AN OVERVIEW OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION BUDGET FOR FISCAL YEAR 2013

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

WEDNESDAY, MARCH 7, 2012

Serial No. 112–68

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PRINTING OFFICE
73–126PDF WASHINGTON : 2012

For sale by the Superintendent of Documents, U.S. Government Printing Office
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AN OVERVIEW OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION BUDGET FOR FISCAL YEAR 2013

WEDNESDAY, MARCH 7, 2012

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

The Committee met, pursuant to call, at 3:08 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph M. Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

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An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

Wednesday, March 7, 2012
2:00 p.m. to 4:00 p.m.
2318 Rayburn House Office Building

Witness

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

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

An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

Wednesday, March 7, 2012
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Purpose

The purpose of the hearing is to review the Administration's FY 2013 budget request for the National Aeronautics and Space Administration and examine its priorities and challenges.

Witness

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

Background

NASA is our nation's civil aeronautics and aerospace research and development agency. Created by Congress in 1958 in response to the Soviet Union's successful launch of Sputnik, NASA was formed by evolving and expanding the mission of the National Advisory Committee on Aeronautics, which was established in 1915. NASA's achievements are well known and unmatched: successfully launching six manned missions to the moon; launching a series of space telescopes including Hubble; launching satellites to orbit or fly-by every planet in the solar system (Pluto is no longer considered a planet, but a NASA mission – New Horizons – is scheduled to fly-by in 2014); orbiting satellites around Earth that measure our atmosphere, oceans, and topography; building and operating (in conjunction with the Russians) the International Space Station; and conducting leading-edge aeronautics research.

NASA's name is instantly recognized throughout the world and is considered a source of inspiration for people of all nationalities. It leads the world community in new discoveries, advancing our understanding of Earth, the solar system, and universe.

In addition to its headquarters, the agency operates nine research facilities –

- Goddard Space Flight Center, Greenbelt, MD
- Kennedy Space Center, Merritt Island, FL
- Langley Research Center, Hampton, VA
- Glenn Research Center, Cleveland, OH
- Johnson Space Center, Houston, TX
- Ames Research Center, Mountain View, CA
- Dryden Flight Research Center, Edwards Air Force Base, CA

- Marshall Space Flight Center, Huntsville, AL
- Stennis Space Center, Bay St. Louis, MS

The Jet Propulsion Laboratory, Pasadena, CA is sponsored by NASA as a Federally Funded Research and Development Corporation. NASA also owns the Wallops Flight Facility in Wallops Island, Virginia and the Michoud Assembly Facility east of New Orleans, Louisiana.

NASA employs 18,000 civil servants and has a contractor workforce of 43,000.

Budget Request

National Aeronautics and Space Administration
President's FY 2013 Budget Request Summary

Budget Authority, $ in millions
By Appropriation Account

	FY2011 Actual	FY2012 Estimate	FY2013 Author.	FY2013 Request	FY2014 Notional	FY2015 Notional	FY2016 Notional	FY2017 Notional
Science	**4,919.7**	**5,073.7**	**5,509.6**	**4,911.2**	**4,914.4**	**4,914.4**	**4,914.4**	**4,914.4**
Earth Science	1,721.9	1,760.5	2,089.5	1,784.8	1,775.6	1,835.5	1,826.2	1,772.8
Planetary Science	1,450.8	1,501.4	1,591.2	1,192.3	1,133.7	1,102.0	1,119.4	1,198.8
Astrophysics	631.1	672.7	1,149.1	659.4	703.0	693.7	708.9	710.2
James Webb Space Telescope	476.8	518.6	---	627.6	659.1	646.6	621.6	571.1
Heliophysics	639.2	620.5	679.8	647.0	643.0	636.7	638.3	661.6
Aeronautics	**533.5**	**569.4**	**590.0**	**551.5**	**551.5**	**551.5**	**551.5**	**551.5**
Space Technology	**456.3**	**573.7**	**515.0**	**699.0**	**699.0**	**699.0**	**699.0**	**699.0**
Exploration	**3,821.2**	**3,712.8**	**5,264.0**	**3,932.8**	**4,076.5**	**4,076.5**	**4,076.5**	**4,076.5**
Exploration Systems Develop	2,982.1	3,007.1	4,040.0	2,769.4	2,913.1	2,913.1	2,913.1	2,913.1
Commercial Spaceflight	606.8	406.0	500.0	829.7	829.7	829.7	829.7	829.7
Exploration R&D	232.3	299.7	724.0	333.7	333.7	333.7	333.7	333.7
Space Operations	**5,146.3**	**4,187.0**	**4,253.3**	**4,013.2**	**4,035.1**	**4,035.1**	**4,035.1**	**4,035.1**
Space Shuttle	1,592.9	556.2	0.0	70.6	0.0	0.0	0.0	0.0
Intl Space Station	2,713.6	2,829.9	3,129.4	3,007.6	3,177.6	3,170.9	3,212.8	3,234.3
Space & Flight Support	839.8	800.9	1,123.9	935.0	857.5	864.2	822.3	800.8
Education	**145.4**	**136.1**	**145.7**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Cross-Agency Support	**2,956.4**	**2,993.9**	**3,276.8**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**	**2,847.5**
Center Mang & Operations	2,189.0	2,204.1	---	2,093.3	2,093.3	2,093.3	2,093.3	2,093.3
Agency Mang & Operations	767.4	789.8	---	754.2	754.2	754.2	754.2	754.2
Construction and Environmental Compliance and Restoration	**432.9**	**487.0**	**366.9**	**619.2**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	373.3	441.3	---	552.8	359.5	362.9	360.0	360.0
Environmental Compliance	59.6	45.6	---	66.4	90.9	87.5	90.4	90.4
Inspector General	**36.3**	**38.3**	**38.7**	**37.0**	**37.0**	**37.0**	**37.0**	**37.0**
NASA TOTAL	**18,448.0**	**17,770.0**	**19,960.0**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**	**17,711.4**

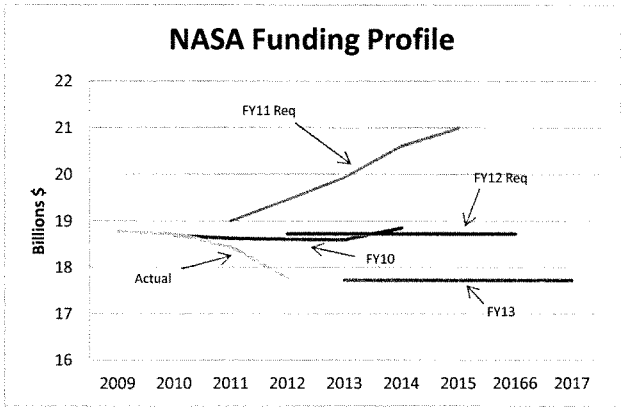
1. Numbers may not add due to rounding.
2. FY2012 Estimates include the impact of a $30 million rescission included in the FY2012 appropriations act, in addition to ~ $1 million from other prior appropriations included in the total.
3. FY2013 Authorization for Astronphysics includes James Webb Space Telescope.
4. FY2013 Space Technology request reflects shifting of some funds that were previously allocated to the Exploration R&D activity.

For FY2013 NASA is requesting $17.711 billion, a decrease of $58 million from its FY2012 appropriation. The request is $750 million less than amounts received in FY2011; and is about $1 billion less than amounts received in FY2009 and FY2010.

For each of the Fiscal Years 2014 – 2017, the budget topline request is the same as FY2013, though the agency considers the outyear numbers to be 'notional.'

There are three initiatives in this year's request that are drawing the most attention: (1) cuts to the Planetary Sciences budget and withdrawing from the European Space Agency's planned 2016 and 2018 Mars missions; (2) requesting substantially higher amounts for commercial crew (compared to current year's funding) while constraining agency investment in a heavy-lift launch system; and (3) combining hypersonic and supersonic research into a single project to focus on fundamental research for high-speed flight. More on these initiatives will be discussed later in this charter.

The graph highlights the continuing decreases in funding proposed - and received - by NASA since 2009.



Science Mission Directorate

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est. $$$	%%%
Science Mission Directorate TOTAL	**$4,919.7**	**$5,073.7**	**$4,911.2**	**-$162.5**	**-3.2%**
Earth Science	1,721.9	1,760.5	1,784.8	24.3	1.4%
Planetary Science	1,450.8	1,501.4	1,192.3	-309.1	-20.6%
Mars Program	*547.4*	*587.0*	*360.8*	*-226.2*	*-38.5%*
Astrophysics	631.1	672.7	659.4	-13.3	-2.0%
James Webb Space Telescope	476.8	518.6	627.6	109.0	21.0%
Heliophysics	639.2	620.5	647.0	26.5	4.3%

($ = millions)

Earth science. The Earth Science division at NASA advances the state of Earth System science through climate studies, spaceborne data acquisition, research and analysis, and predictive modeling. Spaceborne and airborne instruments are utilized to measure the Earth's atmosphere, oceans, sea ice, land surfaces and the interaction of these elements in the ecosystem. There are currently 16 missions in operation, including two new missions launched in 2011 – Aquarius and the Suomi National Polar-orbiting Partnership (Suomi NPP). The remaining 14 missions are all in extended operations, with many well beyond their designed lifetimes.

The budget request for FY2013 of $1.78 billion reflects a modest increase of $24.3 million over the FY2012 estimate. This increase is reflected in expected higher costs for launch vehicles for the Orbiting Carbon Observatory-2 and the Soil Moisture Active Passive (SMAP) spacecraft. This budget delays the launch readiness date of the Global Precipitation Measurement (GPM) mission but continues formulation and development of the recommended decadal survey missions including the Earth Venture instrument demonstrations.

Planetary science. The goal of NASA's planetary science program is to ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere. Within this framework, NASA has embarked on a program strategy of flyby, orbit, land, and rove. In 2011 alone, missions to Jupiter (JUNO), Mars (Mars Science Laboratory – MSL), and the moon (GRAIL) were launched. While GRAIL is already at its destination, MSL will arrive at Mars in August 2012 and JUNO is expected to arrive at Jupiter in July 2017. Additionally, spacecraft are currently operating in orbit around the moon, Mercury, Mars, Saturn, and the asteroid Vesta; the rover Opportunity is operating on the surface of Mars; and New Horizons is 2/3rds of its way to Pluto.

The budget request for NASA's planetary science program is $1.19 billion for FY2013, a decrease of $309 million (20.6 percent) from the FY2012 estimate of $1.5 billion. The Mars Exploration Program sees the bulk of this decrease, going from $587 million in FY2012 to $360.8 million in FY2013. The proposed budget effectively ends the planned joint NASA – European Space Agency (ESA) 2016 and 2018 Mars missions and calls into question the future of the Outer Planets program.

NASA recently stood up a Mars Program Planning Group (MPPG) to develop a revised and more affordable Mars Exploration program with the goal of delivering an initial framework to Congress in March 2012. However, a full proposal is not due until late summer 2012. This latest re-plan effort comes to the dismay of the planetary science – and particularly the Mars science – community. The most recent decadal survey (delivered last year) for planetary science recommended a Mars sample return mission as its top priority and indicated that any flagship mission that would not lead to a Mars sample return should be shelved for other high priority missions, such as a mission to Jupiter's moon Europa. While the report acknowledged the necessity of scaling flagship missions appropriately to anticipated funding and recommended de-scoping such missions to achieve the science objectives less expensively, the report did not suggest abandoning flagship missions altogether as this budget proposes.

Astrophysics. The goal of NASA's Astrophysics program is to discover how the universe works, how it began and developed into its present form, and search for Earth-like planets. Among the highly-visible successes for the program in 2011 was the Nobel Prize in Physics awarded to

NASA Astrophysicist Adam Reiss using data he derived from the Hubble Space Telescope, and the Kepler spacecraft which has been instrumental in the discovery of thousands of possible exoplanets including the first such rocky exoplanet within a habitable zone of its parent star.

The Astrophysics Division currently operates 11 spacecraft, including the Hubble Space Telescope and Kepler. The Nuclear Spectroscopic Telescope Array (NuSTAR) is currently scheduled to launch on March 21, 2012.

The budget request for Astrophysics was $659.4 million, a decrease of $13.3 million compared to the FY2012 estimate. The budget does not provide for the Wide Field Infrared Survey Telescope (WFIRST) which was named the top priority mission identified by the *New Worlds, New Horizons in Astronomy and Astrophysics* decadal survey for 2011-2021.

James Webb Space Telescope. Beginning in FY2012, the James Webb Space Telescope (JWST) was taken out from under the Astrophysics division and was given its own budget line. After an extensive re-planning effort, NASA re-baselined JWST to a total life cycle cost of $8.8 billion and a launch readiness date of October 2018. Based on this effort, the funding profile for FY2013 and beyond increased significantly, with the bulk of the increases in the early years of the re-plan. As such, JWST received a request for FY2013 of $627.6 million, an increase of $109 million over the FY2012 estimate.

Heliophysics. NASA's Heliophysics program focuses on understanding the Sun and its interactions with the Earth and the solar system. This research is achieved through a suite of missions ranging from spacecraft in Earth's orbit, those stationed at LaGrangian points and around the Sun itself, to suborbital sounding rockets. Taking full advantage of a system-wide observational capability enables heliophysics research that looks at the entire space environment.

The Heliophysics division currently operates 16 missions including Voyager, which launched in 1977, the Solar and Heliospheric Observatory (SOHO) and the Solar Terrestrial Relations Observatory (STEREO). The Radiation Belt Storm Probes (RBSP) is scheduled to launch in September 2012.

The budget request for FY2013 is $647 million, an increase of $26.5 million. This budget reflects an increased cost for launch vehicles and a modest investment in Sounding Rocket Sustainer Motor design activity. The proposed budget continues investments in the joint NASA-European Space Agency (ESA) Solar Orbiter Collaboration mission targeting launch in January 2017 and the Solar Probe Plus mission targeting launch in July 2018.

Aeronautics Research Mission Directorate

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est. $$$	%%%
Aeronautics Mission Research TOTAL	**$533.5**	**$569.4**	**$551.5**	**-$17.9**	**-3.1%**
Aviation Safety	67.3	80.1	81.1	1.0	1.2%
Airspace Systems	87.2	92.7	93.3	0.6	0.6%
Fundamental Aeronautics	206.3	186.3	168.7	-17.6	-9.4%
Aeronautics Test	76.4	79.4	78.1	-1.3	-1.6%
Integrated Systems Research	75.9	104.2	104.0	-0.2	-0.2%
Aero Strategy & Management	20.4	26.7	26.4	-0.3	-1.1%

($ = millions)

NASA's aeronautics programs are conducted by the Aeronautics Research Mission Directorate (ARMD) and focus on long-term investments in fundamental aeronautics research to improve aviation safety, efficiency and air traffic management. The ARMD includes four NASA centers: Ames Research Center (CA), Dryden Flight Research Center (CA), Glenn Research Center (OH) and Langley Research Center (VA).

The ARMD FY13 budget request represents a 3.1% decrease in funding from the previous year, dropping from $569.4M in FY2012 to $551.5M in FY2013. Major programmatic changes this year include combining funding for hypersonic research with supersonic research and transferring "entry, descent and landing" (EDL) research to the Space Technology account. The transfer of EDL research accounts for a significant amount of the ARMD funding reduction in FY13.

The ARMD program areas include;

- **Aviation Safety** – develops technologies to improve aviation system-wide safety, advances the state-of-the-art of aircraft systems and flight crew operations, and addresses the inherent presence of atmospheric risks to aviation.

- **Airspace Systems** – develops and explores fundamental concepts and technologies to increase throughput of the National Airspace System and achieve high resource efficiency, and transitions key technologies from the laboratory to the field.

- **Fundamental Aeronautics** – conducts fundamental research to improve aircraft performance and minimize environmental impacts, research for low boom supersonic aircraft, and improving the effectiveness of rotary wing vehicles.

- **Aeronautics Test Program** – manages NASA's aeronautics test capabilities in partnership with the Department of Defense.

- **Integrated Systems Research Program** – conducts integrated system-level research to accelerate transitioning into major aircraft and operations systems.

- **Aeronautics Strategy and Management** – identifies new innovative aviation concepts through "seedling funds" that provide research and analysis of early stage concepts. Also funds ARMD's institutional expenses, as well as NASA's portion of the Joint Planning and Development Office (a program within NextGen) costs.

Over the last decade, the budget for ARMD has shrunk from a peak of approximately $1B to just $551.5M in the FY2013 request and remains flat in the budget run out over the next 5 years. Significant reductions in ARMD infrastructure and personnel have reduced necessary funding levels but a key question remains as to the impact on its mission areas.

Human Exploration and Operations

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est. $$$	%%%
Exploration TOTAL	**$3,821.2**	**$3,712.8**	**$3,932.8**	**$220.0**	**5.9%**
Exploration Systems Devel.	2,982.1	3,007.1	2,769.4	-$237.7	-7.9%
Commercial Spaceflight	606.8	406.0	829.7	$423.7	104.4%
Exploration Research & Develop.	232.3	299.7	333.7	$34.0	11.3%

($ = millions)

Exploration Systems Development
Exploration Systems Development is responsible for designing and building three systems that will form the centerpiece of America's future space exploration beyond Earth's orbit; the Space Launch System heavy lift rocket, the Orion Multi Purpose Crew Vehicle, and the associated Exploration Ground Systems necessary to prepare the systems for launch. Collectively, they will enable long-term human exploration of the Moon, asteroids, or other destinations in the Solar System such as Mars. In addition, the NASA Authorization Act of 2010 directed NASA to develop these systems as a backup capability to reach low Earth orbit to service the International Space Station if commercial or Russian systems are unavailable. NASA is planning for an initial test launch of the SLS and Orion in 2017.

The president's FY2013 request for Exploration Systems Development is $2.77 billion, a decrease of $237.7 million (7.9 percent reduction) from the FY2012 estimate. The Orion Multi Purpose Crew vehicle sees the largest decrease, going from $1.2 billion in FY2012 to $1.02 billion in FY2013 (14.6 percent reduction). The request also cuts the Space Launch System budget from $1.8 billion in FY2012 to $1.74 billion in FY2013 (3.5 percent reduction). The request increases the Exploration Ground Systems budget from $304 million in FY2012 to $404 million in FY2013, a $100 million addition (32.8 percent).

Commercial Spaceflight
Similar to the approach used by NASA since 2006 to develop dual launch systems for commercial cargo delivery to the ISS using two separate programs to fund the effort (the Commercial Orbital Transportation Services and Cargo Resupply Services programs), NASA plans to fund development of a commercial crew capability using two separate budget accounts. NASA's Exploration account funds the partial development of commercial crew systems with industry partners contributing varying amounts of their own money, while the Space Operations

account (which will be discussed later) will be used to procure transportation services on a fixed price basis.

NASA's Commercial Crew program is working with commercial partners to develop the systems necessary to safely transport astronauts to and from the ISS in the 2017 timeframe. NASA has funded space act agreements with various commercial partners and plans to make additional awards this summer for further commercial crew systems development.

The president's FY2013 request for commercial crew is $830 million, an increase of $424 million, or 104 percent above the FY2012 estimate.

Exploration Research and Development
NASA's Exploration Research and Development program funds the development of new technologies needed to enable extended human space exploration. The program is comprised of two parts. The first is the Human Research Program which in 2011 flew 11 major medical experiments and added new ISS biomedical capabilities like second generation ultrasound for medical imaging, and the jointly developed ESA/NASA muscle atrophy research and exercise system. The second is the Advanced Exploration Systems program which began in 2012 and continues several of the Exploration Technology Development and Demonstration projects such as portable life support systems for advanced space suits and a radiation assessment detector for the Mars Science Lab.

The president's FY2013 request for Exploration Research and Development is $334 million, an increase of $34 million (11.3 percent) above the FY2012 estimate of $299.7 million.

Space Operations

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est. $$$	%%%
Space Operations TOTAL	**$5,146.3**	**$4,187.0**	**$4,013.2**	**-$173.8**	**-4.2%**
Space Shuttle	1,592.9	556.2	70.6	-485.6	-87.3%
International Space Station	2,713.6	2,829.9	3,007.6	177.7	6.3%
Space & Flight Support	839.8	800.9	935.0	134.1	16.7%
21st Century Space Launch Complex	*142.6*	*123.5*	*41.1*	*-82.4*	*-66.7%*
Space Communications & Navigation	*456.7*	*445.5*	*655.6*	*210.1*	*47.2%*

($ = millions)

Space Shuttle
In July 2011, the Space Shuttle flew its final mission following the completion and re-supply of the ISS. In FY2012 and FY2013 the Space Shuttle program undergoes final transition, retirement, and disposition of program assets, and will focus on identifying assets that can be transferred to future exploration programs and dispositioning property no longer needed. This includes the processing and delivery in FY2012 of the Space Shuttle orbiters for museum displays.

The president's FY2013 request is $70.6 million, a decrease of $485.6 million or 87.3 percent from the FY2012 estimate. The FY2012 estimate included a one-time payment of $470 million for pension requirements related to the close out of the program that are not included in FY2013.

International Space Station

The ISS is now a functional, permanently crewed research laboratory and technology test bed for exploration and international cooperation, as well as a National Laboratory for non-NASA and potential non-governmental users. The NASA Authorization Act of 2010 directs NASA to take actions "*necessary to ensure the safe and effective operation, maintenance and maximum utilization of the U.S. segment of ISS through at least September 30, 2020.*" Now that assembly is complete, NASA faces a critical window for ISS utilization and research before a notional program end date of 2020. The Administration's request provides for continuous operations and maintenance to ensure the ISS remains viable as a National Lab through 2020. As noted earlier, funding to procure commercial crew or cargo transportation is in the ISS Crew and Cargo Transportation program within the ISS budget.

The president's FY2013 budget request for the International Space Station is $3.0 billion, an increase of $178 million, or 6.3 percent above the FY2012 estimate of $2.83 billion.

Space and Flight Support

Space and Flight Support is made up of a number of programs providing capabilities that play critical roles in several NASA missions. For example, the 21st Century Space Launch Complex program funds modernization at the Kennedy Space Center and Cape Canaveral Air Force Station to benefit multiple users. The Space Communications and Navigation program operates NASA's extensive network of ground-based and orbiting communications hardware and software necessary to receive vast quantities of data generated by NASA's fleet of crewed vehicles and robotic spacecraft. The Human Space Flight Operations (HSFO) program ensures that NASA's astronauts are prepared to safely carry out current and future missions. The Launch Support Program funds various NASA missions that require expendable launch vehicle services. The Rocket Propulsion Test program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners. Together these efforts comprise the Space and Flight Support segment of NASA's budget.

The president's FY2013 budget request for Space and Flight Support is $935 million, an increase of $134 million (16.7 percent) above the FY2012 estimate of $801 million.

Education

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est. $$$	%%%
Education TOTAL	**145.4**	**136.2**	**100.0**	**-36.2**	**-26.6%**
Aerospace Research and Career Deve	70.4	56.2	33.0	-23.2	-41.3%
Space Grant	*45.5*	*38.9*	*24.0*	*-14.9*	*-38.3%*
*EPSCoR**	*24.9*	*17.3*	*9.0*	*-8.3*	*-48.0%*
STEM Education & Accountability	75.0	80.0	67.0	-13.0	-16.3%
Minority Univ. Research Educ Prog.	*28.5*	*30.0*	*30.0*	*0.0*	*0.0%*
STEM Educ. & Accountability Projects	*46.5*	*50.0*	*37.0*	*-13.0*	*-26.0%*

($ = millions)

*Experimental Program to Stimulate Competitive Research

The President's FY 2013 request for NASA's Education program is $100M, a $36.1M decrease (26 percent) from the FY12 estimated budget of $136.1M. The proposed budget run out for five years is flat at $100M. The FY13 request includes:

- Science, Technology, Engineering and Mathematics (STEM) Education and Accountability
  - $37M for STEM Education and Accountability projects;
  - $30M for the Minority University Research and Education Program (MUREP);

- Aerospace Research and Career Development
  - $24M for the National Space Grant College and Fellowship Program (Space Grant); and
  - $9M for the Experimental Program to Stimulate Competitive Research (EPSCoR).

The budget request aligns the projects within the priorities of the OSTP STEM Committee five-year strategic plan. The Office of Education proposes to allocate 63 percent of its funding in support of Space Grant, EPSCoR, and MUREP with the remaining funds supporting education efforts at NASA Centers and grantees.

The STEM Education and Accountability program was established as a new programmatic structure in FY2012. The program provides funding for NASA-unique STEM education opportunities, including internships, launch initiatives, and grants, and provides students and educators with NASA's STEM content. The program also supports a competitive process for science museums, NASA centers and planetariums to enhance education and outreach activities related to space exploration, aeronautics and space science. The STEM Education and Accountability program budget has been decreased by 16.3 percent in the FY2013 request. MUREP supports multi-year research grants at Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges. Additionally, MUREP funds scholarships, internships, and mentoring for K-12 students. The MUREP budget remains flat at $30M in the FY2013 request.

Space Grant supports undergraduate and graduate students with scholarships, internships and research challenges through a national network of 52 consortia representing over 1,000 universities, colleges, and state and local agencies in 50 states, the District of Columbia and Puerto Rico. In FY11, Space Grant programs reached over 21,000 higher education participants. For FY2013 the request proposes reducing the Space Grant budget from $38.9M (FY2012) to $24.0 M (38.3 percent).

EPSCoR develops academic research projects to establish competitive activities in states with modest research infrastructure in an effort to make the organization more competitive in attracting non-EPSCoR funding for research. EPSCoR funds states and regions that do not traditionally compete for Federal aerospace-related research activities. The EPSCoR budget has been decreased by 48 percent in the FY13 President's request.

Chairman HALL. The Committee on Science, Space, and Technology will come to order. I say good afternoon to you and welcome to today's hearing entitled, "An Overview of the National Aeronautics and Space Administration Budget for the Fiscal Year 2013." In front of you are packets containing the written testimony, biography, and truth in testimony disclosure for today's witness, the Administrator of National Aeronautics and Space Administration, our friend, Charles F. Bolden.

I recognize myself for five minutes for an opening statement.

Mr. Bolden, I want to thank you, as always, for taking time from your very busy schedule and appear before our Committee. I understand you were with the Senate all morning, so you must be real warmed up and ready to go here for us. I realize a lot of work and effort goes into these appearances and takes time and takes your time, and we appreciate it. And I also understand that this makes this a very long day for you, you and your staff. And I thank you again.

We are here today to discuss the President's 2013 budget for NASA. The proposal essentially comes in at the same spending levels as of this fiscal year, although when taking into account inflationary effects, the agency's purchasing power is slightly diminished. But given the tough fiscal times we are in, I think the agency's top-line request is reasonable.

NASA's human spaceflight activities accounts for about 45 percent of the agency's budget, supporting the International Space Station, development of a new heavy-lift launch system, and development of commercial crew and cargo capabilities. I continue to be deeply concerned that the Commercial Cargo Program's schedule keeps slipping to the right. All of us understand how important commercial cargo is to our International Space Station, and it is my sincere hope that both SpaceX and Orbital will complete successful demonstration flights later this spring, to be continued.

Commercial crew gives me greater pause, however. I have yet to be convinced that a viable commercial market is going to emerge for human orbital missions other than NASA-funded ferry flights to and from the Station. Yet NASA continues to subscribe to the theory that there is a sufficient market to sustain at least two commercial crew launch systems and is putting large sums of tax dollars at risk to pursue this strategy. I hope my misgivings are wrong, but based on what I have seen to date, I am not optimistic.

I am also troubled by NASA's inability to impose crew safety requirements on participants in the upcoming round of the Commercial Crew Development Program. The third phase, which will kick off this summer, funds participants under Space Act Agreements to design fully integrated launch systems. While I understand that companies have every incentive to comply with NASA's safety standards, it is my strong conviction that at this stage of design, there should be no discretion about safety. NASA should have unfettered insight of the systems before companies begin actual production.

Lastly, with regard to the Human Spaceflight Program, I continue to be frustrated that the Space Launch System and Orion crew capsule are not being developed quickly enough. Current plans indicate they won't be operational until 2021, which conceiv-

ably comes after the International Space Station is retired. SLS and Orion deserve higher priority. Should the Russians or commercial providers suffer any disruptions, we will have no means of getting our crews to or from the International Space Station.

Turning now to NASA's science portfolio, I am generally pleased with the budget request but do have issues with two related programs; NASA's decision to withdraw from the 2016 and 2018 ExoMars Mission with the European Space Agency and the proposed reduction to the Planetary Sciences budget.

For the last several years, both Congress and NASA have repeatedly expressed the desire to more fully collaborate with international partners to help defray the costs of future flagship missions. There is a growing acknowledgement from many quarters that NASA simply can't afford to go it alone, and if we are to pursue ambitious missions that promise to do exciting science, NASA needs to engage and work with other nations to share in the burden of funding, building, and operating these very complex projects.

The ExoMars missions are of high importance and visibility to the Europeans and NASA, seemingly in good faith, agreed in 2009 to join forces with the European Space Agency. But with the unveiling of the 2013 budget, NASA has reneged on its commitment, forcing the Europeans to search for other partners if they hope to keep ExoMars alive.

There is no doubt in my mind that NASA's decision to withdraw from ExoMars seriously imperils the ability of ESA to keep moving forward with this program. It also imperils NASA's ability to be viewed as a trustworthy partner on any future collaborations.

The decision likewise flies in the face of the latest planetary decadal survey which named Mars sample return as its top priority. It ignores the wisdom of our own community of scientists who labored hard to put together a well-reasoned roadmap.

Speaking now about Planetary Sciences, as well as Mars, I am puzzled that NASA would choose to cut one of its most productive and successful Science Programs in this era of tough choices. Typically good behavior is rewarded but in this instance it appears that NASA's successes at Mars, Saturn, and Mercury have garnered the opposite reaction.

Mr. Administrator, I trust you will take these concerns in the sober spirit in which they were delivered and convey them to the White House. We want NASA to succeed in all its endeavors, but we seem to disagree on how best to achieve that goal.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH M. HALL

Mr. Bolden, I want to thank you, as always, for taking time from your busy schedule to appear before our committee. I realize a lot of work and effort goes into these appearances, and I also understand you testified this morning before the Senate Commerce Committee, making this an especially long day for you and your staff.

We're here today to discuss the President's 2013 budget request for NASA. The proposal essentially comes in at the same spending level as this fiscal year, although when taking into account inflationary effects, the agency's purchasing power is slightly diminished. But given the tough fiscal times we are in, I think the agency's top-line request is reasonable.

NASA's human spaceflight activities account for about 45 percent of the agency's budget, supporting the International Space Station, development of a new heavy-lift launch system, and development of commercial crew and cargo capabilities. I continue to be deeply concerned that the commercial cargo program's schedule keeps slipping to the right. All of us understand how important commercial cargo is to our International Space Station, and it is my sincere hope that both SpaceX and Orbital will complete successful demonstration flights later this spring.

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I am also troubled by NASA's inability to impose crew safety requirements on participants in the upcoming round of the Commercial Crew Development program. The third phase, which will kick off this summer, funds participants under Space Act agreements to design fully integrated launch systems. While I understand that companies have every incentive to comply with NASA's safety standards, it is my strong conviction that at this stage of design, there should be no discretion about safety. NASA should have unfettered insight of the systems before companies begin actual production.

Lastly, with regard to the human spaceflight program, I continue to be frustrated that the Space Launch System and Orion crew capsule are not being developed quickly enough. Current plans indicate they won't be operational until 2021, which conceivably comes after the ISS is retired.

SLS and Orion deserve higher priority. Should the Russians or commercial providers suffer any disruptions, we will have no means of getting crews to or from ISS.

