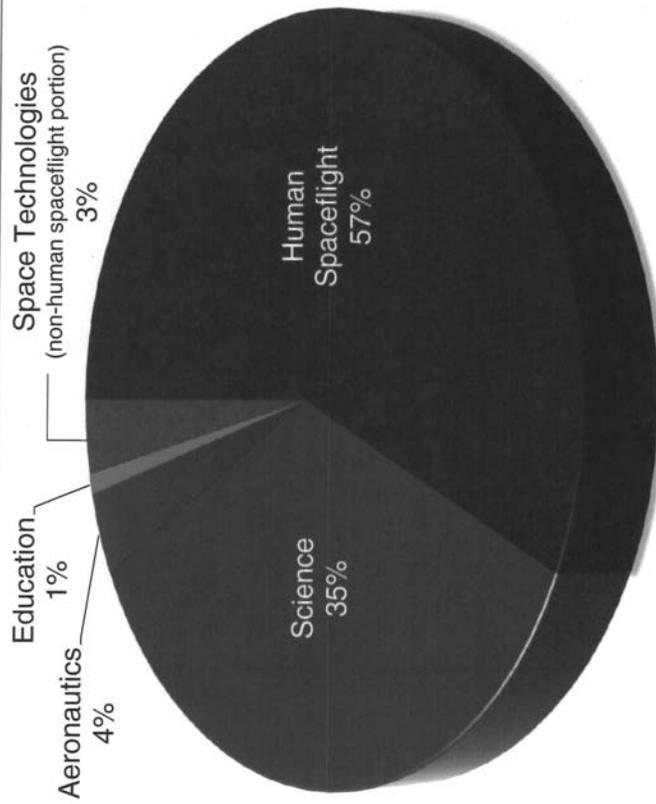


# NASA Budget





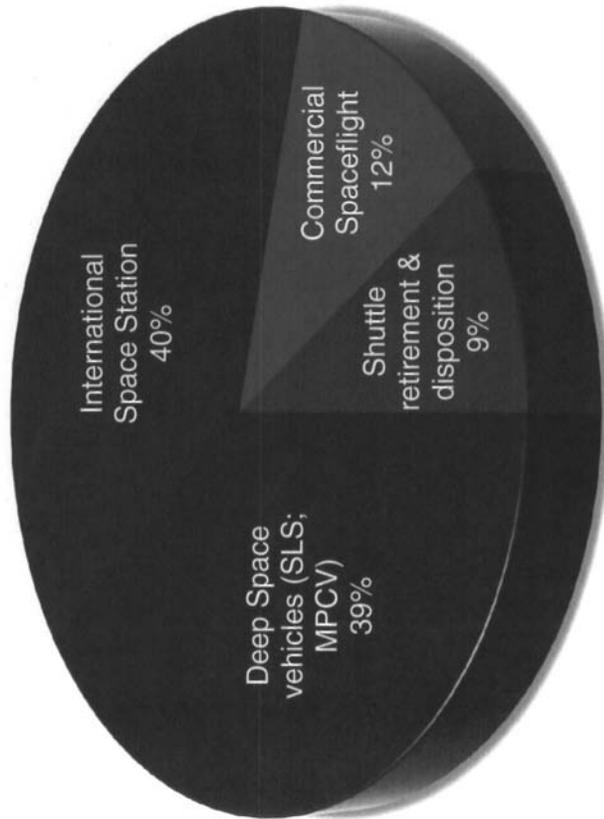
## NASA Programmatic Budget





## NASA Human Spaceflight Budget

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Chairman HALL. Thank you, Mr. Bolden. I think most of you know that our Committee rules limit questioning to five minutes. I will recognize myself for five minutes.

Mr. Bolden, as I said in my opening remarks, I want us to have the safest possible assured access to the space station that meets the goals of the United States and our international partners, and I know you want that same thing.

Trying to stimulate commercial competition is a worthy goal that I support but not at the expense of insuring the safest, most robust system for our astronauts. Norm Augustine's committee report said while there may be potential benefits of commercial services that transport crews to the low-Earth orbit, there are simply too many risks at the present time not to have a viable fallback option for risk mitigation.

Congress has taken these concerns to heart and expressed them in the policy and funding direction in the NASA Authorization Act and in subsequent appropriations measures including the fiscal year 2011 continuing resolution. Yet, NASA's fiscal year 2012 budget request once again seeks to reverse Congressional priorities by proposing increased funding for commercial crew activities and significant reductions in the multipurpose crew vehicle and space launch system that builds on the experience, the workforce of the Shuttle, the workforce of Republicans and Democrats alike and the Constellation program to ensure that we have the capabilities to do the things in space that are strategically important for the United States.

Mr. Bolden, frankly we are exasperated that NASA is not listening to our message, and I guess maybe you are listening to our message and maybe your advice falls on non-receptive ears. I don't know what the problem is, but I think for this Committee here, we would appreciate if you could just justify why NASA is proposing the reductions to the human exploration capabilities budget that is clearly our priority.

Mr. BOLDEN. Mr. Chairman, I get your message loud and clear and so does the President, and as I mentioned, I think the budget does in fact reflect following your guidance.

As I mentioned, these are very difficult times. Things have changed significantly since last year when we all thought that we were on a certain path. I took a look at the priorities that were established for us in human spaceflight, and I will tell you, it was probably 2004. You will remember better than I. But I came with John Blaha, former astronaut. The two of us came up to brief you on potential future human spacecraft when we were trying to decide how we were going to execute the vision for space exploration, and John Blaha got down on his knees at your desk and took a pad of paper and started drawing guidelines and descriptions of why a certain spacecraft could not work or would not work. And you made the statement to us that you understand all that but I need to understand something else and I need to take this message back to the NASA Administrator. We will not lose another crew in spaceflight, and if we do, somebody will have hell to pay. Those words have stuck with me, and I do not intend to have to pay any debt on losing a crew. So safety of our crews is always my number one priority.

When I looked at how we get them safely to the International Space Station on American-made rockets, the best way to do that, and we can discuss this in the coming months, but the best, most efficient, perhaps fastest way to do that is by relying on the commercial entities that are well-along in their development programs to provide access to low-Earth orbit while NASA engages exploration, uses the evolvable heavy-lift vehicle and crew exploration vehicle to go do exploration beyond low-Earth orbit.

So I think we are complying with the major elements of the Authorization Act, and we made the adjustments in the balance inside that Act that now causes the consternation because we wanted to make sure that I put number one priority, safety of the crew. The heavy-lift launch vehicle and the multipurpose crew vehicle, while they are exploration vehicles, and everybody needs to understand that. They are not being built to double as low-Earth orbit vehicles. That is inefficient. I think anybody around here knows that when you try to build one system to do everything, you end up with nothing.

So we are building, we are going to build an exploration system, heavy-lift launch vehicle and multipurpose crew vehicle. Anything that can go beyond Earth orbit can go to low-Earth orbit. It is just very inefficient and a big waste of money. But the exploration systems will have the capability of providing backup should any commercial entity fail. And failure is not meant they failed to produce. They will produce because the commercial entities have produced for years. Orbital, that is one of our competitors right now in both the COTS program and the CRS program and has announced that they intend to compete in commercial crew. Orbital has a record of success since the 1980s and 1990s. They have launched 155 successful space launches. Many of my satellites that are on orbit today were put there by Orbital sciences. So they can produce. Anyone who would try to convince you that they cannot, that American industry cannot produce, is just not being factual and they are not being truthful and they are being disingenuous.

So we have made the decision that safety of the crew is number one priority. The quickest, most efficient, safest way for me to get them there is through relying on commercial entities to handle to access to low-Earth orbit, and then my focus on safety for crews that are going beyond low-Earth orbit.

Chairman HALL. I don't know how much more time I have, but 30 years ago or over 30 years ago when I first came up here, I was lucky enough or fortunate enough to be on this Committee. And I took trips to the areas that launched our people. You and many other brave men and women that made the program such an American program, something we were so proud of, and I had hoped at that time that some day commercial people could, that the private sector could launch these things and take it away from the government. But knowing that it took the tax basis, the background of all of the people of the United States to make it go, I realized that was going to be a long time coming. I think you have the opinion that it is basically here or that we are hoping that we can reach that. And I hope that we can all get together. You and I differ on this, and some of us differ on it. Some of our Members here are good, valuable Members, agree with you 100 percent.

So you have support on this Committee and you have my support, but I want to get together with the people that can make it go and be sure they can make it go. And I don't want to close the bidding to anybody in the world, but I want them to do more than just sign a contract. I want them to show as you say that they can do what they are contracting to do and not go halfway and look back over their shoulder and say so sorry.

Mr. BOLDEN. Yes, sir.

Chairman HALL. That is what we have to guard against, and I thank you for your answer.

Mr. BOLDEN. Thank you, Mr. Chairman.

Chairman HALL. At this time, I recognize Mrs. Johnson.

Ms. JOHNSON. Thank you very much. I am not really sure where to begin. You have indicated that NASA has planned the last Shuttle mission, STS-135 if funds are available. Recognizing that the appropriations for 2011 have not been even finalized, what priority does STS-135 have relative to the priorities of NASA otherwise?

Mr. BOLDEN. Congresswoman, STS-135 is on my schedule, and I intend to fly STS-135 in June. I have a launch date. I think it is June 28, and unless this Congress does something that changes the fiscal status of present conditions, and you can do that. I mean, if you take drastic action and significantly reduce the amount of money that I get whenever we get a 2011 budget, then it could change things. But right now, I anticipate that reasonable people can disagree and that the Congress is going to come to agreements that will not cripple NASA and the rest of the Nation, and we will fly STS-135.

Ms. JOHNSON. Thank you very much, and I yield back, Mr. Chairman.

Chairman HALL. At this time I will recognize the gentleman from Texas, Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman. Mr. Bolden, less than a year ago the President gave a speech and said that he actually wanted to increase NASA's budget by I think \$6 billion. The White House budget is now I think \$2.5 billion less than NASA's flat line budget. You imply in your testimony that there are going to be sufficient resources for the heavy-lift rocket, for the crew vehicle and for landing systems for missions to I guess Mars, moon and the asteroids.

It seems to me that vision without resources is a fantasy and that it is not really credible to say you can complete all those missions with the resources that have been designated, and I just wondered if you would respond to that. There are a lot of professionals, a lot of NASA professionals, that just say it can't be done, and you and the Administration are saying it can be done.

Mr. BOLDEN. So you are the only one that I have heard in the last few weeks that I am saying that anything can be done. Everybody else tells me I am saying it can't, and I do believe it can.

Mr. SMITH. So you stand by your budget and think you are going to accomplish all that with the resources that you have designated?

Mr. BOLDEN. Yes, sir, I do.

Mr. SMITH. Okay. Would you please give me a timetable and a cost for the missions, not to Mars. That is just I think off the books

and too expensive. But give me a cost and a timetable for the missions back to the moon and to the asteroids.

Mr. BOLDEN. Congressman, I am unable to give you a timetable at this particular time because we need to find out first of all what my 2011 budget is going to be. I am spending right now at the 2010 spending level hoping that that doesn't get dramatically reduced below that. If it does, all bets are off because as we get close—I don't intend to be preaching to the choir here, but I just want to remind everybody, the closer we get to the end of the fiscal year, if I get a drastic reduction in my budget, it all hits at one time and all bets are off. We have got to go back to the drawing board. I don't anticipate that that is going to happen. It is my hope that we will be able to continue spending at the 2010 level or higher, and then I think we are planning to bring to the Congress in the summer a plan for a multipurpose crew vehicle and evolvable heavy-lift system that will enable us to meet targets set by the Congress and the President, and those targets to date are an asteroid in the timeframe of 2025 or so and a mission to or around the moon with a follow-on landing some time in the '20, '30s. So those dates I still stand by.

The other date that you gave me in the Authorization Act, 2016 for a heavy-lift launch vehicle and a multipurpose crew module, those were difficult meeting even under the proposed 2011 budget and the amounts, the level of the Authorization Act. And that was what I said in my 90-day report, that I can't—I did not say we could not do it. What I said was given the level of funding in the 2010 Authorization Act, you have now made it very difficult for me to be able to execute the development of a heavy-lift launch system and a multipurpose crew vehicle that is flying in 2016. I have not said I cannot do that, but I don't want to mislead anyone and make them think that I am saying we can do it.

There are a lot of industry representatives sitting behind me here who will tell you that we, together as a team, are going to be challenged no matter how much money you give us. But we will make our effort to do what it is that the Congress and the President—

Mr. SMITH. Mr. Bolden, let me squeeze in one more question and that is I was glad to see I think an eight percent increase in the astrophysics program. A lot of that is going to be directed to the search for Earth-like planets. What is the latest development in that area and what do you expect us to learn in the next couple of years?

Mr. BOLDEN. Congressman, you sound like someone who is interested, so I will tell you the results from WISE and results to date from the Kepler observatory have been next to phenomenal. We have identified, and I can't hold it in my brain, the numbers, but we have just in the last year identified literally hundreds if not thousands—

Mr. SMITH. What about the future, the next couple years?

Mr. BOLDEN. We are going to fly additional missions that will just build upon that knowledge. Kepler is not done. WISE is shut out, but we are looking at a follow-on to WISE. You know, I would love to fly something that goes around Venus and looks back at Earth because I am not an astrophysicist or any of that stuff, but

my science experts tell me that if we can put something like a WISE satellite in a Venus orbit looking back at Earth, when it comes to near-Earth objects, for example, things that will threaten this planet, we will have a much better look at them, a much better ability to make early determinations on their trajectory. And I know this is hokey stuff to some people and they will want to laugh me off the planet but potentially will save the planet one of these days.

Mr. SMITH. Thank you, Mr. Bolden. Thank you, Mr. Chairman.

Chairman HALL. Thank you. At this time the Chair recognizes the gentleman from Oregon, Congressman Wu. All right. The gentlelady Ms. Edwards. I recognize Ms. Edwards and I am proud to.

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you, Mr. Administrator.

I just have a question that goes to the consistencies between the authorization and your budget, and I think there are a number of areas where—what I am trying to read is whether the authorization that we only just recently approved kind of matches your budget priorities. And so I would appreciate your speaking to that, and then further going to the details of the Earth sciences. And my concern is that I think where we try to step up our investment in Earth sciences, it seems that, you know, some of that is being sacrificed in this budget. And so I would like you to address that and address, if you will, the continuing resolution as we have known it, and I think we will see some evolution of that over the next couple of weeks, and what the budget impact of the CR would be on the Earth sciences component, stretching out some of these programs. And in some cases, I guess I wonder whether, you know, once you began to stretch out or cancel these programs, the investment that we have already made in them might cancel out any potential savings from cancelling them. So I am a little unclear about that, and if you could give us some insight into those areas of the budget proposal, I would appreciate it.

Mr. BOLDEN. Yes, ma'am. Congresswoman, let me go back to October of last year. Some of you will remember I was making phone calls to you as debate was going on on the floor of the House about the Authorization Act. I was criticized for being out of the country. Nonetheless, I don't think that any of you knew that I was because I was on the phone to you all night when we debated the level of authorization or even the passage of the authorization bill. At that time we had not had an election. The fiscal environment in the Nation was a lot different than it was one month later when the President finally signed the bipartisan Authorization Act.

So things really changed between the time that this Congress labored to develop the 2010 Authorization Act and the time that the President signed it and now. We always face the budgetary problems that we do today, but none of us have taken the time to sit down and say, okay, we are really going to deal with it.

So the 2012 budget made our first effort to say we are really going to deal with the fiscal reality, and so we took a cut. We made some very difficult choices in all of our programs. The Earth science programs to which you question, many of them went back to the dates of launch that were planned when I became the NASA

Administrator. If you remember, when we proposed the President's 2011 budget, we were really happy because we had a significant amount of plus-up for Earth science. We were going to pull programs like DESDynI and CLARREO forward by as much as two years. We had Earth science missions that were going to be flown that we didn't even know that we could put on the books. Today things have really changed, and so in the case of those two as examples, CLARREO, DESDynI, they are now back to the original dates when I became the administrator which is about 2018.

Ms. EDWARDS. Mr. Administrator, let me just ask you. So if you add together the investments that have already been made in DESDynI and GPM and the Joint Dark Energy Mission and CLARREO, add all of those things together, are we really getting savings by cancelling or stretching these out?

Mr. BOLDEN. We have no choice but to stretch out DESDynI and CLARREO because we don't have the money available that we were going to use to bring them forward. And it appears that we are stretching them out. We are taking them back to the original launch dates. Those two, JDEM is no longer on NASA's books. We are looking for other dark energy missions to replace that. The one that I think came out of the Astrophysics Decadal Survey was WFIRST which is a major mission of significant cost that we may or may not be able to bring into this decade, so it may have to wait.

I don't see any reason to take any of our Earth science missions off the table right now. I am doing everything I can to preserve those missions.

Ms. EDWARDS. Well, you can just answer this for the record when you can, but I really would appreciate a response from the Administration on the effect that these kind of program cuts have on experiments that provide satellite reporting that help us in the present—understanding and tracking tropical storms in Florida and the Gulf Coast, monitoring wildfires in California, tornado formations in the middle of the country. I mean, these have actually present-day impact when you look at the kinds of cuts that are being proposed.

So if you are telling me that maybe it is that we are not going to have any storms, maybe we are not going to have any wildfires or tornados, that would be really cool. You would be quite a projectionist. But the reality is we won't have the tools to look at these things in the way that we need to that cost human lives, cost property and damage and impact our commerce. And with that I close.

Mr. BOLDEN. Congresswoman, I will take that for the record, and I would say I thank you for your observation. We are in dire straits as a Nation when it comes to weather and climate prediction. NPOESS is a satellite system jointly done by NOAA, NASA and the Department of Defense which is no longer there. We have had to break it up because of problems that we had, and we really do need to take a focused look at our Earth science programs so that we make sure that we don't allow gaps to occur in the coverage for things like weather.

