

**U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Space**

***An Update on the Space Launch System and Orion: Monitoring the Development of the
Nation's Deep Space Exploration Capabilities***

CHARTER

Wednesday, December 10, 2014
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

The Space Subcommittee will hold a hearing titled *An Update on the Space Launch System and Orion: Monitoring the Development of the Nation's Deep Space Exploration Capabilities* at 10:00 a.m. on Wednesday, December 10th. This hearing will examine the progress, challenges, and future opportunities for the Space Launch System (SLS) and Orion Multipurpose Crew Vehicle (Orion).

Witnesses

- **Bill Gerstenmaier** – Associate Administrator for Human Exploration and Operations Mission Directorate, NASA
- **Cristina Chaplain** - Director, Acquisition and Sourcing Management, Government Accountability Office
- **The Honorable David Radzanowski or designee (invited)** - Chief Financial Officer, NASA

Background

Following the Space Shuttle *Columbia* accident and the subsequent investigation into its cause, President George W. Bush announced a new “Vision for Space Exploration” in January 2004, to reinvigorate and redirect NASA’s human exploration program. The policy outlined the next major steps for NASA with the International Space Station, missions to return to the Moon, and onward to Mars and beyond. NASA was directed to “implement an integrated, long-term robotic and human exploration program structured with measurable milestones and executed on the basis of available resources, accumulated experience, and technology readiness.”¹ The Constellation Program—comprised of the Orion Crew Exploration Vehicle, Ares I crew launch vehicle, Ares V heavy-lift launch vehicle, along with new space suits and the Altair lunar lander—was born out of the Vision for Space Exploration. The Constellation Program began with NASA’s budget request for fiscal year 2005 and development of these systems continued until Fiscal Year 2010 (FY10).

¹ National Aeronautics and Space Administration-*The Vision for Space Exploration, February 2004*. Retrieved at http://www.nasa.gov/pdf/55583main_vision_space_exploration2.pdf

President Barack Obama proposed to cancel the Constellation program as part of his FY 2011 budget request released in February 2010. The President proposed to cancel a return mission to the Moon in favor of a trip to an asteroid and then to orbit Mars. The President articulated the outline of his plans for NASA in a speech at Kennedy Space Center in April 2010, with continued development of the Orion crew vehicle. Later that year, Congress authorized some of the changes to the human exploration program, mandating continued development of the Orion Multipurpose Crew Vehicle and heavy-lift Space Launch System.

Budget

The Exploration Systems Development program within the Human Exploration and Operations Mission Directorate is responsible for the design, construction, and integration of the next step in human exploration beyond low-Earth orbit. The FY2014 omnibus appropriation (P.L. 113-76) required a minimum of \$1.6 billion for SLS vehicle development, which is a \$230 million increase over FY2013. Additionally, the omnibus appropriation includes \$1.197 billion for the Orion crew vehicle, which is roughly the same amount the program has received for the last two fiscal years.

Each year, the President’s Budget has consistently requested less money for Exploration Systems despite the insistence of Congress that these programs be a priority. Most recently, the President’s budget for FY2015 included a request to reduce the exploration systems programs (SLS and Orion) by over \$330 million² compared to the FY2014 enacted appropriation.

Budget Authority (\$ in millions)	Actual	Enacted	Request	FY14 Vs	Notional			
	2013	2014	FY15	FY15	2016	2017	2018	2019
Exploration	3,705.5	4,113.2	3,976.0	(137.2)	4,079.9	4,049.4	4,107.7	3,673.4
Exploration Systems Dev	2,883.8	3,115.2	2,784.4	(330.8)	2,863.3	2,905.9	2,982.1	3,106.6
Orion Crew Capsule	1,113.8	1,197.0	1,052.8	(144.2)	1,096.3	1,119.8	1,122.9	1,126.7
Space Launch System	1,414.9	1,600.0	1,380.3	(219.7)	1,356.9	1,353.8	1,418.0	1,526.9
Exploration Ground Systems	355.1	318.2	351.3	33.1	410.1	432.3	441.2	453.0

Schedule

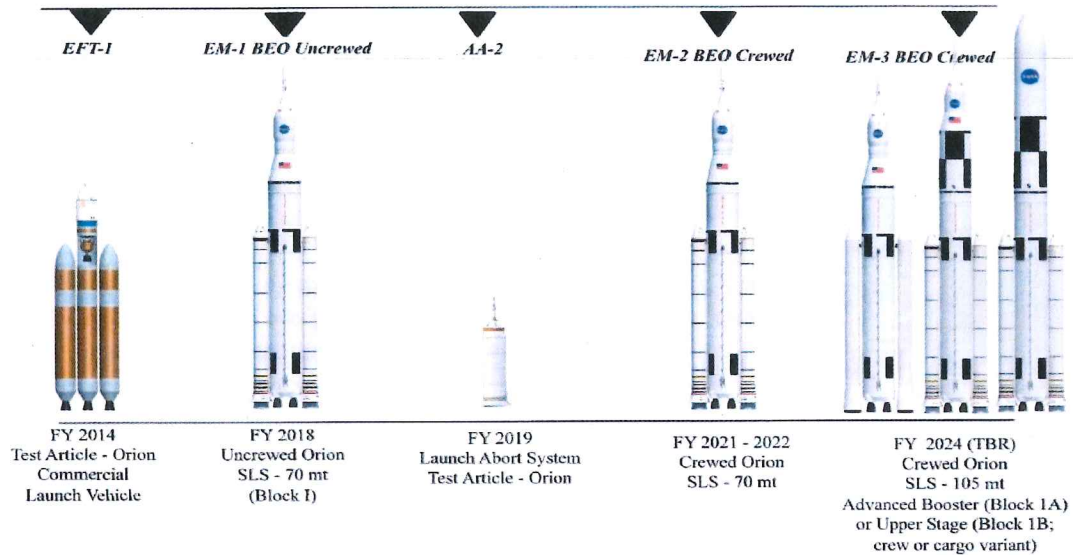
The first test flight of the new SLS/Orion program was conducted on December 5, 2014. The Orion was launched atop a United Launch Alliance Delta IV Heavy Rocket from Cape Canaveral Air Force Station. The mission was conducted for NASA by Lockheed Martin under a commercial launch license. The Exploration Flight Test-1 (EFT-1) was meant to validate various systems including Orion’s heat shield, avionics, and parachutes used for landing. In FY 2018 NASA plans to launch the SLS for the first time with an uncrewed Orion to a circumlunar orbit. This flight, Exploration Mission-1 (EM-1) will demonstrate the integrated capability of both systems. The Exploration Mission-2 (EM-2)—planned for 2021—would launch an Orion and SLS with as many as four astronauts.