Turning now to NASA's science portfolio, I am generally pleased with the budget request, but do have issues with two related programs: NASA's decision to withdraw from the 2016 and 2018 ExoMars missions with the European Space Agency, and the proposed reduction to the Planetary Sciences budget.

For the last several years, both Congress and NASA have repeatedly expressed the desire to more fully collaborate with international partners to help defray the costs of future flagship missions. There is a growing acknowledgement from many quarters that NASA simply can't afford to go it alone, and if we are to pursue ambitious missions that promise to do exciting science, NASA needs to engage and work with other nations to share in the burden of funding, building and operating these complex projects.

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Speaking now about Planetary Sciences – as well as Mars – I am puzzled that NASA would choose to cut one of its most productive and successful science programs in this era of tough choices. Typically good behavior is rewarded, but in this instance, it appears that NASA's successes at Mars, Saturn, and Mercury have garnered the opposite reaction.

Mr. Administrator, I trust you'll take these concerns in the sober spirit in which they were delivered, and convey them to the White House. We want NASA to succeed in all its endeavors, but we seem to disagree on how best to achieve that goal.

I now recognize my good friend and fellow Texan, Eddie Bernice Johnson, for her opening statement.

End

Chairman HALL. I now recognize my good friend and fellow Texan, Eddie Bernice Johnson, for her opening statement.

Ms. JOHNSON. Thank you very much, Mr. Hall, and let me say good afternoon and welcome back, Administrator Bolden. Today might not be as smooth sailing as you would like.

Today's hearing is an important one to this Committee because NASA is a critical part of the Nation's research and development enterprise, as well as being a source of inspiration for our young people and a worldwide symbol of American technological prowess and goodwill. We need NASA to succeed.

It almost goes without saying that NASA's success will depend not just on the amount of funding it receives, but also on whether it is given tasks that are executable, policy direction that is clear, and a funding environment that is more predictable than it has been in recent years.

Which brings me to NASA's fiscal year 2013 budget request, a request that cuts NASA's budget by about a half percent. The good news is that the cut is only a half percent, which can be taken as good news given the fiscal challenges the government is facing.

On the other hand, I think that the important role that NASA plays in pushing innovation and in meeting daunting scientific and technological challenges argues for a bigger commitment to the agency than either the Administration or Congress is currently making. I fear that years from now we are going to question why we didn't recognize how important it is to maintain our investments in research and innovation and to continue to provide the means to inspire our young students, even in challenging economic times.

That said, NASA's constrained funding makes it doubly important for us to make sure that the budget request before us is one that is well constructed and sustainable. I know that NASA Administrator Bolden has one of the toughest jobs in town and will argue forcefully in his testimony that it is, and I respect that. I respect the hard work, and I respect everything he has done to implement whatever budget he is given.

Yet as Members of Congress, we have to take a hard look at the priorities in this budget and be convinced that they make sense. Based on what I have seen so far, I have to say that I still have unanswered questions about it.

For example, this year's NASA budget request would cut NASA's Planetary Exploration Program by over $300 million, a 21 percent cut, with more cuts in the outyears. It is hard for me to believe that such cuts won't do significant damage to our Planetary Exploration Program, a program that has been a highly-successful scientific undertaking that has captured the imagination of people around the world. I want to know why such cuts were made, and what, if anything, could we gain by making them.

More broadly, I am puzzled by the de facto priorities contained in this year's NASA budget request. That is, this budget would cut funding for NASA's overall Science Program. It would cut funding for NASA's Education Program. It would cut funding for NASA's Aeronautics Program. It would cut funding for the operation of NASA's centers and headquarters, and it would cut funding for the Space Launch System and the Orion Multi-Purpose Crew Vehicle

Programs. Despite SLS and Orion being called out as an agency priority by NASA, and despite Congress's direction that they be available as a crew in cargo transportation backup capability if needed.

On the other side of the balance sheet, funding for space technology would increase by almost 22 percent, and funding for NASA's Commercial Crew Program would more than double to almost $830 million.

I can understand providing more funding to NASA's Space Technology Program. Investing in technology is an investment in the agency's future, and NASA's Space Technology funding has lagged in recent years.

I have a lot more difficulty understanding the rationale for cutting all of the worthy programs I listed a minute ago in order to provide such a huge increase for the Commercial Crew Program. It is not because I have anything against the companies who are pursuing commercial crew contracts. I have heard them testify. They can be very exciting. Their enthusiasm is infectious, and I wish them all well.

But as a steward of the taxpayer's dollars, I cannot let enthusiasm override the need for responsible oversight. Administrator Bolden, you are probably tired of hearing me ask the same questions year after year, but I still haven't gotten answers from the agency that would justify endorsing the course you are taking.

For example, NASA still has not provided us with an independent cost and schedule estimate for the Commercial Crew Development Program, and we basically have to take it on faith that your budget requests are neither too small nor too large and that these vehicles will show up before it is too late for them to provide more than a year or two of support for the International Space Station.

Neither has NASA provided us with a good estimate of what it will cost the taxpayer for NASA astronauts to make use of these commercial crew services. But we do know that in using NASA's own budgetary projections, the full cost per seat, when NASA's share of the development cost is factored in, is likely to be much greater than we are being charged by the Russians.

That might be justifiable if the government's investment was opening up large new markets, but as I said last year, so far the only potential non-NASA markets you have identified to Congress are super-wealthy space tourists and non-U.S. astronauts. And I can't justify to my constituents the expenditure of their tax dollars so that the super rich can have joy rides.

And finally, NASA has yet to provide a convincing explanation of why it reversed course and scrapped its plan to use FAR-based contracts, contracts that allow NASA to ensure that its safety and performance requirements are met for whatever systems it funds. I will not belabor the point, but Congress is going to need a lot more concrete justification than it has been given to date if we are to have confidence that the expenditures NASA is asking us to make would be money well spent.

And so I know there will be much to discuss today, Mr. Bolden, and I, again, want to thank you for being here, and I look forward to your testimony.

I yield back.
[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Good afternoon, and welcome back, Administrator Bolden.

Today's hearing is an important one for the Committee, because NASA is a critical part of the nation's research and development enterprise, as well as being a source of inspiration for our young people and a worldwide symbol of American technological prowess and good will.

We need NASA to succeed.

It almost goes without saying that NASA's success will depend not just on the amount of funding it receives, but also on whether it is given tasks that are executable, policy direction that is clear, and a funding environment that is more predictable than it has been in recent years.

Which brings me to NASA's Fiscal Year 2013 budget request—a request that cuts NASA's budget by about a half percent.

The good news is that the cut is only a half percent, which can be taken as good news given the fiscal challenges the government is facing.

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I fear that years from now, we are going to question why we didn't recognize how important it is to maintain our investments in research and innovation and to continue to provide the means to inspire our students even in challenging economic times.

That said, NASA's constrained funding makes it doubly important for us to make sure that the budget request before us is one that is well constructed and sustainable.

I know that NASA Administrator Bolden, who has one of the toughest jobs in this town, will argue forcefully in his testimony that it is.

I respect him and the hard work that he has done to implement whatever budget he is given.

Yet, as Members of Congress, we have to take a hard look at the priorities in this budget and be convinced that they make sense.

Based on what I have seen so far, I have to say that I still have unanswered questions about it.

For example, this year's NASA budget request would cut NASA's planetary exploration program by over $300 million—a 21% cut, with more cuts in the outyears.

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I want to know *why* such cuts were made, and what—if anything—would be gained by making them.

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That is, this budget would cut funding for NASA's overall Science program; it would cut funding for NASA's Education program; it would cut funding for NASA's Aeronautics program; it would cut funding for the operations of NASA's Centers and Headquarters; and it would cut funding for the Space Launch System and Orion Multipurpose Crew Vehicle programs—despite SLS and Orion being called out as an agency priority by NASA, and despite Congress's direction that they be available as a crew and cargo transportation backup capability if needed.

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I will not belabor the point—Congress is going to need a lot more concrete justification than it has been given to date if we are to have confidence that the expenditures NASA is asking us to make would be money well spent.

Well, Administrator Bolden, we have much to discuss today.

I again want to thank you for your service, and I look forward to your testimony.

Chairman HALL. The gentlelady yields back. Thank you, Ms. Johnson.

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

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 (FY) 2013 budget request.

- Today, we are at an important juncture in our nation's space program, having successfully flown-out the Space Shuttle manifest, retired the Space Shuttle fleet, and completed assembly of the International Space Station.

- There is much to be proud of with these accomplishments and I commend the hardworking men and women at NASA and in the contractor workforce on their unwavering commitment to safety and excellence in completing these critical milestones in our human spaceflight program.

- And I'm pleased to see that NASA is making good on its commitment to funding its share of the Shuttle contractor workforce pension plan.

- NASA has also had important accomplishments in science and aeronautics research that have advanced our knowledge and delivered benefits to our society.

- At the same time, NASA faces significant challenges.

- NASA's FY 2013 budget proposes $17.7 billion for our nation's space and aeronautics program, maintaining NASA funding at an essentially flat level with respect to the FY 2012 enacted appropriation.

- Recognizing the severity of our fiscal environment and the fact that many agencies are experiencing cuts, the administration's FY 2013 budget request for NASA signals continued support for the future of our nation's space and aeronautics program.

- This budget proposal maintains several key congressional priorities, including continued development of the Space Launch System and Multipurpose Crew Vehicle, operating the International Space Station, and facilitating development of the next generation air transportation system.

- However, the fact that NASA seeks to maintain such challenging and important priorities within a flat budget outlook requires that we take a close look at the alignment among NASA's requested resources, plans, and capabilities.

- First, NASA's request to facilitate the development of commercial crew transportation systems to the ISS is well in excess of that appropriated for the commercial crew program in FY 2012 and the level authorized for FY 2013. In addition, the approach for working with private industry to acquire those systems has been in flux. I am interested in hearing from the Administrator how NASA will ensure the safety of those systems for carrying NASA astronauts in light of its inability to mandate adherence to

its safety requirements, as well as what factors in his view are necessary to meet the current commercial crew timeline.

- Second, the planetary science budget takes a serious cut and impacts not only NASA's overall Mars exploration efforts, but effectively ends U.S. involvement for the 2016 and 2018 European Space Agency-led missions to Mars. I have particular concerns about NASA's decision to cease exploration for new planet missions that have yielded results and new discoveries. I would like to hear from the Administrator on the agency's rationale for proposing such disproportionate cuts to planetary science, what NASA's plans are for future Mars programs, and if he is concerned that this shift will make the U.S. look like an unreliable partner.

- Third, now that Congress has passed an FAA Authorization bill that the President has signed into law, I am interested in hearing from the Administrator how NASA will ensure that NASA's contributions to the next generation air transportation system—NextGen—remain on track so

that the American people can benefit from increased safety, efficiency and effectiveness in air transportation for generations to come.

- Finally, it goes without saying that NASA has inspired countless individuals to pursue education and careers in science, technology, engineering and mathematics (STEM) education. I would like to hear from the Administrator on the implications of the proposed $36 million reduction to NASA's education program on NASA's ability to leverage its inspiring mission activities in STEM education activities.

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

And before introducing our witness, I would like to ask unanimous consent to insert into the hearing record at this point a letter dated March 7, 2012, submitted by the Planetary Society.

Hearing no objection, it is so ordered.

[The information may be found in Appendix 2.]

Chairman HALL. Mr. Administrator, thank you for being here, and I am honored to get to introduce you again. Charlie Bolden serves as Administrator of NASA. He is well known to members of the Science Committee, so I can be brief.

He retired as a Major General from the United States Marine Corps after serving 34 years, many of them as a Marine aviato,r and flew over 100 missions in southeast Asia during the Vietnam War. During his 14 years as a NASA astronaut, Charlie flew four Shuttle missions, commanding two of them. His flights included deployment of the Hubble Space Telescope and the first joint U.S. Russian Shuttle mission. President Obama nominated Charlie as Administrator, and on July 17, 2009, he was sworn in.

Charlie, it is good to have you here today. I thank you, and as our witness should know, spoken testimony is limited to five minutes. Afterwards, the Members of Congress will have five minutes each to ask questions.

The Chair is able to provide some flexibility for you, understanding the hard day you have already had and you probably are expecting the situation is going to be similar. But I am proud to turn the floor over to you, Mr. Bolden.

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

Mr. BOLDEN. Thank you, Mr. Chairman, Ranking Member Johnson, and Members of the Committee. Today it is my privilege to discuss the President's fiscal year 2013 budget request for NASA. All of us at NASA are very grateful to the Congress and especially to this Committee for the strong level of support we continue to receive.

Our requested budget, as has already been mentioned, is $17.7 billion, and it will enable NASA to continue to execute the bipartisan space exploration plan agreed to by the President and the Congress in 2010.

Despite the constrained fiscal environment facing the Nation, this request supports an ambitious civil space program that puts us on a path to achieving a truly exciting set of goals; to send humans to an asteroid and ultimately to Mars and to broaden human activity in low-Earth orbit.

International Space Station assembly is now complete, allowing us to focus on full utilization of the Station's research capabilities. NASA is operating a fleet of spacecraft to investigate Earth, the solar system, and the universe. All of this is critical to ensuring America's continued leadership in space exploration as well as our stewardship of Earth.

The fiscal year 2013 request supports the implementation of key priorities of NASA. First, American astronauts continue to live and work in space onboard the International Space Station, conducting

research to benefit life here on earth and prepare us for deep space human exploration. NASA is committed to making this national resource available to a broader scientific and commercial research communities.

We are also committed to ensuring that American companies launching from American soil transport our astronauts and their cargo to the Space Station. This year we will see the first commercial cargo flights to the International Space Station, and with Congressional approval of the funding request we are on track to have American companies transporting our astronauts to the Station by 2017.

Second, NASA is on track to develop a flexible deep-space launch system that will ultimately be the most capable in history. The Space Launch System or SLS heavy lift rocket and the multipurpose crew vehicle Orion will carry American astronauts below low-Earth orbit and into deep space within the next decade. We are pushing forward with contracting and design efforts to advance this crucial Next Generation Space Exploration System. Our fiscal year 2013 budget request supports our plans for an uncrewed SLS flight in 2017, and a crewed test mission by 2021.

Third, we propose to continue progress toward the launch of the world's most advanced telescope in 2018. The James Webb Space Telescope will operate deep in space to orbit the sun and look out into space from its vantage point, nearly one million miles from Earth. Over the past year, NASA has made important adjustments to JWST management and put the project on a sound financial footing. NASA is confident that the fiscal year 2013 budget request supports a 2018 launch for JWST.

NASA's budget request supports a portfolio of innovative science missions resulting in a stream of data from orbits around the sun, Mercury, the moon, the asteroid Vesta, Mars, and Saturn. We now have missions on the way to Jupiter, Pluto, Mars. Sixteen Earth science missions currently in orbit study earth as an integrated system. The Hubble, Spitzer, Chandra, and Fermi space telescopes continue to make ground-breaking discoveries on an almost daily basis.

Last year the Messenger Spacecraft entered orbit around Mercury. The ebb and flow satellites began mapping the gravity field of the Moon, and Juno, launched last August, is on its way to Jupiter.

However, tough choices did have to be made, so we will not be moving forward with the planned 2016 and 2018 ExoMars Mission we had been planning with the European Space Agency. Instead, NASA is developing a new integrated strategy for Mars missions to ensure that the next steps for Mars exploration will support science and human exploration goals with advanced space technology developments.

Our plan, including the framework for a mission to take advantage of the 2018 to 2020 launch opportunity, is targeted for completion hopefully in time to support the fiscal year 2013 appropriations process. The fiscal year 2013 request supports this approach, and it will be informed by extensive coordination with the science community and our international partners and of course, the Congress.

The fiscal year 2013 budget request continues to support robust Mars exploration, including two spacecraft currently orbiting Mars, the Opportunity rover on the surface, a multi-year exploration of Mars by the Mars Science Laboratory Curiosity, and the planned 2013 MAVEN Mission to explore Mar's upper atmosphere.

The fiscal year 2013 budget request supports continued advances in new aviation, science, and space technologies, absolutely essential to enable NASA to achieve its ambitious goals. At the same time NASA technology research seeds innovation, supports economic vitality, and helps to create new jobs and expanded opportunities for our skilled workforce.

With the 2013 request, NASA will conduct aeronautics research to enable the realization of the Nation's Next Generation Air Transportation System or NextGen, and the safer, more fuel efficient, quieter, and environmentally responsible aircraft that will operate with NextGen.

To inspire the next generation of scientists and explorers and to foster the development of the U.S. workforce, NASA's education programs will focus on demonstrable results and capitalize on the agency's ability to engage students and educators. To help today's young people envision their future in science, technology, engineering, and mathematics, that is our goal.

NASA is grateful to the American people and to you, their representatives here on this Committee, for your continued support in these difficult and challenging times.

Mr. Chairman, I thank you very much for this opportunity to make these remarks, and I look forward to your questions.

[The prepared statement of Mr. Bolden follows:]

PREPARED STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Mr. Chairman and Members of the Committee, today it is my privilege to discuss the President's FY 2013 budget request for NASA. Our requested budget of $17.7 billion will enable NASA to execute the balanced program of science, space exploration, technology, and aeronautics agreed to by the President and a bipartisan majority of Congress.

Despite the constrained fiscal environment facing the Nation, this request supports a robust civil space program that puts us on a path to achieving a truly exciting set of goals. We are working to send humans to an asteroid and ultimately to Mars, to peer deep into space to observe the first galaxies form, and to broaden human activity in low-Earth orbit (LEO). We have completed assembling and outfitting of the U.S. segment of the International Space Station (ISS), allowing us to focus on full utilization of the Station's research capabilities. NASA is making air travel safer and more efficient, learning to live and work in space, and operating a fleet of spacecraft to investigate the Earth, the Solar system and the Universe.

The FY 2013 request supports the implementation of key priorities for NASA.

First, since the historic construction of the International Space Station (ISS) was completed in 2011, and now that all the international partners have agreed to its extension to at least 2020, we must enhance its utilization to insure the success of this national laboratory. For over eleven years, international crews of space explorers have been living on orbit, both building the International Space Station and conducting a diverse research program continuously. NASA is committed to making this National resource available to the broader scientific and commercial research community. Key to its sustainment is the availability of a U.S. commercial crew and cargo delivery capability as soon as possible. NASA is working with American companies to establish the next generation of safe and efficient vehicles for access to LEO and the ISS. In calendar year 2012, we will see the first commercial cargo flights to the ISS, demonstrating the innovation and capabilities of our industry partners and providing a path forward to ease our sole reliance on Russian transport of astronauts. We will continue to work with our industry partners to develop end-to-end systems for transporting crew and cargo to orbit. I am committed to ensuring that American companies, launching from U.S. soil, are providing the cargo and crew transportation services that we need to keep the ISS functioning. We are making steady progress on these launch services. Later this spring and summer, we expect that both of our private company partners, SpaceX and Orbital Sciences, will complete demonstration flights of their cargo vehicles to Station and actually berth with the ISS, marking a major milestone in our goal to establish commercial space capabilities for low-Earth orbit travel. Some modification of the Iran, North Korea, Syria Non-proliferation Act (INKSNA) provisions will likely be required for the continued operation of ISS and other space programs after 2016. The

Administration plans to propose appropriate provisions and looks forward to working with the Congress on their enactment.

Second, with the FY 2013 budget request, NASA is moving out on plans to develop a flexible launch system that will ultimately be the most capable in history. The Space Launch System (SLS) rocket and the Orion Multi-Purpose Crew Vehicle (Orion MPCV) will carry American astronauts beyond low-Earth orbit and into deep space within the next decade. Following a thorough analysis of alternatives, NASA has established architecture for SLS and the Orion MPCV. In recent months we have continued to push forward with contracting and design efforts to make this system a reality. At the same time, we are moving forward on a critical effort to develop the technologies and capabilities required to support our ambitious exploration goals. Our FY 2013 budget request supports our plans for an uncrewed SLS test flight in 2017 and a crewed test mission by 2021.

Third, we plan to continue progress toward the launch of the world's most advanced telescope in 2018. The James Webb Space Telescope (JWST) will operate deep in space to orbit the sun nearly one million miles from Earth. From that vantage point, JWST will look out into space and back in time almost as far as it is possible to look. Over the past year, NASA has engaged in a thorough review of JWST, made important adjustments to management, and put the project on a sound financial footing. Since we completed this new plan, the project has met 19 of 20 FY 2011 milestones (with one deferred without impact), and has met all FY 2012 milestones to date on or ahead of schedule. NASA is confident that the FY 2013 request supports a 2018 launch of JWST.

Fourth, The FY 2013 budget request supports continued advances in new technologies. The National Research Council (NRC) has determined that future U.S. leadership in space requires a foundation of sustained technology advances, but that the U.S. space program is now living on the innovation funded in the past. Our focus on new space technologies is absolutely essential to enable NASA to achieve its ambitious goals. At the same time, NASA technology research seeds innovation, supports economic vitality and helps to create new jobs and expanded opportunities for a skilled workforce. Space technology investments address long-term Agency technology priorities and technology gaps identified by NASA Mission Directorates and within the Agency's draft space technology roadmaps. On February 1, 2012, the NRC released its final review of NASA's Draft Space Technology Roadmaps. The report, which notes that NASA's technology base is largely depleted and identifies sixteen top-priority technologies necessary for NASA's future missions, which also could benefit American aerospace industries and the nation. This NRC assessment will help guide NASA's technology priorities in the years to come.

NASA's budget request supports a portfolio of innovative science missions that will explore the diverse planetary bodies of our solar system, unravel the mysteries of our universe and provide critical data about our home planet. Currently operating missions continue to return a stream of data from orbits around the Sun, Mercury, the Moon, the asteroid Vesta, Mars, and Saturn. We now have missions on the way to Jupiter, Pluto and Mars. Sixteen Earth Science missions in orbit study the Earth as an integrated system. The Hubble, Spitzer, Chandra, and Fermi space telescopes continue to make groundbreaking discoveries on an almost daily basis. In calendar year 2011, the MESSENGER spacecraft entered orbit around Mercury, Ebb and Flow began mapping the gravity field of the Moon, and Juno launched on its way to Jupiter. Also in 2011, Aquarius produced the first global view of ocean surface salinity and the Suomi National Polar-orbiting Partnership satellite began making observations of Earth's weather and climate. In 2012, we will launch the Nuclear Spectroscopic Telescope Array to study massive black holes, supernovae and other high-energy sources in the universe, and will launch the Radiation Belt Storm Probes into Earth's Van Allen belts. In 2013, we will launch the next land observing mission (the Landsat Data Continuity Mission) and complete environmental testing of the Global Precipitation

Measurement mission, the Lunar Atmosphere and Dust Environment Explorer (LADEE) and the Mars Atmosphere and Volatile Evolution (MAVEN) mission.

In view of these key priorities for NASA and of our constrained fiscal environment, we will not be moving forward with the 2016 and 2018 ExoMars missions we had been studying with the European Space Agency. Instead, NASA is developing a new, integrated strategy for Mars missions to ensure that the next steps for Mars exploration will support science and human exploration goals and take advantage of advanced space technology developments. NASA will complete this integrated plan, including the framework for a mission to take advantage of the 2018 or 2020 launch opportunities, no later than this summer and, hopefully, in time to support the FY 2013 appropriations process. The FY 2013 request supports this approach, and this process will be informed by coordination with the science community and our international partners. The FY 2013 budget request continues to support robust Mars exploration including two spacecraft orbiting Mars, the Opportunity rover on the surface, a multi-year exploration of Mars by the Curiosity Mars Science Laboratory, and the MAVEN mission to explore the Mars upper atmosphere. The August landing of Curiosity will be among the most difficult technical challenges that NASA has ever attempted and Curiosity's mission of exploration will far eclipse anything humanity has attempted on the surface of Mars in the past. We look forward to receiving a treasure trove of data from the surface of Mars to help answer questions about its past and present habitability.

With the 2013 request, NASA will conduct aeronautics research to enable the realization of the nation's Next Generation Air Transportation System (NextGen), and the safer, more fuel efficient, quieter, and environmentally responsible aircraft that will operate within NextGen. Through the aeronautics research we conduct and sponsor with universities and industry, NASA helps to develop the technology that enables continuous innovation in aviation. As a result, U.S. companies are well positioned to build on discoveries and knowledge resulting from NASA research, turning them into commercial products that benefit the quality of life for our citizens, provide new high-quality engineering and manufacturing job opportunities, and enables the United States to remain competitive in the global economy.

The request also continues NASA's dedicated efforts to inspire the next generation of explorers. NASA can provide hands-on experience and inspiration as few other agencies can. To foster the development of the U.S. workforce, NASA's education programs will focus on demonstrable results and capitalize on the Agency's ability to inspire students and educators through unique missions and the big challenges that help today's young people envision their future in science, technology, engineering and mathematics (STEM). NASA Education is one of many Federal government programs that support STEM education. NASA Education is working with other agencies through the National Science and Technology Council's Committee on STEM Education to fund coordinated and effective student and teacher opportunities. NASA will focus its resources on demonstrated areas of strength in its unique role in STEM education, freeing resources for other Agency priorities. NASA brings many assets, beyond funding, to support the Administration's emphasis on STEM education. Our people, platforms like the International Space Station, and our facilities across the Nation all contribute to strengthening STEM education.

NASA is grateful to the American people, and their representatives here on the Committee for the continued support for NASA despite the difficult resource challenges facing our Nation. A more detailed description of NASA's balanced program of science, space exploration, technology development, and aeronautics is provided below.

Science

NASA's Science Mission Directorate develops and operates innovative spacecraft missions and instruments that help researchers deliver new discoveries of the Earth, the Sun, the planetary bodies in our solar system, and the universe beyond. The FY 2013 budget request for Science is $4,911.2 million.

NASA's **Earth Science** Program advances knowledge of the integrated Earth system--the global atmosphere, oceans, land surfaces, ice sheets, ecosystems and interactions among them. The FY 2013 budget request for Science includes $1,784.8 million for Earth Science. In 2011, NASA successfully launched Aquarius/SAC-D, a cooperative ocean surface salinity mission conducted with the Argentine Space Agency, and with our partner the National Oceanic and Atmospheric Administration (NOAA) and the Suomi National Polar-orbiting Partnership (SNPP). SNPP is the first step in developing the Nation's next-generation climate and weather monitoring missions. During calendar year 2012 NASA will select the first small satellite mission under the Earth Venture program as recommended in the National Research Council's decadal survey for Earth science. The FY 2013 budget will fund all three components of the Earth Venture program: this new small mission, the on-going EV-1 airborne science campaigns, and the first EV-I instrument of opportunity. FY 2013 will see the launch of the Landsat Data Continuity Mission and the completion of environmental testing for the Global Precipitation Measurement mission. The FY 2013 budget will also fund continued development of the first two Tier 1 decadal survey missions, Soil Moisture Active Passive mission and ICESat-2. Finally, the FY 2013 budget will fund continued development of three key missions to assure delivery of sustained Earth observations (GRACE-Follow on, OCO-2, and the SAGE-III instrument that will fly on the ISS) and fund the continued operation of 16 missions currently in orbit as well as research using the resultant data. The FY 2013 budget request for Earth Science sustains support for focused research, applications, and technology development activities that redeem the investment in our ongoing missions, while positioning us to accomplish essential new missions in the future. NASA's Earth Science program leads to improved prediction services by other agencies, providing direct tangible benefits to communities, businesses, and citizens.

NASA's **Planetary Science** Program explores the content origin and evolution of the solar system and the potential for life beyond Earth. The FY 2013 budget request for Science includes $1,192.3 million for Planetary Science. In the second half of 2011, NASA launched Juno on its way to Jupiter, GRAIL to the Moon, and the Mars Science Laboratory to the Red Planet. GRAIL's "Ebb" and "Flow" spacecraft will conduct their mission to map the Moon's gravity field and interior structure during the first half of 2012. The Mars Science Laboratory rover Curiosity will land in Gale Crater on Mars on August 6th. The FY 2013 budget request funds the operation of Curiosity on Mars. The FY2013 budget will also fund the beginning of development of the next Discovery mission that will be selected from among three candidates completing their studies in 2012. In FY2013, NASA will be completing development of the LADEE mission to the Moon and the MAVEN mission to Mars for launch in late calendar year2013/early FY2014. Also in FY 2013, NASA will continue the development of the OSIRIS-REx mission to return samples from an asteroid, and will continue operation of the Dawn (the asteroid Vesta), Juno (Jupiter), Cassini (Saturn), New Horizon (Pluto), and MESSENGER (Mercury) missions. However, the resources available over the budget horizon are insufficient to enable either a future Mars or Outer Planets flagship mission as identified by last year's Planetary Science decadal survey.

NASA remains committed to a vigorous program of Mars exploration and continuing America's leadership role in Mars exploration within the available budget. As stated above, NASA is discontinuing its effort on instruments for the joint (NASA/European Space Agency) 2016 ExoMars Trace Gas Orbiter mission and the 2018 mission that NASA had been exploring with the European Space Agency (ESA). Instead, NASA will develop an integrated strategy to ensure that the next steps for Mars exploration will support science as well as long-term human exploration goals. This process will be informed by

coordination with the science community and international community. NASA is developing a plan for a reformulated medium-class robotic science Mars mission, within available resources, to take advantage of the favorable location of Mars and Earth in 2018 or 2020. NASA's plan is to work with potential international partners including ESA and the science community to lay out an initial framework for this mission over the next several months and produce a mission architecture by this summer. To keep this effort moving forward in FY 2012, resources, totaling approximately $30 million, are proposed for work towards a revised mission. The budget request includes $62 million in FY 2013 for this mission.

NASA's **Astrophysics** Program seeks to discover how the universe works, explore how the universe began and evolved and search for Earth-like planets. The FY 2013 budget request for Science includes $659.4 million for Astrophysics. NASA will continue to conduct science operations flights of the SOFIA aircraft in 2012 and 2013 as we upgrade its science instruments, and will continue parallel development of efforts leading to achievement of a full operational capability in 2014. The FY 2013 budget will fund the early stages of development of the next Astrophysics small Explorer mission to be selected early in calendar year 2013. Also in 2013 NASA will complete development of its instrument contributions to Japan's Astro-H mission for launch in FY 2014. The FY2013 budget enables NASA to continue development of the GEMS Explorer mission toward a launch in 2015. Finally, the FY 2013 budget will fund the operation of eleven Astrophysics missions currently in operation, including the Hubble, Spitzer, Chandra, and Fermi space telescopes.

The **James Webb Space Telescope** (JWST) is an infrared telescope designed to study and answer fundamental astrophysical questions ranging from the formation and structure of the universe to the origin of planetary systems and the origins of life. The FY 2013 budget request for Science includes $627.6 million for JWST. A scientific successor to the Hubble Space Telescope (HST) and the Spitzer Space Telescope, JWST will be used by international teams of astronomers to conduct imaging and spectroscopic observations. The Observatory will be located in an orbit near the second Sun-Earth Lagrange point (L2), approximately 1.5 million km from Earth. The telescope and instruments will be operated at a temperature of forty degrees above absolute zero (40 Kelvin) shielded from the heat of the Sun by a large sunshield, to enable the Observatory to achieve unprecedented sensitivity over its entire wavelength range. NASA completed a new baseline cost and schedule for JWST at the end of calendar year 2011, and is now implementing that new baseline. All 18 JWST primary mirror segments have been completed. NASA expects to take delivery of all four JWST instruments in FY2012-2013. In FY 2013, NASA will begin sunshield fabrication and continue development of the Integrated Science Instrument Module and the ground segment.