I need to get people thinking about Earth science as the study of our planet, its atmosphere, its oceans and the topography, the land, so that we don't do dumb things like think we can do away with an Earth science satellite because it is talking about global

warming. That is not what I do. I don't do global warming. I do Earth science. And so we should talk more about.

Chairman HALL. Thank you, Mr. Chairman. I don't do global warming, either. We are sure on the same side there.

Thank you, Ms. Edwards. Now, I recognize one of the real veterans of this Committee, Mr. Rohrabacher, the gentleman from California.

Mr. ROHRABACHER. Did somebody say global warming? I want to thank you, General, for mentioning Earth objects. And again, too many people take this issue so lightly, and it would surprise no one if tomorrow there was a discovery made that an object was heading toward the Earth that could cause tremendous loss of life, and we would be caught flat-footed. So those of us who are willing to take the laughs, et cetera, and the scoffing, are playing a very important role in protecting a large number of people on this planet.

I understand in your budget you are taking care of certain usage of the Arecibo telescope that will ensure that that important part of identifying objects that could threaten the Earth stays in play. Let me know about NPOESS. Had that project, NPOESS project, been on time and on budget, we wouldn't be worried about anything right now, would we? We would have all the money we want. If we just would have run that one project, all of the money for heavy lift, all of that, would have been available because it has all been wasted. Your most important job, General, is to make sure that never happens again and that we never waste billions of dollars by having programs managed so inefficiently as that program was managed.

I would like to place in the record, Mr. Chairman, a letter for the record of 50 leaders, a letter signed by 50 leaders from the space community, including former NASA executives and former astronauts and one former chairman of this very committee, talking basically—I would like to submit this letter for the record at this point, Mr. Chairman.

Chairman HALL. Without objection.

[The information follows:]

OPEN LETTER TO CONGRESS

01 March 2011

Dear Members of Congress:

We, the undersigned space leaders—over 50 of us, are strong supporters of human spaceflight. We are writing to urge you to fully fund NASA's plan to use commercial companies to carry crew to the Space Station because it is critical to the health of the Nation's human spaceflight efforts.

Among us are former NASA executives and advisors, former astronauts, CEOs and directors of firms large and small, space scientists, space journalists, and others. We include 14 former NASA astronauts, 5 former NASA senior executives, 13 educators and nonprofit leaders, and 24 space industry leaders from a wide variety of firms and institutions, both large and small.

We are a diverse group, but we are only a tiny fraction of the Nation's citizens who support U.S. leadership in human space flight and the development of competitive commercial human spaceflight.

By creating competition, and using fixed price contracts, NASA's commercial crew program offers a much less expensive way of transporting NASA astronauts to the Station than any other domestic means. Funding NASA's Commercial Crew program would lower the cost of access to low Earth orbit, thus enabling more of NASA's budget to be applied to its focus on exploration beyond low Earth orbit, and better enabling the kind of program laid out in NASA's authorization bill.

NASA's competitive commercial crew program is the best way to restore US human launch capability after the Space Shuttle retires later this year, to ensure NASA's long-term role in the International Space Station, and to open up budget resources to send crew beyond Earth orbit.

Moreover, by being less expensive than other approaches to Space Station crew transport, the Commercial Crew program represents one of the best means to prevent damage to NASA's human spaceflight capabilities in the face of across the board spending cuts being discussed by Congress.

After the Space Shuttle retires, Russia is set to carry American astronauts to the Space Station. By hiring American businesses, NASA's Commercial Crew to Space Station program also generates thousands of high tech American jobs across states ranging from Florida, to Alabama, to Texas, to California, to Virginia, to Colorado, to Nevada, and to Maryland, rather than sending these jobs overseas to Russia to build Soyuz capsules and rockets.

For these important reasons, we fully and enthusiastically support full funding for NASA's commercial crew to Space Station program and urge you to support this program as well in your votes this year.

Sincerely,

The undersigned, listed alphabetically

Dr. Loren Acton,  
*Former NASA Astronaut,  
Professor, Montana State  
University, Bozeman, Montana*

Mr. Eric Anderson  
*CEO, Space Adventures, Chairman  
of the Board, Commercial  
Spaceflight Federation,  
Seattle, Washington*

Dr. Jim Bell  
*Professor, ASU School of Earth  
and Space Exploration,  
President, The Planetary  
Society Phoenix, Arizona*

Dr. Jay Buckley  
*Former NASA Astronaut,  
Dartmouth, New Hampshire*

Mr. Bretton Alexander  
*President, Commercial Spaceflight  
Federation, Alexandria, Virginia*

Mr. Jeffery S. Ashby, USN, Ret.  
*Former NASA Astronaut, Colorado  
Spring, Colorado*

Mr. Ken Bowersox, USAF Ret.  
*Former NASA astronaut, Vice  
President of Mission Assurance and  
Astronaut Safety, Space Exploration  
Technologies Corp., Hawthorne,  
California*

Ms. Heather Bulk  
*President and CEO, Special Aerospace  
Services, Boulder, Colorado*

- Dr. Robert Farquhar  
*Senior Mission Designer, KinetX Corp., Fairfax, Virginia*
- Dr. Louis K. Friedman  
*Former Executive Director, The Planetary Society, Pasadena, California*
- Mr. Richard Garriott  
*Space Adventures Astronaut, Austin, Texas*
- Mr. Gerald D. Griffin  
*Former Director, NASA Johnson Space Center, Former Deputy Director, NASA Kennedy Space Center, Former Deputy Director, NASA Dryden Flight Research Center, Hunt, Texas*
- Dr. Jeffrey Hoffman  
*Former NASA Astronaut, and MIT professor, Cambridge, Massachusetts*
- Mr. James Muncy  
*Co-Founder, Space Frontier Foundation, Alexandria, Virginia*
- Dr. George D. Nelson  
*Former NASA Astronaut, Bellingham, Washington*
- Mr. Robert Poole  
*Former Member, Bush-Cheney Transition Team, Director, The Reason Foundation, Los Angeles, California*
- Mr. Bob Richards  
*CEO, Moon Express Inc. Google Lunar X Prize Team, Sunnyvale, California*
- Col. Richard Searfoss, USAF Ret.  
*Former NASA/Shuttle Commander, Chief Test Pilot, XCOR, Mojave, California*
- Mr. Robert Walker  
*Former Chair, House Science Committee, Chairman, Wexler and Walker, Public Policy Associates, Washington, D.C.*
- Dr. G. Wayne Finger, P.E.  
*Vice President, Aerospace & Defense, Reynolds, Smith & Hills, Inc., Jacksonville, Florida*
- Dr. Owen Garriott  
*Former NASA Astronaut, Huntsville, Alabama*
- Mr. Jeffrey Greason  
*CEO, XCOR Aerospace, Mojave, California*
- Dr. Leroy P. Gross, MD, MPH  
*CEO, Innovative Health Applications, LLC*
- Dr. Rick Holdridge  
*Chairman of the NM Spaceport Authority, Las Cruces, New Mexico*
- Mr. Elon Musk  
*CEO and CTO, Space Exploration Technologies Corp., Hawthorne, California*
- Mr. Joseph E. Palaia, IV  
*Manager, NewSpace Center, Vice President, 4Frontiers Corp., New Port Richey, Florida*
- Ms. Jayne Poynter  
*President, Paragon Space Development Corp., Tucson, Arizona*
- Dr. Russell L. "Rusty" Schweickart  
*Former NASA Astronaut, Sonoma, California*
- Col. Jim Voss, USAF Ret.,  
*Former NASA Space Shuttle Astronaut and Director of Advanced Programs, Sierra Nevada Corporation, Space Systems, Louisville, Colorado*
- Dr. Jack Burns  
*Professor, University of Colorado, Former Chair, NASA Advisory Council Science Committee, Denver, Colorado*

- Mr. Andy Chaikin  
*Space Historian / Science  
Journalist, Arlington, Vermont*
- Mr. Keith Cowing  
*Former Payload Manager, NASA  
Space Station Program,  
Founder, SpaceRef  
International, Reston, Virginia*
- Dr. Peter Diamandis  
*Chairman and CEO, X Prize  
Foundation, Playa Vista,  
California*
- Mr. Art Dula  
*CEO, Excalibur Almaz, Houston,  
Texas*
- Prof. G. Scott Hubbard  
*Former Director NASA Ames  
Research Center, Stanford  
University, Dept. of  
Aeronautics and Astronautics,  
Palo Alto, California*
- Mr. Michael Joyce  
*President & Founder, Next Giant  
Leap Google LLC Lunar X  
Prize Team, Boulder, Colorado*
- Dr. John Logsdon  
*Founder, Space Policy Institute,  
George Washington  
University., Washington, D.C.*
- Mr. Taber MacCallum  
*CEO, Paragon Space Development  
Corp., Tucson, Arizona*
- Mr. Bill Mitchell  
*Chairman, Environmental  
Tectonics Corporation /  
NASTAR, Southampton,  
Pennsylvania*
- Mr. Mark Sirangelo  
*Chairman, Sierra Nevada  
Corporation Space Systems,  
Former Chairman of the  
Board, Commercial  
Spaceflight Federation,  
Louisville, Colorado*
- Mr. Robert Cenker  
*Former NASA Astronaut, East  
Windsor, New Jersey*
- Mr. Tom Crabb  
*President, ORBITEC, Madison,  
Wisconsin*
- Dr. Michael Drake  
*Head, Lunar and Planetary  
Laboratory, University of Arizona,  
Tucson, Arizona*
- Mr. Edward Ellegood  
*Former Director, Spaceport Florida  
Authority, Director of Aerospace  
Development, Embry-Riddle  
Aeronautical University, Daytona  
Beach, Florida*
- Prof. Millie Hughes-Fulford  
*Former NASA Astronaut, University of  
California  
San Francisco, California*
- Mr. Dale Ketcham  
*Director, Spaceport Research &  
Technology Institute, Merritt Island,  
Florida*
- Mr. David Masten  
*CEO, Masten Space Systems Inc.,  
Mojave, California*
- Mr. Robert Meyerson  
*Program Manager, Blue Origin, LLC,  
Kent, Washington*
- Mr. Brewster Shaw, USAF Ret.  
*Former NASA Astronaut and Vice  
President and General Manager,  
Space Exploration Division, Boeing  
Houston, Texas*
- Ms. Patti Grace Smith  
*Former FAA Associate Administrator,  
and Aerospace Consultant,  
Washington, D.C.*

Mr. George F. Sowers

*Vice President for Business  
Development and Advanced  
Programs, United Launch  
Alliance, Denver, Colorado*

Dr. S. Alan Stern

*Former NASA Associate  
Administrator for Science,  
Niwot, Colorado*

Mr. Lee Valentine

*Chairman and Executive Vice  
President, Space Studies  
Institute, Mojave, California*

Mr. George Whitesides

*Former NASA Chief of Staff,  
President and CEO, Virgin  
Galactic, Los Angeles,  
California*

Mr. Craig E. Steidle, Rear Admiral U.S.  
Navy, Ret.

*Former NASA Associate Administrator  
for Exploration, U.S. Naval  
Academy, Department of Aerospace  
Engineering, Annapolis, Maryland*

Dr. Kathryn Thornton

*Former NASA Astronaut,  
Charlottesville, Virginia*

Mr. Robert W. Werb

*Chairman of the Board, Space Frontier  
Foundation, Nyack, New York*

Mr. ROHRBACHER. These credentialed experts are urging that NASA fully fund the use of commercial companies to carry crew to the space station because it is that in and of itself is a strategy that is critical for the Nation's success in our space efforts. Furthermore, they point out that funding of NASA's commercial crew program would lower the cost of low-Earth orbit, thus enabling more of NASA's budget to be applied to its focus on exploration beyond low-Earth orbit and better enabling the kind of program laid out in the NASA authorization bill.

Let me note it makes no more sense today to have government employees being the ones who manage and operate and build all the space transportation vehicles than it would be if we said 20 years ago or 30 years ago, no, I am sorry, all of the jet airplanes, all of our jet airliners, have to be built and operated by a government-run airline. No, we have reached a technological stage when indeed the private sector can plan a major role in reducing the cost of what it takes for government employees and government programs to operate.

So I, number one, am one person I know at least on this Committee that sides with you and the Administration on at least trying to make sure that we maximize the benefit that the private sector can provide perhaps in partnership with NASA because that is what it is about.

Mr. Bolden, the 2010 authorization painted a stark line between low-Earth orbit operations for which it demanded a commercial process and the exploration applications for which it relied on for the standard NASA development process. Does your budget request support this structure of having that line between those two approaches?

Mr. BOLDEN. Congressman, I am not sure I fully understand the question, but I would like to say I have been unfortunately remiss in effectively articulating the connection among all the NASA programs. We are trying to get rid of stovepipes because we are trying to stay within the budget, fulfill our obligation to live within the

elements of the 2010 authorization act and then when it comes to human spaceflight keeping our crews safe.

The International Space Station as I mentioned earlier is the anchor for all future exploration. That is our moon right now. What is going on at the International Space Station with a full six-person crew and today an additional six plus one in Robonaut, in R2, that we are developing technologies, we are understanding science that we will need to send humans beyond Earth orbit. So it is the anchor.

Mr. ROHRABACHER. We also have a lot of investment in this—

Mr. BOLDEN. Yes.

Mr. ROHRABACHER. But we are talking about an investment of money. How much money will be saved, for example, if we would rely on this private commercial transportation of crew to the space station and back as compared to if we simply kept the Space Shuttle going for another 10 years?

Mr. BOLDEN. Congressman, I wish I could answer that question, but that would be pure conjecture because we haven't flown a single commercial crew flight yet, and I don't want to try to blow smoke. I don't know.

Mr. ROHRABACHER. Well, let me conjecture—

Mr. BOLDEN. Yes, sir.

Mr. ROHRABACHER. —and I would conjecture that we are talking about saving billions and billions of dollars as compared to keeping the Shuttle going or developing other kind of craft only by a NASA program because at least these companies will be investing hundreds of millions of dollars of their own money. Now, how much money have private companies, and which private companies, have invested their money that is not coming from our budget. We are actually having people come in from the outside, releasing further money from NASA to do other things. How much money are we expecting from the private sector?

Mr. BOLDEN. Sir, I will take that for the record, but I can tell you, I do know it is substantially more than we have paid in our fixed cost for the COTS program and we will pay in our fixed cost for the cargo resupply mission.

So the private entities have already invested substantially more than we have. I will take it more for the record because I think your staffs were briefed earlier this week on some dollar figures, and they tried to give me that and I couldn't remember it so I said I would take it for the record.

Mr. ROHRABACHER. Thank you very much, General.

Chairman HALL. At this time I recognize Mr. Clarke, the gentleman from Michigan for five minutes.

Mr. CLARKE. Thank you, Chairman Hall, Ranking Member Johnson. Administrator Bolden, thank you for being here.

I have got a series of questions, and all of them relate to the impact of the proposed CR and the President's budget on NASA's ability to produce technology that can create jobs. And you know, I don't have any space centers or rocket manufacturers in the district I represent. I am from Detroit, and I represent metro Detroit. We do make cars. And back 40 years ago NASA released some structural analysis program technology that auto manufacturers were

ultimately able to use to make better front ends, to design better front ends, and steering linkages.

Most recently, their research in advanced fuels and fuel technology I believe has a lot of potential to help us make better plug-in hybrid vehicles and alternative fuel vehicles. Essentially it is this, is that NASA technology has meant better automotive technology which means that Detroit is able to sell better cars and that creates more jobs for the people that I represent. What if any is the impact of the proposed CR and the President's budget on these types of initiatives that can be commercialized to create good jobs in our country?

Mr. BOLDEN. Congressman, I don't want to speculate on what the impact of a potential CR would be, but in the President's budget, it will allow us to continue the technology and technological innovation that has always been the hallmark of this Administration.

And if I may, I would suggest that you go back home and brag about Detroit's part in STS-133. Detroit is aboard STS-133 in the person, if you will, of R2, Robonaut. Robonaut is a product of a three-year space act agreement between General Motors and NASA. It was done on our nickel and General Motors' nickel. It was not in anyone's budget, but it was exploration technology that came back from the old Constellation program. General Motors came to us and said we are having to pay hospital costs, injury costs, on our workers who are putting the rain panel into cars because they are having to exert so much pressure to put that panel in place. Can you help us? And together we started developing R2. R2 now, I don't know whether it is in operation yet on the GM production line, but the intent is that R2 will take the place of humans in doing some of this high-level maintenance reducing injuries. And General Motors continues their work in the SSA on the International Space Station now because R2 will be unfurled in the springtime and then will begin to do a series of evolutions that are both General Motors' projects as well as NASA's projects. So you and the people of Detroit are on board the International Space Station.

Mr. CLARKE. Well, thank you. That gives me more reason to support your agency and serve on this Committee.

A couple questions I have deal with the refocus of your agency on commercial development and also the impact of the proposed cuts on NASA education programs. But just for a backdrop, you know the President recently said that our economic crisis was this generation's Sputnik moment, and decades ago when the Soviet Union launched Sputnik, that created huge public and political support for massive R&D investment that ended up creating a lot of economic development and spurred investment in education. A lot of people went into math, science and technology fields. Some of the investments Ranking Member Johnson noted in NASA resulted in technology that was applied to the manufacturing of calculators, the microchip and other technologies that we use in everyday life. How does your agency's reorientation, especially your focus on commercial development, really square with that long-term commitment to overall economic activity for our country?

Mr. BOLDEN. Congressman, the President has said the Nation that out-educates wins. You will probably know that education is

a passion of mine, and we have put serious investment into education through programs like the Summer of Innovation, that we piloted last year and will continue the next two summers.