NASA's **Heliophysics** Program seeks an understanding of the Sun, and the complex interaction of the coupled system comprising the Sun, Earth, other planetary systems, the vast space within the solar system, and the interface with interstellar space. The FY 2013 budget request for Science includes $647.0 million for Heliophysics. Later this year, NASA will launch the Radiation Belt Storm Probes mission, and the FY 2013 budget will fund completion of its checkout and its early operations. The FY 2013 budget will fund completion and launch of the IRIS small Explorer mission as well as beginning of the development of the next small Explorer to be selected in early in calendar year 2013. FY 2013 will be a peak year in the development of the Magnetospheric Multiscale (MMS) mission to be launched in 2015. The FY 2013 budget will also fund the continued formulation of the Solar Probe Plus mission and development of the Solar Orbiter Collaboration with ESA. NASA expects to receive the new NRC Heliophysics decadal survey this spring, and will use it to shape the FY 2014 budget request in this area.

Also during FY 2013, NASA will continue development of environmental operational satellites for NOAA on a reimbursable basis. These include the Joint Polar Satellite System, Geostationary Operational Environmental Satellites (GOES-R series), Jason 3, and the Deep Space Climate Observatory. Funding for these programs is in the Department of Commerce budget request for NOAA.

In addition to the space missions emphasized above, the FY 2013 budget funds NASA's Science Mission Directorate to continue to sponsor competitively-selected research by universities, industry, and government laboratories across the nation. Using data from these missions, the nation's scientific community pursues answers to profound scientific questions of interest to all humanity as well as questions that enhance our national capability to predict environmental change including severe storms, droughts, and space weather events, and thereby enhance our economic and environmental security.

Aeronautics Research

NASA aeronautics research will enable the realization of the nation's Next Generation Air Transportation System (NextGen), and the safer, more fuel efficient, quieter, and environmentally responsible aircraft that will operate within NextGen. Through the research we conduct and research we sponsor with universities and industry, we help to develop the technology that enables continuous innovation in aviation. American companies are well positioned to build on discoveries and knowledge resulting from NASA research, turning them into commercial products, benefiting the quality of life for our citizens, providing new high-quality engineering and manufacturing job opportunities, and enabling the United States to remain competitive in the global economy. NASA's FY 2013 budget request for aeronautics is $551.5 million to continue our tradition of developing new concepts for aeronautics applications.

The FY 2013 request for Aeronautics Research includes $168.7 million for the **Fundamental Aeronautics** Program which seeks to continually improve technology that can be infused into today's state-of-the-art aircraft, while enabling game-changing new concepts such as Hybrid Wing Body airframes, tilt-rotor aircraft, low-boom supersonic aircraft, and sustained hypersonic flight. In FY 2010 and 2011 we conducted emissions measurements for alternative non-petroleum fuels derived from coal and biomass that showed dramatic reductions in particulate emissions in the vicinity of airports. In FY 2013 the Program will perform emissions measurements behind aircraft operating at relevant altitudes and cruise speeds to provide the first-ever data on the impact of alternative fuels on contrail formation, an important factor in aviation climate impact. In FY 2013 the Program will also increase its research on composite materials to enable airframe weight reductions beyond those achieved with current materials and structural design concepts.

NASA is combining hypersonic and supersonic research into a single project to focus on fundamental research for high-speed flight. Research into hypersonic flight is also relevant to the Department of Defense and NASA will retain critical core competencies and national asset testing capabilities to continue productive collaborations with DoD. Responsibility for fundamental research on entry, decent, and landing technologies will be transferred to Space Technology to increase synergy with the Agency's exploration and science missions. NASA will continue to work with DOD to maximize the efficiencies of current assets and investments and increase partnership to accomplish common goals. These realignments will enable NASA to focus on higher-priority research to improve the safety and minimize the environmental impacts of current and future aircraft and air traffic management systems. The FY 2013 request for Aeronautics Research includes $104.0 million for the **Integrated Systems Research Program**. This program evaluates and selects the most promising environmentally friendly engine and airframe concepts emerging from the fundamental research programs for further development, integration, and evaluation in relevant environments. Last year, the Program completed a major study by three aircraft manufactures to identify the critical technologies needed to simultaneously reduce emissions, fuel burn, and noise in aircraft entering service in 2025. In FY 2013, the Program will start a 3-year focused research effort on these technologies to advance their technology readiness. The Program is also addressing the emerging desire to integrate Unmanned Aircraft Systems (UAS) into the National Airspace System. Current Federal Aviation Administration (FAA) regulations are built upon the

condition of a pilot being on-board the aircraft. The Program will therefore generate data for FAA use in rule-making through development, testing, and evaluation of UAS technologies in operationally relevant scenarios.

Reductions in environmental impact will be achieved not only through new aircraft, engines, and fuels, but also through improved air traffic management procedures, which is the focus of the **Airspace Systems Program** with $93.3 million requested for FY 2013. Last year the Program advised the FAA on new air traffic management concepts for more efficient routing of flights during their cruise phase. We also completed evaluations of concepts for new fuel-efficient arrival procedures and will deliver requirements for those concepts to the FAA this year. In FY 2013 the Program will begin demonstrations to verify that several new procedures for air traffic management during arrival and taxiing to the gate that are enabled by NextGen Automatic Dependent Surveillance-Broadcast (ADS-B) technology can work together seamlessly. This effort will demonstrate near-term and mid-term ADS-B application benefits and provide airlines with data to support their strategic decisions related to the significant investments they need to make to equip their aircraft with ADS-B capability.

The **Aviation Safety Program,** with $81.1 million requested for FY 2013, conducts research to ensure that current and new aircraft and operational procedures maintain the high level of safety which the American public has come to expect. In FY 2011, the Program advanced data mining methods that permit the discovery of flight operations and aircraft maintenance issues through automated analysis of the vast amounts of data generated during flight operations and by sensors onboard aircraft. These methods have enabled the development of new software for aircraft central maintenance computers on both business jet and large commercial aircraft that can identify the early stages of hardware faults 30 to 50 flights earlier than previously possible. This allows airline maintenance personnel to address equipment issues before they cause a disruptive maintenance delay at the airport gate. The Program also focuses on mitigating environmental hazards to aviation and in FY 2013 will conduct a flight campaign to characterize ice water content at high altitudes in tropical regions as a first step to understanding the causes of severe loss of power due to engine icing that has occurred on a number of occasions.

U.S. leadership in aerospace depends on ready access to technologically advanced, efficient, and affordable aeronautics test capabilities. NASA's **Aeronautics Test Program**, with $78.1M requested for FY 2013, makes strategic investments to ensure the availability of these ground test facilities and flight test assets to researchers in Government, industry, and academia. In addition to this strategic management activity, the Program will continue developing new test instrumentation and test technologies. Last year the Program completed nearly $50 million worth of upgrades to major facilities funded through the American Recovery and Reinvestment Act. These upgrades provide improved research capabilities at Glenn and Ames Research Centers for aircraft and engine icing research, and tilt-rotor designs for a new generation of rotorcraft. New capabilities were also added to the Langley 14x22 Subsonic Wind Tunnel that will enable researchers to measure noise signatures from novel aircraft designs at a fraction of the cost of noise measurement acquired by flying real aircraft over airport microphone arrays. NASA's Aeronautics Test program enables and sustains U.S. leadership in aerospace yielding high quality jobs and ultimately a productive Aerospace sector.

The **Aeronautics Strategy and Management Program** provides for research and programmatic support that benefits each of the other five Programs, and has a requested budget of $26.4 million for FY 2013. The Program manages Directorate functions including Innovative Concepts for Aviation, Education and Outreach, and Cross Program Operations.

NASA is making meaningful contributions to the aerospace community, but we cannot do all these good things alone. Therefore, our partnerships with industry, academia, and other Federal agencies are critical to our ability to expand the boundaries of aeronautical knowledge for the benefit of the Nation. These

partnerships foster a collaborative research environment in which ideas and knowledge are exchanged across all communities and help ensure the future competitiveness of the nation's aviation industry. They also directly connect students with NASA researchers and our industrial partners and help to inspire students to choose a career in the aerospace industry.

Human Exploration and Operations

In 2011, NASA combined the Exploration Systems and Space Operations Mission Directorates to create the Human Exploration and Operations (HEO) Mission Directorate. HEO encompasses everything from the ISS and the commercial cargo and crew vehicles that will support it, to NASA's new exploration vehicles, which will take astronauts beyond LEO. HEO also includes research and technology development efforts that will enable deep space exploration, as well as critical infrastructure and operational capabilities that ensure NASA's ability to conduct testing, launch science missions, and communicate with its spacecraft across the solar system. As NASA reformulates its Mars exploration plans, we will ensure that the next steps for Mars exploration will take into account long-term human exploration as well as science goals.

The FY 2013 budget request includes $2,769.4 million for **Human Exploration Capabilities**, which the Agency proposes to rename **Exploration Systems Development**. This program includes development of the Orion MPCV, SLS heavy-lift launch vehicle, and the supporting ground infrastructure required for NASA's future crewed missions of exploration beyond LEO and into deep space. The amounts requested align with the plan developed and supported by an independent cost analysis performed last summer.

NASA's Orion MPCV will carry astronauts to, and support operations at, a variety of destinations in our solar system for periods of up to 21 days. NASA has recently completed a number of tests on Orion MPCV, including a test of the main parachute, and a series of water drop tests on the 18,000-pound Orion MPCV Boiler Plate Test Article. The Orion ground test article will undergo and complete acoustic, modal, and vibration environment compatibility testing at Lockheed Martin Denver during fiscal year 2012. The results of these tests will help improve the design for the actual flight vehicle. In May, the Orion Crew Module primary structure will be moved to Kennedy Space Center in Florida for the start of Assembly, Integration, and Production. NASA plans to conduct an uncrewed high-energy-atmospheric entry test mission of the Orion MPCV in FY 2014. Designated Exploration Flight Test-1 (EFT-1), this flight test will provide critical data to influence key design decisions. EFT-1 will also validate innovative new approaches to space systems development and operations to reduce the cost of exploration missions. For EFT-1, an early production variant of the Orion MPCV spacecraft will be integrated on a Lockheed Martin-procured, heavy class launch vehicle. The flight test will provide an opportunity to significantly inform critical design elements by operating the integrated spacecraft hardware and software in flight environments that cannot be duplicated by ground testing.

On September 14, 2011, NASA announced the design of the SLS, which will initially be capable of lifting 70-100 metric tons before evolving to a lift capacity of 130 metric tons for more demanding missions. NASA has worked diligently to accomplish the contracting and design work necessary to support a 2017 initial flight mission for the SLS. In FY 2013, SLS will continue detailed preliminary design and development and undergo a preliminary design review to evaluate the completeness/consistency of the program's preliminary design in meeting all requirements with appropriate margins, with acceptable risk, and within cost and schedule constraints. This comprehensive review will determine the program's readiness to proceed with the detailed critical design phase of the project.

The SLS will use a liquid hydrogen and liquid oxygen propulsion system, building upon the investment made by the Nation over the last forty years. The vehicle's core stage will utilize existing Space Shuttle Main Engines (SSME RS-25D) for the initial capability. NASA's use of the SSME inventory will reduce initial design costs and take advantage of an existing human-rated system. NASA plans to modify and use the existing SSME contract with Pratt & Whitney Rocketdyne to acquire RS-25D engine servicing and testing for the initial launch system.

The upper stage of the SLS needed for the full-up SLS capability will also use a liquid hydrogen and liquid oxygen propulsion system that includes the J-2X, a new upper stage engine previously planned for use in the Ares-I vehicle. NASA is negotiating a modification to the Ares I Upper Stage contract with Boeing to develop the SLS core stage and upper stage, including avionics. SLS will also utilize the existing J-2X contract with Pratt & Whitney Rocketdyne to continue developing the upper stage engine. NASA has been running J-2X components through a series of tests. In November and December 2011, the Agency conducted three J-2X engine tests, firing the motor for a total of 680 seconds. These were the last of ten engine test firings completed in 2011. In January and February of 2012, NASA also conducted a series of J-2X Power Pack Assembly tests. These tests are part of a series of over 100 power-pack and integrated engine tests that NASA has planned to complete the engine design and certify the J-2X for use in the SLS Upper Stage.

NASA plans to use five-segment solid rocket boosters for the initial capability test flights of the SLS. We will conduct a competition to develop the follow-on boosters based on performance requirements. In support of this effort, on February 9, 2012, the Agency released a NASA Research Announcement (NRA) for Advanced Booster Engineering Demonstration and Risk Reduction. Proposals are due in April and contract awards are expected in October 2012.

On February 1, 2012, NASA also released a draft for an NRA, for advanced development of key technologies in propulsion, avionics, structures and materials, and other areas. The final release is planned for March, with proposals due in May and contract award in October 2012.

Exploration Ground Systems (EGS) will develop the necessary ground systems infrastructure at the Kennedy Space Center and operational plans and procedures to prepare, assemble, test, launch and recover the Exploration architecture elements for long-term beyond-Earth orbit exploration. EGS will focus on the life cycle of a launch complex as an integrated system (from development, activation, operations, maintenance of capabilities to manufacture, assemble, test, checkout, launch, and recover flight hardware) to enable more efficient and cost-effective ground processing, launch and recovery operations.

The FY 2013 budget request includes $829.7 million for the **Commercial Spaceflight** theme. This effort will support commercial providers to develop and operate safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO.

As part of the Commercial Orbital Transportation Services (COTS) program – NASA's commercial cargo effort – NASA has partnerships with Space Exploration Technologies, Inc. (SpaceX) and Orbital Sciences Corporation (Orbital) using funded Space Act Agreements. These agreements include a schedule of fixed payment performance milestones culminating in a demonstration mission to the ISS that includes vehicle launch, spacecraft rendezvous, ISS berthing, and re-entry for disposal or return to Earth. Both COTS partners continue to make progress in developing and demonstrating their systems. Based on the success of their first COTS demo flight in December 2010, SpaceX plans to fully develop and assemble their next vehicle with the capabilities and equipment necessary to complete rendezvous and berthing demonstration to the ISS, thus potentially combining milestones that had been planned for separate flights. If successful, this will accelerate the completion of the COTS Space Act Agreement and

enable delivery of cargo under the Commercial Resupply Services (CRS) contract. This mission is tentatively planned for April 2012. Orbital Sciences is currently mating the main engines for its Antares vehicle to the core stage in preparation for an integrated static fire later this year. The maiden flight of the Antares is planned for the second quarter of 2012 and the COTS demonstration mission is planned for the third quarter. The pad complex at Wallops Flight Facility in Virginia is being readied and space flight hardware, including the first Pressurized Cargo Module, two Antares core sections, and a Castor-30 upper stage, has already been delivered to Wallops Flight Facility.

The Commercial Crew Program (CCP) aims to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from low Earth orbit and ISS. Since 2009, NASA has conducted two CCDev competitions, soliciting proposals from U.S. industry to further advance commercial crew space transportation system concepts and mature the design and development of elements of the system. During the second CCDev competition, known as CCDev2, NASA awarded four funded Space Act Agreements that are currently being executed with Blue Origin, The Boeing Company, Sierra Nevada Corporation, and SpaceX, all of which are making good progress in achieving their milestones. NASA has also signed Space Act Agreements without funding with three additional companies: Alliant Techsystems, Inc., United Launch Alliance, and Excalibur Almaz, Incorporated .

Under the CCP, NASA plans to partner with U.S. industry, providing technical and financial assistance to facilitate industry's development of an integrated crew transportation system. In the longer term, once those entities are certified, NASA plans to buy transportation services from commercial entities for U.S. and U.S.-designated astronauts to the ISS.

Congress appropriated $406 million for CCP in FY 2012 which reflected a substantial reduction from NASA's request for this program. The FY 2012 appropriation enables the Agency to move forward with its plans to support the development of commercial services that may eventually support crew transportation and rescue capabilities in support of ISS. However, the constrained budget environment necessitated a reassessment of NASA's overall strategy for this Program. On December 15, 2011, NASA announced a modified competitive acquisition strategy designed to make the best use of available resources and to pursue the most effective path to the achievement of a commercial crew capability. Instead of using firm-fixed price contracts for the next phase of the Program, the Agency plans to continue using multiple, competitively awarded and funded Space Act Agreements for another round of CCP. NASA will use procurement contracts to certify these capabilities before they are used to support ISS. Using competitive Space Act Agreements instead of contracts at this juncture will allow NASA to maintain multiple partners during this phase of the Program, and provide NASA with the flexibility to more easily adjust to various funding levels. This new acquisition strategy will allow NASA to preserve greater competition and maintain momentum to provide a U.S.-based commercial crew launch capability at the earliest possible time.

NASA is pleased with the steady progress of U.S. commercial providers in developing domestic cargo and crew transportation services. NASA currently has contracts for cargo services and intends to purchase crew services from U.S. providers once they are certified to our crew requirements. Obtaining needed cargo and crew transportation services from U.S. providers is NASA's preferred method for sustaining and fully utilizing the ISS. Nevertheless, given current funding levels for the development of U.S. crew transportation systems, we anticipate the need to purchase Soyuz crew transportation and rescue capabilities into 2017. As NASA has previously testified, modification of the Iran, North Korea, Syria Non-proliferation Act (INKSNA) provisions will likely be required for the continued operation of ISS and other space programs after 2016. The Administration plans to propose appropriate provisions and looks forward to working with the Congress on their enactment. NASA is evaluating how this issue

impacts the development of U.S. crew transportation systems and NASA's acquisition of services for the ISS and goods and services for other NASA human spaceflight activities, given the possibility that some U.S. domestic providers will need to use Russian goods and services. In addition to the need driven by the ISS transportation requirements, NASA will require Russia-unique critical capabilities for the life of the ISS, such as sustaining engineering for the Russian built U.S. owned Functional Cargo Block, that are not available elsewhere.

The FY 2013 budget request includes $333.7 million for **Exploration Research and Development (ERD)**. The Exploration Research and Development (ERD) theme will expand fundamental knowledge that is key to human space exploration, and will develop advanced exploration systems and capabilities that will enable humans to explore space in a more sustainable and affordable way. ERD is comprised of the Human Research Program (HRP) and the Advanced Exploration Systems (AES) Program, which will provide knowledge and advanced human spaceflight capabilities. NASA's Office of the Chief Technologist (see below) coordinates closely with ERD to ensure that NASA's long range, crosscutting Space Technology research is complementary to ERD's human exploration focused work.

HRP and its associated projects will continue to develop technologies, countermeasures, diagnostics, and design tools to keep crews safe and productive on long-duration space missions. ISS crews are conducting relevant human medical research to develop knowledge in the areas of clinical medicine, human physiology, cardiovascular research, bone and muscle health, neurovestibular medicine, diagnostic instruments and sensors, advanced ultrasound, exercise and pharmacological countermeasures, food and nutrition, immunology and infection, exercise systems, and human behavior and performance. While this research is aimed at enabling astronauts to push the boundaries of exploration beyond low-Earth Orbit (LEO), NASA anticipates that investigations conducted aboard ISS may have broad application to terrestrial medicine, as well. For example, the growing senior population may benefit from experiments in the areas of bone and muscle health, immunology, and from the development of advanced diagnostic systems.

The AES Program is pioneering new approaches for rapidly developing prototype systems, demonstrating key capabilities, and validating operational concepts for future human missions beyond Earth orbit. AES activities are uniquely related to crew safety and mission operations in deep space, and are strongly coupled to future vehicle and exploration capability development. Early integration and testing of prototype systems will reduce risk and improve affordability of exploration mission elements. The prototype systems developed in the AES Program will be demonstrated in ground-based test beds, field tests, underwater tests, and flight experiments on the ground and then on the ISS. Many AES projects will evolve into larger integrated systems and mission elements that will be tested on ISS before we venture beyond Earth orbit, thus leveraging the value of the Station as a vital exploration test-bed.

The FY 2013 budget request includes $70.6 million for the **Space Shuttle Transition and Retirement (T&R)**. In 2011, the Shuttle flew out its remaining missions safely. On February 24, Discovery launched on mission STS-133, carrying supplies to ISS, as well as the permanent a Multi-purpose Module (PMM)-- a Multi-Purpose Logistics Module (MPLM) transformed to remain on orbit, expanding the Station's storage volume. On May 16, Endeavour, STS-134, carried the Alpha Magnetic Spectrometer (AMS) and attached it to the Station's truss structure. The final Shuttle mission, STS-135, launched on July 8, delivered critical supplies to the ISS. With the landing of Atlantis on July 21, 2011, the 30-year Shuttle Program was brought to a close. The Space Shuttle Program is now focused on the transition of key assets and infrastructure to future programs, and the retirement, and disposition of Program assets.

In FY 2012, NASA is funding United Space Alliance's (USA's) Space Program Operations Contract (SPOC) Pension Liability. During the Shuttle Program, USA consistently incorporated and billed the maximum allowable costs into their indirect rates, but the deterioration of the equities and credit markets

caused their plan to be underfunded by a currently estimated $522 million. The estimate will fluctuate until payout in the summer of 2012. The variance is protected in the transition and retirement budget line item. The Space Program Operations Contract, which accounts for almost all of USA's business base, is a cost-type contract covered by the Cost Accounting Standards (CAS). These standards stipulate that any costs of terminating plans are a contractual obligation of the Government (if deemed allowable, allocable, and reasonable). NASA and USA entered into an agreement under which USA froze their pension plans as of December 31, 2010, and deferred any decision about terminating their plan until after NASA received its FY 2012 appropriation, allowing NASA to address this issue with FY 2012 funds. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding. If there is a shortfall, it will reduce available Space Shuttle funds for closeout and some activity could move later than planned. NASA will keep Congress informed as this issue evolves.

The FY 2013 budget request includes $3,007.6 million for the **International Space Station (ISS) Program.** This funding will support ISS Operations and Maintenance, ISS Research, and ISS Crew and Cargo Transportation. The ISS has transitioned from the construction era to that of operations and research, with a 6-person permanent crew, 3 major science labs, an operational lifetime through at least 2020, and a growing complement of cargo vehicles, including the European Automated Transfer Vehicle (ATV) and the Japanese H-II Transfer Vehicle (HTV). The FY 2013 budget request reflects the importance of this unparalleled research asset to America's human spaceflight program.

In the NASA Authorization Act of 2005 (P.L. 109-155), Congress designated the U.S. segment of the ISS as a National Laboratory, and directed the Agency to seek to increase the utilization of the ISS by other Federal entities and the private sector. NASA has made great strides in its effort to engage other organizations in the ISS program, and the Agency now has Memoranda of Understanding with five Federal agencies and Space Act Agreements with nine companies and universities. In the NASA Authorization Act of 2010 (P.L. 111-267), Congress directed that the Agency enter into a cooperative agreement with a not-for-profit organization to manage the activities of the ISS National Laboratory. To this end, on August 31, 2011, NASA finalized a cooperative agreement with the Center for the Advancement of Science in Space (CASIS) to manage the portion of the ISS that operates as a U.S. National Laboratory. CASIS will be located in the Space Life Sciences Laboratory at Kennedy Space Center in Florida. The independent, nonprofit research management organization will help ensure the Station's unique capabilities are available to the broadest possible cross-section of U.S. scientific, technological and industrial communities. CASIS will develop and manage a varied Research and Development portfolio based on U.S. national needs for basic and applied research; seek to establish a marketplace to facilitate matching research pathways with qualified funding sources; and stimulate interest in using the national lab for research and technology demonstrations and as a platform for science, technology, engineering and mathematics (STEM) education. The goal is to support, promote and accelerate innovations and new discoveries in science, engineering and technology that will improve life on Earth.

The FY 2013 budget request includes $935.0 million for **Space and Flight Support** (SFS). The budget request provides for critical infrastructure indispensable to the Nation's access to and use of space, including Space Communications and Navigation (SCaN), Launch Services Program (LSP), Rocket Propulsion Test (RPT), and Human Space Flight Operations (HSFO). The SFS budget also includes investment in the 21st Century Space Launch Complex, whose primary objective is to modernize and transform the Florida launch and range complex at the Kennedy Space Center to benefit current and future NASA programs, along with other emerging users. Fiscal Year 2013 is an important period for NASA's Space Communications and Navigation (SCaN) Program. The Program is responsible for NASA's Tracking and Data Rely Satellites (TDRS) that provide a critical backbone for space communications. FY 2013 will include the scheduled launch TDRS-K, an additional satellite in the

system; completion of TDRS L integration; and the development of TDRS-M, which will be ready for launch in 2015. These spacecraft will refurbish this important network as aging TDRS are retired after 20 years of service to the Nation. Also under construction is a 34-meter antenna at the Deep Space Network's Canberra Deep Space Communication Complex, with plans to build a second, to replace the aging 70-meter antenna. These antennae in the Southern Hemisphere will be particularly important as the Earth's rotation brings this site into the best range for tracking NASA's deep space missions in the coming decade. In preparation for supporting NASA's space science program, SCaN is developing space communications technology, including the Lunar Laser Communications Demonstration and the Laser Communication Relay Demonstration, which will lead to the capability of handling the huge increase in scientific data expected from NASA's planned spacecraft. Additionally, this capability could enable greater bandwidth and capabilities to support expanded education, participatory engagement, and interactive exploration opportunities. SCaN also anticipates the launch of its SCaN Test-bed in June on the Japanese Space Agency's HTV cargo vehicle. The test-bed, composed of three Software-Defined Radios, will provide the bridge to advance technological innovation by actual testing in the real space environment. As a pathfinder it will be made available to industry, academia and other Government agencies.

The Launch Services Program (LSP) has several planned NASA launches in FY 2013, including the, Landsat Data Continuity Mission (LDCM), Tracking and Data Relay Satellite (TDRS)-K, and Interface Region Imaging Spectrograph (IRIS), and will continue to provide support for the development and certification of emerging launch services. In FY 2013, the Rocket Propulsion and Test (RPT) program will continue to conduct test facility management, maintenance, sustaining engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness. The RPT program will continue to assist in rocket propulsion testing requirements definition for low Earth orbit and in-space propulsion systems and related technologies

Technology

The Office of the Chief Technologist (OCT) coordinates the Agency's overall technology portfolio. OCT ensures that NASA's investments are cost-effective and that they are aligned with the Agency's near- and far-term goals. Over the last year, OCT has engaged thousands of technologists and innovators to develop and test cutting-edge technologies distributed across the country. While the NRC conducted its review of NASA's technology roadmaps, OCT worked with mission architecture teams to identify key technology areas requiring immediate investment. Using these internal, cross-Agency working groups, NASA selected nine technologies to receive priority funding based on their criticality in extending human presence beyond low Earth orbit and their ability to dramatically further scientific exploration of the solar system. These "Big 9" projects are: Laser Communications Relay Demonstration, Cryogenic Propellant Storage and Transfer, Low Density Supersonic Decelerators, Composite Cryogenic Propellant Tanks, Robotic Satellite Servicing, Hypersonic Inflatable Aerodynamic Decelerators, Deep Space Atomic Clock, Large-Scale Solar Sail, and Human-Robotic Systems.

On February 1, 2012, the NRC released its final review of NASA's Draft Space Technology Roadmaps. The NRC identified sixteen top-priority technologies necessary for future missions, and which could also benefit American aerospace industries and the nation. The sixteen were chosen by the NRC from its own ranking of 83 high-priority technologies out of approximately 300 identified in the draft roadmaps. In the coming months, OCT will lead an agency-wide analysis and coordination effort to inform future technology investments on the basis of the NRC report.

The FY 2013 request for Space Technology is $699 million and funds on-going high-priority space technology projects that will increase the nation's capability to operate in space and enable long-term

human exploration and develop efficiencies for deep space science missions. In FY 2013, NASA will begin to see major milestones achieved within Space Technology's "Big 9" efforts. Designed to deliver data rates that will enable new class of deep-space exploration missions, the Laser Communications Relay Demonstration project will begin ground validation activities of advanced laser communication systems. Enabling precise landing of higher-mass payloads to the surface of planets, the Low Density Supersonic Decelerators effort will complete three critical full-scale tests to demonstrate parachute and inflatable decelerator performance required prior to supersonic-speed flight demonstration. The Composite Cryogenic (low-temperature) Propellant Tank project will design and build a five-meter-diameter composite cryogenic propellant tank that will yield lower mass and lower cost rocket propellant tanks. The Cryogenic Propellant Storage and Transfer demonstration mission will conduct ground tests of the critical technologies required to enable long-term storage and handling of cryogenic fluids in space in preparation for a flight demonstration. While these projects will make visible individual steps in FY 2013, they are part of a broader portfolio of activities that Space Technology will pursue in order to generate new technologies for use by NASA, other government agencies, and U.S. industry.

Within Space Technology, NASA funds Crosscutting Space Technology Development at $293.8 million to enable NASA to develop transformational, broadly applicable technologies and capabilities that are necessary for NASA's future science and exploration missions, and also collaborates on the aerospace needs of other government agencies and the U.S. space enterprise. NASA's CSTD activities are funded through a mix of competitive and strategically-guided projects to attract a broad array of participants. Investments support research fellowships, NASA Innovative Advanced Concepts (NIAC), Centennial Challenges, suborbital flight opportunities, and advancements in small satellite technologies and systems.

NASA also funds Exploration Technology Development at $202 million to invest in the long-range technologies required for humans to explore beyond low Earth orbit. ETD technologies are higher risk investments that complement architecture and systems development efforts within Exploration by maturing breakthrough technology prior to integration with operational capabilities. As projects are matured, new projects are selected competitively to provide the opportunity to develop the best ideas, innovations, approaches and processes for the future human space exploration efforts.

Funded based on a percentage of the Agency's total extramural R&D, the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs continue to support research and development performed by small businesses through competitively-awarded contracts. Estimated at approximately $173.7 million in FY 2013, these programs produce innovations for both Government and commercial applications. SBIR and STTR provide the high-technology small business sector with the opportunity to develop technology for NASA, and commercialize that technology to provide goods and services that address other national needs based on the products of NASA innovation.

Partnership Development and Strategic Integration, funded at $29.5 million, comprises key Agency responsibilities managed by OCT: technology partnerships, technology transfer and commercialization, and the coordination of NASA's technology investments across the Agency through technology portfolio tracking and technology road-mapping. By providing coordination between Mission Directorates and Centers, and identifying collaboration opportunities with other government agencies and performing technology transfer, NASA can deliver forward-reaching technology solutions for future science and exploration missions, and help address significant national needs.

Within this portfolio, OCT engages in national technology development initiatives such as the National Robotics Initiative, the National Nanotechnology Initiative and the Advanced Manufacturing Partnership, and seeks partnerships with external entities for collaborative technology development. OCT engages the larger aerospace community including other Government agencies, and where there are mutual interests, develops partnerships to efficiently develop breakthrough capabilities.

Education

The FY 2013 request includes $100 million for NASA's Office of Education to develop Science Technology Engineering and Mathematics (STEM) education activities that only NASA can provide. The funding request would allow undergraduate and graduate students to work alongside NASA scientists and engineers through internships and fellowships at NASA centers. It includes educator professional development, helping our country's educators become proficient in STEM topics, and providing them opportunities to practice hands-on investigations. NASA will also continue to support the institutions where learning takes place. Through the Space Grant and Minority University Research and Education projects, NASA will work with hundreds of universities and community colleges, strengthening their capacity to train the next generation of scientists and engineers, encouraging student design challenges, and connecting faculty with NASA research. And, because we know inspiration doesn't just happen in a classroom, we will engage learners in NASA content at our visitor centers and in partnership with museums, science centers, planetariums and other informal education venues.

NASA is one of many Federal government programs that support STEM education. NASA is working with other agencies through the National Science and Technology Council's Committee on STEM Education to effect optimal revisions to fund coordinated and effective student and teacher opportunities. NASA will focus its resources on demonstrated areas of strength in its unique role in STEM education. NASA brings many assets to support the Administration's emphasis on (STEM education beyond funding. Our people, platforms like the ISS and our facilities across the Nation all contribute to strengthening STEM education.

Recognizing that the nature of our work is inspirational to learners and educators, NASA will leverage the talents of our workforce to support the critical STEM education needs of our Nation. In collaboration with other Federal agencies, NASA will leverage unique assets like the International Space Station (ISS), to provide meaningful experiences. In March, Educator Astronaut Joe Acaba, a former middle and high school teacher, will begin a six-month mission onboard the ISS. During his time in space, he will work closely with our education team on the ground to share his experience with classrooms across America.

Cross-Agency Support

The FY 2013 budget request includes $2,847.5 million for Cross-Agency Support, which provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency. These important functions align and sustain institutional and program capabilities to support NASA missions by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. Within this budget request, NASA has taken steps to reduce its administrative expenses, including a hiring slowdown and reduced travel.

NASA's FY 2013 budget request includes $2,093.3 million for **Center Management and Operations,** which funds the critical ongoing management, operations, and maintenance of nine NASA Centers, as well as associated major component facilities. NASA Centers continue to provide high-quality support and the technical engineering and scientific talent for the execution of programs and projects. This technical expertise represents a true national resource. Center Management and Operations provides the basic support required to meet internal and external legal and administrative requirements; effectively manage human capital, information technology, and facility assets; responsibly execute financial management and all NASA acquisitions; ensure independent engineering and scientific technical oversight of NASA's programs and projects in support of mission success and safety considerations; and, provide a safe, secure, and sustainable workplace that meets local, state, and Federal requirements.

NASA's FY 2013 budget request includes $754.2 million for Agency Management and Operations, which funds the critical management and oversight of Agency missions, programs and functions, and performance of a broad spectrum of NASA-wide activities. These programs include Safety and Mission Success activities, essential to reducing the likelihood of loss of life and likelihood of mission success in our human and robotic programs. Safety and Mission Success funding supports the maintenance of independent safety, health, medical and engineering assessments of systems and processes, as well as the performance of the broad risk assessments, mitigations, and acceptance related to critical Agency decisions. Agency Information Technology Services (AITS) encompasses Agency-level cross-cutting services and initiatives in Information Technology (IT) innovation, business and management applications, and infrastructure necessary to enable the NASA Mission. The Strategic Capabilities Assets Program (SCAP) ensure that vital Agency test capabilities and assets, such as flight simulators and thermal vacuum chambers are sustained in order to serve Agency and national needs. The Agency Management and Operations account funds salary and benefits for civil service employees at NASA Headquarters, as well as other Headquarters personnel costs, such as mandated training. It also contains labor funding for Agency-wide personnel costs, such as Agency training, and workforce located at multiple NASA Centers that provide the critical skills and capabilities required to execute mission support programs Agency-wide.

Construction and Environmental Compliance and Restoration

The FY 2013 budget request includes $619.2 million for Construction and Environmental Compliance and Restoration. NASA Construction and Environmental Compliance and Restoration provides for the design and execution of all facilities construction projects, including discrete and minor revitalization projects, demolition of closed facilities, and environmental compliance and restoration.

The FY 2013 budget request includes $552.8 million for the **Construction of Facilities** (CoF) Program, which funds capital repairs and improvements to ensure that facilities critical to achieving NASA's space and aeronautics programs are safe, secure, sustainable, and operate efficiently. The Agency continues to place emphasis on achieving a sustainable and energy-efficient infrastructure by replacing old, inefficient, deteriorated buildings and infrastructure with new, efficient, and high performance buildings and infrastructure that will meet NASA's mission needs while reducing the Agency's overall footprint and future operating costs. In August 2011, NASA opened the Agency's first building designed for "Net-Zero" energy operations, the Propellants North Administration and Maintenance Facility at the Kennedy Space Center in Florida. Two active programs that result in NASA achieving greater efficiencies and reduced operating costs are NASA's demolition program and recapitalization program, in which old inefficient facilities are replaced with new, efficient, consolidated facilities. Twelve horizontal infrastructure projects that sustain our major utility systems are included in this request; completion of these projects will reduce our usage of potable and process water, electricity and steam.

The FY 2013 budget request includes $66.4 million for the **Environmental Compliance and Restoration** (ECR) Program, which supports the ongoing clean-up of sites where NASA operations have contributed to environmental problems. The ECR Program prioritizes these efforts to ensure that human health and the environment are protected. This Program also supports strategic investments in sustainable environmental methods and practices aimed at reducing NASA's environmental footprint and lowering the risk of future cleanups.

Conclusion

NASA's FY 2013 budget request of $17.7 billion represents a substantial investment in a balanced program of science, exploration, technology and aeronautics research. Despite the constrained budget

environment facing the Nation, this request supports a robust space program that keeps us on a path to achieving a truly audacious set of goals. NASA is working to send humans to an asteroid and ultimately to Mars, to observe the first galaxies form, and to expand the productivity of humanity's only permanently-crewed space station. We are making air travel safer and more efficient, learning to live and work in space, and developing the critical technologies to achieve these goals. The coming year will include the first commercial cargo flights to the ISS, a nuclear powered robot the size of a small car landing on the surface of Mars, and the launch of the Nation's next land observing satellite. We have spacecraft studying the Sun, circling Mercury, cruising to Pluto and investigating almost everything in-between. In the face of very difficult times, the American people continue to support the most active, diverse and productive space program in the world. We at NASA are honored by our fellow citizens' continued support and we are committed to accomplishing the goals that Congress and the President have laid out for us. The program described and supported by our FY 2013 budget request represents our plan to accomplish those goals.

Chairman HALL. All right. I thank you, sir, for your testimony, and I remind Members that Committee rules limit questioning to five minutes, and the Chair will open—at this point open the round of questions. The Chair recognizes himself for five minutes, and I will try to stay within the five minutes. I will stay within the five minutes.

Charlie, NASA continues, we think, to ignore a provision in the 2010 Authorization Act to develop the Space Launch System and Orion and Orion Multi-Purpose Crew Vehicle in time to provide a back-up capability to reach International Space Station if the Russians or the commercial companies are unable to perform.

Using NASA's very best case scenario, commercial crew capabilities will not be available any earlier than 2017, and the Space Launch System and Orion Multi-Purpose Crew Vehicle would not be operational before 2021, after the Space Station's current planned life. NASA has reduced the Orion Multi-Purpose Crew Vehicle budget by $200 million in this fiscal year 2013 request.

In the interim, what plan does NASA have in place to access International Space Station should the Russian Soyuz or the commercial system be unavailable or not work for some reason?

Mr. BOLDEN. Mr. Chairman, regretfully as I think everyone here knows, we have set ourselves up for a 2017 first availability of any capability beyond the Russians to take crews to the International Space Station. That is regrettable, but it is due to a lack of execution prior to now, and we are trying to correct that.

I would say what is critical is that we not extend the gap between now and when we do have an American capability to get humans back into space any farther than it is right now, and that is why we are asking for the funds that we are, to support the Commercial Crew Development Program.

Chairman HALL. In July or August NASA's Commercial Crew Program plans to give, I think, 300 million to 500 million to multiple companies using Space Act Agreements instead of more typical government contracts. According to NASA's Office of General Counsel, Space Act Agreements do not permit NASA to impose design or safety requirements on the contractors.

I don't understand how we can be assured that NASA is developing safe systems, and safety is so important if it is prohibited from imposing any requirements or performance tests from the companies? And what recourse does the government have if these companies fail to perform or go out of business? And what, if anything, will NASA own after making these expenditures?

Mr. BOLDEN. Congressman, the main recourse I have is that I pick the winner. My pledge to this Congress has always been that safety is foremost as long as I am the Administrator.

While it is true that we don't have the opportunity to impose requirements and specifications under Space Act Agreements, in response to continued prodding from the Aerospace Safety Advisory Panel, a panel empowered by this Congress, we have now developed a set of design requirements for a human-rated vehicle, as well as human-rating standards for the same vehicles. And the industry companies, American companies have participated in the development of those standards and everyone has access to that now.

So whereas a year ago a company would have said I am reluctant to bid because I don't know what requirements you are going to impose upon me, that argument—no longer holds water. Everyone has in their possession the design requirements for a human-rated vehicle that they will have to comply with when they enter into a contract. Everyone knows what the human-rating standards are.

So for minor things about human rating they know what they are. So I have people who are working with the companies right now that can look at how they are designing and developing their vehicle, and we will get a very good feel for whether or not they are serious about designing to those standards. They can't fool us.

So I may not be able to impose the requirements yet, but they know what requirements they are going to have to meet once we enter into a contract with them.

Chairman HALL. Well, Charlie, you have some control over the Office of the General Counsel, don't you, and they are subject to your suggestions, your demands, your requests.

Mr. BOLDEN. Mr. Chairman, I do, but I don't have control over the law, and I don't have control over procurement regulations and the job of my general counsel, and it is one that I respect dearly because he is a Marine, and he is the world's greatest fighter pilot formerly, and so I respect his opinion, and he tells me that I need not stray from procurement law, and I am happy with that.

And I assure you, again, in all seriousness, safety is my number one concern, and I will make sure that we don't fly any American astronauts on any spacecraft if it is not safe and it doesn't meet our requirements.

Chairman HALL. But safe to me is you ought to permit NASA to impose these safety requirements and have it in writing in the contracts, and that would give you more substance to take them on for in our behalf.

Mr. BOLDEN. Congressman——

Chairman HALL. Why not do that?

Mr. BOLDEN [continuing]. You just used a key word when you said impose on the contractor. They are partners right now. They are not contractors, and it is a subtle difference, but it is a difference. When they become contractors, when we put a request for a proposal out, somewhere between 14 and 20 months after we go through this Space Act Agreement process, they will bid on that proposal. They are then contractors, and once they sign on the dotted line, then they have hard requirements with which they have to comply.

If we have any indication from our teams in their facilities between now and when our contract is met that they are not seriously approaching the standards that we need, they won't win the contract. I can say that upfront. So if someone thinks they are going to fool us or say that they will put political pressure on us later because I have no other choice, they are sadly mistaken. We know, and they know. We know that they know what the requirements are. We know that they know what the human rating——

Chairman HALL. My time is over, and I thank you so much. I may write you about that. Thank you.

Mr. BOLDEN. I will make them comply.

Chairman HALL. Now recognize Ms. Johnson for her five minutes.

Ms. JOHNSON. Thank you very much.

Administrator Bolden, you know as well as I know that NASA is a unique source of inspiration for our young people, and it really is distressing to see the assessment of the value of NASA's education activities.

Your total request for fiscal year 2013 is about $59 million less than you were appropriated by the Congress in fiscal year 2012. I know that many people are sitting here listening to you, think yeah, yeah, yeah, but at the same time the fiscal year 2013 budget request for education is $36 million less than appropriated for fiscal year 2012.

And I understand that you had to make difficult choices, yet with all of the puts and takes, the optics of education taking the lion's share of the agency's reduction just does not sit well with me.

So how is it that during your priority setting, as Dr. Holdren told us, education didn't stack up well against other agency programs or STEM education programs in other agencies? Could you elaborate on that?

Mr. BOLDEN. Congresswoman, I won't comment on Dr. Holdren's statement if he said that, but I would say education had to stack up well. Education is very important. It is critical, and what we are doing that is a little bit different than we have ever done before is one of the first things that I did when I came in was we established and we had an education summit, and we brought in, and I think I mentioned this to you before, we brought in 25 of the most expert people we could find in foundations and educational institutions to help us determine which direction we should go in. They recommended we form a design team to help us reform NASA's Education Program, and that is what we are trying to do now.

There is also the President's desire is to more adequately collaborate among agencies so that we don't have duplication of effort, and that is under Dr. Holdren's leadership in the Co-STEM, the Committee on Science, Technology, Engineering, and Math, and what we are doing is giving that collaborative organization an opportunity to set some goals for all of us. One of the things I mentioned is we have to be able to measure. I have to be able to get metrics that say my programs are effective, and I think in the end we will be able to do that, and you will find that we are even more effective than we are right now.

Ms. JOHNSON. Okay. Can you tell me where are you in terms of getting the measurements in place?

Mr. BOLDEN. We have been working for 2–1/2 years now to establish those metrics, and I think they are, the metrics are now well established, and we can have Mr. Melvin and his folks come in and talk about what they are. We have tried to work them out with educational institutions and foundations, and so I think we have the metrics established.

The measurement of those, as I think most people understand, is not something that happens in a week or a day or a month. We are talking about years in the making to be able to verify that your program was successful.

But we do have measures from the Summer of Innovation Program that is now getting ready to go into its third summer that we have had a measurable affect on the interest of children, students, mainly in middle school. That was our focus. The interest of students in STEM education and following STEM courses, and we definitely have metrics that show that the effectiveness of our work with teachers is much better than it has ever been before. We now have teachers who proudly stand in front of a class and feel they know what they are talking about when they talk about math and science, and they are not afraid to teach it.

Ms. JOHNSON. Yes, and I believe that, but I am trying to figure out what did you give up by giving up this $36 million?

Mr. BOLDEN. Well, Congresswoman, I think what we gave up was the number of different places that we would be able to reach, not the programs themselves, and Leland and I had a discussion about this yesterday, and if you look at EPSCoR or you look at Space Grant, the content is not affected. What is affected is the number of schools or the number of communities that we will be able to reach for some period of time, and we are trying to find ways to overcome that.

NASA is now much better than ever in utilizing social media. I don't have any statistics, I don't have any metrics to show this. My guess is we are probably reaching more students today although we are spending less money and getting into fewer areas than we ever reached before through Facebook, iTunes, apps. NASA has probably as many apps out there now that are available to students as anybody, and we didn't have that before.

Ms. JOHNSON. Thank you very much.

Chairman HALL. The gentlelady yields back.

I recognize Mr. Sensenbrenner for five minutes.

Mr. SENSENBRENNER. General, thank you for coming.

Mr. BOLDEN. Thank you.

Mr. SENSENBRENNER. Trying to squeeze programs into whatever the President says you have got available I know is a very difficult job, and you have got to pick some winners and losers. I know that programs talk about hardware and delivery systems and stuff like that. I am kind of concerned about people, and we are all in favor of having more jobs available and haven't done a very good job in that during the current recession.

But delays in developing the new Space Launch System resulted in the loss of about 10,000 jobs, and do you think the private sector will be able to absorb these 10,000 jobs as a result of increased reliance on the private sector, or are we going to be having some highly-trained engineers who know a lot about developing spacecraft to just go off into another area of endeavor?

Mr. BOLDEN. Congressman, regretfully the answer to that question is regional. If you would ask me about Texas, we have had incredible success in placing our employees who have lost their job because the petrochemical industry has sucked them up. If you are talking about Florida, that is probably the area that is the hardest hit, and it is because we have been unsuccessful in working with the State of Florida to get them to bring high-tech jobs, alternative high-tech jobs into the area.

But the lieutenant governor and I are working diligently to try to find companies that want to come into Florida and utilize the talent that we have there.

So it is a slog. We are going to get there.

Mr. SENSENBRENNER. What is NASA doing to ensure that we don't lose these people forever?

Mr. BOLDEN. Congressman, what we are trying to do particularly with the NASA workforce, unfortunately, I have to differentiate between the civil service workforce and the contractor workforce because I actually have very little control over the contractor workforce and what happens to them other than going out and using more of our money to hire contractors instead of focusing on programs and keep the civil service workforce.

In the case of the civil service workforce, we are trying to do everything we can to retrain people where necessary, to make lateral moves so that we put them in the proper skill, the proper position to utilize their skills, and in some cases in my visits to the centers I am asking people to come in and say, hey, I am not happy doing what I am doing. I think I would be better at doing this and asking for a move into another field if they think there is something else they can do.

Mr. SENSENBRENNER. Now, we spend about $3 billion a year on the Space Station. We have two astronauts up in the Space Station now, which I think is probably the most expensive jobs program in the universe.

Ms. Johnson has complained about some changes. How about reducing the Space Station budget and perhaps reducing the billion and a half per job that we create up there?

Mr. BOLDEN. Congressman, I would disagree with you in your assessment that it is an expensive jobs program. The Space Station Program is not a jobs program at all. The Space Station Program is the most incredible technological achievement of this Nation and the world, and I would refer anybody to, not just to NASA's website but to the website of any of our other four international partners.

This document which shows——

Mr. SENSENBRENNER. What portion do they, the partners pay for——

Mr. BOLDEN. Every partner pays a proportional amount. Russia and the United States pay the lion share because only we know how to build spacecraft the way we do, but every partner is required to put in a certain amount, and we don't—there is no exchange of funds. Let me make sure everybody understands that.

We work with our partners on a barter arrangement. So we may get a spacecraft from them for an opportunity for one of their astronauts to fly, or we may get some other component from them for some service, but there is no exchange of funds.

Mr. SENSENBRENNER. Okay. I have one more series of questions relative to the James Webb Space Telescope.

Mr. BOLDEN. Yes, sir.

Mr. SENSENBRENNER. It currently has a cost overrun of 900 percent, and that is shameful, and that is shocking. What would happen if we said we weren't going to give you anymore money on this? You are going to have to do with what is on the baseline, and my second question and this is not facetious, is that telescope going

to be strong enough to see the bottom of the financial hole that we have dug for it?

Mr. BOLDEN. Congressman, I would say first of all, James Webb has the potential to expand our understanding of our universe many times more than the Hubble Space Telescope has done, and we never dreamed of what Hubble would do.

I don't think you can put a financial price tag or a value on the incredible achievements of the Hubble Space Telescope. If I were to go through the benefits in this document and try to put a dollar value on it and divide it by the number of people who have worked on the International Space Station Program in the 12 or so years we have been flying, I think you would be marveled at the small cost per person to do this. So I don't think we can attach financial value to this. It is unfortunate, because we are talking about life-saving drugs, we are talking about medical——

Mr. SENSENBRENNER. I know about all of that, but one thing I have experienced in the 30 years that I have been on this Committee is that NASA always seems to have cost overruns on everything, and with the James Webb Telescope it is 900 percent.

Mr. BOLDEN. Congressman, if I were to show you instruments or satellites such as Juno and GRAIL, who are—Juno is on its ways to——

Mr. SENSENBRENNER. You are dancing around the question about the Webb Telescope.

Mr. BOLDEN. Since I became the NASA Administrator, and I did not do this, by the way. This started in 2009, before I became the Administrator, NASA adopted a process called Joint Cost Level. We are looking at cost in schedule, and we are making sure that we can guarantee an 80 percent probability of success on missions. Juno, GRAIL, MAVEN, other projects that have been conducted in my time as the NASA Administrator have no cost overruns. In fact, some of them have under-run their cost estimate. All of them have been delivered on time. The James Webb Space Telescope in the last year and a half since we have brought out this re-plan to this Congress and got it approved, James Webb is on target. Every milestone it was supposed to reach except one has been reached on time. That one was deferred because we needed to do that for another reason not related to our ability to do it. Cost is on cost.

So I think we have adopted a new way of pricing that makes us much more attendant to cost and schedule, and I don't think you are going to see the overruns that we have historically had.

Mr. SENSENBRENNER. I thank the Chair.

Chairman HALL. The gentleman yields back.

I now recognize the gentleman from North Carolina, Mr. Miller, for five minutes.

Mr. MILLER. Thank you, Mr. Chairman.

Administrator Bolden, there are obvious ethical concerns with revolving door government. Some of this has to do with the appearance of impropriety and sometimes the conduct goes beyond the appearance of impropriety.

The ethical concerns behind the Procurement Integrity Act seemed pretty evident. That prohibits former federal officials who oversaw certain procurements from going to work for the contractor

that they gave those contracts to, from getting paid by the very folks that they had given business to.

And those apply to all procurements above a certain dollar value but apparently not to all kinds of contracts, including apparently the Space Act Agreements, and NASA is using Space Act Agreements extensively in the acquisition of commercial crew capabilities. There are hundreds of million of dollars involved, and it seems to be important to the integrity of the agency that Congress and the American people have the ethical expectations that the Procurement Integrity Act is designed to protect apply to the acquisition of commercial capabilities.

Is it correct that the post-employment restrictions of the Procurement Integrity Act do not apply to Space Act Agreements for those acquisitions, for those procurements, and if they don't, do you think Congress should make them apply?

Mr. BOLDEN. Congressman, I cannot answer that question, and I will get you an answer for the record.

Mr. MILLER. Okay. Well, you may have difficulty with the next question, too, because it is along the same general lines.

Your policy directive 1050.1(l), which deals with the use of Space Act Agreement, says that agreements may be used only when the agency's objective cannot be accomplished through the use of a procurement contract, grant, or cooperative agreement. NASA has decided, however, to use Space Act Agreements for the Commercial Crew Acquisition. That appears to be a reversal of the earlier decision to use contracts that did have the restrictions.

Can you explain that decision?

Mr. BOLDEN. Yes, sir.

Mr. MILLER. Okay, and is your rationale consistent with your policy directive limiting the use of those agreements?

Mr. BOLDEN. And Congressman, I won't ask you to read it for me again because I don't remember all that you said, but the simple explanation for the reason that I went from a—my plan, the acquisition strategy to enter into a contract to put out a request for proposal for Commercial Crew was the fact that the 2012 appropriation from the Congress was half of what we had explained to the Congress we would need to conduct a viable Commercial Crew Program.

The GAO and other oversight organizations came to the Congress and came to me and said we think you need to relook at your acquisition strategy, because we don't think you can do what you said you could do, and I agreed with them reluctantly.

And so in order to maintain competition, in order to give more companies an opportunity to participate in the production of a system, not an individual vehicle like we did through the Commercial Crew, the earlier program that we had, my decision was that we would prolong the period of time utilizing Space Act Agreements where we would continue to partner with industry and not go into contracts.

If I had had to enter into a contract, if I had had to submit a request for proposal in February as I had planned, at $406 million I would have had to select one contractor, and the cost, the subsequent cost on that contract would, I think, have been—I would not have been able to afford it.

And so that was the basis for my decision to extend the period of time that we were utilizing Space Act Agreements.

Mr. MILLER. Well——

Mr. BOLDEN. It may have been legal to do so, but it would not have made sense. It would not have made financial sense.

Mr. MILLER. The traditional Procurement Law requirements that the Space Act Agreements get around don't apply. I just talked about one of them, the Revolving Door concerns. What are the concerns, what are the provisions or safeguards that drive up cost and——

Mr. BOLDEN. Congressman, I just have to ask. I am confused because the implication is that we have selected a company that is violating the Revolving Door rule, and I don't know of any. So, if you are asking me to justify why we selected a company that has someone who was involved earlier in the decision to do Space Act Agreements, I would be glad to answer that question, but I don't know whether you are dealing in a hypothetical or whether you are alluding—what you are implying is that we have violated the law.

Mr. MILLER. You seem to have gone to view some of the restrictions that appear to have good sense behind them, that those are a problem, and they might drive up costs. I would like to know why they are a problem. Should they perhaps not apply to any contracts, or if there is, in fact, good sense behind them, why aren't they applying to these contracts?

Mr. BOLDEN. Sir, the problem with going with a contract at $406 million is that I would only have one company to be awarded a contract if they would be willing to accept a contract at that price. I don't think I could have gotten, I may have found one company.

The one thing I do not want to find, the situation I do not want to find myself in ever again or my successor is where there is only one alternative to taking humans to space without going to a foreign entity. I would like to have and my purpose in stretching this out is to hopefully have at least two American companies, not two alternatives, Russia and an American company, but two American companies who can provide transportation to low Earth orbit.

Mr. MILLER. It is—I understand my time has expired. You said you would get back to me on whether the Procurement Integrity Act Revolving Door Provision should apply. Please do.

Mr. BOLDEN. Yes, sir. I will.

Mr. MILLER. All right. Thank you.

Chairman HALL. The gentleman yields back.

The Chair recognizes the gentleman from Mississippi, Mr. Palazzo, for five minutes.

Mr. PALAZZO. Thank you, Mr. Chairman, and thank you, Mr. Administrator, for appearing here today.

My questions today are offered in the context of my continued frustration that NASA seems to be an agency without a clear mission. As we wrap up the Shuttle Program and send the orbiters to museums, we so, too, lose expertise and a skilled workforce to other opportunities. It just adds that some of those opportunities are outside of the aerospace industry.

Meanwhile, our access to the ISS is limited to the Russians, a reliable partner, but not without concerns after this last fall's launch mishaps. And I wondered what our European partners feel

about our future human programs when they see our schizophrenic nature in mission planning.

After 50 years of leadership in human spaceflight this heralded agency faces the question of what is next. It is my commitment as Chairman of the Space and Aeronautics Subcommittee that we come together to advance common, worthwhile goals and protect America's legacy of space leadership. Having said that I would like to ask you a few specific questions.

Mr. Administrator, I am extremely pleased with the critical role the Stennis Space Center has in support of SLS, COTS, and CCDev, but I want to make sure those investments are comparable to the investment and resources and infrastructure at the Kennedy Space Center.

Stennis's role is prior to flight, and there seems to be a disparity in investment. Can you speak to that?

Mr. BOLDEN. Congressman, Stennis is playing a critical role right now, and they are doing something that the Kennedy Space Center is not doing, and that is test firing on a routine basis. We have quite a bit of activity going on at Stennis, and that required us to make investments in upgrading the test stands, and I think we are doing that.

We have been able to attract not only interest from the traditional engine manufacturers but now some of the newcomers. So I think our investment in Stennis is doing exactly what we want to do and bringing benefit to the area in terms of testing that we are doing.

Mr. PALAZZO. Okay. So the concern is that the investment in Kennedy is not going to get so far ahead because there is some additional investment that needs to go into Stennis for the 21st century launch facility.

Mr. BOLDEN. Congressman, you heard me say once before while we were both together for the anniversary at Stennis, and I didn't make this up. I have heard it. All roads to space lead through Stennis, and that is a true statement, because we don't fly an engine that hasn't been tested at the Stennis Space Center.

So my development of test stands or my upgrade of test stands has to pace the development of the vehicles that we are planning to fly at Kennedy.

So 21st century launch facility, the exploration ground systems, we are trying to piece all of that such that we end up with a system, all of its integral parts coming together at the same time. I think you are very aware J–2X is something that while we won't need it for a number of years, we are trying to get some testing behind us on the J–2X. If I weren't worried about that, I would say, okay. Let us hold off for a few years before we test J–2X. I don't think that would be prudent because, you know, we probably would not be able to find any problems that we may have with it, and it would not be ready when we need it.

So I think the answer to your question is we are trying to pace the improvements, the construction, and the development at all of our centers such that everything keeps pace and comes together in the case of SLS MPCV in 2017, when we fly our first uncrewed launch.

Mr. PALAZZO. Parallel path.

Mr. BOLDEN. Yes, sir.

Mr. PALAZZO. Okay. Also I have seen in the news media reports that NASA is making investments in other agency rocket test stands at the expense of the agency's primary rocket test facility at Stennis. Are you approving those investments at other centers?

Mr. BOLDEN. Congressman, I am not aware of an investment that we are making in another agency test stand. I will take that for the record.

Mr. PALAZZO. Plum Brook, $150 million investment.

Mr. BOLDEN. Oh, that is, but that is our test facility, and that investment is one of long standing. This is not a new budget item or a new investment. It has been ongoing, and we are just trying to make sure that Plum Brook is ready when it is time to take, whether it is Orion or any other vehicle there, that it will be ready to test.

Mr. PALAZZO. So you don't think that is a duplication of test facilities?

Mr. BOLDEN. No. They are totally different. Plum Brook and Stennis, Plum Brook is a vacuum, it is a chamber that we can simulate conditions in space for a vehicle itself, whereas Stennis, as you know, is a facility where we simulate the operating conditions of an engine.

So totally different.

Mr. PALAZZO. Mr. Administrator, I appreciate it. My time has expired. I yield back.

Chairman HALL. The Chair recognizes the gentlelady from Maryland, Ms. Edwards, for five minutes.

Ms. EDWARDS. Thank you, Mr. Chairman and Ranking Member Johnson and General Bolden, I appreciate your being here as well for your leadership.

I know that today we are focused on the long-term goals and flight missions beyond earth and NASA's activities to develop the capabilities of the program, and I do want to highlight and appreciate the breath of life that has been breathed into the work at Goddard Spaceflight Center on Earth Science missions and the continued work at—with the James Webb Space Telescope. And unlike some of my colleagues, I really do see a value in James Webb as does my friend over in the Senate who breathed life into the James Webb Space Telescope in the appropriations process when some on the other side frankly wanted to zero it out entirely.

But I do have some concerns about Goddard's budget and the reduction of $180 million this year, and it is not specifically about Goddard, but it goes to the question of the priorities for the agency and your overall vision and strategies.

I am concerned when I look at the budget and it proposes increased funding for ground support systems without a completed design for a commercial vehicle. It bucks the recommendations of a decadal survey by ending the ESA, the European Space Agency partnership for planned Mars missions in 2016 and 2018, and it doesn't follow through on the authorization that was passed in 2010.

This creates an atmosphere, I think, of great uncertainty by, certainly by members of this committee about our ability to maintain U.S. leadership in a number of the areas that we have pioneered.

And so to that point, I look at every program in your budget and it seems to take a hit except for the commercial crew, and in that one request it is $829 million, more than double what has been appropriated for fiscal year 2012, two-thirds more than what is authorized for 2013. And according to your staff if NASA is not appropriated at the requested level and instead receives something close to last year, it will slip the operational date for commercial services to 2018.

I wonder if you can tell me how we can expect support on this Committee for a 104 percent increase when you have yet to provide us, despite being asked numerous times, frankly, General, a credible cost and schedule estimate that justifies an annual funding stream lending to the operational date that you indicated.

And I wonder if you also could tell us why you don't have plans any longer to have an independent cost assessment and schedule estimate done despite assurances that you made last fall that one would be done, and if that is true, I wonder why you are abandoning it.

And then lastly, going to the acquisition strategy, I wonder—since you permit NASA's safety requirements that you have considered to be risky by your own staff—how you can project with any confidence that our astronauts will be able to fly safely on a commercial spacecraft to the International Space Station by 2017.

I know that is a lot to take in, but it does raise some concerns with me anyway about projecting goals and costs for something that we haven't even proven yet, and if that is true, why do we need to spend that money for 2013? It seems to me we need to get something that is more of a sure shot from you before we authorize spending levels when we are cutting in other critical parts of the agency and the agency's mission.

Thank you.

Mr. BOLDEN. Congresswoman, when we made the initial assessment of what would be required for a Commercial Crew Program, we did a number of things. We went to industry and asked them themselves, which I understand is sending the fox to the henhouse, some say, but we did get independent assessments of whether or not that was reasonable, and the estimate that we originally brought in for $850 million was something that was supported by people that said if you want to have a commercial crew capability by 2016, then you need $850 million, and I think——

Ms. EDWARDS. Did you say you got that independently from the industry? I am so confused.

Mr. BOLDEN. Oh, no, no, no, no, no. No, ma'am. I said we got estimates from industry. I think, you know, the Augustine Committee got the original estimates from industry, the Aerospace Corporation took a look, and I would get back to you on what other entities we had look, but $850 million was the estimate that we had for bringing in a viable commercial crew capability by 2016. When we testified last year, not just me but Bill Gerstenmaier and others, we said if we are allocated less than $850 million, it will cause the program to move to the right. We didn't know how much, but we estimated that if we went down to—I think the number at the time was if we go down to $500 million, which we called the

floor, then that is going to push the program out to no earlier than 2017.

So that is where we are today. We are at 2017. The reason we are asking for the $829 million is because we do not want to see it go to the right anymore. The gap between now and 2017 is excessive. A gap that increases would be unacceptable, and that is the reason we came back and asked for a restoration of funds for the Commercial Crew Program.