We now have an Office of Chief Technologist. His focus is on working with academia, industry and just general researchers. Trying to find innovative ways to bring value to our own economy, to grow our economy if you will. Those things are still covered in the President's 2012 budget, not to the extent that they were in the President's proposed 2011 budget, but still I think effectively covered—we have got to demonstrate that we can do what we say we can do.

So while I would love to have more money for technology demonstrations, NASA has a history of promising a lot in technology demonstrations and then squandering the money. We do not intend to do that. We intend to work with centers like the Glenn Research Center, the Langley Research Center, Ames Research Center and others and actually bring some of this technology development to the forefront where industry and academia are participating. If you go out to Colorado where one of our competitors in commercial crew development program is building their rocket, they bring college students in, and they work alongside engineers. That is not NASA, but that is a commercial entity that is supporting NASA and the future of commercial spaceflight. They are bringing college students in to get them excited about being a part of this program.

Chairman HALL. You know, in my brief 8 weeks as Chairman of this Committee, I have my first real problem. We recognize those who I am to call upon to speak for five minutes by the time they get here. There are two who got here at identically at the same time, Mr. Rigell and Mrs. Adams. Not only that, they sat down at exactly the same time, and knowing Mr. Rigell as a gentleman, Mrs. Adams is a very lovely lady, I am going to recognize Mrs. Adams for five or six or seven or eight minutes. Whatever she wants.

Mrs. ADAMS. Thank you, Mr. Chair. Mr. Bolden, I want to commend you for your statement, the safety of our crew members is our priority, and I don't think you will see anybody in this Committee that disagrees with that statement.

I am going to go back to the authorization bill and the budget request. NASA told Congress in January there was no way it could meet the 2015 flight schedule deadline for multipurpose crew vehicle and space launch systems, citing among other things, financial constraints. Based upon the request for \$1.2 billion less for these systems than what was authorized by Congress. I am concerned that you are really not interested in meeting this deadline at all, coupled with the recent interview with your chief technologist, Mr. Robert Braun, he was quoted as saying that a new vehicle for NASA's spaceflight is, "Let us call it, think about it as a decade if you want to put a timestamp on it." Is this your timetable? This is something I want to know. Is this what you believe Congress has authorized?

And then the NASA authorization bill stated that the space launch system and the multipurpose crew vehicle should act as a back-up in case the commercial crew is not ready in time. And again, is this something you are pursuing? I want to state that

when you were earlier speaking, you said that this would not be a productive use of the cost and time and ability of NASA, or something similar to that. And it struck me as interesting that you said that we would not use this as a capability of this vehicle.

Mr. BOLDEN. Yes, ma'am. We would not want to use an exploration vehicle as a low-Earth orbiting vehicle because it would indicate two things had happened, one, we had either had a loss, a physical loss, of a low-Earth orbiting vehicle, whether it is Soyuz currently or whether it was an Orbital or a Boeing or a Space X or any other vehicle. It would mean that we had lost a vehicle and crew, and that would be why we would have to rely on a government back-up. I don't ever want to get to that day that I have failed in my effort to keep my astronauts safe if we have to rely on Orion or—

Mrs. ADAMS. But shouldn't we have a back-up vehicle?

Mr. BOLDEN. We should always have a back-up vehicle. We don't have one right now once I land the Shuttle in June. The multipurpose crew vehicle on a heavy-lift vehicle will serve as a backup to any system. I ideally would like to have two commercial—

Mrs. ADAMS. And a timetable?

Mr. BOLDEN. The timetable for this? The timetable for commercially available crew access is the 2015, 2016 timeframe, there are a lot of people who—that is dependent on. If you ask industry, I have been told by them that three years from the day they sign a contract, they will be able to fly a commercial crew to orbit.

So the sooner I can get them through the early stages where we are now, the sooner we can sign a contract and make it possible for them to fly.

Mrs. ADAMS. Since I only have five minutes, I want to get as many questions as possible—

Mr. BOLDEN. Okay.

Mrs. ADAMS. —because I have a lot of questions. On page 1 of your testimony you state, "The request supports an aggressive launch rate over the next two years with about 40 U.S. and international missions to the ISS for science and to support other agencies." Can you please tell the Committee how many of those flights are NASA flights?

Mr. BOLDEN. Those are all NASA-related flights.

Mrs. ADAMS. NASA flights.

Mr. BOLDEN. I will get back to you on that, ma'am.

Mrs. ADAMS. Page 2 you outline the 2012 budget priorities for human spaceflight. Can you please tell the Committee where those priorities were developed, from the most recent authorization bill or sources or other methods?

Mr. BOLDEN. The priority for human spaceflight has been on the record for a number of years as we developed the International Space Station. So since that is our only destination over the next ten years, that schedule is already laid out, relatively firm.

Mrs. ADAMS. Through the authorization bill or—

Mr. BOLDEN. Long before the authorization bill was even thought of

Mrs. ADAMS. And you said something about global climate change, and I just wanted to ask you. I know that you referenced global change. That is not climate change?

Mr. BOLDEN. Change in the climate is it could be global warming, it could be global freezing, it could be anything.

Mrs. ADAMS. What is global change in your eyes then?

Mr. BOLDEN. Change is what we are experiencing today. When you go out in the middle of the summer and it is blistering hot and you come in in the middle of the winter and it is the coldest winter you have ever felt, that is climate change.

Mrs. ADAMS. But you have global change in your testimony. And so I am trying to determine, is that global—

Mr. BOLDEN. Global climate—

Mrs. ADAMS. —change or climate change?

Mr. BOLDEN. The testimony probably says global climate change which says—

Mrs. ADAMS. It says global change. That is why—

Mr. BOLDEN. I will go back and check.

Mrs. ADAMS. Thank you.

Mr. BOLDEN. We missed the word

Mrs. ADAMS. Thank you.

Mr. BOLDEN. Yes, ma'am.

Chairman HALL. Thank you. I now recognize Mrs. Fudge, the gentlelady from Ohio, for five minutes.

Ms. FUDGE. Thank you, Mr. Chairman. Good to see you again, Mr. Bolden.

Mr. BOLDEN. Always good.

Ms. FUDGE. Administrator Bolden, as you know, I have many NASA Glenn employees in my district, as well as we have a NASA Glenn Visitor's Center. I am glad to see that the President's budget request includes a diverse portfolio of initiatives for Glenn that utilizes them as strength and core capabilities. However, I am concerned about anticipated shortfalls in the center management and operation funding at NASA Glenn.

A continuation of fiscal year 2010 level funding as described under the current CR represents an \$8 million reduction of what is being proposed for fiscal year 2012. I have been to NASA Glenn, and the one thing I am certain of is that this is a group of extremely hard-working and brilliant scientists who know how to achieve extraordinary things on a tight budget, but I am very concerned about the effects that cuts to the center management and operations will have on the contractor workforce and the facility's maintenance at Glenn.

Could you please just discuss with me how you see these cuts impacting NASA Glenn if government continues operating under the CR and will it have similar effects on other centers?

Mr. BOLDEN. Congresswoman, if I understood correctly, if you are talking about the amendment to the CR that took—

Ms. FUDGE. Yes.

Mr. BOLDEN. —cross agency support out, I don't want to speculate on what would happen to any single center, and I really am going to violate my rule and I am not going to speculate, I am going to tell you what that amount of money equals. That amount of money equals a couple of NASA centers. So if in fact the Congress were to pass, you know, that CR, I would have to find a way to either stretch money around or—we are talking about the funds to run two NASA centers.

Ms. FUDGE. Correct.

Mr. BOLDEN. But that is not what I expect to happen. As I said earlier, I expect that reasonable people can disagree and come to an ultimate agreement that is best for the Nation. And so we continue to expect that we will be operating at a 2010 level through the end of fiscal year 2011 and then that we will work to reach an agreement on a 2012 budget that follows along the lines of the budget that was proposed by the President and I introduced two weeks ago, you know, that will fund NASA and allow us to do the things that you want us to do.

Ms. FUDGE. So that there is in fact still a commitment to make sure that when we have discussions about the fiscal year 2012 budget that we were still talking about the same level that was proposed in the President's budget as we go forward?

Mr. BOLDEN. Congresswoman, that is correct if I understand the question correctly. When we look specifically at Glenn, Glenn will do well under the proposed fiscal year 2012 budget, and I think you have had this conversation with Ray Lugo.

Ms. FUDGE. Absolutely.

Mr. BOLDEN. And Ray is very conservative. Ray does not like to go out and brag about things for fear that someone will take them away. Ray understands, as do most of our center directors, that the money to the community does not come with a program office designation. The money to the community comes with projects and task orders through that program. So the fact that a center does—I don't have enough programs to make sure that every center has a program office. But it really doesn't matter to the people of the center. It may matter to people who are looking for titles, but to the workers in that community, it is really important that they get projects and task orders, and Glenn will do well.

Ms. FUDGE. Well, certainly obviously I am pleased with the 2012 budget. I think that Glenn has done well as it relates to that budget, but if you look at fiscal year 2010, you are looking at \$196 million to Glenn. In fiscal year 2012, you are looking at \$204 million. So for the year of 2011, the effect of trying to move forward with projects knowing what is happening in 2011 that we are going to remain at this 2010 level, is a problem. It is a question. Let me not say it is a problem. Let me say that we need to understand better how we function at this fiscal year 2010 level knowing that there is much expected as we go into the fiscal year 2012.

Mr. BOLDEN. Yes, ma'am. I agree.

Ms. FUDGE. Thank you so much.

Mr. BOLDEN. Yes, ma'am. Thank you.

Chairman HALL. Now the gentleman from Virginia, Mr. Rigell.

Mr. RIGELL. Thank you, Mr. Chairman, and Mr. Bolden, thank you so much for being here and providing your testimony. I certainly respect your military service and your bravery as a test pilot and now your service with NASA. I think it is a distinguished career.

In your opening statement, you mentioned that there was, I think you characterized it as some concern about NASA's commitment to manned spaceflight or human spaceflight. I would say that doesn't capture my view. I am deeply troubled and really disturbed by it. I think the figure that you referenced, you said look, we are

allocating 44 percent of our budget to human spaceflight. Well, I come to the exact opposite conclusion. That doesn't reinforce the idea that we are committed to human spaceflight. That number in my view indicates that we are not as committed as we were, nor are we as committed as we should be to human spaceflight.

I see human spaceflight really as the essential DNA of NASA, and I would like for us to get back on a path of really investing in human spaceflight as quickly as we can. I think as you said, reasonable people can disagree over these matters, but I am here today to petition you and to move back in the direction of allocating more toward human spaceflight.

We can talk about the proper allocation between commercial and actual NASA flights, but I still think we need to move in the other direction.

You mentioned also in response to a question offered today that the savings of commercial spaceflight versus NASA human spaceflight, I believe, your response was, I don't know. It seems to me that that is an essential question that is really fundamental to some of the things that we are going to have to deal with here on the Committee. Would you please just expound on that answer a bit?

Mr. BOLDEN. I am glad you asked the question because it gives me an opportunity to elaborate. When we talk about connecting all the aspects of NASA, the NASA portfolio, we cannot separate human spaceflight from science. Our science missions may in the future utilize the same launch vehicle that we use to launch astronauts into space. Today my science budget is under attack because of the rising cost of a launch vehicle. If I can find a way to get a cheaper launch vehicle, I can fly more science, that same launch vehicle that would take humans to low-Earth orbit.

So the integrated advantage of going to commercial carriers, to adding competition to the mix, whereas today—if you look at Orbital Sciences, Orbital designed the Taurus II not to take humans to orbit. They designed it to meet a market that they saw being there which was for medium-lift rocket. They say that is where the science market is. That is the way that they targeted. We have done a little bit of conversation and some analysis of the market.

So they are very comfortable. Whether they participate in human spaceflight or not, they have hit the target because that is where the market lies. If they can win in being one of the carriers for humans to low-Earth orbit, they have multiply magnified, you know, their profit. They have decreased the cost to orbit for me because now all I do is buy service. I don't operate it, I don't carry the infrastructure costs, and there is some debate now about how much I am really spending on the Kennedy Space Center. There is disagreement even among my own people. We spend a lot of money every day, every month, every year, just maintaining the infrastructure of the Kennedy Space Center, whether I fly a Shuttle or not. I am trying to get rid of that.

Mr. RIGELL. Well, on this point, I think we are in full agreement. I think that there is a place for a commercial role here, and I think that having—as a businessman who is now a representative in our Congress, I am instinctively drawn to the statement, you know, about competition and having companies compete here. But the

question specifically is, and I think one that I would ask that you maybe circle back around and provide some more information for the Committee and for me in particular, is the ability to properly develop and answer to that legitimate question of what are the relative costs of NASA putting a human in flight versus the private sector. And I think that merits more exploration

Mr. BOLDEN. Sir, I will get you that answer, and the word you just used, that requires more exploration, the reason I can't give you the answer is because exploration is just that. It is something that we pursue having no idea what we are going to find. If I looked at, you know, putting a dollar value on the A-Train, it is a five Earth science satellites that orbit Earth, near polar orbit, every day, you know, what is the dollar value on having the A-Train there to the people in Haiti many of whom were saved because one of the satellites revealed three areas of the country that were subject to landslides with the big Earthquake that we would have never found for weeks? What is the value on the people of the Gulf Coast for what came out of the A-Train to help us understand the Gulf Oil spill? I can't put a dollar value on that.

So I appreciate your question and will try to get you an answer.

Mr. RIGELL. Thank you. My time is expired. Thank you very much.

Chairman HALL. Thank you. Thank you, Mr. Rigell. I recognize the gentlelady from Alabama, Mrs. Sewell, for five minutes.

Ms. SEWELL. Thank you, Mr. Chairman. Thank you, Mr. Bolden.

NASA's proposed budget indicates that there will be \$138 million for education initiatives, including the Space Grant and Minority University Research programs. These are valuable partnerships that exist in the State of Alabama where I am from for institutions such as the University of Alabama in Huntsville (UAH) and Alabama A&M and the University of Alabama at Birmingham (UAB) and University of Alabama. This is a 5.1 percent decrease from the nearly \$146 million for fiscal year 2011. How will this anticipated decrease in funding impact these valuable educational initiatives? I, like you, are quite concerned about educating the next generation and would like to see those partnerships continue.

Mr. BOLDEN. Congresswoman, like every other agency in the government and like every company in America, we are looking for ways to streamline the way we do business. Leland Melvin, who is my new Associate Administrator for Education, once chaired and now since he is the Associate Administrator, he oversees the work of an education design team within NASA. We have gone out and we are working with professional educators, colleges and universities, secondary educators, to determine how we can better implement our education program within NASA so that we get the same value that we get right now for less money.

So the \$138 million is a significant amount of money for our education efforts. We are also trying to collaborate much more with other agencies. We are working with the First Lady's White House initiative for things such as helping military families. An aspect of that is education for military families. We have content that we can offer that we don't spend another dime on. It is already there, whether it is talking to astronauts from the International Space Station. One of the best things I did when I was flying was we used

to do something called SAR-X where you get on a ham radio and you talk to kids in schools. That is incredible, and that comes at almost no cost.

So we are trying to find better ways that we can implement what we have at lower cost.

Ms. SEWELL. Great. The proposed budget for fiscal year 2012 also provides \$1.8 billion to help develop a heavy-lift vehicle, the SLS, that will launch the crew. Marshall Space Center in Huntsville, Alabama, will likely be a very major contributor in designing that heavy-lift vehicle. And in fiscal year 2012, the funding request for this project significantly, is it sufficient, I would say, to fully fund and sustain the development of the heavy-lift vehicle through 2016 which is the desired timetable, and are you committed to making sure that those funding levels stay about the same?

Mr. BOLDEN. I am committed to try to make sure that the funding levels remain about the same, and one of the things that you will see in our congressional justifications is beginning in 2013 I have asked, and I think I have been granted—it remains to be seen whether the Congress will agree—that we put human exploration in one budget line so that as we go with the development of an evolvable heavy-lift system and a multipurpose crew vehicle, that we can move the funds around as necessary in each successive year so that we marry those programs up when we need them, that being the 2020 timeframe is when we will need an integrated heavy-lift launch vehicle and crew exploration vehicle that can go beyond low-Earth orbit. There may be available systems before that time, but I don't need one for beyond low-Earth orbit until 2020.

Ms. SEWELL. Thank you.

Mr. BOLDEN. Yes, ma'am.

Chairman HALL. Thank you. The Chair now recognizes the Chairman of the Space and Aeronautics Subcommittee, Mr. Palazzo, the gentleman from Mississippi.

Mr. PALAZZO. Thank you, Mr. Chairman. Thank you, Mr. Bolden, for being here, and like my colleague, Mr. Rigell, thank you for your 34 years of service to the Marine Corp. After seeing that you have been in Vietnam and had over 100 missions, I doubt there is much that I can say or do to rattle you.

Mr. BOLDEN. Just don't shoot me.

Mr. PALAZZO. Or shoot at you, right? Absolutely. I do have some questions for you, and one is you have often made the argument that access to low-Earth orbit is well-understood enough that we can turn this over to commercial providers. How can you be confident that the commercial crews and cargo is sufficiently mature enough to justify firm fixed contract, and if so, can you explain some of the significant delays in time and cost that are in the COTS and the CRS program today?

Mr. BOLDEN. I am certain that commercial entities can deliver because in the past, if you look at the two that I am working with right now, at least one of them has been doing it for more than 20 years. Orbital has been delivering cargo and other things—well, not cargo, delivering satellites to orbit since their inception. And if I look at just one of the rockets that they prepare for us, Minotaur, which is a government rocket that we procure and surplus and

then it is given to Orbital to prepare. They have 100 percent success rate with Minotaur launches. So I am not concerned about their ability to deliver.

In terms of why have we had setbacks, we are now trying to take in some cases existing systems or emerging systems and certify them for human spaceflight. So the companies are trying to get as much information data as they can while they are doing the COTS and CRS programs that can be transferred into a commercial crew program so that it cuts down on the amount of time that they have to invest in development of techniques and procedures and the like for them. And like in a development program, they experienced setbacks.