Ms. EDWARDS. Well, thank you, Mr. Chairman, and I know my time has expired.

I have to tell you, General Bolden, I don't know how you can really legitimately make those estimates when it doesn't seem to me that there is a real plan yet, and so I hope we are not going to be coming back to this Committee another year from now and saying, you know what? It is not $829 million because we had some other things that we have to consider, and we have something more real that is a deliverable from the industry. I think that is very problematic.

Thank you, and I yield back.

Mr. BOLDEN. Congresswoman, I will take the action to get with you and your staff to make sure that I understand what you mean when you are asking for a plan and the cost for that plan, because I think we have that, and I think we know where we are going, and I think we know how much it is going to cost.

So I will take the action, I will take it to get back with you on that.

Chairman HALL. The gentlelady yields back.

Recognize Ms. Adams, lady from Florida, for five minutes.

Mrs. ADAMS. Thank you, Mr. Chair.

I see that NASA has requested $41.1 million in the 21 CLC Line and Space Operations. There seems to be some confusion about how much money is being directed to the ground ops overall.

Can you explain how much money is being spent on—out of the space exploration, space operations, and CECR lines for ground ops and modernization projects?

Mr. BOLDEN. There is about——

Mrs. ADAMS. If you have specific dollar amounts that would be great.

Mr. BOLDEN. I will get you the exact number, but I think it is about $504 million for ground operations, but in order to try to be clear to the Congress and make it easier, we call ground operations 21st Century Launch Complex, and that is mostly for commercial crew and other assets, and then we have what we call Exploration Ground Systems that is for SLS.

So the bulk of that money goes to Exploration Ground Systems, $47 million of it is for 21st Century, which is for modernization and upkeep that makes—modernization, not upkeep, for modernization and transformation that makes Kennedy a flexible facility for use of commercial and SLS.

So that piece is confusing because it does serve SLS and other users. Exploration Ground Systems is strictly SLS, and that is where the bulk of it is.

Mrs. ADAMS. So I look forward to getting those exact numbers from you.

My understanding is also that Orbital Sciences is ready to launch, but their pad in Virginia is not ready for them. Is this true, or are there other problems that you would like to share with us?

Mr. BOLDEN. All I can tell you, Congresswoman, is what the contractor tells us. We do know that the lack of a launch pad is one problem right now for Orbital. I am not able to say that they could launch today if they had a launch pad. So I would——

Mrs. ADAMS. Well, is Kennedy Space Center in danger of similar issues, or does NASA have the resources needed to be prepared to launch when the time comes?

Mr. BOLDEN. The reason that we want to spend money now on ground systems as I have explained to some of your counterparts who are more concerned about the vehicle, is as I told Congressman Palazzo, we are trying to work everything on a parallel pass so that we all get to the same date——

Mrs. ADAMS. So the question is——

Mr. BOLDEN [continuing]. At the same time. No, ma'am. We are not going to run into the problem——

Mrs. ADAMS. Okay.

Mr. BOLDEN [continuing]. At Kennedy that we are facing at Wallops. But that——

Mrs. ADAMS. Thank you.

Mr. BOLDEN [continuing]. And for different reasons, though, and I can go into that with you later but totally different operation.

Mrs. ADAMS. I have a couple more questions, and I don't want to get filibustered because I want some answers.

Mr. BOLDEN. Yes, ma'am.

Mrs. ADAMS. The price tab for James Webb is now up to 8.8 billion with a B. Essentially NASA is cannibalizing everything in science except climate change research and earth science, which was untouched to pay for the James Webb. The James Webb Telescope is supposedly an international partnership.

Can you tell me how much funding of our international partners has been contributed to this project given our $8.8 billion investment, not including the launcher, which NASA gave away to a foreign country?

Mr. BOLDEN. Congresswoman, first of all, I would disagree that we have cannibalized the Science Program for James Webb. That is not accurate nor true, and the other thing is that the international partners, as I mentioned with the International Space Station, contributes in-kind——

Mrs. ADAMS. How much?

Mr. BOLDEN. They don't give dollars. They give instruments, the launch vehicle is an Orion Spacecraft, which if you compared that to the price of an Atlas, it is $450 to $550 million. So it is a contribution in kind.

Mrs. ADAMS. It is in kind, but you will agree that the climate change research part has not been changed?

Mr. BOLDEN. Congresswoman, I would say that we have not funded climate change, Earth science to the level that it should be funded for what we need to do to respond to the Nation's needs.

Mrs. ADAMS. General, I know you have not yet responded to the March 5 letter from our colleague, Appropriations Subcommittee Committee Chairman Frank Wolf, about discussions among the

International Space Station partners to include China in the program.

However, I would like you to respond to the concerns raised by Lieutenant General Ron Burgess, Director of Defense Intelligence Agency, about how China's space warfare activity is carried out under the guise of China's civil space program.

Have you been briefed by the DIA or CIA on China's espionage activities to gain American space technology, especially through cyber hacking? Are you concerned about China's collection efforts against NASA engineers, scientists, and your contractors?

Mr. BOLDEN. Congresswoman, first of all, I will just correct for the record, Congressman Wolf and I had a long conversation yesterday. I told him I did not want to send him a letter when I could talk to him and explain what happened at the heads of agency meeting. So that meeting has been had, and he considered that adequate response to his letter.

I am continually informed by members of the intelligence community, I get briefs all the time, I go and read what is called a Read Book for me that contains classified information about all of our partners and non-partners and their intelligence activities. So I am aware of what is going on.

Mrs. ADAMS. Are you concerned?

Mr. BOLDEN. Anyone who is not concerned about what is going on with our partners and our non-partners would be foolish. Everyone wants our technology, so we need to be——

Mrs. ADAMS. Was that a yes?

Mr. BOLDEN. I am concerned.

Chairman HALL. The gentlelady yields back her time.

Recognize Mrs. Fudge, the lady from Ohio, for five minutes.

Ms. FUDGE. Thank you, Mr. Chairman and Ranking Member Johnson.

Good afternoon, Administrator Bolden.

Mr. BOLDEN. Good afternoon, ma'am.

Ms. FUDGE. I was pleased to see that Glenn Research Center is well positioned in your request for conducting cutting-edge space technology work in fiscal year 2013. With the planned engagement of almost 140 FTEs and with the center distribution of over $120 million requested in fiscal year 2013, I am certainly confident that Glenn will answer the call.

In particular, I note that Glenn will be leading one of the big nine space technology projects, specifically cryogenic propellant storage and transfer. Stepping back a bit, I would like to give you the opportunity to explain to Members why it is so important to make investments in space technology and what NASA will benefit by doing so.

Mr. BOLDEN. Congresswoman, this is a joke. I could—no, no, no. I am going to make a joke referring to Congressman Rohrabacher. Your question is incredibly timely. I was going to ask Congressman Rohrabacher if he would like to provide the response because we spent about an hour and a half together yesterday, my explaining to him our efforts in cryogenic propellant storage, the importance of doing that as a technology pursuit, the fact that it is the number one priority of my Technology Program, my Space Technology Program.

While it is not vital for us presently, we have to be developing that capability to support the heavy-lift launch vehicle when it comes available. We will need that capability if commercial companies want to, if they want to pursue ventures beyond low Earth orbit someday, as they may, we need to have the capability to put propellant depots in space, and we can't do that today. We don't have the capability because we lack—we need big thermos bottles.

Let me put it simply. We don't know how to do that. So that is what the program you are talking about and that is the work that Glenn will do. Simply.

Ms. FUDGE. Thank you. Now, I am concerned about the five percent cut to funding institutional needs in support of NASA centers and headquarters. It seems that this account had taken more than its fair share of cuts over the past two years.

What impact will this latest proposed cut have on the centers' abilities to address increasing needs and requirements and on the civil servant staff's ability to meet challenging expectations?

Mr. BOLDEN. Congresswoman, these are very difficult fiscal times. I know you know that as well as anyone. We are really trying to tighten our belt. You will hear people complain about cuts in travel. Every time you take money away from a center, it impacts, but we are trying to make sure that they are smart reductions.

So we are looking at reductions in paper usage, in pencils, in travel, and we are trying to make sure that we don't get any muscle, you know, as we do the reductions that are required, trying to live within our means with the budget that we have.

Ms. FUDGE. Okay. Lastly, certainly I was disheartened to see that the President's request for education—and this may have happened earlier and I was late, forgive me——

Mr. BOLDEN. That is fine.

Ms. FUDGE [continuing]. If I am being repetitive. But I was disheartened to see that the President's request for education at NASA reflected a $36 million decrease. Last week my office met with the Ohio Space Grant Consortium, and we heard about how NASA's education dollars are impacting the lives of students and encouraging them to pursue careers in STEM fields.

It seems to me that the Space Grant and other education programs at NASA are unique in their ability to inspire our Nation's youth. Can you explain the justification behind the reductions to these programs?

Mr. BOLDEN. Yes, ma'am. We had to establish priorities, and we had to decide where we were going to take reductions, and we did it essentially across the board. But what we have done with education, as with a number of other programs, is we have looked at new ways of doing what we did.

As I mentioned earlier, I think if you would ask the Space Grants if they have increased their reliance upon social media, that they get help from us in doing, they may not be able to reach the numbers of communities or the numbers of schools that they did before, but my guess is they are reaching more students because they are doing it by a different means now.

So we have taken an education design team to try to tailor our education efforts. We are putting control, not control, we are put-

ting oversight of our expenditures on education from the centers and the programs that have their own independent education and outreach funds. We are trying to synergize it such that we spend that money more wisely, and we don't have different centers doing different things that when you look at them in total everybody is doing the same thing but spending it from a different pot of money.

So we are trying to be smarter in the way that we reach students, and I think, as I mentioned earlier, when we look at a program such as the Summer of Innovation, which is going into its third and final year of the pilot, we will find that the metrics that we establish verify that we have, in fact, had a greater impact on reaching middle school students, although we didn't do it the way we have traditionally done it.

The Space Grants were not involved in the types of programs that we are doing in the Summer of Innovation, and now in many states they are the implementing organization. It was hard for them. They don't like doing that because they love being at the college and graduate level, but we told them you got to go down and work with middle school kids, and they are doing that, and we are reaching students and teachers.

Ms. FUDGE. Thank you, Mr. Chairman. I yield back.

Chairman HALL. I thank you.

The Chair recognizes the gentleman from Texas, Mr. Smith, for five minutes.

Mr. SMITH. Thank you, Mr. Chairman.

General Bolden, I think you responded to most of my questions already either when I was out of the room or in the room, one way or the other. I just want to run over a couple real quickly, and then I have a couple of new ones as well.

I understand that the James Webb Space Telescope is on schedule both in regard to resources and timing, and that is fully supported by the Administration. Is that——

Mr. BOLDEN. That is correct, sir.

Mr. SMITH. Okay. There is no possibility it will be before 2018, would it?

Mr. BOLDEN. Congressman——

Mr. SMITH. It is one of the most important things we could possibly do, but maybe there is no way to speed it up. I don't know.

Mr. BOLDEN. That is one that an infusion of funds now would help, but if we wait years and say we will increase the funding, it won't make a difference.

Mr. SMITH. I understand. Also, I understand that you feel ASAP's concerns have been addressed as well?

Mr. BOLDEN. I do.

Mr. SMITH. Okay. On the Space Launch System, does the Administration fully support it? There has been a slow down in the past, and that led some of us to wonder about the seriousness of purpose.

Mr. BOLDEN. Congressman Smith, the Administration fully supports the Space Launch System and Orion and as a demonstration of that support we have, as I mentioned earlier, we are test firing the J–2X, which is an upper-stage engine. We have moved all of the Shuttle main engines over to Stennis for further testing and

modification. We are actually doing hardware things now that we were not doing this time last year.

Mr. SMITH. Okay, and response to Congresswoman Adams' questions a few minutes ago, I assume that China is not being considered as a partner with the International Space Station?

Mr. BOLDEN. China is not, not by the United States, and as I explained when asked that at the heads of agency meeting, I am complying with the law and that I am not allowed to do any bilateral activities with China.

Mr. SMITH. Okay.

Mr. BOLDEN. And we are not.

Mr. SMITH. I mean, their space program is a little, is a thinly-veiled cover for, I think, other purposes, and I think we are aware of that, too.

Another question is this. NASA, as NASA begins to plan for the first in a series of deep space missions, what studies are underway to better determine the impact on the health of the astronauts themselves? International Space Station astronauts have had trouble with their vision. There have been other problems as well. What kind of studies are being conducted that will anticipate or try to address those kinds of health——

Mr. BOLDEN. Congressman, we have an ongoing human research program that looks at astronaut health, and it has helped us to improve the condition of astronauts as they spend six months on the International Space Station. We have continually tried to get funding, unsuccessfully, for a long-term health program for astronauts after they leave the program because what we are finding now is that there are long-term affects of spaceflight that we will only find out about if we have access to the medical records. When someone leaves the astronaut office, participation in the longitudinal study program as I do is voluntary, and most people don't do it because they have got to go pay for, you know, for the doctor's visit or medical treatment.

If we had a program whereby I had lifetime access to an astronaut, their health, and their medical records, it would benefit people, future spaceflight.

Mr. SMITH. Is anything being done to specifically address the——

Mr. BOLDEN. Vision problem?

Mr. SMITH. Yeah. Vision problem with the astronauts.

Mr. BOLDEN. We have, what you are talking about increased inter-cranial pressure that causes flattening of parts of the eye. We don't fully understand it.

Mr. SMITH. Nothing can be done to prevent it that you are aware of?

Mr. BOLDEN. We don't know. It is a question yet to be answered. We hope so.

Mr. SMITH. Okay. Last question. The Atlas V has proved itself 100 percent success rate and so forth. The real issue for the commercial crew is the lack of a capsule or a crew vehicle to put on top of the rocket. Why wouldn't we just save ourselves a lot of time, perhaps a lot of money, decide on the Atlas V, and then we can go forward and focus on developing the crew vehicles?

Mr. BOLDEN. Congressman, what we are doing is we are buying a service that requires a complete integrated system, and I think

what you have seen is that a number of the potential bidders have chosen the Atlas V, and they are working, and we have funded to a certain extent as a partner ULA, the company that provides the Atlas V, to find ways to human rate that launch vehicle. But the launch vehicle itself is just a piece of the puzzle. We need a launch vehicle and crew capsule, and then when you talk about deep space exploration, you need a service module and other things.

So they all come together.

Mr. SMITH. That is my point. We ought to be focusing on those latter developments rather than spending so much time trying to figure out what is the best vehicle to use. Why not use the Atlas V, just make that decision right now?

Mr. BOLDEN. Because every person that produced a module doesn't want to use an Atlas V.

Mr. SMITH. Okay. Well, that is up to you all to——

Mr. BOLDEN. No. That is actually up to the contractor, to the private industry. What we asked them to do was bring us the best system, In response to a question earlier, we are trying to give industry a reasonable amount of time, not forever——

Mr. SMITH. Okay.

Mr. BOLDEN [continuing]. But a reasonable amount of time to put their plans together and do testing that we can observe and make sure that they are going to meet the standards, the safety requirements——

Mr. SMITH. Right.

Mr. BOLDEN [continuing]. And the human rating standards that we have set forth, and they know what they are. It is—we are past where they didn't know what they were.

Mr. SMITH. Okay.

Mr. BOLDEN. They know.

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

Chairman HALL. The gentleman yields back.

Recognize the gentleman from Illinois, Mr. Lipinski, for five minutes.

Mr. LIPINSKI. Thank you, Mr. Chairman.

Mr. Bolden, I just wanted to begin by saying I was pleased to see that in the year that we have been forced to make tough funding decisions, your fiscal year 2013 budget request for aeronautics R&D Programs prioritizes safety and NextGen, which I think are critically important. Despite some concerns that I have about cuts to fundamental research, this budget does try to remain true to NASA's aeronautics mission, and I know that oftentimes that "A" is forgotten in—the first "A" in NASA is Aeronautics, with all the focus on space, but I hope—I am happy to see what is in this budget generally for aeronautics and want to—hope that you continue that focus and that Congress will also continue to fund that.

Now, I want to move now to your plans regarding the Commercial Crew Integrated Capability, and what is going on with that. There were a few questions about that earlier about the safety issues and how you are dealing with that. And as you said, once a design is selected, it will be held to NASA's safety requirements.

What I am concerned about is what are the contingency plans you have if none of the designs that result from the CCiCap meet

these requirements. Are you going to be—as the plans evolve, is NASA going to be doing any review of the design plans to ensure that this does not happen? You know, getting to the point where we are expecting, we have put the funding into these. We have been expecting that these are going to come through, and then the design doesn't meet the safety requirements.

So what is NASA doing to prevent that from happening, getting stuck in that spot?

Mr. BOLDEN. Congressman, what we have done is we have made available to anyone who is interested in even considering potential bidding on a commercial crew system, we have provided them with the vehicle design requirements for a commercial crew vehicle. They have that in hand. We have also provided them with human rating standards, and so that there is no question about whether they are reasonable or not, industry helped us to develop those requirements and standards, and in some cases they had standards that were even more stringent than ours. When that was the case, then we said, okay, you can use the NASA standard or you can stick with your own company standards. So it is NASA's standard or better.

And they know what that is, and our thought is that they will design to those standards and those requirements as they go through this 14 to 20-month interim period before we release a request for proposal.

Mr. LIPINSKI. So then because that is out there, you expect that the plans will meet the standards so that when you get to the end, they will have that.

Mr. BOLDEN. Congressman, hope is not a plan, which is what you are implying, and I am not, my plan is not hope. We have put what we call a PIT team. It is called a Partner Integration Team, and every viable vendor that we think stands a reasonable chance of submitting a proposal for commercial crew, if they request it, we provide to them at their cost a PIT team that comes from the Johnson Space Center, Marshall, anywhere they ask, that acts as, not as consultants but just to observe what they are doing, and it is a team that they can say, you know, would NASA do it this way.

And the results that we are seeing from the PIT teams, both the reports that I get from Ed Mango and his commercial crew program people, but most especially the comments that I get from CEOs of companies that say, you know, this is good, it is great having NASA team in my facility looking at my work and at least telling me that I am headed in the right direction. They won't tell me everything I want to know, but they are telling me I am headed in the right direction.

So that has given us an increased level of confidence that we are going to get a good product.

Mr. LIPINSKI. All right. With my 20 seconds left I know earlier on, Mr. Sensenbrenner raised questions about the Space Station. You had that, you showed the book that you have about the benefits of the Space Station. So before I go and look at the book, what would you tell me is the greatest benefit that we are receiving from the Space Station?

Mr. BOLDEN. The one greatest benefit?

Mr. LIPINSKI. If you want to go on, it is up to the Chairman how long you can go.

Mr. BOLDEN. No, no, no. No, sir. I would say—I will give you, and I will use the name Don Pettit. One of the greatest benefits from the International Space Station is it allows a guy like Don Pettit, who is in orbit right now, to talk to kids every day. Don Pettit is a modern Mr. Wizard, and he mesmerizes kids when he talks to them, and some of you have had an opportunity to be in on video teleconferences into classrooms.

That one reason alone makes Space Station worth it.

Mr. LIPINSKI. Thank you. I yield back.

Chairman HALL. The Chairman recognizes the gentleman from Texas, Mr. McCaul, for five minutes.

Mr. MCCAUL. Thank you, Mr. Chairman.

Mr. Bolden, welcome, and thank you for your service to our country, and I agree with you. The kids. There is nothing better than taking an astronaut through the schools and watching them, their faces light up, and it piques their interest, and math and science, as you know, is so important. And so thank you and your astronauts for what they do.

I have just a couple of questions on a timeline for things and how this is going to go forward under the proposed budget for the SLS and Orion.

Your budget appears to be lower than what was appropriated for the program and well below the authorized amount, yet the timeline does not change. And so my question is do you really see that as a realistic expectation, and if so, where do the efficiencies come from that allow you to do that?

Mr. BOLDEN. Well, we have gone to school on the Constellation Program for one thing. So we had a great lessons learned session among the people who are now with SLS and MPCV, with the folk in the Constellation Program as they phased out. Many of them are now SLS, MPCV persons.

We don't know for certain the dates we have given, the 2017 date for an un-crewed test is pretty hard because that is dependent on design and manufacturing. It is pretty much set in place. The 2021, crewed mission date could change. Bill Gerstenmaier and his folk are telling me we have a number of reviews. We have performance, cost schedule reviews that are still to be done in this coming year that will allow us to make a better assessment and give us a better estimate of when the first crewed mission can be flown.

But 2021, is a conservative date right now.

Mr. MCCAUL. For the first crew mission?

Mr. BOLDEN. For the first crewed mission.

Mr. MCCAUL. And then 2017 would be the first——

Mr. BOLDEN. 2017 is the first uncrewed test of the integrated vehicle. What hopefully you all are excited about is 2014, two years from now, we are going to fly Orion. It is a Lockheed Martin run test at our request, but they have chosen a Delta IV to put Orion on and send it into two highly-elliptical orbits that will allow it to make a reentry as it would be doing if it were coming back from the moon or an asteroid, and our plan is for it to have a successful intact reentry and recovery. It will buy down significant risks from the Orion vehicle that we won't later have to do.

Mr. MCCAUL. And so then prior to 2021, in terms of human spaceflight, we will have to rely essentially on the Russians and the Chinese. Is that correct?

Mr. BOLDEN. No, sir.

Mr. MCCAUL. Okay.

Mr. BOLDEN. If we are able to continue the progress that we are making right now with the Commercial Crew Program, and Congress does agree to fund at the level that the President has asked for this year, we will be no later than 2017, in having an American capability to take astronauts to the International Space Station and other low-earth orbit destinations.

There is a possibility that if we are funded at the level requested that that could be accelerated, but that, again, the 2017 time is an estimate based on, you know, our—what we saw in working with——

Mr. MCCAUL. Then it would be fair to say that prior to 2017, we will have to rely on the Chinese and the Russians.

Mr. BOLDEN. I wish I could say differently but——

Mr. MCCAUL. Yes.

Mr. BOLDEN [continuing]. We will rely on——

Mr. MCCAUL. I wish you could, too.

Mr. BOLDEN. Yes.

Mr. MCCAUL. Is the plan to go back to the Moon or just orbit the Moon and then try to hop on an asteroid? I mean, what is the vision here?

Mr. BOLDEN. Congressman, the plan right now is the first destination for humans is an asteroid in 2025. The ultimate destinations for humans is the Martian environment, whether that is landing on a moon of Mars or landing on the Martian surface is the mid '20, '30s, but as the President even says himself, you got to walk, crawl before you can get there, and so the asteroid is an intermediate step in getting to Mars.

It is possible that we could put some rovers that are presently being developed and tested at the Johnson Space Center, we could put them on the moon and run tests with them, but—what we do between now and the first crewed mission in 2021, 2025, is still in work.

Mr. MCCAUL. Well, that would be very interesting to watch.

Last, I got 30 seconds, I know that you are going to have multiple companies participating in this commercial spaceflights, but only one at the end of the day is going to be picked. Is that correct?

Mr. BOLDEN. Congressman, I hate to use the term hope. My plan is that we will have a minimum of two American companies that are capable of providing transportation to low-earth orbit, to the International Space Station because that gives us reliable, redundant, routine access to space from an American capability.

Mr. MCCAUL. And what would be the time frame on that?

Mr. BOLDEN. 2017 right now, and that, again, we need to be certain that we understand that the 2017 date is forecast or based on fully funding the President's request for commercial crew, which to some may seem like an increase, but it is actually saying we really meant $850 million is what we need to get us to 2016, 2017.

And I think I said it but somebody has told me I should make sure every member of the committee understands we are only de-

pendent on the Russians for transport to the International Space Station. We have no bilateral activities with China in case I was——

Mr. MCCAUL. No. That is a good point.

Mr. BOLDEN [continuing]. I confused someone.

Mr. MCCAUL. I see my time has expired. Thank you so much, Mr. Bolden.

Chairman HALL. Charlie, I am going to hold you to that 2030 date. I will be 106.

Mr. BOLDEN. Mr. Chairman, and I told you, don't give up. My wife and I lived in Japan for two years, and we actually talked with some young ladies who were 120.

Chairman HALL. Young ladies?

Mr. BOLDEN. Ladies. I am just—yes, sir. There is hope.

Chairman HALL. Okay. Thank you.

The Chair recognizes the fine gentleman from California, very patient, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman, and I want to thank General Bolden for the fine briefing that I had yesterday and for the record, Mr. Chairman, I want to make sure that I, again, mention and Representative Fudge helped me bring up the issue of cryogenic propellant storage and transfer as a, really vital technology, and I was very satisfied with our conversation and discussion yesterday as to the importance of that technology and recognition of that.

Let me just mention before I get into some of the transportation issues and Space Station as such, there was an article I saw in the news, and I get my news on the Internet now, you know, and what is the headline news, and asteroid headed toward the world. Okay, and that is what it said. So I went, my gosh. An asteroid is headed towards the world, and it was the same asteroid that we have known about, and they just declared that as it swings around the second time, again, people realized and have stated for the record that we don't know what earth's gravity is going to do to the actual course of that asteroid.

Now, in your NASA budget we do have continued money for detection of objects that could hit the earth, and that is an important thing that I have been trying to talk about for a long time, and I am glad that is still recognized, but there is still, and Mr. Chairman, I would suggest that this is a very important point, and that is we still do not have a plan in place that if that asteroid is, indeed, if shown that its course is altered and it is going to hit the world and cause billions of dollars of damage and maybe millions of lives lost, we still do not have in place a plan of how to deflect one of these.

And I think that it behooves us that maybe we should pay attention and just, yes, it might not happen for 100 years or 1,000 years or it could happen tomorrow. So I would hope that we pay a little attention to that, and at least we have kept in a shrinking budget the money for detection of these. At least we can tell our people they can pray. What do we do about this asteroid about ready to destroy our civilization. Well, we can pray about it.

But now onto some other things. I also in order to maintain our leadership I would hope that we maintain a good relationship,

whether it is on the issue I just described or on other NASA missions, whether it is deep solar missions, exploratory missions or whatever, we are going to have to work with our allies and partners, and yet we are now withdrawing from the Joint Mars Programs and several other international partnerships with the European Space Agency.

What is that going to do? The 2016 Mars Orbiter and the 2018 Mars Rover Programs. We backed out of those. What is this going to do to our ability to be reliable partners, and partnership is so important for success as we have a shrinking budget.

Mr. BOLDEN. Congressman, our international partnerships and international collaboration are key, and they have been stressed by the President since he came in office. It is a part of our international space, our National Space Policy, and we have not stepped away from our European friends. I have asked John Grunsfeld, the head of my Science Mission Directorate, to put together a team to look at how we restructure the Robotic Mars Exploration Program so that we can accomplish the objectives that were set out——

Mr. ROHRABACHER. Uh-huh.

Mr. BOLDEN [continuing]. By our joint European American discussions on ExoMars that fill the priorities for the decadal survey, the planetary decadal survey, but also support our efforts toward human exploration of Mars.

So that is in the works. He has now assigned Orlando Figueroa, a formal NASA employee, some refer to him as a Mars czar, to take the leadership in formulating a strategy that we hope to bring to the Appropriations Committees and to this committee in time for appropriations work.

Mr. ROHRABACHER. Well, as you are fully aware, General, I am very concerned that we have committed ourselves to this new mega rocket transportation system which may, I think, siphon money away from other projects that are vital, and maintaining our reliability with our European partners is vital to the success of our future missions. And if we end up in order to build this big rocket that may or may not succeed ten years down the road, if we end up putting ourselves in jeopardy with these other type of things, whether we are talking about cooperation or other type of projects that we need to do, then we haven't really done a good service for our whole space effort.

But I rely on your judgment. As we have all said, we are grateful for your service to the country.

Mr. BOLDEN. Thank you, Congressman.

Mr. ROHRABACHER. Thank you, General.

Mr. BOLDEN. Thank you.

Chairman HALL. The Chair recognizes the gentleman from Illinois, Mr. Costello, for five minutes.

Mr. COSTELLO. Mr. Chairman, thank you, Mr. Chairman and Administrator Bolden. I had hoped to be here earlier but got tied up. I got a couple of brief questions.

One, I would like to refer to a statement that was recently made by the ASAP Panel. They made the following statement, and it is minutes from a recent meeting, and I quote. "What is the purpose of the Commercial Space Program? Is it to transport humans to the

ISS? Is it to nurture a commercial space industry? Or is it something in between?"

The ASAP believes there is now a sea change in the objective to be one of supporting industry's capability to deliver national economic benefit. If we are going to ask the U.S. taxpayers to invest in this program, I think that it is necessary that we are absolutely clear on what the objective is of the Administration.

One, I would ask you do you agree with the statement made by the ASAP?

Mr. BOLDEN. I do.

Mr. COSTELLO. And, two, what—can you explain the primary objective of the Administration?

Mr. BOLDEN. Joe Dyer and the members of the ASAP and I have had this discussion particularly with my senior leadership. The objective of the Commercial Crew Program originally was to service the International Space Station, and that is still a primary objective for us.

When we were funded at the level of $406 million in the fiscal year 2012 budget, it caused us to slip the expected delivery date of a commercial capability to we think, we hope that we can be no later than 2017. But what it did was it put us in a posture that we are not guaranteed programmatically that we can have a commercial capability in time to support the International Space Station. So it means that by default the Congress and the Administration have agreed that we are going to develop a commercial capability for the benefit of the American economy, and it will serve other purposes, but it may not make it in time to serve the International Space Station.

And that is why I keep emphasizing the critical importance of fully funding the President's request for Commercial Crew because we do not, I cannot afford to have the gap increase from now until 2017, even farther out. It is a programmatic risk that we have incurred by going to this strategy that we are on now, not a safety risk.

So I do want to make sure that everybody understands that. There is no safety risk, no increase in our risk to safety to the crews by going with a changed strategy. The risk is in programmatics. Until I can get someone under contract and hold their feet to the fire as we have had this discussion all day, I can't guarantee a date of delivery. I can never guarantee a date, but I sure can get closer when we enter into a contract, and that is where I want to get.

Mr. COSTELLO. Let me ask you about NASA's involvement in the Next Generation of the Air Traffic Control System. As you know, I chaired the Aviation Subcommittee, and I am the Ranking Member there now.

How effective in your opinion has NASA been in working with the FAA to move NextGen further to implementation?

Mr. BOLDEN. I am proud to say we have been incredibly effective. If you ask the industry, specifically Continental Airlines, United Airlines, Southwest Airlines, who have flown in tests particularly in the en route transportation changes that are coming with NextGen, they will tell you they see results already that have re-

sulted in millions of dollars of savings in fuel costs just by implementing some of the systems that we have developed.

Being able to do direct descent, direct ascent to a cruise altitude has changed dramatically the cost of fuel for the airline industry.

Mr. COSTELLO. And when you say that "we" have developed, are you talking about NASA?

Mr. BOLDEN. We are in collaboration with the FAA. Most of the work on the NASA part in the en route, the traffic management portion that you are addressing——

Mr. COSTELLO. Right.

Mr. BOLDEN [continuing]. Is done at Ames and the Langley Research Centers. That is our primary focus, and that is what we are bringing to the team. It is a DOD, FAA, NASA team trying to do this, and so we have delivered as best we can with the funding we have our parts of the traffic management portion.

Mr. COSTELLO. Last question. The proposed budget before us, in your opinion what will NASA look like with the proposed budget today in the year 2020?

Mr. BOLDEN. Oh, NASA in the year 2020, we talk about this a lot, with the budget that we have today, if we are able to demonstrate that we can accomplish the plans that we have presented, you, Members of the Congress, will have much more confidence in us, and you are going to increase my budget by the time we get to 2020, and I think you will see increased spending in aeronautics research, you are going to see totally different types of airplanes being designed because we will have a large-scale test bed for commercial and cargo transportation. You won't hear NASA talking about commercial crew because that will have been turned over to the private enterprises, and that will not be in my budget. It will be a line item for purchase of crew service for transportation. I won't be developing it. It will be industry's.

You will see us wanting more money so that we can go to places farther away than Mars because we are confident that we are going to make it to an asteroid in 2025, and we are confident we are going to put humans in the Martian environment, and my granddaughter is going to be pressing on somebody because—she then wants to take humans to a far more distant planet.

And I don't say that with any facetiousness at all. With the budget that we have in place, with the vision that the President has allowed us to present for him, that is what 2020 is going to be.

Mr. COSTELLO. I thank you, and I thank you, Mr. Chairman.

Chairman HALL. Thank you, sir.

The Chair recognizes the very patient gentleman from Alabama, my friend, Mo Brooks. Five minutes.

Mr. BROOKS. Thank you, Mr. Chairman.

Mr. Bolden, you have said that NASA has made some tough budget decisions. As we ponder that statement for a moment, let me emphasize some facts. While in fiscal year 2011, NASA's budget was $18.4 billion. In fiscal year 2012, it looks like it is going be $17.77 billion. In fiscal year 2013, requesting a cut of $60 million to $17.7 billion, at the same time in fiscal year 2011, Federal Government spending went up $141 billion, an increase, while we are looking at cuts for NASA, and then we have a Presidential budget

that seeks to increase spending by $200 billion, from $3.6 to $3.8 trillion.

And so I am curious as to why NASA is having to absorb this cut atmosphere in the context of a Presidential budget that increases spending by more than $200 billion.

But having said that, with respect to the human spaceflight fiscal year 2013 budget request, it appears that those decisions targeted the Space Launch System and Orion Multi-Purpose Crew Vehicle Program for budget cuts, while doubling the Commercial Crew budget over fiscal year 2012's 406 million appropriated levels to 829.7 million, well above the authorized levels.

Last fall you announced an agreement among NASA, the White House, and Congress the top priorities for NASA over the next five years. Space Launch System and Orion were stated as top priorities on the list.

Please explain why just a few months later NASA seems to have already changed its priorities, again favoring Commercial Crew Transport above development of the Space Launch System and those systems required for deep space exploration.

Mr. BOLDEN. Congressman, the budget we supported, that we submitted supports an ambitious exploration program. As we have always said and you have said, it is difficult times, so we had to make some difficult decisions. The three priorities that you mentioned are collaborative. They go together. They don't stand alone, and that was well thought out. Those priorities are SLS and MPCV for exploration supported by Robust Technology Development Program. I don't quite have the Robust Technology Development Program in place yet. ISS, sustainment beyond 2015 to at least 2020. I cannot support ISS if I don't have a commercial crew and cargo capability, so that is vital, and then the James Webb Space Telescope to open vistas to our universe that we have never done before.

They all go together. James Webb will help us with our exploration. Commercial Crew will make it possible for me to take the money that I am spending now and helping them develop that capability to put it on exploration and on the subsequent pieces of the evolvable heavy-lift launch system. We still have pieces to add, and I can only do that if I free myself up from the cost of paying the Russians $450 million a year for access to space.

So they go together. If you isolate any one of them, then the agreement that the President made with the Congress falls apart, and none of the priorities get accomplished.

Mr. BROOKS. Can I get to a follow-up question then? The 2010 NASA Authorization Act, and I emphasize 2010, authorizes $2.6 billion for the Space Launch System and other necessary support for fiscal year 2013, yet the President's fiscal year 2013, request is $1.3 billion or roughly half for Space Launch System, attributing the decrease to diversion of approximately $405 million to a new account entitled Exploration Ground Systems.

What percentage of this $1.3 billion, which is half of what was expected back in 2010 with the Authorization Act, what percentage of that $1.3 billion does NASA plan to actually use for direct development of the Space Launch Vehicle?

Mr. BOLDEN. Congressman, I don't have a calculator with me, so I will take action to take it for the record to give you the answer on the percentage, but as we tried to explained before, we are doing parallel development of the——

Mr. BROOKS. Well, do you have a range? If you can't give an exact percentage.

Mr. BOLDEN. I will take it for the record. My brain is tired, and I don't even know how to do the percentage thing right now.

Mr. BROOKS. May I infer from that that it is clearly not 100 percent, that it is something less than that? I am asking what percentage of the $1.3 billion that you are asking for Space Launch System does NASA plan to use for development of the Space Launch Vehicle.

Mr. BOLDEN. Oh, the amount of money—that is an easy answer. One hundred percent of the funds shown for vehicle development goes to vehicle development.

Mr. BROOKS. And that is the $1.3 billion?

Mr. BOLDEN. And I think that is the $1.3 billion.

Mr. BROOKS. All right.

Mr. BOLDEN. The reason that you do not see $1.9 as you saw before is because we made a bad assumption. We assumed that everyone would know that we had to develop ground systems in order to have a vehicle, a place for a vehicle to fly. It didn't work that way, so we backed it out, and as I explained earlier, we now have two separate accounts that address ground systems. One is 21st Century Launch that is mainly for multi-user facilities at the Kennedy Space Center, and then Exploration Ground Systems that is totally for the SLS and MPCV.

And I think the number is about $407 million for Ground Systems totally, and then so what you see in the line item for SLS is strictly for vehicle development for the heavy-lift launch vehicle.

Mr. BROOKS. All right. You have answered my question. Just one closing remark.

Mr. Bolden, I appreciate your service. I also appreciate what you have done for NASA and how NASA has represented America so well. It truly is American exceptionalism at its best, and I yearn for the day where we no longer have to thumb a ride with the Russians, and I yearn for the day when we can have a President that we can call the NASA President or the American Exceptionalism President for space efforts and exploration like we had in the '60s and in the decades thereafter.

And anything we can do to help make this President have that name, I would love to be able to help you with.

Mr. BOLDEN. Congressman, I yearn for the day when you and I will agree that we have that President.

Mr. BROOKS. Well, when he will quit cutting NASA, we might get to that day.

Mr. BOLDEN. We will agree to disagree on how good he is. I am very happy.

Chairman HALL. We yearn for the day when we just have a nominee.

Okay. Charlie, you have been great. We thank you for your very valuable testimony and members for their questions, and as you

know, the members may have some questions to ask you, and I ask you to please answer those, and I know you will.

The record will remain open for two weeks for additional comments from Members, and Mr. Administrator, thank you for today. You are excused, and this hearing is adjourned.

Mr. BOLDEN. Thank you very much.

Chairman HALL. Thank you, Charlie.

[Whereupon, at 4:59 p.m., the Committee was adjourned.]

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Hon. Charles F. Bolden, Jr.,
Administrator, National Aeronautics and Space Administration

Questions Submitted by Chairman Ralph M. Hall, Committee on Science, Space and Technology

An overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2012

1. **In July or August NASA's commercial crew program *[known as the Commercial Crew Integrated Capability i.e. CCiCap]* plans to give $300 to $500M to multiple companies using Space Act Agreements instead of more typical government contracts. According to NASA's Office of General Counsel, Space Act Agreements do not permit NASA to impose design or safety requirements on the contractors.**

   a. **How can we be assured that NASA is developing safe systems if it is prohibited from levying any requirements, or demanding performance tests from the companies?**

ANSWER: In order to ensure safety is not compromised for the Commercial Crew Program, NASA plans to transition to a Federal Acquisition Regulation (FAR)-based contract for certification of commercial systems prior to flying crew on these systems. NASA intends to structure the certification phase following the Commercial Crew Integrated Capability (CCiCap) effort to permit the Agency to fully evaluate the proposed systems and accommodate any necessary redesign to ensure compliance with NASA safety, performance, and mission success requirements. The provider(s) awarded a certification contract will not only be required to meet the NASA requirements in order to fly NASA personnel, but they will also have to show verified compliance of how the design and hardware will meet these requirements. Thus, there will be no reduction in the safety expectations or requirements as a result of this change in acquisition strategy.

NASA believes that it is implementing the best strategy for commercial crew that will maximize the taxpayer investment without compromising safety by using Space Act Agreements (SAA) in this next phase. First, NASA has released the baseline set of safety, performance, and mission success requirements to all of industry. NASA also has made these requirements available to all providers as reference under the CCiCap effort. Although compliance with these requirements is optional for industry under a funded SAA, NASA anticipates that providers will use the NASA requirements to inform their development activities, thereby reducing the technical risk associated with the lack of NASA oversight under an SAA. Second, because NASA plans to have two to three companies involved in the next phase of SAAs, we believe the competitive environment provides strong incentive for the companies to align with NASA's certification requirements in order to remain competitive in the future certification and services phases.

Third, NASA included an "Overall Safety Goal" in the CCiCap Announcement for Proposals (see page 3 of the Announcement) which states:

> "Successful commercial human space flight demands the highest commitment to safety; therefore NASA has the goal of fostering a safety culture in the commercial space flight industry that ultimately will minimize the risks associated with human space flight to LEO. NASA's goal is for Participants to demonstrate safety processes that include strong inline checks and balances, healthy tension between responsible organizations, value-added independent assessments and appropriate data archival, which will increase Government confidence in the Participant's approach to safety."

As a result, NASA will have full insight into the providers' approach to safety during CCiCap as the providers meet their milestones associated with the CCiCap agreements.

b. What recourse does the government have if these companies fail to perform or go out of business?

ANSWER: Under the CCiCap Space Act Agreements (SAAs), NASA is entitled to terminate an SAA if a provider misses a milestone and NASA determines that additional efforts are not in the best interests of the parties. NASA would consult with the provider prior to exercising this termination. If NASA terminates an agreement for the partner's failure to perform, NASA is entitled to exercise Government purpose rights in any technical data or inventions developed under the agreement. This allows NASA to use the data or inventions to continue the activity by or for the Government. Competition and having multiple providers is important in this overall strategy. If one company is unsuccessful, we can terminate and continue work with the others and still achieve our goals. In the unlikely event that all parties fail, then NASA could continue to purchase Soyuz seats for crew transportation and rescue purposes, as the Agency will have been doing for several years, assuming appropriate INKSNA relief and pending sufficient contracting lead time.

c. What, if anything, will NASA own after making these expenditures?

ANSWER: A principal goal of CCiCap is to "seek and encourage the fullest commercial use of space," a stated purpose of NASA under the National Aeronautics and Space Act of 1958 (the "Space Act"), as amended. In order to foster such commercial use, participants in CCiCap retain maximum Intellectual Property (IP) rights permitted by law.

NASA does not obtain rights to use our partner's proprietary data unless special circumstances arise, such as termination of the SAA for the partner's default or our partner's failure to make commercial use of the technology developed under the SAA. NASA retains "government purpose" rights in reported inventions owned by the Participant as required under the Space Act. NASA has agreed not to exercise its "government purpose" rights for five years after the end of the SAA. NASA's ability to exercise its government purpose rights in inventions is accelerated in the event of the participant's default. This means that the data and inventions can be used by or on behalf of NASA in future development efforts.

NASA has determined that title to all tangible property acquired by the participant under the CCiCap Agreement will remain with the participant(s). Unlike a procurement contract, the

purpose of a funded Space Act Agreement is not to obtain property for NASA. Instead, it is to stimulate the Commercial Partner's efforts. However, NASA reserves the right to acquire any tangible personal property acquired or developed under the SAA from the SAA partner, taking into account the amount NASA has already contributed under the Agreement. The specific terms applicable to data, inventions and personal property can be found in the model SAA attached to the CCiCap Announcement: http://prod.nais.nasa.gov/cgi-bin/eps/sol.cgi?acqid=149848.

2. **NASA officials have asserted that if the FY2013 request of $830M for commercial crew is not fully funded for each of the next five years, the program's ability to begin routine flights in 2017 will be jeopardized, possibly for several years. Given the current fiscal environment, NASA may find it advantageous to, reduce the number of contracts down to one or two firms. This would allow the agency to use a standard acquisition contract that would permit them to put safety requirements in place, and allow the agency to implement stricter insight/oversight. Why not down-select now and put one or two companies under contract, and avoid the uncertainties and possible wasted investment of carrying unsuccessful bidders through the upcoming phase?**

ANSWER: NASA believes that having multiple companies competing against each other at this stage of the Commercial Crew Program will result in lower overall costs for the Government and will help enable voluntary adherence to safety requirements. In a traditional program with a single prime contractor from the start using a cost-plus contract, the NASA-Air Force Cost Model (NAFCOM) cost estimates are approximately $8-11B for the development of an ISS crew transportation capability. Using the current, innovative approach of competing Space Act Agreements will result in multiple awards to industry with fixed Government costs. NASA estimates being able to cut the development costs substantially and to deliver an ISS capability for around $5B. Maintaining competition is a key factor in achieving these savings.

While the Agency has not established a specific number of awardees for the next phase of the Commercial Crew Program, referred to as CCiCap, NASA is planning to have fewer funded companies in CCiCap than are currently participating in CCDev2. There are 7 partners in CCDev2 (4 funded and 3 unfunded partners). NASA would like to maintain as much competition as it can for as long as possible.

Removing competition by developing a single system from various companies' system elements would eliminate most of the commercial aspects of the program. With only one provider from which NASA could purchase services, there would be little incentive for the companies to expand their commercial market base by selling services to any other customers or to maintain reasonable prices. There would also be no incentive for the companies to share in the development costs. Having industry share in the cost of development and selling seats to other customers in addition to NASA will likely decrease NASA's costs for crew transportation services in both the short and long-term.

3. **Now that the life of the International Space Station has been extended to 2020, does NASA anticipate negotiating new barter arrangements with our international**

partners to extend their cargo service agreements?

ANSWER: Yes, NASA is conducting barter discussions with our international partners to enable the continuing offset of their respective ISS common system operations cost obligations through 2020.

a. How do NASA and the international partners plan to supply and maintain the ISS?

ANSWER: The ISS Partnership continues to employ the successful mixed fleet strategy to supply and maintain the ISS. This fleet includes proven transportation vehicles from Russia, Europe and Japan, as well as services that will be provided by Orbital Sciences Corporation (OSC) and Space Exploration Technologies (SpaceX) under the Commercial Resupply Services contracts. These U.S. commercial vehicles are scheduled to be demonstrated this year.

b. How many total future cargo flights have the Europeans and Japanese committed to?

ANSWER: In payment of their ISS Common System Operations Costs obligations through 2015, the European Space Agency (ESA) committed to provide five Automated Transfer Vehicle (ATV) flights through 2014 and the Japan Aerospace Exploration Agency (JAXA) committed to seven H-II Transfer Vehicle (HTV) flights through 2016. To date, three ATVs have been provided (including ATV-3 currently on orbit) and two HTVs have been provided (HTV-3 is scheduled for launch on July 21, 2012).

c. What is NASA's plan to supply and maintain the ISS if the commercial providers continue to experience delays, or are unavailable or out of business?

ANSWER: There is sufficient margin in logistics, consumables and systems spares through early 2013, to protect ISS operations for a delay in the start of commercial cargo delivery. Commercial Resupply Services (CRS) flights will augment existing resupply capability needed to support the crew on-orbit. Those needs continue to be met through the ESA-provided ATV, the Roscosmos-provided Progress and Soyuz, and JAXA-provided HTV vehicles now that the Space Shuttle has been retired. The U.S. commercial providers are in the process of bringing their vehicles on-line to provide the needed resupply capability. Recognizing the challenges of initial flights and bringing a new vehicle into operations, NASA and its international ISS partners previously delivered additional supplies to accommodate potential slips to the CRS schedule. The commercial strategy does not rely on a single flight or provider. On May 22, 2012, SpaceX launched its second COTS demonstration flight, and three days later, the Dragon spacecraft was berthed to the ISS. The mission, which accomplished the remaining COTS demonstration goals for Space X, was brought to a successful conclusion on May 31, with the deorbiting and splashdown of the Dragon capsule.

4. The FAA is responsible for licensing commercial launches. Yet, the recently passed FAA reauthorization *prohibits* the FAA from regulating "the design or

operation of a launch vehicle to protect the health and safety of crew and space flight participants," until at least October 1, 2015.

a. Which agency is responsible for regulating the safety of the astronaut crews?

ANSWER: Although it is not a regulatory Federal Agency, NASA is responsible for ensuring the safety of NASA crews/workforce and assets during NASA or NASA-sponsored space operations. In addition, NASA retains responsibility for public safety during launch and reentry operations if those operations are not FAA-licensed. In support of those responsibilities, NASA is currently developing the certification requirements and program processes for commercial transportation of NASA crews to the ISS.

At some time in the future, both NASA and the Federal Aviation Administration (FAA) envision a scenario where the FAA licenses commercial human spaceflights provided by a robust industry, from which NASA and the private sector can purchase transportation services. The FAA has already developed processes and procedures for licensing and regulating commercial space activities to protect the safety of the public. Additional regulations for the protection of crew safety are in development, pending Congressional authority for the FAA to propose crew and spaceflight participant safety regulations.

b. Which agency is responsible for regulating the safety of astronauts on commercial sub-orbital flights funded by NASA? Could you please describe how you are working with the FAA to ensure their ability to verify a vehicle is safe?

ANSWER: NASA is currently only funding research payloads using suborbital providers. Flying astronauts is not part of the current programming for suborbital flights funded by NASA.

NASA has agreements with seven different suborbital flight providers to allow for purchase of flight services for research and development payloads. Of these providers, only two are flown by pilots and constructed to carry passengers (Virgin Galactic and XCor Aerospace). At this time, NASA has no plans to use commercial suborbital flight providers to fly astronauts, civil servants or NASA-funded researchers.

Like all developmental and experimental aircraft, the flight providers are putting their vehicles through a rigorous testing profile with continuous improvements until they are capable of achieving the desired altitude and vehicle performance outcomes.

NASA requires the suborbital providers under contract to obtain approval from the FAA or other governing authority for the flight activity. Launch vehicles that fall under jurisdiction of FAA Office of Commercial Space Transportation are normally required to be licensed. NASA collaborates with the FAA in payload reviews and flight scheduling, but the licensing process remains between the flight provider and the FAA. In addition, NASA and the FAA remain in regular communications about the progress of the flight providers.

5. For NASA's first manned mission beyond low Earth orbit, agency officials have

stated that lunar fly-bys, asteroid missions, and missions to a LaGrange Point are under consideration. What steps is NASA taking to develop a habitation module and/or a service module to sustain the crew on a long-duration mission? What is the *next* hardware development that NASA is planning beyond SLS and MPCV?

ANSWER: The Deep Space Habitation project was started in the Advanced Exploration Systems (AES) Program in FY 2012. This project is developing system requirements and concepts for habitats, and demonstrating habitat mockups in ground-based tests. In parallel, the AES Program, in partnership with the Game Changing Development (GCD) program under Space Technology, is developing technologies for highly-reliable, next generation life support systems, radiation monitoring and protection, advanced space power systems, fire safety, logistics reduction, and autonomous mission operations that will be incorporated into a habitat mockup around 2015 for integrated testing. The AES Program is also pursuing a commercial partnership to demonstrate an inflatable module on the ISS. ISS is being used to look at life support systems as well as many components of the new systems.

- **What international contributions are assumed for long-duration missions?**

ANSWER: NASA has continued to build and strengthen international partnerships to meet the greater challenges of human exploration including future long duration missions. In addition to the on-going research being conducted on the International Space Station (ISS), partnership discussions are underway to explore how the ISS can be most effectively used as a test-bed for long duration missions. In parallel, the International Space Exploration Coordination Group (ISECG) space agencies are coordinating an international effort to define technically feasible, programmatically implementable, and sustainable exploration pathways beyond low-Earth orbit (LEO). As a result, significant progress has been made and there is now a consensus among NASA and the participating ISECG agencies that the next steps for human exploration is sending humans sustainably beyond LEO to destinations in cis-lunar space, such as near-Earth asteroids, the Moon, the moons of Mars, and eventually Mars. Specific international cooperation with NASA in its beyond-LEO exploration architecture will be defined as NASA's human space exploration strategic planning and analysis advance, and specific near-term opportunities for international contributions to the SLS and Orion MPCV, as well as technology demonstrations and robotic missions will be explored as these programs develop.

6. **The current budget request indicates that Mars exploration is not a priority for this Administration despite the stated goals of a human mission to Mars in the 2030s.**
   - **Without robotic precursor missions that include sample return, is Mars really a planned destination? Does NASA anticipate omitting a sample return mission prior to putting astronauts on the surface of Mars or one of its moons?**

ANSWER: While the current fiscal climate required us to make tough choices, it also presented an opportunity to reformulate a Mars program optimized to further the nation's and NASA's goals in scientific discovery, human space exploration, and technological innovation. Within constrained budgets, coordinating these activities makes sense. These goals include the return of samples from the Martian surface, and the enabling of human expeditions to Mars in the 2030s.

NASA is working on a new architecture for Mars exploration aimed at both of these goals, beginning with definition of a mission concept to take advantage of the favorable 2018 or 2020 launch windows within available resources.

7. **Some of NASA's most productive and exciting science missions have been flagships, examples being Hubble Space Telescope, Cassini mission to Saturn, Galileo mission to Jupiter, and the Mars Science Laboratory. Why has NASA chosen to abandon this highly successful class of missions? The normal development cycle for a flagship mission often takes a decade or more. When does NASA plan to begin planning and formulation of a future flagship mission?**

ANSWER: NASA has not abandoned this class of mission, as evidenced by our continuing development of the James Webb Space Telescope. NASA plans a balance among missions driven by science objectives. Flagship missions provide the capability to answer the most challenging science questions and serve to advance research by the largest fraction of the scientific community. Moderate and small missions address unique, exploratory science questions, often through Principal Investigator-led missions that enhance the experience of the science community in space mission design and implementation. Discoveries from some of these smaller missions will likely inform and shape future large flagship missions. Currently, budgetary resources do not afford the pursuit of more than one flagship-scale science mission at a time in a balanced science program. Thus, NASA's budget request for FY 2013 does not initiate any new flagship-class mission. A future determination to initiate a flagship-class mission will be driven by science and exploration objectives and resource availability.

Ranking Member Eddie Bernice Johnson

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

1. **In all prior communication, including your message accompanying the budget justification, NASA has defined its agency priorities as (1) SLS and MPCV for exploration, (2) enhancement of the ISS supported by a robust commercial crew and cargo program, and (3) JWST. Yet, in your written testimony, you now add a fourth priority, space technology. Please explain why you have redefined NASA's priorities.**

ANSWER: Space Technology is and has been a priority for NASA, as evidenced by the initiation of the separate Space Technology program in 2011 and our request for increased Space Technology funding in 2012 and 2013.. Space Technology is not an end, in and of itself; however it is absolutely critical element of NASA's strategy for achieving the Agency's scientific and exploration goals. Space Technology can also result in benefits to other government and commercial space programs and to life on Earth. The underlying importance of Space Technology, as reflected NASA's budget request has not changed. As the President said when laying out the Administration's broader exploration goals for deep space exploration:

"At the same time, after decades of neglect, we will increase investment -- right away -- in other groundbreaking technologies that will allow astronauts to reach space sooner and more often, to travel farther and faster for less cost, and to live and work in space for longer periods of time more safely."

NASA has remained consistently committed to this vision.

2. **Given the slips in the schedules for both commercial cargo and commercial crew operational capabilities and the recent difficulties with the Russian Soyuz vehicles, why is the Administration unwilling to request funding and support for developing the capability for the MPCV and SLS to serve as backup transportation to low Earth orbit, as NASA was directed to do by law? Does NASA consider the risk of commercial services being unavailable by 2017 to be low? How much additional funding would be required, and what is the basis for that estimate?**

ANSWER: NASA believes that commercial crew transportation systems could be available to provide services to the Agency and other customers by the middle part of the decade. Given reasonable funding levels, NASA is planning for commercial crew capability to be in place in 2017; but these plans will not preclude earlier availability of services.

NASA plans to rely on U.S. commercial providers for the delivery of cargo and crew to ISS. The Orion MPCV and SLS could be used as a back-up system for transportation to and from the

ISS, but this would be a very inefficient use of vehicles that are being designed and developed for deep-space missions.

The 2017 date of the uncrewed SLS/MPCV test mission is driven primarily by technical development schedules, not funding, and NASA is working to develop these vehicles as rapidly as possible, in part through the use of existing contracts. NASA is currently conducting an integrated technical, schedule, and cost review, which will be completed late this summer. The results of this review will help NASA assess whether it might be possible to accelerate the crewed SLS/Orion MPCV test mission, currently scheduled for 2021.

SLS/MPCV Orion is uniquely designed for deep space travel and will be extremely costly to use for low Earth orbit activities. The Commercial Crew Program is the best way to develop crew transportation to the ISS.

3. Congress has established the policy that the U.S. will support ISS utilization and operations through at least 2020.

a. What is NASA doing to prepare for a decision on whether to support the ISS beyond 2020?

ANSWER: The lifetime extension data that NASA and the ISS Partnership have reviewed to date indicates that extension to 2028 is technically feasible. The analysis and certification, once completed, will determine the ISS structural hardware's ability to operate safely through 2028.

In addition, current spares procurements and planned procurements assume ISS life at least through 2020. The date for determining which spares are required to support beyond 2020 is reassessed each year assuming the updated Mean Time Between Failure (MTBF) numbers. Based on past performance, many of the spares procurements should support ISS beyond 2020, but if specific additional spares are required to extend ISS beyond 2020, the procurements should be on contract by 2017.

b. When does that decision need to be made?

ANSWER: The decision to extend ISS Operations beyond 2020 will need to be made well before 2020 to enable a smooth continuation of the program. If the ISS is going to be extended, NASA would prefer to have procurements in place by the end of FY 2017 for crew seats, logistics vehicles, consumables, and possibly some spare components. An early decision point also attracts and better supports ISS research and utilization customers that will be planning to wind down their efforts in preparation of ISS deorbit in 2020.

4. You indicate that NASA will be requesting modification to its waiver of the Iran, North Korea, Syria, Nonproliferation Act (INKSNA) which lapses in July 2016. What time period for the waiver will you be requesting? When can Congress expect to receive the request?

ANSWER: Some modification of the Iran, North Korea, Syria Non-proliferation Act (INKSNA) provisions will likely be required for the continued operation of ISS and other space programs after 2016. The Administration plans to propose appropriate provisions and looks forward to working with the Congress on their enactment.

5. **As you mentioned in your prepared statement, NASA will no longer participate with the European Space Agency in previously agreed to collaborative Mars missions in 2016 and 2018 and is initiating an analysis of how it can implement an integrated strategy for long-term human and robotic exploration of Mars.**

   a. **How is NASA addressing the loss of U.S. leadership and critical capability in landing and operating spacecraft on the surface of Mars, a technical skill that no other nation currently possesses?**

ANSWER: NASA is working to reformulate a Mars program optimized to further the nation's and NASA's goals in scientific discovery, human space exploration, and technological innovation. These goals include the return of samples from the Martian surface, and the enabling of human expeditions to Mars in the 2030s. NASA is working on a new architecture for Mars exploration aimed at these goals, including the definition of a mission concept to take advantage of the favorable 2018 or 2020 launch windows within available resources. We plan to have this initial architecture ready this summer. Landing large masses on the Martian surface remains a necessary part of any strategy for Mars exploration. Therefore, while a loss of some skilled personnel after the landing of MSL is likely, NASA will work to retain critical skills and capabilities sufficient to enable the necessary surge in our entry, descent, and landing capacity prior to the next landed mission to Mars, thus retaining our leadership in the exploration of the Red Planet.

   b. **How do you propose to deal with the perception by the international space community that the U.S. is an unreliable partner, thus damaging future opportunities for international collaborations?**

ANSWER: NASA has a long history of very successful cooperation with nations around the world, and a part of that history has from time to time included some decisions by NASA and some by our international partners to re-phase or redesign or even terminate planned cooperative activities. Our partners are very aware that in all instances our cooperation is based on the availability of appropriated funds, just as we are aware that their participation has similar funding constraints. Consistent with the National Space Policy and the Space Act, NASA will continue to pursue international cooperation in support of its activities and mutual objectives. Currently, NASA has over 500 active agreements with over 100 countries and anticipates that international cooperation will remain a cornerstone of all of its future activities.

6. **Has NASA identified the specific path forward for its human exploration program, including intermediate objectives, destinations, and options for human exploration that maximize the productive use of MPCV and SLS as soon they become available, and if not, what is preventing you from doing so?**

ANSWER: NASA's ultimate destination for human exploration is Mars. Consistent with policy and law, NASA is planning an asteroid mission as the first part of a capability driven approach to explore multiple deep space destinations. Mission analysis and international discussions supporting these efforts are ongoing. NASA will ramp up our capabilities to reach -- and operate at -- a series of increasingly demanding targets, while advancing our technological capabilities with each step forward. This will include early test and demonstration activities in cis-lunar space as called for in the NASA Authorization Act of 2010. Along these lines, we will fully tap the potential of the ISS. We will also conduct a series of test and demonstration flights. For example, we plan test flights of an uncrewed Orion spacecraft in 2014 and of the SLS in 2017, followed by a crewed mission in 2021 as part of developing the foundation for our longer journeys. NASA's Orion and SLS will enable the Agency to send astronauts beyond LEO for the first time since 1972 and will provide the nation a capability and architecture designed to also allow flexibility, partnering and technological on-ramps. This approach provides a path for a sustainable program to extend human presence into the solar system.

Congressman Dana Rohrabacher

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

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1. **NASA has $229.3M requested for the ISS Research line item. Parts of these funds are used for Multi-user System Support (MUSS). MUSS provides strategic, tactical, and operational support to all the NASA sponsored payloads and non-NASA sponsored payloads, including five international partner research payloads. This includes maintenance and operation of the ISS research infrastructure, including research integration, payload engineering, integration, and operations; payload systems support etc.**

   - **What percentage of the ISS Research request for FY 2013 will be spent for Multi-User System Support, and what percentage will be spent for pure grant opportunities?**

ANSWER: The budget for Multi-User System Support (MUSS) in FY 2013 is $154M, or 67 percent of the total ISS Research budget of $229M. The Non-Profit Organization (NPO) budget is $15M, or 7 percent of the total ISS Research budget. The biological and physical research budget is $60.3M, or 26 percent of the ISS Research budget (approximately $15M is directly awarded for grants). However, the remaining funds also support grants through hardware development and other activities required by grantees to conduct their research on ISS.

   - **What else does "ISS Research" encompass?**

ANSWER: ISS Research is primarily broken into the three major categories listed above: MUSS, NPO, and biological and physical research.

   - **What percentage of the ISS research capability is NASA utilizing? What percentage remains unused?**

ANSWER: At the rack level, 78 percent of the ISS research locations contain a payload rack (18.25 racks of the 23.25 rack capacity, not including 0.75 rack used for systems). NASA research outfitting of rack-level facilities is complete, with other rack space being used for payload stowage.

At the sub rack level, averaged across the capacity of each rack, the overall sub-rack volume utilization is 72.5 percent (as of the end of FY 2012). This includes several different types of racks. Some racks are fully occupied with equipment for the science objectives. Such equipment may be in either continuous or occasional use due to the nature of the science supported. Some racks that can support multiple runs of experiments for a discipline could

support more throughput than is currently being done. Some multipurpose EXPRESS racks are only partially occupied with scientific experiments, providing capacity for future users. For EXPRESS racks alone, the occupancy at the end of FY 2012 will be 62 percent.

Resources for using the pressurized volume support the current throughput with the ability to support growth in future up mass and down mass. Crew time is currently 100 percent subscribed.