I give the example, and I will make it really quick——

Mr. PALAZZO. Okay.

Mr. BOLDEN. If I had had a failure or a problem like Orbital had last December before they launched the Dragon capsule on Falcon 9, where they had a crack in an engine bell, I would still be sitting on the ground. We would not have launched. It took me four months to get Discovery off the ground successfully on STS-133 after we found a small crack in foam which revealed a structural problem we had in the external tank. Commercial entities do what we do, they just don't have the bureaucracy that we have.

So we will learn from them, and we will be able to speed up the time—decrease the amount of time we have when we do experience a delay.

Mr. PALAZZO. And you know, we are going to be watching closely, so it would be nice to see if they can actually come in under budget, on time and within cost.

Mr. BOLDEN. Yes, sir.

Mr. PALAZZO. Now, NASA has not always been forthcoming with details of its acquisition strategy for commercial cargo and has not shared their strategy for commercial crew, but the key to both has been to open with a Space Act agreement. Devoid of any meaningful checks and balances followed by an overlapping fixed price contract to the same contractors, it is hard to see how there can be a true, full and open competition for the fixed price contracts under those circumstances when Space Act selectees are already under contract. Why is NASA proceeding in this manner and why avoid using a traditional FAR acquisition process?

Mr. BOLDEN. Congressman, we have not decided on the acquisition strategy yet. I have not approved it, so it is not that we are not being forthcoming, I am pushing my people now to get to the point where we develop an acquisition strategy for commercial crew. So the hold-up is us. It is not the commercial entities. They are asking for our acquisition strategy. We have given them what we call human ratings standards. We gave it to them in the draft form. They utilize that. We now have published human ratings standards, so we are making as much as we can available to the commercial entities as quickly as we can.

Mr. PALAZZO. Now as you know, Stennis Space Center is in my district, and as NASA moves forward with plans for both NASA and commercial activities, I want to know if there will be any impact on Stennis and their leadership in rocket propulsion test, and

will Stennis remain the leader for NASA and commercial rocket propulsion?

Mr. BOLDEN. We made an announcement yesterday that Marshall Spaceflight Center will be the home of the program office for the SLS, the space launch system. A sister center that used to be a part of Marshall and is now its own entity is the Stennis Spaceflight Center. Stennis is the Nation's center for propulsion test. It is where people go, and we are trying to encourage the commercial entities to come and fully utilize the facilities at Stennis, to a much greater extent than they do right now. And we are starting to get overtures from some of the commercial entities that say we really would like to come down and look at your facilities and perhaps use that.

Ideally, everyone will come to Stennis to test engines. When I was there and you had been there the day before at Stennis, I went down for the test firing of the second AJ-26 engine produced by AeroJet for Orbital. It was incredible. I mean, the morale of the people there was absolutely incredible, and they now have completed the test on two engines for a commercial entity that will now put those two rockets on the Taurus II that eventually will be Orbital's entry into COTS.

Mr. PALAZZO. And I have one last, brief question. Many NASA facilities are going to require upgrades to continue providing their mission for NASA's future. Are you committing to providing the necessary resources to upgrade the test facilities at Stennis?

Mr. BOLDEN. I am committed to do that, and I think we have talked to you about the A-3 test stand. My commitment to complete the work on the A-3 test stand is an example.

Mr. PALAZZO. Thank you, Mr. Bolden.

Chairman HALL. Thank you. I now recognize the gentleman from California, Mr. McNerney, five minutes.

Mr. MCNERNEY. Thank you, Mr. Chairman. Mr. Bolden, thanks for coming and testifying this morning. This is certainly an issue that I think everybody is interested in in this country, space exploration, spaceflight and so on.

I had the opportunity to visit the SpaceX reception here in DC a couple weeks ago. Apparently they sent up a vehicle that launched, orbited and reentered successfully. What is your assessment of that mission? Was it very successful?

Mr. BOLDEN. Awesome, in one word. You have to understand what the significance of that was. Only three nations up until now, and there are many who want to be able to do this. India is one. The three nations are China, Russia and the United States that have successfully launched something from the planet, put it into orbit and then safely deorbited and then recovered it intact. The fourth entity to do that became SpaceX in December when they launched Falcon 9 and Dragon. I did not go, but I understand what you saw was the Dragon capsule that had been pulled out of the Pacific Ocean, and you could tell for yourself what condition it was in. Their intent is for it to be a reusable capsule. That is why it was awesome.

Mr. MCNERNEY. I know that some of these questions have been asked before, so I am just going to sort of run over them. You expect this sort of mission to be more cost-effective than NASA could

do it for reasons that you mentioned. How about compared to Russia or some of the other countries that we have heard NASA may use once the space Shuttle stops operating?

Mr. BOLDEN. We will continue to use the Soyuz spacecraft to get our astronauts to and from the International Space Station since we have done since the Columbia accident.

My hope is that as soon as possible we will finally have American-made rockets by American-made companies that will be available to take our astronauts back and forth, do it safely and efficiently. And so that is why I made the tough decision to take some of the funding away from heavy lift and MPCV and put it toward commercial development because I have to have a way to get my crews safely to the International Space Station as soon as possible. I don't think anybody on this Committee wants to have to rely on the Russians but they are an incredible partner. They have been with us through thick and thin. They rescued us after the Columbia accident and until we were flying Shuttle's again. They took our crews back and forth to space and they continue to do that. I don't want to have to do that forever. I want to have American-made rockets and American-made capsules that take our crews to low-Earth orbit, and I have been ineffective in explaining the critical value of making that possible as soon as possible.

I don't have enough money to give them to bring it in—I am trying to buy down the risk on that. Every dime I can put toward that effort buys down the risk.

Mr. MCNERNEY. You know, I was in industry before I came here, and I understand the importance of having multiple suppliers because if you just have one, they are going to—you are at their mercy. What is the prospect for having multiple private companies in this country capable of carrying out these missions, these transportation missions?

Mr. BOLDEN. I will give you my guess, and that is only a guess. And with all due respect to everybody on this Committee, I don't run a company. I have never run a company. But I talk to people who run companies, and they have boards that they have to convince that it is worth the investment. And so I think some of my industry partners are still back here. They will tell you, they have had to fight to convince their boards that what we are about to do is worth the risk. It is a big risk for these companies, and they have convinced their boards that they need to put assets against it and I am going with them. I think they can do this.

Mr. MCNERNEY. Are there foreign companies doing the same thing?

Mr. BOLDEN. There are foreign companies that are teaming with American companies in everything we do.

It is hard to find any industrial effort today where people are not teaming with international partners. The President's, our own space policy, emphasizes the importance of teaming with international partners. The Hubble Space Telescope, which I helped deploy in 1990, would have never been possible without the cooperation of the European Space Agency as a partner. The solar rays came from the British Aerospace.

Mr. MCNERNEY. So the last question I have then is are there going to be any restrictions on these companies in terms of car-

rying out commercial missions that may have some harm to our national security?

Mr. BOLDEN. There are always restrictions, and that is where you have to help me. I am not sure which committees you are on, but the Secretary of Defense, the Secretary of State, the President, all of us are pleading for help from the Congress in streamlining the export/import laws so that we don't continue to penalize American industry. You hurt NASA because I have to rely on my industry partners. When they are held to very strict standards under the Iran, North Korea, and Syria Nonproliferation Act (INKSNA) and you name it—they could give you a whole list of import/export laws, there is a happy medium somewhere and we are not there right now. We have driven business offshore, and we have got to get it back. Just having commercial launch services available is not going to bring the business back. We have got to make some changes in our export/import laws.

Mr. MCNERNEY. Okay. Thank you. Thank you, Mr. Chairman.

Chairman HALL. Thank you, and the Chair recognizes now the Chairman of Research and Science Education Subcommittee, Mr. Brooks, the gentleman from Alabama, for five minutes.

Mr. BROOKS. Thank you, Mr. Chairman, Mr. Bolden. Mr. Bolden, were you aware that a couple of weeks ago when the House was debating a continuing resolution for this fiscal year that there was an amendment proposed to cut roughly \$300 million from the NASA budget and divert that to the COTS program?

Mr. BOLDEN. Oh, yes, sir. I am very much aware of that. We talked about it quite a bit.

Mr. BROOKS. And what harm would be done to NASA if any by the diversion of this \$300 million if it is left to stand in the Senate?

Mr. BOLDEN. Congressman, you know, if we talk just about that amendment to the provision and nothing else, I might be able to give you an answer but because I don't know what is going to be the final result of the CR, it would be conjecture for me to guess. There may be some offsetting adjustments made in the final CR that puts all that money back. So I don't want to run the risk of guessing on something that is not there yet.

Mr. BROOKS. Well, as it stands right now, would the loss of that \$300 million adversely affect NASA's capabilities?

Mr. BOLDEN. I think I answered a little bit earlier, that amount of money—I think what you are asking is that amount of money is a couple of NASA centers, maybe, you know, in terms of day-to-day operations.

Mr. BROOKS. I am a freshman, but that sounds pretty significant to me. Would you agree that that is a significant adverse effect?

Mr. BOLDEN. That would be a significant adverse effect, but again, I am not going to speculate because that is a decision that has not been made by the Congress yet, you know, the House has passed and the Senate will still have a say. So you are asking me to guess on something that the other house of this Congress is going to—

Mr. BROOKS. Well, I am not asking you to guess about what the Senate may or may not do. I am asking you to testify whether there is an adverse effect from what the House's position has been,

and that is the loss of \$300 million to NASA. Do you have a position?

Mr. BOLDEN. Sir, there is always an adverse impact about any decrease in funding. If I look at the effect on contractors, I am told that that is about 4,000 contractor jobs. So that is an adverse impact.

Mr. BROOKS. Given that kind of adverse impact on NASA, what effort did either NASA or the White House undertake to communicate that adverse impact to congressmen before they voted in order to help protect the NASA budget?

Mr. BOLDEN. I don't know what effort the White House made, and I just know that whenever we came to the Hill and were asked about it, we generally said it would have an adverse impact but we tried not to second-guess what the Congress was going to do as we always try to do.

Mr. BROOKS. Well, I am not aware of any effort by NASA or the White House to communicate any kind of adverse impact to the Members of the House of Representatives from the diversion of \$300 million from NASA to a local police and deputy program. Are you aware of any effort by the White House or NASA to communicate that to House Members before the vote?

Mr. BOLDEN. Congressman Brooks, I am not personally aware, but let me take it for the record, and I will get back to you on any actions that our folk took because we have been up here over the last several weeks or months, and I will find out for you.

Mr. BROOKS. Well, I am pleased to report that 70 percent of the Republicans in the House tried to protect the NASA budget. Unfortunately, 83 percent of the Democrats tried to undermine the NASA budget by diverting the programs to a local police officer program which I would submit is not an essential function of the Federal Government, while NASA is a function of the Federal Government. So I would appreciate anything you can do in the future to try to help communicate to House Members or Senators as the case may be when these kinds of amendments come up that can have that kind of adverse impact on NASA, on 4,000 contractors and their jobs, or two NASA centers as you just brought up.

Moving onto a different matter, going back to April 15, 2010, the President made public remarks at the Kennedy Spaceflight Center that suggested the moon was no longer a destination for future manned missions when he said, "The simple fact is, we have been there before. There is a lot more space to explore." However, in looking at your comments today, I am thankful that on page 2 of your official statement you mention that the moon is a target. Is that correct?

Mr. BOLDEN. Sir, the moon is a continuing target for NASA. We have ongoing missions to the moon all the time, so lunar exploration remains in our portfolio.

Mr. BROOKS. What is the targeted date for landing on the moon?

Mr. BOLDEN. A human landing on the moon?

Mr. BROOKS. Yes, sir.

Mr. BOLDEN. We don't have a target date for a human landing on the moon because at present that is not one of the missions that I think is essential for us to be able to do.

Mr. BROOKS. So if I am clear on this, we are planning on sending scientific instruments, but as of now, NASA has no plans to have any human space activity on the moon?

Mr. BOLDEN. I have no plans that I have brought forth to the Congress or anyone. That does not say what is going on inside the agency does not include human lunar missions. You know, we are developing a lunar rover right now that would completely do away with any need for habitats on the surface of the moon.

So we are always looking at where we can go in the future. That is a part of being prepared to do exploration.

Mr. BROOKS. Well, my time is expired. Thank you for your assistance.

Mr. BOLDEN. Thank you very much, sir.

Chairman HALL. Thank you. And Mr. Chairman, if you are short of people that you want to send to the moon, I got several in my district that I would like to volunteer for you.

Next we will have the gentlelady, one of my very favorites, from California, Ms. Woolsey—

Ms. WOOLSEY. Thank you.

Chairman HALL. —for three minutes or five minutes.

Ms. WOOLSEY. Thank you, Mr. Chairman. Last week I had the privilege of attending a conference on the subject of energy security, and it was bipartisan, bicameral, and it was clear in our discussions with scientists and experts that the decision-makers in our country, which is all of us and others, have to come to terms with climate change. You can call it global warming, climate change. And so I want to go on record and have always been one that is willing to talk climate change and know that we have to start addressing it and doing something about it, and I appreciate that NASA's view of the Earth is going to be very helpful in that regard.

And that leads me directly to what I want to talk about and that is about being educated and having the right support in order to be able to do what you need to do as an agency. President Obama has set a goal of recruiting 10,000 teachers in the STEM fields. He calls these subjects essential to competing in the 21st global economy. Yet, his proposal for his budget drastically cuts funding for NASA's education programs including the STEM education programs.

So I ask you, how are we supposed to increase participation in STEM if we are cutting the very programs that foster interest in STEM in the first place, and how are you, how is your agency adjusting to this? You need those smart people.

Mr. BOLDEN. Congresswoman, the difference between what you see in the 2012 budget and what you saw in previous budgets is actually the result of action on the part of, thankfully, the Congress. The proposed amount of funding for education from this Administration has been consistent, and it usually is at about the \$140 million level each year, give or take. And that has been consistent. But what happens, thankfully, is that the Congress usually ads money back onto that. So if you say that we have cut spending on education, we didn't cut it. We didn't add back in what the Congress chose to put on in previous years, if that is not too confusing.

Ms. WOOLSEY. Well, it is not confusing because we work very, very hard to get that additional funding for STEM. And Chairman Gordon was a leader in it, and he worked with Chairman Hall when they were in reverse positions and really made something positive happen for NASA and for STEM programs.

Mr. BOLDEN. Yes, ma'am. And Congresswoman, as I mentioned before, our focus is on STEM education. The Summer of Innovation targets middle school children and most importantly their teachers because we want to make middle school teachers very comfortable with teaching math, and science. We want them not to run away from it. That pilot program last year we understand was very successful. If we can reach 1,000 teachers, multiply that times the number of students in a classroom. So that is our big focus.

The design team that we put in place is trying to, as I mentioned to Congresswoman Sewell, I think I can do a better job with \$138 million than we have done in the past because we are going to take the recommendations from the design team and we are going to redo the way that we do education in NASA. People will have to trust us, though, because if everybody makes me go back to doing education the way I have always done education, it is \$138 million and we will get the—you know, insanity is doing the same thing over and over and assuming something is going to be different. If somebody makes me spend my \$138 million exactly the same way year after year, I can't have any effect.

Ms. WOOLSEY. Well, one of the recommendations I would have is, in reevaluating your programs, that you put an extra effort into women and minorities joining the STEM fields.

Mr. BOLDEN. That is a point of emphasis for us. We are active on the President's Council on Women, you know, everywhere. I have three granddaughters and a daughter. I have a son, too, but I try to take care of the women in my life, so education of women and minorities is pretty important since I happen to be one.

Ms. WOOLSEY. Well, therefore, they can take care of themselves if they—

Mr. BOLDEN. I want them to take care of me years from now and so—

Ms. WOOLSEY. That is right. I got it.

Mr. BOLDEN. —they need to be very well-educated and they need to be astronauts and doctors and engineers.

Ms. WOOLSEY. Thank you very much.

Chairman HALL. I thank the lady, and I recognize Congressman Hultgren from Illinois. I got a chance to know Randy very well. He accompanied me to watch the Discovery launch, what, last week. Thanks for that. I recognize you for five minutes.

Mr. HULTGREN. Thank you, Chairman Hall. Administrator, thank you so much. I'm hiding in the corner over here. But I just wanted to say I really appreciate you being you here. It really was a privilege to be down for the launch with Chairman Hall and other Members of the Committee last week, and to steal or borrow one of your words, it was awesome. So it was great, and it really was helpful for us. Everybody there was so informative in really helping us understand the mission, and I was so excited to be a part of that. So thank you for your work.

I want to shift gears just quickly. Oftentimes we wear different hats here, and I want to get your perspective on something. I also sit on the Transportation Committee, Aviation Subcommittee. One of the areas that we have worked on and talked about pretty significantly is NextGen, looking at Next Generation Air Transportation System. I know NASA has had a significant part along with other departments as well, and I just wanted briefly to get your thoughts on NextGen, some of the work there as a key partner along with the FAA, Defense Department, other federal agencies. What does NASA see as some of the biggest challenges confronting NextGen and from your perspective, how do you feel like this multi-agency collaboration is going? What can we do to improve that, to make sure that lower space travel is going well?

Mr. BOLDEN. Congressman, NextGen is incredibly important to this Nation, and I am thankful you asked the question and I will try not to take all your time, but I could talk forever about this.

NASA is heavily involved in NextGen. If you look at what we have done in terms of aircraft safety with the Next Generation Transportation System development, and if you look at the descent and arrival profiles that are being worked on with the FAA and DoD, we actually, through Langley Research Center and Ames Research Center, have designed some of the software and the programs that now have allowed us to go through some actual demonstrations of constant descent, constant climb-outs. United Airlines and Continental were participants in tests that we did at Denver over the last few years. Those have all proved that—we are talking about hundreds of thousands of gallons of fuel saved.

My aeronautics budget is \$588 million or something like that. Somebody asked about giving them a cost benefit. If I look at the amount of money that the airlines will save just through some of the work that came from NextGen, new airplanes and engine designs that we participated in, the estimate is one percent of the savings to the airlines will pay for my aeronautics budget. If I could find a way if you all could devise some system such that industry put money back into us when we help them realize savings, then all of our jobs would be a lot easier. But one percent of the projected savings from some of the work that NASA has done in NextGen would fund my aeronautics budget.

Mr. HULTGREN. Well, I want to thank you for that, and I agree with you. I think that is part of our job, is to get that message out there and to see that although it was great to be down there last week, that there is so much more that NASA is doing that we all appreciate and see the benefit from. Many of us are frequent air travelers coming back and forth to Washington, DC. My district is just west of Chicago, so I think I have got the highest number of folks who are helping to make sure that our skies are safe, who help with air traffic control with O'Hare, one of the busiest airports in the world. So I do appreciate your work there.

I think we have to keep telling that message of the work of NASA and collaboration that is happening, the savings that we see and the better environment that we have, the cost savings that are there. And the thing I am most excited about is the safety, where it is has been over two years now since we have had a fatality with commercial airlines. So we need to continue that record, and I just

again want to say thank you for the work that you are doing, and hopefully we can tell that story of how collaboration does make our lives better and save so much money into the future. So thank you so much.

Mr. BOLDEN. Sir, I thank you for the question and I would just ask if you would keep asking aeronautics questions, I don't get very many of them, and I would really like to tell our aeronautics story. But we get caught up in human spaceflight. If we can do what you say, aeronautics covers everything right up to the edge of the atmosphere. It is the way we get into space, and it is the way we come back. Hypersonic aeronautics is entry. It is what SpaceX learned how to do to bring the Dragon capsule back. So that is aeronautics. Everybody has got to come back to Earth some time. Thank you.

Chairman HALL. That is exactly five minutes. Well done. And to the very patient, Mr. Sarbanes, from Maryland, I recognize you for five minutes.

Mr. SARBANES. Thank you very much, Mr. Chairman. Thank you for being here today and for your testimony.

I am a new Member to the Committee, and it seems it is common practice to let NASA know if you have a facility in your district, so I will present by credentials by saying that I have the Applied Physics Lab in my district in Howard County, and they do tremendous work, particularly with respect to deep space exploration which I know is one of the areas that is funded by NASA, so I hope to learn more about that particular relationship.

I am also new to this discussion on commercial spaceflight. It is a pretty fascinating one. I understand the broad implications, and we have a lot of different perspectives in the mix. I had this past weekend the opportunity to spend a fair amount of time with Peter Diamandis who founded the X Prize, of course, and he really gets you going with his vision of things and he has obviously been very involved in this.

I was hoping you could—and again, I apologize because I am getting, you know, this is a curve for me, but with respect to the commercial spaceflight and the costs associated with it, is there a way you could just describe kind of the baskets that those costs go into? So in other words, I understand there is a cost associated with making certain NASA facilities available for, I guess, co-development of the technologies that will help promote commercial spaceflight. I gather that once those crews are in place that NASA will have costs associated with renting space or seats on those flights. And there must be other dimensions of being a partner in the development of the commercial spaceflight program that represent part of the expenditures that you lay out.

So I was wondering if you could just talk about the broad baskets that those costs go into, and then the extent to which some of those represent kind of transitional costs in effect launching the commercial spaceflight program as opposed to ongoing costs that NASA will incur with respect to commercial spaceflight, you know, over time.

Mr. BOLDEN. If I go back to the very beginning of our efforts, the COTS program, the Commercial Orbital Transportation System, which is just getting cargo to orbit, that was a Space Act agree-

ment with a defined amount of money, like a fixed-price contract for all intents and purposes. NASA paid a certain amount—as milestones are met by the two participants. The two companies were SpaceX and Orbital. And so through the completion of a COTS, we will pay them a pre-determined amount of money for each milestone they meet. When we move into the CRS which is cargo resupply portion, that is where we get into a contractual arrangement, and we have made contractual arrangements with those two companies since again, they were the winners. So they get paid again as they meet certain milestones. But once they start delivering cargo for a set price we will buy the ride to the International Space Station or wherever else we take it.

When you get into commercial crew, that is the area that has some vagueness right now because those prices are not yet determined. There are things that need to be determined. I have to present to industry a procurement strategy. That is what we talked about a little bit earlier, an acquisition strategy. That is what we have not fully developed yet. Once we have a fully developed acquisition strategy, we can sit down with the competitors and say, okay, here is what we are going to do. These are the types of contracts we are going to use, whether it is Space Act agreements, fixed-price contracts, cost-plus, you name it, and here are some of the requirements that you are going to have to meet. We can then sit down and say, okay, what is NASA's percentage of investment in this enterprise? Once we decide what that is, then I will have essentially a fixed price, a cost—

Mr. SARBANES. Let me ask another question. My time is about to expire, and I don't want to go beyond the allotted time if I can help it.

There is a lot of focus on NASA helping to support and develop commercialization with respect to human spaceflight. But what are some other areas of what NASA does where you see this kind of commercial partnering effort going on that maybe you don't get to discuss so much?

Mr. BOLDEN. The ones that don't get discussed are the ones we do all the time. And just before you came in, we were talking with the representative from Detroit. Robonaut 2, R2, is a humanoid robot that is now on the International Space Station. It was taken there by Discovery last week, STS-133. R2 is the result of a collaboration and a Space Act agreement between General Motors in Detroit, and I will get in trouble because they will say it was, well, General Motors in Chicago, but General Motors, the automobile manufacturing arm of General Motors, and NASA where General Motors needed a robot that could relief some of the problems they were having with injuries to workers. NASA needed a robot to help offset some of the risks to spacewalk crew members, things that a robot could do that we wouldn't even have to send an astronaut outside to do. That is one example.

There are a number of examples like that where we have done it on a shoestring because it is technology development. We turn a few guys loose in a laboratory somewhere around the country, and they go off and pick an industrial partner and develop something that comes into play. How many of them are successful? I couldn't tell you. Most of them don't work, but that is the good part

about it. Scientists and engineers love it because they bring college kids in.

We have something now called Small Sats or Micro Sats. Colleges and universities around the country, even secondary school kids now are getting involved in Small Sats or Micro Sats. It is something that NASA and DoD developed and now we utilize to try to reach kids and help them understand that they, too, can participate in space exploration from their classroom. So these are all good things.

Mr. SARBANES. Thank you very much. Mr. Chairman, I yield back. I have no more time, thank you.

Chairman HALL. He is right on the dot. At this time I will recognize a very, very patient Mr. McCaul, the gentleman from Texas.

Mr. MCCAUL. Thank you, Mr. Chairman. I have been sitting here patiently, and I assure you, next time I will arrive before the gavel comes down.

Chairman HALL. You know, when I was first up here 30 years ago, I was the second one here always. I didn't want to wait until the end to talk.

Mr. MCCAUL. I guess I will close out the proceedings, possibly. I plan to attend the April Shuttle launch, and I think that is going to be a historic mission. I know Gabby's husband, Mark, will be leading that effort. And you mentioned her in your testimony very affectionately. I think we all look forward to the day that she will be serving back on this Committee, and there is no greater champion for the human spaceflight program than Gabby. And I remember working with her on the reauthorization. She was obviously opposed to the President's decision to cancel the Constellation program. One of the last conversations I had with her, in fact, the last one, was we were walking onto the House Floor just a day or two before the tragic event, and she talked about NASA. She was just a staunch advocate for the human spaceflight program, as am I.

I represent a district that was once held by Lyndon Johnson, and on the Houston end of my district in the suburbs, I represent many Johnson Space Center employees and contractors. I know in our reauthorization we restored a lot of funding for human spaceflight in spite of this Administration's attempt to kill that, and I guess as you present this budget and as I go back home to my district, they will want to know what is their future? So I guess what I am asking you is what am I to tell them when they ask me about contracts related to human spaceflight, about the future of human spaceflight program. And I know these are some of your dearest friends. But what am I to tell my constituents who are part of the Johnson Space Center?

Mr. BOLDEN. Congressman, you should tell them that the future of human spaceflight is bright and robust and that we need their help in rapidly developing new systems so that we can go explore.

This Nation has not ventured beyond the moon with humans. We have been saying we were going to do it forever. I get chastised when I talk about wanting to go to Mars. I want to go to Mars. When I came into the astronaut office in 1980, I thought I would fly on the Shuttle a couple of times, and then I would be among those that would be returning to the moon, and then Challenger

happened. And my dream of ever going to another planet went away.

I don't want that for my grandkids. So I need their help. We have got to develop commercial capability to get to low-Earth orbit so that we can continue to support the International Space Station. That is our moon right now. That is where we do technology development. That is where we do medical research. That is where we do things to make life better on Earth.

Contrary to what people think, NASA doesn't do stuff just for astronauts. Most of what we do is returned to Earth in terms of benefits for humankind. And I can go down that you all can do it yourselves. You can look at an EMT ambulance that has the developments that were put in place for the Apollo program. Wireless communications. Congresswoman Johnson listed a whole bunch of them in her opening remarks.

The Nation needs to become unafraid of exploration. We need to become unafraid of taking risks. Is it a risk to go with commercial entities? For me, no more risk than anything else because I have always—every rocket I have flown on, and I have only flown on three, four times but three, was built by a commercial entity. It was Rockwell when it started and when I finished, I think it was Boeing maintained by U.S.A., United Space Alliances.

Mr. MCCAUL. If I could ask one last because my time is running out. I appreciate your passion. I know you are very passionate about returning to the Moon. I would hope that I could work with you in terms of restoring the morale at some of the employees at the Johnson Space Center and assure them that there is a bright future ahead. And I think we in the Congress have a responsibility to make sure you have the resources to do this.

You mentioned in your testimony, if I am correct, that it would be 2030 before we could get back to the moon. You know, it has been 42 years since we landed on the moon. President Kennedy set the goal by the end of the decade, and less than ten years we were on the moon in 1969. I think a lot of people wonder why now it would take almost 20 years to get back to the moon. Most Americans, they don't understand we landed there so long ago. Why has it taken so long to get back? Because like you, I agree with the—and you are very passionate about it—with the goal that eventually we are going to have to go back to the moon and beyond. So perhaps if you can explain that to me and the American people?

Mr. BOLDEN. Congressman, I need to correct one thing. It would not take us until 2030 to go to the moon. If we decided that we wanted to go to moon and put humans there, that potentially could be done by the end of this present decade, but that is not one of the targets that has been produced either by the Congress or the President. What has been set forth as targets are 2025 to an asteroid and then the 2030s to be able to get to Mars with a follow-on landing. The reason we have not been there is because that has not been a goal of the Nation, and you know, we were content to stay in low-Earth orbit, which is hard. But it has not been something that the Nation thought was important.

Mr. MCCAUL. Well, no, the prior Administration, President Bush, did set that as a goal, the moon, Mars and beyond. So I think that was at one point in time the goal for NASA. And Mr. Chairman,

I hope we can work together to perhaps restore that vision and that goal in the Congress which I think is so vitally important and I know, Administrator, you agree with. With that, I yield back. Thank you.

Chairman HALL. I thank you, and if the Ranking Member would have a final question for the Administrator, please?

Ms. JOHNSON. Thank you, Mr. Chairman. And Administrator Bolden, thank you very much for your time here and your passion and your interest and your ability. It is extraordinary that you are sitting there defending the President's budget. I think it is grossly inadequate, and I hope that we can help a little bit. I know that I heard the gentleman I think from Mississippi mention that we had no aviation deaths the last two years. I know that you know why. We have got those satellites that are predicting weather and making sure that even farmers know when a drought is coming and whether for food supply and what have you. Do you know the condition of those satellites?

Mr. BOLDEN. Congresswoman, I will get back to you on specific satellites and their life expectancy. Most currently on orbit have outlived their planned lifetime. We tend to not remember that our technology is such that we always build things that last a lot longer than we thought. When we ought to be thinking about obsolescence. And so we are behind as a Nation in providing Earth science satellites, those that can supply weather and the like, not only for civilian use but for the Department of Defense. You talk about trafficability. My son is a Marine, and if he is on the ground, he needs to know what the soil is going to be like before he goes somewhere. That comes from satellites. And so we owe it to these young men and women who are doing things for us to provide them with satellite systems that are reliable, and we are behind.

Ms. JOHNSON. Thank you. One final question. I know that NASA had something to do with helping to rescue those miners in Chile. Could you explain that?

Mr. BOLDEN. I could explain that. I love it. It has nothing to do with NASA, no intent, whatsoever. No one in NASA ever dreamed that we would be able to do what we did, but when we learned of the Chilean miners, the 33 who were trapped were still alive, a number of our NASA employees from around the country, three doctors and one engineer, had asked if they could go down to Chile and just ask around, see what needed to be done. And they started finding that, okay, we need to find ways to get food to these people. We need to determine what is needed to keep them alive for the months that we originally thought they were going to be down there. When we bring them back to the surface, how do we triage them, how do we get them back to normal. What we used was all the lessons we have learned from flying on MIR, the International Space Station, and all the way back to Skylab days.

So we put to work the lessons that we had learned in exploration, things we never thought about. One of our engineers from the Langley research center who was a Navy submariner got together with a Chilean submariner who happened to be an engineer on the project, and the two of them led the team that designed the capsule that brought all 33 miners back to the surface, plus the additional five or six that went down to stabilize everybody.

So that is one of the most phenomenal success stories that excited the President because nobody ever dreamed we would do that. Same thing with the Earthquake in Haiti, same thing with the Gulf oil spill. NASA is sort of the Marine Corps of the science and aeronautics community. We are the most ready when the Nation is least ready.

Ms. JOHNSON. Well, thank you very much, and I think that the life of NASA depends on the life of our Nation. Thank you.

Mr. BOLDEN. Thank you very much.

Chairman HALL. Thank you. Those are the things that should be better known to school children and everybody else that has ill words for the work of NASA.

I thank you, Mr. Bolden, and I thank you for your very good testimony, and the Members of the Committee will have additional questions maybe for you and ask you to respond to those in writing. The record will be kept open for two weeks for additional comments from Members as Mrs. Johnson I think has suggested she has some comments she wants back. So you are excused. I really do thank you. We appreciate you very much.

Mr. BOLDEN. Mr. Chairman, thank you very much. And we will try to get the responses back to you in a timely manner.

Chairman HALL. And just before I hit the gavel I want to recognize the gentleman from New York, the long-time chairman here, Chairman Boehlert. And with that, we are adjourned.

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



Appendix I:

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ANSWERS TO POST-HEARING QUESTIONS

## ANSWERS TO POST-HEARING QUESTIONS

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

**Questions for the Record  
for the March 2, 2011 Hearing on  
A Review of NASA's FY 2012 Budget Request**

**Chairman Ralph M. Hall**

**QUESTION 1:**

NASA recently signed a \$753 million modification and extension of the current International Space Station contract with the Russian Federal Space Agency for crew transportation, rescue, and related services through June 30, 2016.

- a. What was the justification for this extension?

**ANSWER 1a:**

Fabrication of Soyuz vehicles must begin approximately 36 months prior to launch. As such, contractual arrangements for crew rotation and rescue services were necessary at this time or the production of Soyuz vehicles to support U.S. crew and U.S. obligations for our non-Russian International Space Station (ISS) partners would have been at risk. Specifically, this contract modification provides for the launches of 12 crew members in calendar years 2014 and 2015.

**QUESTION 1b:**

When would a new contract extension need to be finalized in order to ensure that the Russian capabilities would be available after June 2016 if needed?

**ANSWER 1b:**

Any contract extension or barter with Russia beyond Russia's obligations that will be completed by June 2016 would require further legislative modification of the Iran, North Korea and Syria Nonproliferation Act (INKSNA). NASA's goal is to have U.S. commercial crew transportation services available as soon as possible. The Agency anticipates the availability of these commercial systems by the middle of the decade, contingent upon the availability of appropriated funding. To ensure a smooth transition as this new capability is developed, NASA is considering continuing Soyuz support as a backup capability for approximately one year after U.S. commercial services become operational. As noted above, fabrication of Soyuz vehicles must begin approximately 36 months prior to launch. As such, contractual arrangements for backup crew rotation and rescue services beyond 2015 would need to be concluded in spring 2013 or the availability of these vehicles could be at risk.

**QUESTION 1c:**

Assuming a waiver to the Iran, North Korea, Syria Non-Proliferation Act is granted, under what conditions would NASA seek to extend the Soyuz capabilities beyond 2016?

## ANSWER 1c:

In order to maintain a U.S. presence on the ISS and satisfy U.S. obligations to its non-Russian ISS partners, NASA intends to continue to purchase Soyuz seats until demonstrated commercial crew transportation services and rescue services are available, and provided that there is an extension of the current exception to the INKSNA prohibition that allows the Agency to procure such services. Once U.S. commercial transportation services become available, NASA plans to purchase 8 commercial crew seats per year (4 seats twice a year) in order to maximize ISS utilization. NASA made Commercial Crew Development Funded Space Act Agreement awards in 2010 and 2011 to stimulate efforts within the private sector, encouraging them to develop and demonstrate human spaceflight capabilities. We anticipate that these awards and private sector investments will lead to the ability for domestic commercial crew providers to provide NASA's primary transportation to and from the ISS for U.S., Canadian, European and Japanese astronauts. NASA anticipates availability of these services by the middle of the decade, contingent upon the availability of appropriated funding. As noted above, NASA plans to have a period of time where crew transportation and rescue services provided by Russian and U.S. commercial vehicles overlap to ensure a smooth transition with no gap in services, currently intended to be about a one-year overlap between these two capabilities.