NASA has rights to 15 external payload sites. Currently, 6 sites are occupied, with 1 additional payload to be added on the next HTV flight. The occupancy for external sites at the end of FY 2012 will be 47 percent.

- **Why is the MUSS function included in the ISS research funding line, rather than in ISS operations?**

ANSWER: MUSS is basically the Operations and Maintenance (O&M) function related to research on ISS. While it is currently booked under ISS Research, it could alternatively be reported as part of ISS Systems Operations and Maintenance, since it is O&M work. It is being reported in ISS Research because historically it has been reported as part of ISS Research.

2. **NASA is requesting funds to restart Plutonium-238 production to power deep space missions, but there is no corresponding request at the Department of Energy, which would need to produce the Pu-238.**

- **Is Plutonium-238 production restarting?**

ANSWER: DoE has started the project definition phase of the Pu-238 restart effort. This assessment is necessary to understand how facilities can be used to begin the production of Pu-238. We expect that the study will be complete by the end of calendar year 2013. At the end of project definition phase, we will have a better estimate of the schedule and cost to re-establish Pu-238 production.

- **Is NASA expecting to cover all of the relevant costs moving forward?**

ANSWER: NASA is funding all the costs of conducting the current project definition phase assessment (i.e., through FY 2013). How to apportion costs between the agencies will be the subject of future discussions between DOE and NASA and will inform future budget requests.

Congressman Randy Neugebauer

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

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1. **Administrator Bolden, in recent years NASA has experienced numerous issues of cost overruns and missed deadlines. As you well know, the United States' $15 trillion debt necessitates major cuts in spending and tighter budgets. As a result, accurate cost projections and strict adherence to timelines are crucial to keeping spending under control and ensuring that important projects are able to continue receiving funds each year. What assurance can you provide in the current timelines and budgets for Commercial Crew, SLS, MPCV, and the James Webb Space telescope? What makes current projections more reliable than previous ones and what is NASA doing to ensure that programs come in under cost and before the projected timelines?**

ANSWER: NASA recognizes the critical importance of improving cost and schedule performance of our one-of-a-kind Research and Development projects.

In cost management as in technical challenges, we learn from our successes and failures and adjust to improve our performance. In recent years, NASA has implemented a series of new policies and approaches for improving cost performance. These include:

- Establishment of Key Decision Points which serve as formal gateway review through which missions must pass to proceed to the next stage;
- Establishment of Life Cycle Cost targets based on probabilistic independent cost estimates;
- Establishment of Joint Confidence Levels to determine those targets based on integrated cost and schedule analyses
- Monitoring of cost and schedule performance with independent assessments of Earned Value (work accomplished compared to resources expended).

These changes are benefiting projects currently in development, and projects initiated after these measures were put in place will benefit the most. Cost performance for recent missions has improved. In 2011, we launched Juno, a planetary science mission to Jupiter. This billion-dollar mission launched on time and within budget. GRAIL, a twin-spacecraft, half-billion dollar mission to study the moon, completed its development at seven percent under the Agency's cost estimate.

The Orion MPCV and SLS programs are developing detailed estimates this year as part of the Agency's budget development process. However, NASA is developing this capability under a flat-line budget as reflected in the President's Request. These estimates will build upon the initial cost estimates the programs developed last summer in support of the announced

Exploration architecture. As part of this process, an external party conducted an Independent Cost Assessment that was used to help inform and reinforce NASA's budget planning estimates. Both of these programs are using heritage systems to minimize development risk, holding a tight requirements focus, and being implemented in a scaled, evolvable manner with a test and flight cadence to drive results. All of these factors have been cited in independent and DOD reports on improvement areas. We have also established an independent "best practices" and assessment group to look at all of NASA's projects and programs.

The FY 2013 budget request for Science includes $627.6M for the James Webb Telescope (JWST). The scientific successor to the Hubble Space Telescope (HST) and the Spitzer Space Telescope, JWST will be used by international teams of astronomers to conduct imaging and spectroscopic observations. The Observatory will be located in an orbit near the second Sun-Earth Lagrange point (L2), approximately 1.5M km from Earth. The telescope and instruments will be operated at a temperature of 40 degrees above absolute zero (40 Kelvin) shielded from the heat of the Sun by a large sunshield, to enable the Observatory to achieve unprecedented sensitivity over its entire wavelength range. Over the past year, NASA has engaged in a thorough review of JWST, made important adjustments to management, and put the project on a sound financial footing. Since we completed this new plan, the project has met 19 of 20 FY 2011 top-level milestones (with one deferred without impact), and has met 19 of 21 FY 2012 milestones through May on or ahead of schedule (the two missed milestones were completed in May without impact. All 18 JWST primary mirror segments have been completed and tested. The first of the four flight instruments was delivered to GSFC on May 29, 2012. NASA expects to take delivery of the remaining three JWST instruments in FY 2012-2013. In FY 2013, NASA will begin sunshield fabrication and continue I&T of the Integrated Science Instrument Module and development of the ground segment. NASA is confident that the FY 2013 request supports a 2018 launch of JWST.

2. **How much money did NASA spend specifically on NextGen research and development in FY 2011, what are the estimates for FY 2012, and what does the Administration expect to spend in FY 2013? Please detail the operational partnership and cost sharing between NASA, the FAA, and any other agencies involved in the development of the NextGen system. How effective has this partnership been, and excluding funding levels what are the potential barriers or delays in deploying the system from NASA's perspective?**

ANSWER: All four of NASA Aeronautics' research programs contribute directly or indirectly to the achievement of NextGen. Airspace Systems Program (ASP) research investments in air traffic management-related concepts and technologies and the Integrated Systems Research Program (ISRP) contributions to advancing technologies needed to support unmanned aircraft systems (UAS) routine access to the National Airspace System (NAS) most directly advance NextGen goals. In FY 2011, $96.6M of the Aeronautics budget contributed directly to the advancement of NextGen in this fashion. In FY 2012, this figure has risen to $122.7M and is projected to be $123.7M in FY 2013 based on the FY 2013 President's Budget. Other NASA research focused on improving the safety of air transportation and enabling new aircraft technologies which

improve efficiency, expand mobility choices and reduce the environmental impacts of aviation indirectly contribute to NextGen. Total direct and indirect contributions for each of those fiscal years are $355.7M for FY 2011, $417.8M for FY 2012, and $420.1M for FY 2013.

NASA coordinates closely with the FAA, other Federal agencies and the aerospace industry in planning and executing research to achieve both the near-term improvements in air travel and the longer-term NextGen vision. In addition to working closely with the FAA as a member agency of the Joint Planning and Development Office (JPDO), NASA and the FAA created research transition teams (RTTs) in order to accelerate progress for NextGen advancements in critical areas and effectively transition advanced capabilities to the FAA for certification and implementation. Under RTTs, NASA and FAA develop joint research plans and fund their respective portions of the planned research according to the nature of the research and their relative capabilities. To a limited extent, the FAA provides funding to NASA to perform specific studies or simulations through reimbursable agreements. A recent GAO report (D11604) identified RTTs as a federal best practice for interagency collaboration.

This model for cross-agency collaboration and cost sharing has been very effective, resulting in several recent demonstrations of advanced technology benefits. One such RTT example is NASA's Efficient Descent Advisor (EDA) technology, which will save fuel by enabling more efficient arrivals into congested airports. EDA was developed and field tested through a three-year collaborative effort between NASA, FAA, Boeing, MITRE, Sensis/SAAB, United Airlines and Continental Airlines under a NASA-FAA RTT, and then transferred to the FAA on November 30, 2011, for certification and integration into mid-term (2014-2018) NextGen operations. NASA estimates $300M in fuel savings per year during descents if EDA is implemented fleet-wide at the nation's busiest airports. For this particular effort, the NASA/FAA procurement cost investments were split on a roughly 75/25 basis, not including labor, indirect costs and other in-kind contributions.

NASA transferred the research results from another RTT to the FAA in August 2011 regarding tools and methods for in-flight "flow-based trajectory management" in the NextGen. Joint work continues under two other RTTs, and NASA and the FAA are now building on the RTT model to enhance planning and cooperation in other research areas. Also in 2011, NASA, the FAA, and other federal agencies developed a joint research, technology, and demonstration roadmap for enabling UAS access to the NAS, and strengthened coordination on UAS operational issues through the UAS Executive Committee (EXCOM) that is composed of senior executives from DoD, FAA, DHS, and NASA.

There are a myriad of other coordination activities between NASA and other federal departments and agencies for research directly and indirectly related to NextGen improvements across the entire NASA portfolio. For example, NASA is coordinating with the DoD on aircraft engine improvements through participation on the Steering

Committee for the DoD's Versatile Advanced Affordable Turbine Engine (VAATE) program, and with the FAA in an advisory capacity for the Continuous Lower Energy, Emissions, and Noise (CLEEN) program. NASA research partnerships and coordination also extend to topics such as rotorcraft, subsonic fixed wing aircraft, alternative fuels, aviation safety technologies, and environmentally responsible aviation.

Advances in technologies that address NextGen operational improvements are critical, but several obstacles remain to deployment of broad system-wide improvements. One such area is in the verification and validation (V&V) of complex flight systems. Current techniques for certifying complex systems are inadequate to provide verification and validation of highly automated, non-deterministic software systems, which are expected to be a major component of NextGen. The V&V of complex flight systems was identified as a critical gap to realize NextGen vision by the JPDO, and NASA started its investment for about $20M per year in FY 2011 to address this gap in close coordination with FAA, industry, and academia. Another area that presents a critical gap is the ability to demonstrate system-wide operational concepts. The interoperability of individual technology applications in the NAS cannot be effectively tested or evaluated in anything but the actual NAS, which cannot be readily conducted for safety concerns and other operational issues. Sophisticated system-wide NAS/NextGen simulators need to be developed to enable NextGen technologies to be safely and effectively evaluated for operational benefit and performance.

Congressman Jerry Costello

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

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1. **In response to my question regarding the Administration's primary objective of the Commercial Space Program, you responded that you agreed with the Aerospace Safety Advisory Panel's (ASAP) assessment that a "sea change" had occurred. You also remarked that the FY 2012 budget level meant that *"by default the Congress and the Administration have agreed that we are going to develop a commercial capability for the benefit of the American economy, and it will serve other purposes, but it may not make it in time to serve the International Space Station".***

    a. **Has the White House agreed to the change in the primary objective of the commercial crew program to being one of developing a commercial capability for the benefit of the American economy? Are you seeking an explicit agreement by Congress to the change in objective as part of this year's budget process?**

ANSWER: The objective of the Commercial Crew Program is to facilitate the development of a U.S. commercial human space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from low-Earth orbit (LEO) and the International Space Station (ISS).

This basic objective has remained unchanged since the program was unveiled in the spring of 2010. NASA plans to use commercial capabilities to provide services to ISS once those capabilities have been certified to meet NASA requirements. NASA's strategy is to use Federal-Acquisition-Regulation-(FAR)-based contracts for certification activities. FAR-based contracts will enable NASA to "certify" commercial crew transportation systems for use by NASA for crew transportation and rescue services. Through this process, NASA will ensure that all the necessary NASA safety and performance requirements are met.

    b. **How are you addressing the programmatic risk, which you acknowledged at the hearing, that under the Space Act Agreement approach, you cannot guarantee *"a commercial capability in time to support the International Space Station."***

ANSWER: The programmatic risk of not being able to guarantee a commercial capability in time to support the ISS is not increased because of the use of SAAs. NASA believes the risk could actually decrease because the commercial providers are responsible for determining the best approach to the design and development of their commercial systems which may permit the providers to maintain a rapid pace of technical development.

The risk in developing a commercial system in time to support the ISS is driven primarily by available budgets. NASA's original request for the Commercial Crew Program was:

($ in millions)	2011	2012	2013	2014	2015
FY 2011 BUDGET REQUEST	500	1,400	1,400	1,300	1,200

With the FY 2011 budget request, NASA estimated that a commercial crew capability could be in place by 2015. However, the amount available under the FY 2011 appropriation was $312M ($188M less than requested). Thus, NASA reduced its expected progress and initiated CCDev Round 2, which only matured elements of the systems instead of overall integrated crew transportation systems. The combined impact of the lower than expected budget and having to focus on elements of the system instead of an integrated system was that it delayed the expected operational date of commercial crew to 2016.

The amount appropriated in FY 2012 was $406M ($444M less than the newly requested amount of $850M). This resulted in a further slippage of the NASA's expected operational date to 2017, assuming funding at the level proposed in the President's FY 2013 request and reasonable technical progress on the part of the commercial providers (many of the potential providers have said that they believe they can service the ISS before 2017).

NASA is planning for commercial crew capability to be in place in 2017; but the Agency's plans will not preclude earlier availability of services. If funding levels are further reduced or if significant technical difficulties are experienced by the commercial providers, then the ability of commercial crew providers to be able to service the ISS by 2020 may be jeopardized.

2. **What critical measures need to be taken to preserve a crewed SLS/Orion flight in 2021 or earlier? What would it take to accelerate the timetable for that crewed flight?**

ANSWER: While adequate funding is critical, the 2017 date of the uncrewed SLS/Orion MPCV test mission is driven primarily by technical development schedules, not funding, and NASA is working to develop these vehicles as rapidly as possible, in part through the use of existing contracts. NASA is currently conducting an integrated technical, schedule, and cost review, which will be completed late this summer. The results of this review will help NASA assess the degree to which it might be possible to accelerate the crewed SLS/Orion MPCV test mission, currently scheduled for 2021, which is primarily driven by budget availability.

3. **You indicate in your statement that you expect Orbital to complete its demonstration flight of their cargo vehicle to the Station by this summer. Orbital has qualified its ability to do so by saying that this would require the upcoming tie-down engine test and *Antares* maiden flight to proceed without any glitches. In light of Orbital's own caveats, please explain the basis for your prediction of "summer".**

ANSWER: Orbital Sciences Corporation (OSC) reported to NASA that, pending the successful completion a hot fire engine test on the pad and the maiden test flight of the Antares, the demonstration flight to the ISS is currently planned to be conducted by the end of September 2012. NASA recognizes that further delays are likely due to challenges in completing the new commercial launch complex at Wallops Island,

currently the pacing item, and engineering issues that may be discovered during the upcoming test firing and flight. OSC is required to cover any additional costs due to the delays since NASA makes payments only upon the successful completion of milestones. NASA is closely monitoring OSC's progress and is offering technical assistance to help expedite completion of the Commercial Orbital Transportation Services (COTS) demonstrations flights.

4. I understand that the schedule for contracted-for commercial cargo flights has slipped significantly, with the first CRS flight now scheduled for launch no sooner than later this year.

a. What is the production status of the hardware needed for CRS flights?

ANSWER: Below is the Commercial Resupply Services (CRS) production status for the first two cargo resupply missions for Space Exploration Technologies (SpaceX) and OSC.

SpaceX-1 Production Status
Falcon 9-4 launch vehicle - The interstage and first stage are complete and at the Cape. The second stage has been manufactured and is in Texas for hot fire testing. The Merlin Vacuum engine (MVAC) skirt production is scheduled for completion in June.

Dragon 3 - All Draco thrusters are complete and installed. Berthing Mechanism is installed and checked out.

SpaceX-2 Production Status
Falcon 9-5 launch vehicle – First stage engine section assembly complete. All nine engines installed. MVAC skirt complete.

Dragon 4 - Pressure system capsule built and leak checks completed.

Orbital-1 Production Status
Antares launch vehicle – First stage core delivered to Wallops Flight Facility (WFF). First stage engines at Stennis Space Center awaiting hot fire. Upper stack avionics cylinder, motor cone, payload cone, and interstage have completed testing. The Castor 30B is in final assembly.

Cygnus – Pressurized cargo module is complete. Service module completed thermal vacuum testing.

Orbital-2 Production Status
Antares launch vehicle – First stage core delivered to WFF. Upper stack cylinder and payload cone in manufacturing, with scheduled delivery in July.

Cygnus – The service module propulsion system completed. Service module open panel testing starting. Pressurized cargo module in final assembly.

b. Will each company be able to fulfill the CRS flight rates originally planned for 2013? If not, what flight rates do you expect will be achieved in 2012 and 2013?

ANSWER: Both SpaceX and OSC are making significant progress in preparing for the upcoming demonstration missions to ISS as well as preparing for the first CRS missions. Although the original missions planned for 2013 have slipped somewhat, NASA is confident that the providers will be executing cargo delivery missions to the ISS in the 2012 and 2013 timeframe.

Both SpaceX and Orbital are currently preparing the hardware and mission products necessary to execute the near term CRS flights while they are focused on successfully and safely executing the demonstration flights. Once the COTS demonstration flights are flown successfully, NASA expects that the CRS providers will be able to provide one cargo resupply mission in FY 2012 and up to four in FY 2013.

c. Will Space X and Orbital be ready to resupply the ISS once they have demonstrated their capabilities in the upcoming demonstration flights?

ANSWER: NASA expects that each of the CRS providers will be able to settle into a steady production and mission flow once the capability to deliver cargo to the ISS has been demonstrated successfully. NASA is working with both SpaceX and OSC in preparation for the upcoming demonstration flights including demonstrating simulated delivery of cargo to ISS. NASA is currently working with SpaceX to support the first five CRS flights and the Agency is working with OSC to support the first four CRS flights. NASA has identified the cargo manifest for the near term CRS missions and is working with the CRS providers to integrate the cargo into the Dragon and Cygnus vehicles.

d. What is NASA's contingency plan if any of these CRS flights are further delayed?

ANSWER: There is sufficient margin in logistics, consumables and systems spares through early 2013 to protect ISS operations for a delay in the start of commercial cargo delivery. On May 22, 2012, SpaceX launched its second COTS demonstration flight, and three days later, the Dragon spacecraft was berthed to the ISS. The mission, which accomplished the remaining COTS demonstration goals for Space X, was brought to a successful conclusion on May 31, with the deorbiting and splashdown of the Dragon capsule. The second mission also demonstrated launch, orbit and successful recovery of a simplified Dragon spacecraft. Commercial Resupply Services (CRS) flights will augment existing resupply capability needed to support the crew on-orbit. Those needs continue to be met through the ESA-provided Automated Transfer Vehicle (ATV), the Roscosmos-provided Progress and Soyuz, and JAXA-provided H-II Transfer Vehicle (HTV) vehicles now that the Space Shuttle has been retired. The U.S. commercial providers are in the process of bringing their vehicles on-line to provide the needed resupply capability. Recognizing the challenges of initial flights and bringing a new vehicle into operations, NASA and its international ISS partners previously delivered additional supplies to accommodate any potential slips to the CRS schedule. The commercial strategy does not rely on a single flight or provider. In addition to SpaceX, OSC has one demonstration flight and one CRS flight scheduled in 2012.

5. Have the Research Transition Team (RTTs) been successful in ensuring that research and development needed for NextGen implementation is identified, conducted, and effectively transitioned from NASA to FAA?

ANSWER: Close coordination with its partners in other Government agencies is critically important for NASA Aeronautics. To enable greater and more timely support for the implementation of NextGen, NASA's Aeronautics Research Mission Directorate (ARMD) has formed Research Transition Teams (RTTs) with the FAA and Joint Planning and Development Office (JPDO) to identify the right technologies to develop and conduct well coordinated research including joint field trials to ensure relevancy and accelerate acceptance of new air traffic management tools and technologies. Initially, four RTTs were formed in 2008 for the technology areas where NASA and FAA jointly determined the close collaboration was essential. It is well recognized that the RTT construct has been vital to a success in accelerating transition of NASA developed technologies to FAA enabling FAA's much speedier evaluation and implementation. The four RTTs are described below including several examples of NASA technologies that have been recently transitioned or are about to be.

Under the Efficient Flow Into Congested Airspace (EFICA) RTT, NASA is creating new ways to tackle inefficient operations in congested airspace near terminal areas by improving legacy air traffic control procedures that limit the number of incoming aircraft an airport can handle. During a three-year collaborative effort with the FAA, Boeing, MITRE, Sensis/SAAB, United Airlines, and Continental Airlines, NASA developed and field tested a new capability called Efficient Descent Advisor (EDA) that gives air traffic controllers the ability to better manage incoming traffic in the most fuel efficient manner while ensuring that each aircraft meets its scheduled time for arrival, while avoiding flight path conflicts between aircraft. EDA helps to determine the best time and place to begin a plane's descent so that the plane can make a smooth gliding descent with the engines idling all the way down, saving fuel and making less noise as planes fly over neighborhoods.

The EDA technology was transferred to the FAA on November 30, 2011. The FAA Air Traffic Organization will evaluate the technology and determine the appropriate allocation of EDA functionality to systems and software builds for implementation in the mid-term (2014-2018) NextGen operations. If widely used across the country, the EDA tool has demonstrated the potential to reduce local noise and emissions, reduce flight time and save $300M per year in wasted jet fuel. Test results also showed significant reductions in controller workload, helping to maintain aviation's current outstanding safety record.

Under the Flow-Based Trajectory Management (FBTM) RTT, NASA and FAA researchers conducted work in tools and methods for in-flight "flow-based trajectory management" in NextGen. The FBTM is a set of new software tools and procedures that help air traffic controllers identify and deal with potential traffic issues that might occur in the upcoming 20 to 60 minutes of flight, such as congestion or bad weather. FBTM tools provide practical guidance for modifying flight paths, or trajectories, of one or more aircraft in the face of changing conditions. The concept of FBTM evolved through a series of studies that culminated in 2011 demonstrating an effective method for successful management of future aircraft operations at levels 30 percent greater than today. FBTM can also be integrated effectively into today's operations without additional controller resources. NASA transferred FBTM research results to the FAA in July 2011, where the technology will receive additional testing and evaluation. The FAA will use FBTM results to help develop and deploy traffic management and controller tools to be used in NextGen in the near future. The results support 10 out of 50 Operation Improvements as described in the FAA's NextGen Implementation Plan.

Under the Integrated Arrival/Departure/Surface (IADS) RTT, NASA is collaborating with the FAA to explore how to use NASA's Precision Departure Release Capability (PDRC) to improve the coupling of advanced airspace and surface traffic tools. PDRC allows precision scheduling of departing aircraft to allow for smooth integration into available slots in the high-altitude overhead streams. The FAA plans to incorporate PDRC in Traffic Flow Data Manager (TFDM) Concept Demonstration #2, which begins in October 2012. NASA will continue to work with the FAA TFDM team to support maturation of the PDRC technology for successful transition over the next year.

Under the Dynamic Airspace Concepts (DAC) RTT, NASA and FAA researchers are collaborating on far-term NextGen concepts for demand-capacity management. Under this RTT, NASA researchers have delivered results on the Corridors In The Sky concept to the FAA to help narrow the scope of needed research for far-term concepts on airspace management. This and other concepts for dynamic airspace allocation and structuring are at a lower level of maturity, and hence will require longer collaborative research efforts with the FAA before technology transition is feasible.

6. **You propose to restructure high-speed flight in the Aeronautics Research Mission Directorate. Although you are transferring hypersonics work pertaining to entry, descent and landing to the Space Technology office, you propose to eliminate research into air breathing propulsion systems.**

    - Since NASA's time horizon runs well into the next two or three decades, are we mortgaging our future by ignoring this possible flight regime for civilian flight?

    - What is the Administration's policy with regards to the hypersonics research needs of DOD? Instead of leveraging NASA's expertise and facilities, will DOD need to conduct a separate program? Have you discussed this matter with DOD and what are DOD's plans?

ANSWER: Hypersonic air-breathing technologies require significant further development and testing before they can eventually be utilized for civilian applications such as transportation or space access. The early steps in hypersonics technology development will be military applications. Therefore, NASA Aeronautics is focusing its remaining hypersonic research on efforts that directly support the DoD. Flight experience gained by the DoD will be leveraged by NASA and will be critical for advancing this field for civilian applications. Specifically, NASA is reducing funding for hypersonics research related to air-breathing systems, including propulsion technologies and structurally integrated thermal protection systems. We are, however, maintaining some critical national capabilities related to scramjet propulsion and core competencies to provide support for both Agency and DoD missions. NASA's Space Technology Program will assume responsibility for the fundamental research associated with Entry, Descent, and Landing (EDL). NASA Aeronautics' hypersonic investment will support the NASA Langley Research Center's 8-ft High Temperature Tunnel because it is a key facility for the DoD's hypersonic programs.

NASA is also actively working with the DoD to minimize the impact of these decisions on their missions. NASA has already met with senior DoD officials who agree that the NASA investment does align with the highest hypersonic priorities in the DoD. NASA

is aware of the DoD plans to expand research in hypersonic flight systems and is continuing to discuss options to optimize this collaboration. In the same way that NASA supported the development of the USAF X-51 system, we expect DoD collaboration and coordination to continue.

In the meantime, NASA ARMD is focusing its resources on other civil aviation transportation priorities. These include a number of future vehicle types including advanced rotorcraft, civil transports and even supersonic airplanes.

Congresswoman Donna Edwards

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration
Budget for Fiscal Year 2013

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1. **When NASA first contracted for cargo resupply services for the International Space Station, initial service flights were anticipated to begin in 2010. At present, the two companies involved are between 20-34 months behind schedule in carrying out the COTS cargo demonstration flights, a necessary precursor to providing actual services.**

   a. **Since the COTS program also was carried out under Space Act Agreements, what do these delays to commercial cargo demonstration flights say about likelihood of the private sector's meeting NASA's 2017 schedule for operational commercial crew flights?**

ANSWER: The schedule delays experienced by our partners over the life of the Commercial Orbital Transportation Services (COTS) program are indicative of the challenges associated with developing and flying new, highly complex launch vehicles and spaceflight systems. The magnitude of the delays is also not outside NASA's experience on previous developmental efforts.

NASA is working with both COTS partners to facilitate their development activities and overcome schedule issues. However, safe and successful spaceflight is the primary objective, not schedule.

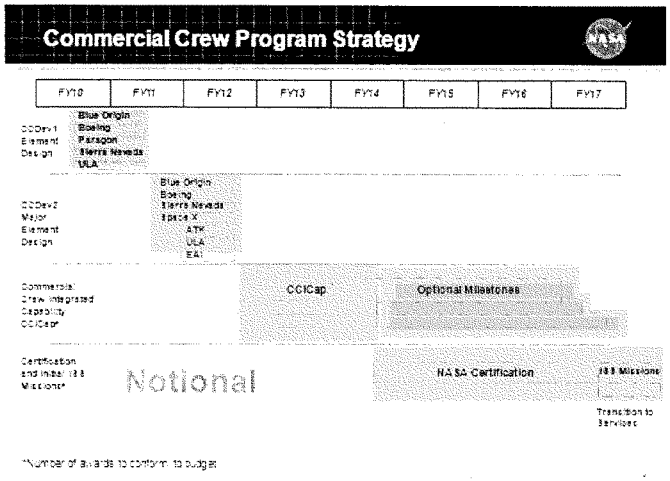
Similarly, the goal of the Commercial Crew Program is also safe and successful spaceflight. Variations from the pre-negotiated milestone dates will be addressed immediately by the Commercial Crew Program Office, along with discussions or documentation to ensure a complete understanding of the reasons for any changes. In some cases, this could result in the planned date of a milestone being changed. With the overall goal of success firmly in mind, the Program Office will work with commercial partners when the results of the partners' efforts to accurately predict the progress of an aggressive and years-long development activity need to be adjusted.

In addition, most of the current commercial providers have indicated that they believe they can be ready prior to 2017. However, NASA's assessment has led to a more conservative estimate of 2017, including predicted budget authority, although earlier delivery of services will not be precluded.

   b. **In establishing 2017 as the new date of when operational commercial crew services will be available, has NASA incorporated all acquisition-related steps that need to be followed by the government in the development and**

procurement of such services? For example, does the timeline account for activities such as solicitation preparation and release; contract competition, award, negotiation, potential protest resolution; and certification for operations involving U.S. astronauts before commencing commercial crew transport services to the International Space Station in 2017? Please provide the steps included in the timeline and estimated time required for the completion of each step.

ANSWER: NASA has incorporated all the necessary acquisition-related steps that need to be followed in order to establish a planned operational date of 2017 for commercial crew services. The steps and timeline are shown in the graphic below, assuming adequate budgets and technical progress on the part of the commercial partners. Details in this strategy are being further refined.



b. Does the schedule estimate include any contingency margin for unanticipated delays, given the COTS cargo demonstration program participants have experienced delays to date of between 20 and 34 months? If so, how much margin has been included, and if not, why not?

ANSWER: NASA believes it has included margin for longer than anticipated development schedules. As mentioned above, most of the current commercial providers have indicated that they believe they can be ready prior to 2017. However, NASA's assessment has led to a more conservative estimate of 2017. Given that there are multiple systems in development and each one has its own development schedule, there is not a specific quantitative amount of margin that has been applied to the above schedule. The schedule above reflects NASA's

current, best assessment of when commercial crew services missions will be accomplished, assuming adequate budgets and technical progress on the part of the commercial partners.

2. The Administration appears to insist on a level of rigor in establishing the potential cost of SLS that is not expected for the commercial crew program. Why does the Administration continue to request significantly more funding than authorized for commercial crew without requiring a comparable level of rigor in cost assessment? What would you estimate the confidence level of your cost estimate for the commercial crew program, to be, and on what do you base that confidence level?

ANSWER: During the FY 2013 budget development process, NASA strove to strike the right balance between all our human spaceflight capabilities. As the primary means of U.S. access to the ISS, NASA wanted to take all steps necessary to provide assured crew access to the ISS and to eliminate our sole reliance on foreign systems.

NASA does not have a "confidence level" associated with the Commercial Crew Program, as the budget was not and cannot be developed with a traditional confidence level. Confidence levels are obtained when using a parametric cost estimating tool that leverages multiple, historical data points for costs for comparable hardware elements. Given that NASA does not have multiple, historical data points to compare (the nearest analogy to a commercial crew system is NASA's Gemini program), traditional cost estimating tools are not appropriate. In addition, NASA is using a unique and innovative acquisition strategy, which we believe, will produce a crew transportation system for significantly lower costs than predicted using traditional models. NASA's understanding of the cost will be improved after seeing the bids from the potential providers, performing analysis on their cost estimates and developing estimates for the cost of certification.

2. NASA justifies its last minute switch to using Space Act Agreements instead of FAR-based contracts in part on the need to accommodate multiple partners.

a. For the purposes of the commercial crew program, what is your definition of multiple"?

ANSWER: NASA believes that having multiple companies competing against each other at this stage of the Commercial Crew Program will result in lower overall costs for the Government. In a traditional program with a single prime contractor from the start using a cost-plus contract, the NASA-Air Force Cost Model (NAFCOM) cost estimates are approximately $8-11 billion for the development of an ISS crew transportation capability. Using the current, innovative approach with fixed Government costs, investment from industry, and maintaining competition – NASA estimates being able to cut the development costs substantially and deliver an ISS capability for around $5 billion. Maintaining competition is a key factor in achieving these savings.

NASA plans to have two to three companies involved in the next phase of SAAs, we believe the competitive environment provides strong incentive for the companies to align with NASA's

certification requirements in order to remain competitive in the future certification and services phases.

b. What funding level is needed to accommodate multiple partners through design and development of commercial crew systems that is, having them ready for certification? Please provide the basis for that estimate.

ANSWER: NASA believes the President's FY 2013 Budget Request is needed to accommodate multiple partners through design and development of commercial crew systems. The Agency has not specified an exact number of partners for the next phase of the program; however, NASA plans to make multiple awards, depending on the quality, number, and overall portfolio benefits of the proposals received.