## QUESTION 2:

The Exploration Systems Mission Directorate has been developing a new spacesuit.

- a. What specific assumptions is NASA making about when such a spacesuit will be needed?

## ANSWER 2a:

The Multi-Purpose Crew Vehicle (MPCV) Program is planning on using suits for crew protection during launch and entry, and NASA's eventual beyond low-Earth orbit (LEO) exploration missions will require suits for extra-vehicular activity (EVA). The exact timing of when suits will be needed (beginning with the first crewed MPCV test flights) is not yet determined, and is being reviewed as an integrated part of the MPCV/SLS test plan that is currently being developed.

Although the NASA Authorization Act of 2010 specifies as a goal to have operational beyond-LEO capability by 2016, the earliest integrated MPCV/SLS test flights in this timeframe will be uncrewed. Therefore, crew suits for launch and entry protection will likely not be needed until several years after 2016 and later further for EVA on beyond-LEO missions.

To meet the MPCV launch and re-entry requirements, existing suits (two used by NASA and one by the Russians) would likely need moderate to significant modification so as to accommodate longer-duration deep-space missions. The ACES suit, for example, is used only for the brief ride into space and re-entry, and as such does not include the life-support functions needed for longer-duration travel. Additionally, NASA uses EMU suits on the ISS for conducting EVA activities. Therefore, NASA is continuing to assess options for spacesuits for future crew members who would travel aboard the new SLS and MPCV space transportation system under development. For example, NASA has been considering whether it is appropriate to continue

work on developing a new spacesuit, as envisioned by the former Constellation Program, or whether it would be better to repurpose current suits or to develop new suits.

QUESTION 2b:

What is the proposed funding level, by fiscal year, for this activity?

ANSWER 2b:

The funding level beyond FY 2011 specifically for space suit development to support the MPCV and the Space Launch System (SLS) Programs has not yet been determined. Planning and budgeting for new spacesuit development will be addressed in formulation of the FY 2013 President's Budget.

QUESTION 2c:

What changes have been implemented as a result of transitioning from Constellation to SLS/MPCV?

ANSWER 2c:

No changes have yet been implemented to the spacesuit development efforts as a direct result of the transition from Constellation to SLS/MPCV. With FY 2011 appropriated funds, efforts focus on performing requirements assessments and trade studies for a streamlined, minimally capable launch/entry suit and finding ways making the suit design solution for Orion (and now MPCV) more affordable.

QUESTION 3:

With Space Act Agreements what recourse does the government have if the companies fail to perform?

ANSWER 3:

Under its funded Space Act Agreements (SAAs) for the COTS and CCDev activities, NASA is entitled to terminate the SAA and is not obligated to pay future milestone payments if a partner fails to meet a milestone and NASA determines, after ascertaining the cause of the failure, that additional efforts are not in the best interest of the parties. If NASA terminates a funded SAA for the partner's failure to perform, NASA has taken steps to protect the Agency's investment by including terms in the SAA that provide NASA with rights in data and inventions developed under the SAA and the ability to leverage investments in property acquired with government funds by the partner.

Specifically, in the event of termination for non-performance, NASA reserves the right to exercise "government purpose" rights in any data first produced by the partner in carrying out its responsibilities under the SAAs. Similarly, NASA reserves "government purpose" rights to use any inventions first conceived or actually reduced to practice under the SAAs. This means that the data and inventions can be used by or on behalf of NASA in future development efforts.

Further, NASA reserves the right to acquire any tangible personal property acquired or developed under the SAA from the SAA partner. The price for such property is the fair market value, with a discount based on the amount of the government funds put into the property.

QUESTION 4:

On June 9, 2010, NASA sent a letter to Congress explaining that it was scaling back the Constellation program because of insufficient funding as a result of termination liability costs.

- a. As of June 9, 2010, how many NASA programs required that termination liability costs be carried for their contracts?
- b. As of June 9, 2010, how many programs actually carried those costs?

ANSWER 4a&b:

NASA's policy relative to managing and funding potential contract termination liability is to rely on the Federal Acquisition Regulations (FAR's) limitation of funds or limitation of cost clauses which are in all NASA cost-reimbursement contracts. These clauses act as a mechanism to limit the Government's liability in the event of a contract termination to the allotted funds on the contract. It is the responsibility of the contractor, not the Government, to manage its obligations, to include any potential termination liability costs, within the allotted contract funding under the limitation of funds or limitation of cost clauses.

QUESTION 4c&d:

As of June 9, 2010, how many programs did NASA determine were in potential violation of the Anti-Deficiency Act based on termination liability costs?

How many of those programs were scaled back as a result of possible Anti-Deficiency Act concerns?

ANSWER 4c&d:

In June, 2010 NASA directed the Constellation program (CxP) that the Agency would fully comply with provisions of the FY 2010 Consolidated Appropriations Act with respect to prohibitions of termination of CxP projects/activities. NASA also reminded Constellation contractors that they must abide by the provisions of their contracts with respect to termination liability. It is the responsibility of the contractor, not the Government, to manage all costs within the estimated cost of the contract. After NASA reminded the CxP contractors of the relevant provisions of their contracts, one contractor said after reevaluating their position that they would soon run out of money. At that time NASA had released nearly all FY 2010 funds to Constellation contractors, so NASA had no choice but to initiate a plan to rescope work in FY10 if that contractor was to be allowed to proceed. During that period, the HQ and Center CFOs also performed a high-level review of the funding situation on NASA's large cost-plus contracts and found only one other with a significant problem (which was connected with the James Webb Space Telescope project).

QUESTION 4e:

The James Webb Space Telescope has seen significant cost growth in recent years. As of June 9, 2010, did the program have enough money to cover potential termination liability costs?

ANSWER 4e:

Yes, enough funds existed to cover potential termination liability costs; however the funds for the Potential Termination Liability (PTL) resided at the Program Level not on the contract.

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

**Ranking Member Eddie Bernice Johnson**

**QUESTION 1:**

You testified that “So we have made the decision that safety of the crew is number one priority. The quickest, most efficient, safest way for me to get them [crew] there is through relying on commercial entities to handle to access to low-Earth orbit”. In the absence of any flight record, what evidence do you have to support your statement that commercial entities would provide the “safest”, “quickest”, or “most efficient” way to get crew to low-Earth orbit?

**ANSWER 1:**

With regard to safety for future astronauts, at no point in the development and acquisition of commercial crew transportation services will NASA compromise crew safety. Simply put, U.S. astronauts will not fly on any space vehicle until NASA is convinced it is safe to do so – and this applies both to NASA-developed vehicles as well as to commercially-developed vehicles.

There is a very robust set of flight histories for commercial vehicles. The following examples illustrate the historical records of some existing successful commercial launch vehicle capabilities. The Atlas family of rockets has had over 90 consecutive successes including 21 consecutive successes for Atlas V, and additional unmanned flights will occur over the next few years before any astronaut flights would potentially begin. Similarly, the Delta IV has had 13 consecutive successful flights, and the Falcon 9 has had two consecutive successful flights, with many more Delta IV and Falcon 9 flights scheduled in the next few years. These vehicles are shown to illustrate commercial successes only and may, or may not be selected by NASA to perform commercial crew missions because those awards have not been made yet. But, astronauts will not be flying on any vehicles that lack a strong and robust safety capability.

Regarding schedule, the commercial crew mission is strictly focused on low Earth orbit, similar to a Gemini-class capability. It is simpler, and therefore, likely to be quicker than developing a system for beyond low Earth orbit. The first piloted Gemini flight to orbit was achieved a little more than 3 years after the contract was awarded to develop Gemini. Today, the fastest way for America to regain its ability to send astronauts to the International Space Station is to support development of a simple Gemini-class capability rather than waiting for a more complex Apollo-sized system. Also, because NASA currently plans to support the development of multiple, commercial crew systems, schedule delays with any one company will not delay the availability of astronaut launch capability.

With respect to cost, the Augustine Committee provided a basis for the potential for cost savings provided by the Commercial Crew Program when it stated:

"The best preliminary estimate of the Committee was about a \$3 billion program for the fraction of the design, development, test, and evaluation (DDT&E) effort that would be borne by NASA. After multiplying by the historical growth factors and other multipliers associated with 65 percent confidence estimating the cost carried in the Committee's final estimate of the cost of the program to NASA is about \$5 billion. Comparing the scope of providing a commercial crew capability to the cost of historical programs offers a sanity check. In the existing COTS A-C contracts, two commercial suppliers have received or invested about \$400-\$500 million for the development of a new launch vehicle and unmanned spacecraft. Gemini is the closest historical program in scope to the envisioned commercial crew taxi. In about four years in the early- to mid-1960s, NASA and industry human-rated the Titan II (which required 39 months), and designed and tested a capsule. In GDP-inflator-corrected FY 2009 dollars, the DDT&E cost of this program was about \$2.5-3 billion, depending on the accounting for test flights. These two comparatives tend to support the estimate that the program can be viable with a \$5 billion stimulus from NASA."

Ongoing NASA commercial cargo and crew projects are providing data that supports the notion that commercially developed transportation systems can be developed in a cost effective manner. CCDev 2 partners are making great strides with their commercial developments efforts as well. Additionally, our COTS cargo partners continue to make progress developing and demonstrating their commercial cargo transportation systems. Both COTS and CCDev partners are developing their systems for substantially less funding compared to traditional NASA vehicle and spacecraft development efforts. NASA will continue to work with our commercial partners to incorporate and leverage the efficiencies demonstrated by the private sector.

#### QUESTION 2:

In response to a question on how much would be saved by relying on private commercial transportation of crew to the space station and back as compared to maintaining the Space Shuttle, you replied that providing an answer to the question "would be pure conjecture because we haven't flown a single commercial crew flight yet, and I don't want to try to blow smoke. I don't know." However, in your oral statement you said that your priorities in human spaceflight in fiscal year 2012 include "cost-effective U.S.-provided commercial access to low Earth orbit for American astronauts". What justification do you have to support the notion that commercial crew transportation would be cost-effective? What is your definition of "cost effective" in the context of your statement and as compared to what existing costs?

#### ANSWER 2:

The Augustine Committee provided a basis for the potential for cost savings provided by the Commercial Crew Program when it stated:

“The best preliminary estimate of the Committee was about a \$3 billion program for the fraction of the design, development, test, and evaluation (DDT&E) effort that would be borne by NASA. After multiplying by the historical growth factors and other multipliers associated with 65 percent confidence estimating the cost carried in the Committee’s final estimate of the cost of the program to NASA is about \$5 billion. Comparing the scope of providing a commercial crew capability to the cost of historical programs offers a sanity check. In the existing COTS A-C contracts, two commercial suppliers have received or invested about \$400-\$500 million for the development of a new launch vehicle and unmanned spacecraft. Gemini is the closest historical program in scope to the envisioned commercial crew taxi. In about four years in the early- to mid-1960s, NASA and industry human-rated the Titan II (which required 39 months), and designed and tested a capsule. In GDP-inflator-corrected FY 2009 dollars, the DDT&E cost of this program was about \$2.5-3 billion, depending on the accounting for test flights. These two comparatives tend to support the estimate that the program can be viable with a \$5 billion stimulus from NASA.”

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QUESTION 3:

In your testimony, you noted that “We should always have a back-up vehicle” and that “the exploration systems will have the capability of providing backup should any commercial entity fail.”

- a. What specific assumptions are you making about how you will provide a back-up capability to ISS?

ANSWER 3a:

NASA has efforts underway to develop an American-made commercial capability for crew transportation and rescue services to the station following this year’s retirement of the Space Shuttle fleet. The Agency anticipates these commercial systems will be available by the middle of the decade. These services will provide the primary transportation to and from the International Space Station (ISS) for U.S., Canadian, European and Japanese astronauts. To ensure a smooth transition as this new capability is developed, Russian Soyuz support will continue as a backup capability for about a year after commercial services begin. The use of Russian Soyuz services in support of the ISS is dependent on NASA’s current exemption in the Iran, North Korea, and Syria Non-proliferation Act (INKSNA). This exemption

will expire in July 2016. NASA is also developing the Multi-Purpose Crew Vehicle (MPCV) – based on the Orion Crew Exploration Vehicle – for missions of exploration beyond Low Earth Orbit (LEO). In accordance with the NASA Authorization Act of 2010, the MPCV will also provide a back-up capability to transport astronauts to/from ISS in the event the commercial crew and/or international partners are unable to do so, though this type of mission would be a costly and inefficient use of the MPCV.

QUESTION 3b:

What would NASA do to ensure U.S. transportation to and from the ISS if there were an anomaly leading to a commercial launch failure involving a loss of vehicle and crew and if such an event occurred after the completion of any contracted seats on Soyuz?

ANSWER 3b:

Steps taken to ensure the transportation of U.S. astronauts to and from the ISS in the event of a commercial launch failure resulting in loss of crew and vehicle (LOCV) would depend upon the availability of other vehicles. If NASA had multiple crew transportation services under contract, the Agency would rely on other providers during the post-anomaly stand-down. If the MPCV had achieved operational status at the time of the anomaly, the Agency would have the option of using that vehicle to transport astronauts to and from the ISS although this would be a costly and inefficient use of the MPCV.

In the event that neither commercial vehicles nor MPCV were available, NASA would likely have to suspend flights of U.S. astronauts to ISS until the resolution of the anomaly or the operational availability of another vehicle, or pursue new opportunities to fly U.S. astronauts on international partner vehicles.

QUESTION 3c:

Under what scenarios would NASA invoke a back-up capability?

ANSWER 3c:

There are a variety of scenarios under which NASA might utilize a back-up capability to transport U.S. astronauts to and from the ISS. While LOCV is one such scenario, the Agency might also use a back-up in the event of a serious testing anomaly or an operational event that resulted in a launch scrub and extended stand-down period. It is important NASA and its international partners to be able to respond to unforeseen circumstances with several options.

QUESTION 3d:

How much time might elapse from when NASA decides to use the back-up capability and when such capability is operationally available?

ANSWER 3d:

The time between the decision to employ a back-up capability for the transportation of astronauts to the ISS and its availability is highly dependent on the specific circumstances and the processing flow time for a particular spacecraft, as well as the overall status of spacecraft production. It should be noted, however, that the time criticality of engaging a back-up capability is somewhat mitigated by the facts that ISS missions are six months in length, and the Station can be resupplied indefinitely using automated cargo vehicles from several countries. This gives NASA and its international partners schedule flexibility when deciding whether or not to use a back-up system.

QUESTION 4:

Please provide the status and condition of NASA's Earth observing satellites.

ANSWER 4:

NASA is operating 14 Earth observing satellites that are providing data on a wide variety of interactions among the oceans, atmosphere, land surface, ice sheets and biota that compose the Earth system. These data enable research that improves our scientific understanding of and enables improved prediction of climate, weather, and natural hazards. The list of satellites and their status is given in the table below.

Of the 14 satellites, 12 are in their extended phase of operations. As satellites go beyond their planned lifetime, they can experience degradation in their redundant systems and additional time and resources must be dedicated to monitoring and resolving age-related issues. However, the missions in extended operations continue to return valuable scientific data that drive climate and weather research and provide decision support information and tools through NASA's Applied Sciences Program.

Mission <sup>1</sup>	Launched	Phase <sup>2</sup>	Planned Lifetime (Years)	Current Status	Expected Last Year of Ops
Tropical Rainfall Measuring Mission (TRMM)	11/27/97	Extended	3	Four instruments operating nominally; failed CERES instrument	2015
Quick Scatterometer (QuikSCAT)	6/19/99	Extended <sup>3</sup>	3	Age-related failed spin mechanism	2015
Terra	12/18/99	Extended	5	Four instruments operating nominally; failed	2017

				Shortwave Infrared subsystem on ASTER instrument, but other two ASTER subsystems operating nominally	
Active Cavity Radiometer Irradiance Monitor (ACRIMsat)	12/20/99	Extended	6	Operating nominally	2020
Earth Observer -1 (EO-1)	11/21/00	Extended	1.5	Operating nominally	2015
Jason	12/7/01	Extended	3	Four instruments operating nominally; Age-related failed GPS receiver	2012
Gravity Recovery and Climate Experiment (GRACE)	3/17/02	Extended	5	Battery anomaly due to age; duty cycling of instruments due to power constraints will cause a degradation of data	2015
Aqua	5/3/02	Extended	6	Three instruments operating nominally; Advanced Microwave Scanning Radiometer for EOS antenna spin motor showing increasing torque but operating nominally; one of 15 Advanced Microwave Sounding Unit-	2018

				A channels failed; failed Humidity Sounder for Brazil	
Solar Radiation and Climate Experiment (SORCE)	1/25/03	Extended	5	Battery anomaly leading to duty cycling of instruments; instruments operating nominally	2015
Aura	7/15/04	Extended	6	Three instruments operating nominally; failed High Resolution Dynamics Limb Sounder from mission on-set	2018
Cloudsat	4/28/06	Extended	2	Age-related battery anomaly; recovery activities underway	2015
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)	4/28/06	Extended	3	Two instruments operating nominally; CALIOP instrument operating nominally on redundant laser unit	2016
Ocean Surface Topography Mission (OSTM)	6/20/08	Prime	3	Operating nominally	2018
Aquarius	6/10/11	A&C	3	In-orbit checkout underway	TBD

1. Information on the measurements these missions make and the research and applications that they enable is available at: <http://nasascience.nasa.gov/earth-science/missions/>

2. Operating missions are either in Activation and Checkout (A&C) which is the 60-90 day period after launch, Prime operations which is the phase in which the mission's primary purpose is to be accomplished, or the Extended operations phase in which we gain additional value to the science and application communities and the

taxpayer by continuing to operate the mission as long as the benefits exceed the costs or until the satellite ceases to function. Missions in the Extended phase are evaluated every two years to assess the value of continuation.

3. After ten years of operation of a system designed for three years, in the Fall of 2009, QuikSCAT experienced an age-related failure of the mechanism that rotates the scatterometer antenna. QuikSCAT still acquires accurate and precise global backscatter measurements; it is being used as a transfer standard to improve the data from an Indian satellite which copied the QuikSCAT design, and thereby extended the QuikSCAT data set for climate and weather research.

In addition to these missions operated by NASA, the US Geological Survey operates the Landsat 5 and 7 satellites developed and launched by NASA. These are both operating well beyond their design lifetimes but continue to return valuable data on land surface change for agriculture and natural resources management as well as scientific research.

The following missions are in development or formulation:

<u>Mission</u> <u>Readiness Date</u>	<u>Planned Launch</u>
NPOESS Preparatory Project (NPP)	October 2011
Landsat Data Continuity Mission (LDCM)	June 2013
Global Precipitation Measurement (GPM)	2013
Orbiting Carbon Observatory-2 (OCO-2)	2013
Stratospheric Aerosol and Gas Experiment (SAGE III on ISS)	2014
Soil Moisture Active/Passive (SMAP)	2014
ICESat-2	2016

Several other missions are in a pre-formulation study phase. These include Earth Venture-2, the first "Venture Class" orbital mission. On June 17, 2011, NASA released the Announcement of Opportunity for this PI-led, science-based, competitively selected small orbital mission. Once the selection process is complete, the Earth Venture-2 mission will undergo a rapid development for flight.

#### QUESTION 5:

Your statement acknowledges that the amount requested for an expanded commercial crew development program exceeds that authorized for 2012; and that the amount is critical to ensure NASA has "*one or more companies that can transport American astronauts to the ISS.*"

- a. Is NASA saying it would be satisfied with only one company to transport crew to the Space Station? If so, are you moving away from your prior argument that you were achieving reduced risk by terminating Constellation and substituting for it with multiple commercial vehicles?

## ANSWER 5:

NASA still strongly desires to support multiple commercial providers through the commercial crew development phase for as long as possible, as allowed by the budget. Currently, we have four funded partners performing solid development work on their commercial systems under Commercial Crew Development, round 2 (CCDev2) Space Act Agreements (SAAs). Until we conduct a competition relating to development work beyond CCDev2, we do not know how many providers NASA can support all the way through development and certification under the current budget profile. However, NASA intends to do everything possible within appropriated budgets to maximize the possibility of supporting multiple providers through to completion and still provide crew transportation services by the middle of the decade.

## QUESTION 5b:

Under the proposed new strategy, what does NASA plan to do if commercial providers run into problems during the development phase, given the lack of an alternative government system?

## ANSWER 5b:

The Commercial Crew Program (CCP) has been structured to minimize the likelihood of this risk from occurring, and there are several mitigation strategies that can be employed should issues occur during the development phase.

NASA plans to execute agreements with at least two providers; this will insulate the Agency from the impact of any single provider not completing its development of its system through certification. However, the structure of the CCP incentivizes providers to "stay in the game" even when encountering difficulties. Because the CCP is intended to support the development of both transportation to the ISS and commercial services, providers will be working toward the implementation of their commercial business case in addition to working toward the opportunity to compete for ISS service missions through 2020 and beyond. Because it is in both NASA and the provider's interests to increase the likelihood that development will be completed, NASA anticipates providing providers valuable expertise and support derived from its decades of experience in human spaceflight operations. By ensuring that providers have access to NASA facilities, technology and expertise, NASA can significantly contribute to the success of commercial providers.

If it appeared that a delay in the development of a commercial system would impact the safety of the crew on the ISS, NASA would continue to purchase *Soyuz* seats for crew transportation purposes, contingent upon the Agency receiving authority to do so under the provisions in the Iran, North Korea, and Syria Nonproliferation Act (INKSNA).

## QUESTION 5c:

What will NASA do if one or more of the companies that NASA is depending on for crew transport decides to exit the business after development is underway?

ANSWER 5c:

Please see answer 2b.

QUESTION 5d:

In the absence of a government system, what options do you have if the commercial companies are unable to satisfy NASA's safety standards?

ANSWER 5d:

See answer to 2b. In addition, it should be noted that the commercial companies will not be alone in their efforts to satisfy NASA's safety standards. NASA will be there every step of the way, providing its unique and unparalleled experience in human spaceflight and will also provide access to NASA's unique facilities and infrastructure. CCP is a partnership between NASA and industry, each leveraging the strengths and talents of the other. This partnership will provide a strong capability for commercial companies to satisfy NASA's human certification requirements and standards.

QUESTION 6:

Citing time exigencies, NASA deviated from its initial plan for acquiring commercial cargo services by making an award for such services long before demonstrations were complete. The risks would be far greater if NASA were to do the same for commercial crew transportation.

- a. What assurances can you provide this Committee that you will require demonstrations to be complete before you sign a contract for commercial crew transportation services?

ANSWER 6a:

NASA has not completed developing its acquisition strategy for commercial crew transportation services. NASA is currently evaluating when would be the optimum time for signing contracts for services. Launch vehicle and spacecraft development timeframes are dictated by a number of factors, including available funding, architectural complexity and the number of elements requiring design and development. During CCDev2, our partners are maturing their commercial spacecraft designs as well as the integrated architectures. As it continues to work with industry to support acquisition strategy development, NASA will gain additional insight into architectural complexities allowing better understanding of risks associated with completing demonstration/certification efforts and identifying potential impacts to crew transportation services.

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

**Questions for the Record from Congresswoman Sandy Adams**

**QUESTION 1:**

NASA's budget request for the Space Launch System and Multi Purpose Crew Vehicle in FY 2012 is \$1.2 billion less than directed by the NASA Authorization Act.

- a. Why is NASA seeking to significantly reduce the funding, and therefore reduce the overall priority, that was recently established in law?

**ANSWER 1a:**

All goals of the NASA Authorization Act of 2010 are reflected in the President's FY 2012 budget request. The FY 2012 budget request strikes what the Administration believes is an appropriate balance between Human Exploration Capabilities (the MPCV and SLS and associated elements) and other priorities from the Authorization Act, including science, aeronautics, and the development of commercial crew transportation systems.

**QUESTION 1b:**

How does NASA plan to reach an operational capability by 2016 with this reduced level of funding?

**ANSWER 1b:**

The NASA Authorization Act of 2010 sets a goal for achieving an initial operational capability by 2016. Unfortunately this goal will be very difficult to achieve with either the funding levels in the Authorization Act or in the President's Budget. However, NASA's current technical approach is working to launch a test flight as close to 2016 as is feasible.

**QUESTION 2:**

Administrator Bolden testified that, "The request supports an aggressive launch rate over the next two years with about 40 U.S. and international missions to the ISS, for science, and to support other agencies." How many of those launches are conducted by NASA?

**ANSWER 2:**

NASA's FY 2012 budget request supports a launch rate of about 40 missions from FY 2011 through FY 2012, including science missions flown to Earth orbit and beyond, as well as United States and international flights to the International Space

Station (ISS). During that period, NASA will conduct a total of 12 launches of its own listed below.

Science: Glory (which experienced a launch failure), Aquarius (launched successfully), Gravity Recovery and Interior Laboratory (GRAIL), Juno, National Polar-orbiting Operational Environmental Satellite (NPOESS) Preparatory Project, Mars Science Laboratory (MSL), Nuclear Spectroscopic Telescope (NuSTAR), and Radiation Belt Storm Probes (RBSP).

Space Operations: Space Shuttle missions STS-133, STS-134, and STS-135; and the Tracking and Data Relay Satellite-K (TDRS-K).

QUESTION 3:

On page 2 of Administrator Bolden's testimony, he outlines the FY 2012 priorities for human spaceflight. How were those priorities developed?

ANSWER 3:

The FY 2012 human spaceflight priorities outlined in Administrator Bolden's testimony were developed as part of the Agency's budget formulation process to reflect guidance and direction provided by the National Space Policy of the United States of America (June 28, 2010) and the NASA Authorization Act of 2010 (P.L. 111-267).

QUESTION 4:

Please provide a detailed list of all climate change research projects currently funded by NASA and the amounts allocated to each of those programs.

ANSWER 4:

The table below provides a list of projects related to climate research currently conducted by NASA. While these projects contribute in a substantial way to understanding Earth's climate system, they are not designed exclusively for that purpose; that is, many contribute to research and applications in areas other than climate. For example, the Global Precipitation Measurement (GPM) mission will provide data on global rainfall rates that will feed directly into numerical weather prediction models to aid in forecasting the waxing and waning of hurricanes and other tropical storms, as its predecessor the Tropical Rainfall Measuring Mission does today. Similarly the Soil Moisture Active/Passive (SMAP) mission will measure soil moisture as a key component of the Earth's water cycle, also a key component needed to improve regional weather prediction and projections of seasonal agricultural productivity. The Landsat Data Continuity Mission (LDCM) is the next in a series of Landsat missions that has for over 30 years provided the basis satellite land imaging data set used by natural resource managers at the local, state, and federal levels around the country and beyond. The Jason series of ocean altimetry satellites provides data used by the Oceanographer of the Navy for fleet numerical weather prediction models to inform naval operations. One application of this research is to understand the impacts to NASA's Kennedy Space Center from

sea level rise and changes in severe storm patterns associated with projected climate change.

In short, these missions and research activities are vital to NASA's effort to understand Earth as a planet—the field of Earth System Science that NASA has pioneered over 50 years of observing the Earth from space.

NASA Climate Change Research Missions/Activities*	2011 Enacted (\$K)	2012 Budget Request (\$K)
Ozone Trends Science	2,468	1,250
Interdisciplinary Science	56,790	66,394
Research & Analysis	132,680	143,529
Carbon Cycle Science team	2,398	2,340
Global Modeling & Assimilation office (GMAO)	9,934	9,130
Scientific Computing	22,912	22,368
Carbon Monitoring System(CMS)	5,900	3,650
High-End Computing Capability	4,336	3,981
Fellowships and New Investigators	6,575	8,098
Earth Science Education & Outreach Activity	9,747	9,947
Multi-Mission Operations	116,733	125,313
EOSDIS	30,703	35,922
Global Precipitation Mission (GPM)	133,566	77,361
Decadal Survey Missions	73,018	122,626
ICESat II	53,874	101,839
Soil Moisture Active and Passive (SMAP)	98,295	127,226
Glory Mission	13,000	0
Landsat Data Continuity Mission (LDCM)	54,769	50,045
Ocean Surface Topography Mission (OSTM)	1,069	1,181
Ocean Surface Topography Science Team (OSTST)	5,368	6,177
TRMM	9,239	9,017
Earth Systematic Mission Research	7,259	11,089
Earth Observation Systems Research	25,535	23,574
QuickScat	3,559	3,664
NPOESS Preparatory Project (NPP)	101,860	13,647
Precipitation Science Team	6,487	6,746
Ocean Winds Science Team	3,167	4,764
Landcover Science Project Office	1,147	1,055
Terra	33,317	30,617
Aqua	32,408	31,259
Aura	29,616	28,329
ICESat	3,849	1,390

ACRIMsat	1,142	1,295
SORCE	4,526	5,205
JASON	4,557	4,667
ESSP Mission Research	14,581	13,474
Orbiting Carbon Observatory - 2 (OCO)	89,025	91,000
Aquarius	28,078	6,689
GRACE	2,598	2,477
Cloudsat	7,125	7,843
CALIPSO	6,700	5,340
Venture Class Missions	32,049	59,641
Applied Science	36,567	33,050
* Earth Science program activities counted as directly contributing to USGCRP.		

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

Questions for the Record from Congressman Jerry Costello

QUESTION 1:

How will the proposed funding level for aeronautics R&D impact NASA's ongoing work on NextGen and other aeronautics and aviation priorities?

ANSWER 1:

The President's FY 2012 budget request for the NASA Aeronautics Program strongly endorses NASA's contributions to the nation's Next Generation Air Transportation System (NextGen) and other national priorities in aviation such as energy efficiency, environmental impact mitigation, and aviation safety. NASA Aeronautics invests approximately 70 percent of its annual budget to directly or indirectly support improvements needed for the NextGen. For FY 2012, NASA Aeronautics plans to increase research in the utilization of advanced ground-based and flight deck technologies and automation for efficient and safe airport surface operations; the effects of high altitude ice crystal on aircraft engines; composite structures and materials; and utilization and understanding of alternative fuels for fuel-flexible aircraft engine development. The budget also continues support for new FY 2011 initiatives into the Integration of Unmanned Aircraft Systems into the National Airspace System and the Validation and Verification (V&V) of Flight Critical Systems.

In addition, NASA Aeronautics research priorities are aligned with the goals and objectives of the National Aeronautics Research and Development (R&D) Policy and Plan, in which national priorities in the U.S. government aeronautics R&D investment are identified in order to ensure the Nation's technological leadership in the aeronautics enterprise is maintained and strengthened. These goals and objectives include mobility through the air, national security, aviation safety, and energy efficiency and environmental impact mitigation. Investments being made by NASA Aeronautics are well aligned with all of these goals and objectives through fundamental research programs and integrated systems level research. With regard to testing infrastructure, we support and provide strategic management of national level assets NASA owns and operates in the ground testing and experimental flight research to ensure state-of-the-art testing capabilities are well maintained and available to meet the testing needs of NASA and the nation.

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

**Questions for the Record from Congressman Brad Miller**

Last December, the Federal Communications Commission granted conditional approval for a company to build a new ground-based system of up to 40,000 high-power transmission towers across the nation for next-generation wireless internet access.

That system would use part of the "L" band of the radio frequency spectrum, which unfortunately is adjacent to the frequency used by the DOD Global Positioning Satellites and millions of federal, state, local government and commercial users.

**QUESTION 1:**

The Committee understands that NASA and other federal agencies such as the Defense Department and FAA have formally raised concerns about the potential for interference to the Global Positioning System (GPS) L1 band used for military, federal and all commercial applications if the FCC decision stands. How does this issue affect NASA?

**ANSWER 1:**

The LightSquared proposal, which would conduct stand-alone terrestrial wireless operations in the radio frequency band immediately adjacent to that used by the Global Positioning System (GPS), could create effects that would impact a broad range of GPS applications. Impacts to NASA operations are well articulated in the Agency's submission to the National Executive Committee (EXCOM) for Space-Based Positioning, Navigation, and Timing (PNT) Engineering Forum (NPEF) technical assessment. Disruption of GPS reception would affect numerous NASA science applications, including geodetic surveying, environmental monitoring (e.g., earthquake monitoring and measurement of changes on the Earth's surface), space-based navigation applications, satellite measurements of ocean surface salinity, and a wide variety of other science applications. One of the important science applications that would be affected is NASA's use of space-based receivers to perform Radio Occultation (RO) measurements to characterize the Earth's atmosphere. RO measurements are used to significantly improve weather forecasting, and loss of data from these measurements would mean deficient weather forecasting for the Nation.

The Administration believes that we must protect existing GPS users from disruption of the services they depend on today and ensure that innovative new GPS applications can be developed in the future. At the same time, recognizing the President's instruction to identify 500 MHz of new spectrum for innovative new mobile broadband services, we will continue our efforts at more efficient use of spectrum. Therefore, in the short run, we will participate in the further testing required to establish whether there are any mitigation strategies that can enable LSQ

operation in the lower 10MHz of the band. We also encourage commercial entities with interests to work with Lightsquared toward a possible resolution, though any proposed mitigation must be subjected to full testing. The challenge of meeting the President's goal also depends on long-term actions by Federal agencies in the area of research and development, procurement practices that encourage spectrally-efficient applications, and new policy development.

QUESTION 2:

What would be the impact on the nation's scientific research community if 40,000 towers are built around the country that causes dead-spots for GPS receivers?

ANSWER 2:

The implementation of a system that causes GPS dead spots would have a significant impact on NASA's scientific research. There are many examples where this interference would be detrimental, some of which are described below.

1. **Ground-truth measurements.** In order to calibrate on-orbit instruments, scientists often use ground-truth measurements. Precise knowledge of the location of these measurements is critical to enabling accurate calibration of the on-orbit instrument. For example, suppose a new spacecraft instrument takes a measurement of algae blooms in lakes or air samples. Those measurements are taken over a precisely identified time and location, as defined by the spacecraft GPS location data. The ground measurement is also precisely known (in time and location) based on GPS data. If the measurements on the spacecraft match the measurements on the ground, we know the on-board instrument is working properly. This important calibration procedure is completely dependent on the availability of the in-situ GPS location data. Without this ground truth of the instrument data, the resulting observations and data interpretations will be suspect. Ultimately this will make the public less willing to use green technologies because the scientific foundation for the benefit of reducing carbon footprints will be in doubt.
2. **Ground-based infrastructure.** The National Research Council recently published a report on the national imperatives for a precision positioning infrastructure. NASA is a lead agency in the operation and maintenance of this infrastructure and interference to GPS operations will compromise the utility of this infrastructure. There are numerous applications of ground-based science that are dependent on the precise location information available from GPS. One critical type of science is research on natural hazards such as earthquakes, landslides, and volcanic eruptions. In this research area, the smallest movement of the Earth's surface is tracked to better understand the possibility of catastrophic events. These measurements must be extremely precise if scientists are to have insight into the pressures building up within fault zones or volcanoes that ultimately result in a release of the pressure in the form of an earthquake or volcanic eruption. Natural hazards research has become increasingly dependent on GPS data, the loss or impairment of which would be devastating and jeopardize thousands of lives.