For the purposes of developing the budget request, NASA estimated a range of potential CCiCap awards from $300-500M per partner. It is assumed this range will support a portfolio of multiple partners. However, the actual proposals and resulting negotiations will determine how many partners may be accommodated. There are multiple ways NASA could fund the awards by using part or all of FY 2013 and FY 2014 appropriations.

4. Why has NASA now decided not to have an independent cost and schedule estimate performed for the commercial crew program, despite last fall's statements that one would be done?

ANSWER: The Commercial Crew Program continues to refine its cost estimates for the development effort. Since the Agency decided to implement the next phase of the program under Space Act Agreements (SAAs) instead of contracts, the cost modeling and cost estimates are being reworked. Under a SAA, the partner is paid pre-negotiated fixed amounts upon successful completion of milestones, not based on costs incurred. The CCiCap Announcement for Proposals asks the bidders to estimate their total cost to reach a state of a demonstrated crew flight. As a part of the solicitation effort for CCiCap, NASA will perform independent reviews of bidders' costs and schedules for validity and comprehension to support the CCiCap evaluation.

Once the CCiCap awards are made, during the summer of 2012, NASA will further refine its total cost estimates for development, including the value of performance milestones under CCiCap, and the NASA Certification effort required to complete design and development and finally readiness for services. This effort will be done in the FY 2013 timeframe and at that point, NASA intends to employ an independent cost and schedule estimate. At that time, NASA should have the detailed data necessary for a valid independent cost estimate to be accomplished. The independent review will be incorporated into the Agency's plans prior to any award for a certification contract for commercial crew systems.

Congressman Brad Miller

March 7, 2012 Hearing
on
An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2013

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1. **Administrator Bolden, NASA Policy Directive 1050.1!, which deals with the use of Space Act Agreements, states the following:**

   "Funded Agreements may be used only when the Agency's objective cannot be accomplished through the use of a procurement contract, grant, or cooperative agreement."

   NASA has decided to use Space Act Agreements in the next round of Commercial Crew acquisition. This decision was a reversal from an earlier decision to use regular FAR- based contracts for this round of Commercial Crew acquisition.

   Can you explain why the decision was made to switch from a FAR based procurement to a Space Act Agreement-based procurement, and does that rationale comport with NASA's own policy directives on the use of such agreements?

ANSWER: The FY 2012 Consolidated and Further Continuing Appropriations Act provided NASA with $406M for the Commercial Crew Program, which was less than half of the President's Budget Request and may have required NASA to award a single contract for the previously planned Integrated Design Contract (IDC) phase. The Conference Report accompanying the FY 2012 Appropriations Act stated, "NASA is directed to work expeditiously to alter its management and acquisition strategy for the program as necessary to make the best use of available resources and to define the most cost effective path to the achievement of a commercial crew capability."

Upon performing a reassessment as directed, NASA determined that the most cost effective path to the achievement of a commercial crew capability in light of the $406M appropriation in FY 2012, and the uncertainty associated with the FY 2013 budget levels, was to alter the Commercial Crew Program acquisition strategy. Rather than moving forward with awarding a single firm-fixed price contract for IDC, which would remove future competition for follow-on Certification phase of the program, NASA will continue to support the design and development of commercial crew transportation through the use of multiple funded Space Act Agreements (SAAs). NASA will shift the formal design acceptance and certification planning acceptance to the follow-on Certification Phase. Utilizing SAAs for the next phase provides tangible benefits in terms of cost and schedule flexibility in comparison to FAR-based contracts. SAAs are also

expected to provide more flexibility to deal with possible variations in funding levels without the need for potentially protracted and inefficient contract renegotiations. NASA believes this change is consistent with all applicable laws and policy directives.

Appendix 2

Additional Material for the Record

ADDITIONAL MATERIAL FOR THE RECORD

Additional Material Submitted by Hon. Charles F. Bolden, Jr., as Requested During Hearing

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

Reply to Attn of: OLIA/2012-00219&00233:MDC:eel

June 28, 2012

The Honorable Ralph M. Hall
Chairman
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Chairman Hall:

Enclosed is the edited transcript and material requested for the record and responses to written questions submitted by you, Representatives Johnson, Rohrabacher, Neugebauer, Costello, Edwards and Miller resulting from the March 7, 2012, hearing at which Administrator Bolden testified regarding "*An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2012*". This material completes the information requested during that hearing.

Sincerely,

Seth Statler

L. Seth Statler
Associate Administrator
for Legislative and Intergovernmental Affairs

Enclosures

Material requested for the record on page 34, line 772, by Cong. Miller during the March 7, 2012, hearing.

The post-employment restrictions of the Procurement Integrity Act (41 USC § 423, as amended), which prohibit former Federal employees who perform certain duties related to Federal contracting from accepting a position with a contractor benefiting from particular agency decisions for a year, only apply to government contracts to obtain goods or services under Title 41 of the U.S. Code. Accordingly, they do not apply to grants, cooperative agreements, and other instruments to which the U.S. Government is a party such as Space Act agreements. We note additionally that NASA is not using Space Act agreements to acquire commercial crew capabilities, but to support the development of commercial services that could eventually provide access to low-Earth orbit. However, the broad restrictions on post-employment representational activities contained in 18 U.S.C. § 207 apply with equal force to contracts and Space Act agreements, and in NASA's experience are more likely to result in restrictions affecting an employee's post-employment options than the restrictions in the Procurement Integrity Act. Accordingly, NASA believes that the post-employment restrictions contained in 18 U.S.C. § 207 provide appropriate protection for the U.S. Government for non-procurement matters, such as Space Act agreements.

Material requested for the record on page 46, line 1074, by Rep. Edwards during the March 7, 2012, hearing.

NASA's overall approach for the next phase of the Commercial Crew program is a non-traditional approach using funded Space Act Agreements (which we have used previously in the Commercial Orbital Transportation Services program and other partnership activities). The approach is characterized by fixed government costs, milestone payments, investment from industry, and competition. In addition to the space act phase, NASA will procure certification assurance and services under a more traditional government contracting, FAR-based model. Using this hybrid approach, NASA estimates being able to cut the development costs substantially and deliver an ISS capability by 2017–without precluding earlier service- for approximately $5B (consistent with the FY 2013 President's budget request). NASA has continued to apply principles that support the successful implementation of an acquisition strategy aimed at maximizing value for taxpayer investments through competition. This requires NASA's commitment to support multiple systems as far along through development as possible, to capture the direct value of competition.

Since NASA is not using a traditional acquisition approach and there are few historical spacecraft that are analogous to a crew transportation system, NASA did not use NASA/Air Force Cost Modeling (NAFCOM) cost estimates to develop the commercial crew budget requests. NASA performed a NAFCOM cost estimate on the Falcon 9 launch vehicle and the results were several times higher than SpaceX's actual costs, which suggests that NAFCOM cost estimating may not be an appropriate tool for estimating costs for non-traditional development such as commercial crew. NASA has instead continued to refine an estimate of the required government investment to successfully develop a commercial crew capability for several years using a variety of inputs. NASA's budget request for the program drew from the following sources:

- Industry inputs adjusted by Aerospace Corporation
- Gemini historical experience (39 months, $2.5–3B)
- Commercial Crew Request for Information – May 2010 ($1–8B range, with the average around $3B)
- Various data inputs from industry partners participating in Commercial Crew Development 1 and Commercial Crew Development 2 (mostly technical data which fed into new cost models)
- Performance of the commercial cargo providers on similar but different tasks

Further, NASA has continued to receive detailed information from potential commercial partners and independent analysis, providing a general range of $2.5 - $3B per system. NASA has received other data from industry in more formal settings, including: Industry Days, Program Forums, and One-on-One Meetings with potential commercial crew transportation system providers. All these data appeared to substantiate this estimate range for full commercial crew development costs. Ranges of proportional industry

investment were between 10 percent and 20 percent, while some were above 50 percent. In September 2011, NASA was provided an external assessment by Booz Allen Hamilton, which found that NASA's estimates for commercial crew development were reasonable.

In February 2012, NASA announced an effort known as Commercial Crew Integrated Capability (CCiCap). The overall CCiCap strategic goal is to advance integrated commercial crew transportation system concepts to the stage of an orbital-crewed demonstration flight capability as soon as possible and maintain crew safety while considering additional potential customer standards. NASA plans to award two to three funded Space Act Agreements in the July/August timeframe after which NASA will be able to further refine estimates of future funding requirements.

Letter to Chairman Ralph M. Hall from Charlene M. Anderson
Associate Director, The Planetary Society

THE PLANETARY SOCIETY
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March 7, 2012

The Honorable Ralph M. Hall
Chairman
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

Dear Rep. Hall:

The Planetary Society is deeply troubled with the priorities reflected in NASA's FY13 budget. If implemented, it will portend grave consequences for our nation's ability to conduct deep-space science missions and could irreversibly erode unique aspects of the space industrial base needed for such missions.

Specifically, the disproportionate cut to the Planetary Science budget would force NASA to walk away from planned missions to Mars, to back out of international agreements with the European Space Agency (ESA), delay for decades any flagship missions to the outer planets, and radically slow the pace of scientific discovery, including the search for life on other worlds. We think this is the wrong direction for America's space program.

Planetary Science is the part of NASA that's actually conducting interesting and scientifically important missions. Spacecraft sent to Mars, Saturn, Mercury, the Moon, comets, and asteroids have been making incredible discoveries, with more to come from recent launches to Jupiter, the Moon, and Mars. The country needs more of these robotic space exploration missions, not fewer.

For the first time in human history, we have the tools available to directly test the hypothesis of whether there is, or has been, life on other worlds such as Mars or Europa. Such a discovery would be a seminal event in human history and would have a deep and profound impact on how we view our place in the Universe, much as Copernicus sparked the Age of Enlightenment 500 years ago with his theory that the Earth orbits the Sun, just like any other planet. We stand at the dawn of a similar period in which our knowledge and understanding of the Universe is poised to take another giant leap forward.

We understand that NASA is undertaking a review to examine options for potential future Mars missions and we support efforts to put the program back on track, but we are also adamant that decisions for future planetary missions be guided by the most recent Planetary Science Decadal Survey of the National Research Council. It took almost two years to forge a consensus of 1700 planetary scientists and should not be dismissed or watered-down. NASA's science programs have achieved great successes based on the decadal-survey process and all should be reluctant to abandon it.

While it may appear attractive to develop an integrated strategy for Mars science missions and an eventual human mission to Mars, the lack of clear goals and tangible program plans on the human side suggests the discussion is premature, at best.

We recognize the intense fiscal and budget pressure the country faces. We understand that agency programs are receiving unprecedented scrutiny and that budgets are shrinking. However, today's budget environment is also an opportunity to take stock of what's working and what's not working, and to adjust priorities.

Today, approximately 27 percent of NASA's budget goes to Science, with 8 percent of NASA's total going to Planetary Science. The human spaceflight program (SOMD+ESMD) consumes about 45 percent of NASA's budget, and the remaining 28 percent goes to aeronautics, technology and infrastructure. The Planetary Society is a strong supporter of both human and robotic space exploration and a strong advocate for investments in technology. However, given the impacts of the proposed FY13 budget, some adjustments are needed.

Specifically, the Planetary Society recommends reallocating approximately 3 percent from within NASA's total budget to rebaseline the share for Science to at least 30 percent, and restoring the $300 million cut to Planetary Science to fund it at $1.5 billion. This modest rebalancing will allow NASA to fully implement the decadal survey for Planetary Science, send a mission to Mars and prepare for missions to the outer planets, while allowing NASA to continue a robust program of missions in Earth Science, Astronomy and Heliophysics.

We arrive at this conclusion primarily because NASA's Science program currently has an abundance of compelling world-class science missions with clearly defined mission goals and carefully crafted program plans that are poised to move out. We believe that a healthy and vibrant Science program is an excellent investment that will energize, engage, and inspire the next generation of scientists, engineers, educators and the public, as has been the case with the Mars rovers and many other missions. The diversity and frequency of science mission opportunities laid out by the decadal survey will significantly contribute to thousands of high-tech jobs in the aerospace industry, at research laboratories, and in universities. These programs

will stimulate the best and brightest with interesting and meaningful scientific and technical challenges that will make our nation stronger and more competitive.

While we recognize these are difficult choices, we believe an increase in the share of the NASA budget for Science to 30 percent is the best place for the agency to make the most effective use of the taxpayers' money at this time and in today's budget environment.

We are at the brink of the next revolution in scientific understanding. A great government will lead this pursuit and makes these investments because it will make a difference to our society and to our children.

Thank you for your consideration.

Sincerely,

Charlene M. Anderson
Associate Director

Additional Information

Human Exploration

Exploration Systems Development
Exploration Systems Development is responsible for designing and building three capabilities that will form the centerpiece of America's future space exploration beyond Earth's orbit. These systems will enable long-term human exploration of the Moon, asteroids, or other destinations in the Solar System such a Mars. The NASA Authorization Act of 2010 also directs NASA to develop these systems as a backup to reach low Earth orbit to service the International Space Station if commercial or Russian systems are unavailable. The Exploration Systems consist of the Space Launch System heavy lift rocket, the Orion Multi Purpose Crew Vehicle, and the associated Exploration Ground Systems necessary to prepare the systems for launch. NASA is planning for an initial test launch of the SLS and Orion in 2017.

The president's FY2013 request for Exploration Systems Development is $2.77 billion, a decrease of $237.7 million or -7.9 percent from the FY2012 estimate. The Orion Multi Purpose Crew vehicle sees the largest decrease, going from $1.2 billion in FY2012 down to $1.02 billion in FY2013, a -14.6 percent reduction. The Administration cuts the Space Launch System budget from $1.8 billion in FY2012 down to $1.74 billion in FY2013, a reduction of -3.5 percent. The Administration increases the Exploration Ground Systems budget from $304 million in FY2012 to $404 million in FY2013, an increase of $100 million or 32.8 percent.

Commercial Spaceflight
Similar to the two account approach used by NASA since 2006 to develop systems for cargo delivery to the ISS using the Commercial Orbital Transportation Services (COTS) and Cargo Resupply Services (CRS) programs, NASA plans to fund the commercial crew development activities out of two separate budget accounts. NASA's Exploration account funds the partial development of commercial systems with the commercial partners contributing varying amounts of their own money, and NASA uses the Space Operations account (which will be discussed later) to procure transportation services on a fixed price basis.

[Maybe this paragraph is unnecessary, but I tried to explain the funding situation using a familiar example]
Using the commercial cargo program as an example, since 2006 NASA has used the Commercial Orbital Transportation Services program to fund the commercial participants development of a capability demonstration to deliver supplies to the International Space Station. Most of that funding has been paid out in prior years and will stop completely in FY2012 with NASA hopeful that those initial demonstration flights to the ISS occur later this year. NASA uses a different account, the Space Operations account, to procure transportation services on a fixed price basis, and since 2008 NASA's Cargo Resupply Services program has funded the procurement of commercial cargo services (although no demonstrations to ISS have yet taken place) and has spent $835 million on CRS thus far.

Similarly, NASA's Commercial Crew program is working with commercial partners to develop the systems necessary to transport human astronauts to and from the ISS in the 2017 timeframe. NASA has funded space act agreements with various commercial partners and plans to

additional awards to multiple providers for further commercial crew systems development later this year.

The president's FY2013 request for commercial crew is $830 million, an increase of $424 million, or 104 percent above the FY2012 estimate.

Exploration Research and Development

NASA's Exploration Research and Development studies advanced exploration systems necessary to enable extended human space exploration. The program is comprised of two parts. The first is the Human Research Program which in 2011 flew 11 major medical experiments and added new ISS biomedical capabilities like second generation ultrasound for medical imaging, and the jointly developed ESA/NASA muscle atrophy research and exercise system. The second is the Advanced Exploration Systems program which began in 2012 and continues several of the Exploration Technology Development and Demonstration projects such as portable life support systems for advanced space suit and radiation assessment detector for the Mars Science Lab.

The president's FY2013 request for Exploration Research and Development is $334 million, and increase of $34 million, or 11.3 percent above the FY2012 estimate of $299.7 million.

Space Operations

Space Shuttle

In July 2011, the Space Shuttle flew its final mission following the completion and re-supply of the ISS. In FY2012 and FY2013 the Space Shuttle program undergoes final transition, retirement, and disposition of program assets. In FY2013 the Space Shuttle program will focus on identifying assets that can be transferred to future exploration programs and dispositioning property no longer needed. This includes the processing and delivery in FY2012 of the Space Shuttle orbiters for museum displays.

The president's FY2013 request is $70.6 million, a decrease of $485.6 million or 87.3 percent from the FY2012 estimate. The FY2012 estimate included a one-time payment of $470 million for pension requirements related to the close out of the program that are not included in FY2013.

International Space Station

The ISS is now a functional, permanently crewed research laboratory and technology test bed for exploration and international cooperation, as well as a National Laboratory for non-NASA and potential nongovernmental users. The NASA Authorization Act of 2010 directs NASA to take actions "*necessary to ensure the safe and effective operation, maintenance and maximum utilization of the U.S. segment of ISS through at least September 30, 2020.*" Now that assembly is complete, NASA faces a critical window for ISS utilization and research before a potential program end date of 2020. The Administration's request provides for continuous operations and ensures adequate maintenance to ensure the ISS remains viable as a National Lab through 2020. As noted earlier, funding to procure commercial crew or cargo transportation is in the ISS Crew and Cargo Transportation project within the ISS budget.

The president's FY2013 budget request for the International Space Station is $3.0 billion, an increase of $178 million, or 6.3 percent above the FY2012 estimate of $2.83 billion.

Space and Flight Support

Space and Flight Support comprises multiple programs providing capabilities that play critical roles in several NASA missions. For example, the 21st Century Space Launch Complex program funds modernization at the Kennedy Space Center and Cape Canaveral Air Force Station to benefit multiple users. The Space Communications and Navigation program operates NASA's extensive network of ground-based and orbiting communications hardware and software necessary to receive the vast quantities of data generated by NASA's fleet of crewed vehicles and robotic spacecraft. The Human Space Flight Operations (HSFO) program ensures that NASA's astronauts are prepared to safely carry out current and future missions. The Launch Support Program supports various NASA missions that require expendable launch vehicle services. The Rocket Propulsion Test program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners. Together these efforts comprise the Space and Flight Support segment of NASA's budget.

The president's FY2013 budget request for Space and Flight Support is $935 million, an increase of $134 million, or 16.7 percent above the FY2012 estimate of $801 million.

NASA's aeronautics programs are conducted by the Aeronautics Research Mission Directorate (ARMD) and focus on long-term investments in fundamental aeronautics research to improve aviation safety, efficiency and air traffic management. The ARMD includes four NASA centers: NASA Ames Research Center, NASA Dryden Flight Research Center, NASA Glenn Research Center and NASA Langley Research Center.

The ARMD FY13 budget request represents a 3.1% decrease in funding from the previous year, dropping from $569.4M in FY12 to $551.5M in FY13. Major porgramatic changes this year include combining funding for hypersonic research with supersonic research and the transfer of "entry, descent and landing" (EDL) research to the Space Technology account. The transfer of EDL research accounts for a significant amount of the ARMD funding reduction in FY13.

Aeronautics Research Mission Directorate Budget

FY11 Actual	FY12 Estimate	FY13 PBR	FY14 PBR	FY15 PBR	FY16 PBR	FY17 PBR
$533.5M	$569.4M	$551.5M	$551.5M	$551.5M	$551.5M	$551.5M

The ARMD program areas include;

- **Aviation Safety** – develops technologies to improve current and future aircraft safety and address safety challenges for the Next Generation Air Transportation Program (NextGen).
- **Airspace Systems** – conducts research in NextGen technologies that will allow increases in capacity, efficiency, and flexibility of the National Airspace System (NAS).
- **Fundamental Aeronautics** – develops technologies and concepts to reduced aircraft noise, improve efficiency and increase air travel flexibility.
- **Aeronautics Test Program** – manages NASA's aeronautics test capabilities in partnership with the Department of Defense.
- **Integrated Systems Research Program** – conducts integrated system-level research to accelerate transitioning into major aircraft and operations systems.
- **Aeronautics Strategy and Management** – identifies new innovative aviation concepts through "seedling funds" that provide research and analysis of early stage concepts.

The NASA Authorization Act of 2010 stated that "NASA aeronautics research should be guided by, and consistent with, the National Aeronautics Research and Development Policy that guides the Nation's aeronautics research and development activities." To that end, the Authorization Act directed NASA to collaborate with the Department of Defense on aeronautics R&D and the Federal Aviation Administration (FAA) on NextGen. The bill also authorized $590M in FY13 and directed NASA ARMD to pursue three fundamental goals, including;

> (1) AIRSPACE CAPACITY.—NASA's Aeronautics Research Mission Directorate shall address research needs of the Next Generation Air Transportation System, including the

ability of the National Airspace System to handle up to 3 times the current travel demand by 2025.

(2) ENVIRONMENTAL SUSTAINABILITY.—The Directorate shall consider and pursue concepts to reduce noise, emissions, and fuel consumption while maintaining high safety standards and shall pursue research related to alternative fuels.

(3) AVIATION SAFETY.—The Directorate shall proactively address safety challenges with new and current air vehicles and with operations in the Nation's current and future air transportation system.

Over the last decade, the budget for ARMD has shrunk from a peak of approximately $1B to just $551.5M in the FY13 President's request and remains flat in the budget run out over the next 5 years. Significant reductions in ARMD infrastructure and personnel have reduced necessary funding levels but a key question remains as to the impact on its mission areas.

Cross Agency Support Program

	FY11 Actual	FY12 Estimate	FY13 Request	FY13 Req vs. FY12 Est $$$	FY13 Req vs. FY12 Est %%%
Cross Agency Support TOTAL	**2,956.4**	**2,993.9**	**2,847.5**	**-146.4**	**-4.9%**
Center Mang & Operations	2,189.0	2,204.1	2,093.3	-110.8	-5.0%
Agency Mang & Operations	767.4	789.8	754.2	-35.6	-4.5%

($ = Billions)

The Cross Agency Support Program accounts for about 16% of NASA's budget. It is comprised of two separate activities, noted in the table above. Center Management and Operations funds the maintenance and operation of facilities at the individual centers, the workforce, equipment, tools, and other resources needed to ensure program execution. Agency Management and Operations funds headquarters activities such as management and oversight of agency missions, programs, functions, and performance of NASA-wide mission support activities.

For FY13, NASA proposes to reduce Cross Agency Support Program by almost 5%, mostly through ongoing efforts to scale back basic services such as IT support, and facilities maintenance and repair. Efforts are now underway to 'right-size' agency facilities, such as consolidating redundant capabilities, mothballing an under-utilized wind-tunnel, and closing facilities are associated with the Shuttle program.

National Aeronautics and Space Administration
President's FY 2012 Budget Request Summary

Budget Authority, $ in millions
By Appropriation Account
By Theme
By Activity

	FY2012 Request	FY2012 Estimate	FY2013 Request	FY2013 v FY2012 Est $$$	FY2013 v FY2012 Est %%%
Science	**5,016.8**	**5,073.7**	**4,911.2**	**-162.5**	**-3.2%**
Earth Science	1,797.4	1,760.5	1,784.8	24,3	1.4%
Planetary Science	1,540.7	1,501.4	1,192.3	-309.1	-20.6%
Astrophysics	682.7	672.7	659.4	-13.3	-2.0%
James Webb Space Tel.	373.7	518.6	627.6	109.0	21.0%
Heliophysics	622.3	620.5	647.0	26.5	4.3%
Aeronautics	**569.4**	**569.4**	**551.5**	**-17.9**	**-3.1%**
Space Technology	**1,024.2**	**573.7**	**699.0**	**125.3**	**21.8%**
Exploration	**3,948.7**	**3,712.8**	**3,932.8**	**220.0**	**5.9%**
Human Exploration Cap.	2,810.2	3,007.1	2,769.4	-237.7	-7.9%
Space Launch Syst	*1,800.0*	*1,807.1*	*1,744.5*	-62.6	-3.5%
Multi-Purpose Crew Veh	*1,010.2*	*1,200.0*	*1,024.9*	-175.1	-14.6%
Commercial Spaceflight	850.0	406.0	829.7	423.7	104.4%
Exporation R&D	288.5	299.7	333.7	34.0	11.3%
Space Operations	**4,346.9**	**4,187.0**	**4,013.2**	**-173.8**	**-4.2%**
Space Shuttle	664.9	556.2	70.6	-485.6	-87.3%
ISS	2,841.5	2,829.9	3,007.6	177.7	6.3%
Space & Flight Support	840.6	800.9	935.0	134.1	16.7%
Education	**138.4**	**136.1**	**100.0**	**-36.1**	**-26.5%**
Cross-Agency Support	**3,192.0**	**2,993.9**	**2,847.5**	**-146.4**	**-4.9%**
Construction & Envir. Compliance and Restoration	**450.4**	**487.0**	**619.2**	**132.2**	**27.1%**
Construction of Facilities	397.9	441.3	552.8	111.5	25.3%
Envir. Compliance	52.5	45.6	66.4	20.8	45.6%
Inspector General	**37.5**	**38.3**	**37.0**	**-1.3**	**-3.4%**
NASA TOTAL	**18,724.3**	**17,770.0**	**17,711.4**	**-58.6**	**-0.3%**
		17,771.9			

FY2012 Budget Request					FY2013 Budget Re		
FY2013 Notional	FY2014 Notional	FY2015 Notional	FY2016 Notional	5 Year Total	FY2014 Notional	FY2015 Notional	FY2016 Notional
5,016.8	**5,016.8**	**5,016.8**	**5,016.8**	**25,084.0**	**4,914.4**	**4,914.4**	**4,914.4**
1,821.7	1,818.5	1,858.2	1,915.4	9,211.2	1,775.6	1,835.5	1,826.2
1,429.3	1,394.7	1,344.2	1,256.8	6,965.7	1,133.7	1,102.0	1,119.4
758.1	775.5	779.8	810.9	3,807.0	703.0	693.7	708.9
375.0	375.0	375.0	375.0	1,873.7	659.1	646.6	621.6
632.7	653.0	659.7	658.7	3,226.4	643.0	636.7	638.3
569.4	**569.4**	**569.4**	**569.4**	**2,847.0**	**551.5**	**551.5**	**551.5**
1,024.2	**1,024.2**	**1,024.2**	**1,024.2**	**5,121.0**	**699.0**	**699.0**	**699.0**
3,948.7	**3,948.7**	**3,948.7**	**3,948.7**	**19,743.5**	**4,076.5**	**4,076.5**	**4,076.5**
2,810.2	2,810.2	2,810.2	2,810.2	14,051.0	2,913.1	2,913.1	2,913.1
--	--	--	--		*1,884.9*	*1,884.9*	*1,884.9*
--	--	--	--		*1,028.2*	*1,028.2*	*1,028.2*
850.0	850.0	850.0	850.0	4,250.0	829.7	829.7	829.7
288.5	288.5	288.5	288.5	1,442.5	333.7	333.7	333.7
4,346.9	**4,346.9**	**4,346.9**	**4,346.9**	**21,734.5**	**4,035.1**	**4,035.1**	**4,035.1**
79.7	0.8	0.8	0.9	747.1	0.0	0.0	0.0
2,960.4	3,005.4	3,098.0	3,174.8	15,080.1	3,177.6	3,170.9	3,212.8
1,306.8	1,340.7	1,248.1	1,171.2	5,907.4	857.5	864.2	822.3
138.4	**138.4**	**138.4**	**138.4**	**692.0**	**100.0**	**100.0**	**100.0**
3,192.0	**3,192.0**	**3,192.0**	**3,192.0**	**15,960.0**	**2,847.5**	**2,847.5**	**2,847.5**
450.4	**450.4**	**450.4**	**450.4**	**2,252.0**	**450.4**	**450.4**	**450.4**
384.0	359.5	362.9	360.0	1,864.3	359.5	362.9	360.0
66.4	90.9	87.5	90.4	387.7	90.9	87.5	90.4
37.5	**37.5**	**37.5**	**37.5**	**187.5**	**37.0**	**37.0**	**37.0**
18,724.3	**18,724.3**	**18,724.3**	**18,724.3**	**93,621.5**	**17,711.4**	**17,711.4**	**17,711.4**

quest FY2017 Notional	5 Year Total	FY13 v FY12 Runouts $$$	 %%%
4,914.4	**24,568.8**	**-515.2**	**-2.1%**
1,772.8	8,994.9	-216.3	-2.3%
1,198.8	5,746.2	-1,219.5	-17.5%
710.2	3,475.2	-331.8	-8.7%
571.1	3,126.0	1,252.3	66.8%
661.6	3,226.6	0.2	0.0%
551.5	**2,757.5**	**-89.5**	**-3.1%**
699.0	**3,495.0**	**-1,626.0**	**-31.8%**
4,076.5	**20,238.8**	**495.3**	**2.5%**
2,913.1	14,421.8	370.8	2.6%
1,884.9	*9,284.1*	--	--
1,028.2	*5,137.7*	--	--
829.7	4,148.5	-101.5	-2.4%
333.7	1,668.5	226.0	15.7%
4,044.1	**20,162.6**	**-1,571.9**	**-7.2%**
0.0	70.6	-676.5	-90.6%
3,243.3	15,812.2	732.1	4.9%
800.8	4,279.8	-1,627.6	-27.6%
100.0	**500.0**	**-192.0**	**-27.7%**
2,847.5	**14,237.5**	**-1,722.5**	**-10.8%**
450.4	**2,420.8**	**168.8**	**7.5%**
360.0	1,995.2	130.9	7.0%
90.4	425.6	37.9	9.8%
37.0	**185.0**	**-2.5**	**-1.3%**
17,720.4	**88,566.0**	**-5,055.5**	**-5.4%**

Office of Education

The FY 2013 President's request for NASA's Education program is $100M, a $36.1M decrease from the FY12 estimated budget of $136.1M. The proposed budget run out for five years is flat at $100M. The FY13 request includes:

- Science, Technology, Engineering and Mathematics (STEM) Education and Accountability
  - $37M for STEM Education and Accountability projects;
  - $30M for the Minority University Research and Education Program (MUREP);
- Aerospace Research and Career Development
  - $24M for the National Space Grant College and Fellowship Program (Space Grant); and
  - $9M for the Experimental Program to Stimulate Competitive Research (EPSCoR).

The budget request aligns the projects within the priorities of the OSTP STEM Committee five-year strategic plan. The Office of Education proposes to allocate 63 percent of its funding in support of Space Grant, EPSCoR, and MUREP with the remaining funds supporting education efforts at NASA Centers and grantees.

The STEM Education and Accountability program was established as a new programmatic structure in FY12. The program provides funding for NASA-unique STEM education opportunities, including internships, launch initiatives, grants and provides students and educators with NASA's STEM content. The program also supports a competitive process for science museums, NASA centers and planetariums to enhance education and outreach activities related to space exploration, aeronautics and space science. The STEM Education and Accountability program budget has been decreased by 16.3% in the FY President's request.

MUREP supports multi-year research grants at Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges. Additionally, MUREP funds scholarships, internships, and mentoring for K-12 students. The MUREP budget remains flat at $30M in the FY13 President's request.

Space Grant supports undergraduate and graduate students with scholarships, internships and research challenges through a national network of 52 consortia representing over 1,000 universities, colleges and state and local agencies in 50 states, the District of Columbia and Puerto Rico. In FY11, Space Grant programs reached over 21,000 higher education participants. The Space Grant budget has been decreased by 38.3% in the FY13 President's request.

EPSCoR develops academic research projects to establish competitive activities in states with modest research infrastructure in an effort to make the organization more competitive in attracting non-EPSCoR funding for research. EPSCoR funds states and regions that do not traditionally compete for Federal aerospace-related research activities. The EPSCoR budget has been decreased by 48% in the FY13 President's request.