3. **Ionospheric measurements.** The sun routinely sends out radiation that, on Earth, is trapped by the ionosphere. When a particularly strong solar flare erupts, it has the potential to send enough radiation to disrupt (and even disable) the country's electric power grid and to disrupt communications and radar tracking. By using very precise GPS measurements, scientists can watch for changes in the ionosphere to mitigate the effect of these changes or to prepare for impending events. This information is useful to a broad group of users including electric companies (who can take action to protect their systems), radar and radio operators, and scientists who seek to better understand this phenomenon. Without these GPS measurements, notification of potential disruptions will be delayed resulting in damage to the power grid or interference to radar and radio transmissions.
4. **UAV and Aircraft operations.** Not all science data is collected from satellites or in-situ measurements; some is collected using UAVs and aircraft. For example, NASA's highly successful UAV Synthetic Aperture Radar project recently flew a sophisticated radar to study the Gulf of Mexico oil disaster and the impact of the Mississippi floods on levees and farmland. These UAVs and aircraft use GPS for navigation and would not be usable for science without it (or without a costly change to perform navigation using another method).
5. **Precision spacecraft navigation.** Spacecraft use GPS for precise navigation. While these new transmission towers would not interfere with the use of GPS signals that are directly overhead of the spacecraft, there would be interference for ultra-precise navigation that requires the input of multiple GPS signals simultaneously. In this instance, the scientific satellite would be looking at a very low angle to obtain the signals from GPS satellites that are further away. The high power emissions from these transmission towers would interfere with these low look-angle signals, thereby reducing the accuracy of the navigation information leading to a degradation of the science data. Many spacecraft also use a reference system of ground networks that would be dramatically impacted by this GPS interference. The US hosts a significant number of ground observatories that function as reference sites for the precision navigation of satellites and aircraft and interference to the GPS signal would degrade the science data.
6. **Weather sensing.** A technique known as GPS radio occultation uses the bending of GPS signals by the atmosphere as it travels from the GPS satellites to an orbiting spacecraft. This NASA-developed technique is now used operationally by NOAA to improve their long-range weather forecasts. The interference to the GPS signal would render this technique, which looks all the way down to the Earth's surface, useless over the continental US, thus impacting the accuracy of NOAA's weather forecasts.

Although the plans of this company are for towers within the continental United States, approval for this U.S. company could have global implications. There is great concern that companies outside the U.S. will pick up this technology causing scientific impacts across the globe, and eroding the capabilities of all Global Navigation Satellite Systems, not just the U.S. GPS.

## QUESTION 3:

I understand that the FCC used a “fast-track” approval process in this case. Would you say that FCC adequately studied and fully understood NASA’s concerns before it made a decision? Did the FCC even talk to anyone at NASA at all?

## ANSWER 3:

The conditional waiver issued to LightSquared, LLC on January 26, 2011, established a very aggressive schedule to evaluate interference potential to GPS users, with a final report deadline of June 15, 2011. As part of its bifurcated process, the Federal Communications Commission (FCC) is required to coordinate spectrum issues affecting the Federal agencies with the National Telecommunications and Information Administration (NTIA). The NTIA chairs the Interdepartment Radio Advisory Committee (IRAC). NASA expressed its concerns in memoranda to the NTIA Associate Administrator and IRAC Chairman regarding potential interference with GPS reception from LightSquared’s proposed terrestrial wireless network, and advocated that NTIA oppose the FCC granting a conditional waiver until such time as proper technical analysis could be conducted and mitigation developed. While NTIA did not explicitly oppose the granting of a conditional waiver in its memorandum to the FCC, NTIA did concur with NASA’s and other Federal agencies’ concerns about potential interference to GPS and advised the FCC that it needed to deal with those concerns regarding interference before any interference occurs. NASA and other Federal agencies reiterated their concerns with the FCC’s subsequent approval of the conditional waiver, without adequate study, at the Deputy Administrator/Secretary-level Positioning, Navigation, and Timing (PNT) Executive Committee meeting on May 11, 2011. The FCC has acknowledged the significance of the interference concerns and has stated its intention to permit operations by LightSquared only where and when those concerns have been resolved.

## QUESTION 4:

Would it be fair to say that NASA would not support a solution to the possible GPS interference issue if that meant the need for widespread upgrade or replacement of the government’s and scientific research community’s inventory of GPS receivers?

## ANSWER 4:

NASA will continue to participate in the interagency process in defining what further testing is required to establish whether there are any mitigation strategies that can enable LSQ operation in the lower 10 MHz of the band. Any proposed mitigation strategies must be subjected to full comprehensive testing to ensure that agency missions are not negatively impacted. NASA is working with NTIA to identify its complete GPS inventory, to determine the scope of any additional testing.

NASA fully supports the Administration’s goal of identifying additional spectrum for broadband use, and will continue to cooperatively investigate and assess mitigation strategies, while not compromising the performance of NASA’s GPS-dependent systems or missions.

## QUESTION 5:

What plans does NASA have to participate in the unfolding process that FCC will use to resolve this new GPS interference issue?

## ANSWER 5:

The conditional grant of the waiver to LightSquared by the FCC required the establishment of a Technical Working Group (TWG) to examine the GPS interference issues. LightSquared submitted a final report stemming from the work of the TWG to the FCC on June 30th. NASA participated in the work of this industry group to ensure its GPS equities were appropriately considered and represented. In addition, NASA conducted independent tests and analysis of the susceptibility of its GPS receivers to interference from the LightSquared network. NASA also participated in the Federal agency test and analysis efforts, under the National Executive Committee (EXCOM) for Space-Based Positioning, Navigation, and Timing (PNT) Engineering Forum (NPEF), jointly led by the Air Force and the Federal Aviation Administration. FCC just ended, on July 30<sup>th</sup>, a 30-day public comment period for the TWG report and LightSquared's independent recommendations on mitigation options. Additionally, a 15-day reply comment period recently ended on August 15th. Federal agency comments on spectrum matters are coordinated and submitted to the FCC by the NTIA.

## QUESTION 6:

What concerns has NASA raised with FCC over this issue, and what recommendations have you given to FCC on what needs to be done to adequately protect military and public safety GPS equipment from mission-degrading interference?

## ANSWER 6:

NASA, along with other Federal agencies, is investigating the full range of possible effects of the LightSquared network on GPS applications, including those related to scientific endeavors, public safety, and national security. NASA is also working cooperatively with other Federal agencies to develop recommendations that will address NASA's specific concerns, as well as concerns of other potentially affected Federal agency missions.

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

Questions for the Record from Congressman Daniel Lipinski

**NextGen**

**QUESTION 1:**

How much of NASA's Aeronautics research budget goes to NextGen? Can you describe what NASA has done under the existing Continuing Resolution (CR) to advance Aeronautics research programs, including NextGen? If Congress were to enact the FY 2012 budget level for Aeronautics research, what specific, near-term NextGen benefits would be seen?

**ANSWER 1:**

Approximately 70 percent of NASA Aeronautics' budget directly or indirectly supports the NextGen goals. The FY 2011 Continuing Resolutions did not have a significant impact on the ongoing Aeronautics Research Mission Directorate (ARMD) research programs because we were receiving funding at the same level as FY 2010. Specifically for advancing the NextGen, during the FY 2011 Continuing Resolution, ARMD continued the planning effort to demonstrate full benefits of the ADS-B in the dense terminal airspace with NASA-developed technologies through flights and high fidelity simulations.

If ARMD were to receive the requested level of \$569.4M in FY 2012, while continuing on-going research activities as planned, NASA would be able to start a full implementation of two new initiatives, Verification and Validation (V&V) of Flight Critical Systems and the Integration of Unmanned Aircraft Systems into the National Airspace Systems. Both of these are critically important to advance the NextGen goals. In particular, the demands from the aviation community for technologies that will allow routine access to National Airspace System by unmanned aerial systems are tremendously high and time-critical. The requested level of the FY 2012 budget also includes a start of a research activity that will utilize advanced ground-based and flight deck technologies and automation for efficient and safe airport surface operations to exploit the full benefit of ADS-B infrastructure.

**Alternative jet fuels (highlighted in NASA budget documents as an area of "major change")**

**QUESTION 2:**

What is NASA planning to accomplish in the field of alternative jet fuel research? How much does the FY 2012 budget increase funding for this research? How do you plan to coordinate your increased investment in alternative fuels with similar programs run by the FAA (including the CLEEN program), Air Force, and other stakeholders such as airlines?

**ANSWER 2:**

NASA's alternative jet fuel research is focused on the use of alternative fuels (including biofuels) in engine systems and the characterization of the emissions produced by use of those fuels. This research will contribute to fuel-flexible engine technology development and enable substantially reduced environmental effects of aviation. Specifically, this research is focused on the measurement, analysis, and assessment of a number of gaseous and particulate (soot) emissions resulting from the use of a variety of

alternative fuels in jet engine systems. This research activity is being increased by approximately \$6M per year in the FY2012 President's Budget Request to expand the fundamental research to include flight testing on a subsonic aircraft for in-flight measurement of emissions characteristics and fuel performance. These tests will be complemented by expanded laboratory-scale tests and altitude simulation tests and additional efforts in fuel combustion modeling and combustion science to be able to accurately predict emissions from alternative fuels. Research results will benefit multiple speed regimes of air vehicles and will be examined for effects on both local air quality and global climate.

NASA coordinates very closely with other agencies, including the Air Force and the Federal Aviation Administration (FAA), on areas of research related to alternative fuels through regular communications at multiple levels including project and senior management and scientist/researcher levels. Specifically, research objectives, plans and data are shared and joint support for tests of mutual interest are defined and executed. For example, NASA and multiple government agency partners recently completed the Aviation Alternative Fuel Experiment (AAFEX-2) test in which emissions data was gathered from engines operating on alternative jet fuels run on the NASA DC-8 aircraft at the Dryden Flight Research Center.

Additionally, NASA has supported the FAA Continuous Lower Energy, Emissions and Noise (CLEEN) Program by providing technical experts to contribute to the solicitation development and proposal review processes, as well as providing current support and technical expertise for the assessment of the on-going program efforts. NASA has been coordinating with a wider set of government agencies to ensure that respective efforts are complementary. The NASA focus on use and characterization of alternative fuels in engines draws upon the NASA strengths in aircraft and jet engine systems and specifically engine combustion systems testing and analysis. This focus is complementary to the roles of other government agencies, such as the Department of Energy and Department of Agriculture, who have responsibility for supporting and incentivizing the development and production of alternative fuels and associated feedstocks. NASA also coordinates with other government agencies, industry (including the airlines), and academia on development of roadmaps for the development of alternative jet fuels through our participation in the FAA-led Commercial Alternative Aviation Fuels Initiative (CAAFI).

**Questions for the Record  
for the March 2, 2011 Hearing on  
*A Review of NASA's FY 2012 Budget Request***

Questions for the Record from Congressman Ben Ray Lujan

QUESTION 1:

On Monday, February 28, 2011, the New York Times published an article entitled "Space Tourism May Mean One Giant Leap for Researchers." I was excited to see New Mexico mentioned in the article, as the article points out that many of these commercial scientific suborbital flights, such as Virgin Galactic's, will occur from New Mexico's new spaceport. The article notes that university students will be able to fly science experiments into space at prices far below what has previously been achievable. How could NASA best use these new commercial vehicles to promote Science, Technology, Engineering, and Mathematics (STEM) education and excite the next generation of students?

ANSWER 1:

NASA has a rich history of providing exciting opportunities for students to pursue payload and flight project opportunities including historically successful projects such as the Reduced Gravity Education Flight Program, and more recent opportunities such as the High Altitude Student Platform (HASP), BalloonSat High Altitude Flight (BHALF) competition, the University Student Launch Initiative (USLI) competition, High Schools United with NASA to Create Hardware (HUNCH) and the CubeSat Launch Initiative.

Per the requirements of the America Competes Reauthorization Act of 2010 (PL 111-358; Sec 205), NASA will continue to study and assess the potential impacts on science, technology, engineering, and mathematics (STEM) education of a program that would facilitate the development of scientific and educational payloads involving United States students and educators and the flights of those payloads on commercially available orbital platforms, when available and operational, with the goal of providing frequent and regular payload launches.

The recent NASA-chartered Education Design Team (EDT) report recommended that the NASA Education program place increasing emphasis on providing experiential opportunities for students, internships, and scholarships for high school and undergraduate students; and engage strategic partners with common objectives and complementary resources.

NASA has been given Congressional direction to pursue activities through the International Space Station (ISS) National Laboratory Education (NLE) project which leverage the resources of entities external to NASA, including commercial companies, academic institutions, not-for-profit organizations and other U.S. Government agencies. (See report to Congress dated May 25, 2011.) Collaborative educational activities directly partnered with, or in conjunction with, the ISS Program International Partner space agencies are included in the expansion of ISS educational activities.

Under the ISS National Lab and ISS NLE concept, commercial payloads such as the Commercial Generic Bioprocessing Apparatus (CGBA) Science Inserts, the Synchronized Position Hold Engage and Reorient Experimental Satellite (SPHERES), and Space Dynamically Responding Ultrasonic Matrix System (Space-DRUMS) are poised for additional partnering opportunities and expansion of their educational activities. Some of these payloads will expand their educational scope to incorporate content applicable in both the Kindergarten through 12<sup>th</sup> grades (K-12) as well as at the University level. Activities to include international student participation as well as students from traditionally underrepresented and underserved institutions will also be emphasized and considered part of an expansion opportunity.

Commensurate with the NLE goals, the NanoRacks ISS National Lab payload (also known as CubeLab), offers flight opportunities for K-12 schools and Universities to conduct experiments of their own design within the NanoRacks facility. The NanoRacks hardware is developed by NanoRacks LLC in partnership with Kentucky Space, an ambitious non-profit enterprise focused on R&D, educational and small entrepreneurial and commercial space solutions involving several Universities in the state of Kentucky.

The NASA Flight Opportunities program, managed by the Office of the Chief Technologist, helps foster the development of the commercial reusable suborbital transportation industry, an important step in the longer-term path that envisions suborbital reusable launch vehicles evolving to provide the Nation with much lower-cost, more frequent, and more reliable access to orbital space. The Flight Opportunities program will competitively secure commercial suborbital flight services and extend the opportunity for flights through a competitive process. By reducing the cost of suborbital flights, researchers and students will have increased access to testing payloads in a reduced gravity environment. The program has already provided contracts to Armadillo Aerospace and Masten Space Systems to provide developmental test flights. One of these vendors will provide flights for the Excelsior STEM mission; a commercial unmanned suborbital mission sponsored by Teachers in Space and scheduled to fly in 2011. Experiment kits for the Excelsior STEM mission will be assembled by teachers at a Suborbital Flight Experiment Workshop to be held August 1-5, 2011, at the NASA Dryden Flight Research Center's AERO Institute in Palmdale, California. NASA hopes to make more opportunities available as more commercial suborbital flights are scheduled.

Appendix II:



ADDITIONAL MATERIAL FOR THE RECORD

## PREPARED STATEMENT OF REPRESENTATIVE JERRY COSTELLO

Thank you, Mr. Chairman, for holding today's hearing on the National Aeronautics and Space Administration's (NASA) Fiscal Year 2012 (FY12) budget request.

NASA's FY12 budget provides \$18.7 billion and follows the direction Congress laid out in the 2010 NASA Authorization bill. However, the administration's budget proposal raises several questions about NASA's mission and the future of human space flight.

First, investing in Science, Technology, Engineering, and Mathematics (STEM) education programs is necessary to ensure the next generation of our aerospace workforce is competitive. For this reason, I applaud NASA's new focus on working with community colleges to prepare students for pursuing STEM education at four-year universities and building new skills for careers in aerospace. In addition, I am pleased NASA will continue its partnerships with schools to ensure students in 4th through 9th are exposed to STEM curricula.

Second, I appreciate NASA's efforts to complete the development of a multi-purpose crew vehicle and space launch system. I am interested to hear from Administrator Bolden if 2016 is still a viable deadline for completing this work and how NASA will continue its work at a reduced funding level.

Finally, NASA's aeronautics research program is vital to ensuring the safety and security of the flying public and the competitiveness of the aviation and aerospace industry. In particular, NASA's contributions to NextGen will play a critical role in increasing airspace capacity in the future. I am concerned about the \$10.2 million reduction from the Fiscal Year 2011 request in aeronautics funding included in the FY12 request. This lower request will make it harder to recover from the \$143 million reduction in funding for NextGen in Fiscal Year 2010. I am interested to hear from Administrator Bolden how this reduction will impact the ongoing work on NextGen and other aeronautics and aviation priorities.

I welcome Administrator Bolden, and I look forward to his testimony. Thank you again, Mr. Chairman.

## PREPARED STATEMENT OF REPRESENTATIVE RANDY NEUGEBAUER

Thank you, Mr. Chairman, for holding this full Committee hearing to examine the National Aeronautics and Space Administration's budget request for Fiscal Year 2012. Administrator Bolden, welcome.

Since 1958, NASA has played an important role in American innovation and inventiveness. Much of the technological advancement in the United States over the last five decades can be attributed to the projects undertaken at NASA. I am confident that it will continue to develop valuable and cutting-edge technologies.

I am, however, concerned that the Administration's budget for fiscal year 2012 does not adequately address our nation's current fiscal crisis. Americans are earning less, over nine percent of our population is unemployed, and families are struggling to find ways to make ends meet, yet federal government agencies are not feeling that same pain. Our country is on an unsustainable path of spending. We will not successfully decrease our \$14 trillion debt by increasing spending or even maintaining current spending levels. It is imperative that the federal government make difficult choices to cut spending below current levels, and NASA is no exception. The Administration's proposed budget would maintain NASA funding at Fiscal Year 2010 levels, but I believe it must be reduced to 2008 levels.

The cuts will not be pleasant, and they do not imply that NASA's work is not important or beneficial. I understand that NASA made some difficult choices to reduce funding for some programs in this budget proposal, while other programs would see an increase in funding. But without immediate, significant reductions in bottom-line spending, future generations will have difficulty even paying down the interest on our national debt.

Administrator Bolden, look forward to hearing your testimony.