² President’s Budget Request for NASA, Fiscal year 2015, accessed at http://www.nasa.gov/sites/default/files/files/508_2015_Budget_Estimates.pdf



Human Exploration and Operations

Exploration Systems Development: Integrated Manifest



NASA Authorization

The NASA Authorization Act of 2010 (the Act) directed the Administration to develop a heavy-lift launch capability and a next generation exploration vehicle. Specifically, Congress directed that:

It is the policy of the United States that NASA develop a Space Launch System as a follow-on to the Space Shuttle that can access cis-lunar space and the regions of space beyond low-Earth orbit in order to enable the United States to participate in global efforts to access and develop this increasingly strategic region.³

Additionally, the Act required the continued development of the Orion:

The Administrator shall continue the development of a multi-purpose crew vehicle to be available as soon as practicable, and no later than for use with the Space Launch System. The vehicle shall continue to advance development of the human safety features, designs, and systems in the Orion project.⁴

³ NASA Authorization Act of 2010, Section 303(a). Retrieved at <https://www.congress.gov/111/plaws/publ267/PLAW-111publ267.pdf>

⁴ NASA Authorization Act of 2010, Section 302(a). Retrieved at <https://www.congress.gov/111/plaws/publ267/PLAW-111publ267.pdf>

Last June, the House passed the NASA Authorization Act of 2014 by a vote of 401-2. This strong bipartisan bill included an endorsement of the continued development of the SLS and Orion. In particular, Congress directed that:

*...the Administrator shall make the expeditious development, test, and achievement of operational readiness of the Space Launch System and the Orion crew capsule the highest priority of the exploration program.*⁵

The Space Launch System (SLS)

The SLS is the nation's next generation human exploration launch vehicle. At its most capable, the SLS will have the ability to lift 130 tons into low-Earth orbit. The NASA Authorization Act of 2010 explicitly included this minimum capability requirement.⁶ Last June, NASA and Boeing definitized the contract for the SLS core stages that will be built and delivered for both the FY 2018 EM-1 test flight and the 2021 EM-2 flight. The value of the contract is \$2.8 billion over six years. The work under this contract includes two SLS cores, including hydrogen and oxygen tanks as well as avionics.

Major projects at NASA go through a system of "key decision points" or "KDPs." As the program progresses, the agency evaluates its progress and determines whether it is prepared to proceed to the next phase. Last August, NASA completed Key Decision Point-C (KDP-C) for the SLS program. This KDP is significant in the planning process for both the agency and outside stakeholders because it is the point at which NASA formally establishes a cost and schedule baseline for the program.

In the case of the SLS, NASA determined that if the program receives \$7 billion over the next three years, there is a 70 percent probability it will launch EM-1 by 2018.⁷ This would roughly translate into \$1.75 billion a year between fiscal year 2014 through fiscal year 2018. This is the first time that NASA has publicly acknowledged that EM-1 may not be ready to launch in 2017 as the agency had previously claimed in the President's budget requests.

The KDP-C agency baseline is somewhat in conflict with statements made by the NASA Administrator about the funding necessary to keep the program on schedule. In testimony before the House Committee on Science, Space, and Technology on April 24, 2013, Administrator Bolden testified on the topic of SLS funding reductions, saying:

*"If I added \$300 million to the SLS program, you wouldn't know it."*⁸

In that same hearing, in reference to the President's budget request, when asked about reductions to the program, he added:

⁵ NASA Authorization Act of 2014, Section 203 (c). Retrieved at <https://www.congress.gov/113/bills/hr4412/BILLS-113hr4412rfs2.pdf>

⁶ NASA Authorization Act of 2010, Section 303(c). Retrieved at <https://www.congress.gov/111/plaws/publ267/PLAW-111publ267.pdf>

⁷ "NASA Completes Key Review of World's Most Powerful Rocket in Support of Journey to Mars," retrieved at <http://www.nasa.gov/press/2014/august/nasa-completes-key-review-of-world-s-most-powerful-rocket-in-support-of-journey-to/#.VINC8sknrWg>

⁸ Verbal testimony of NASA Administrator Charles F. Bolden during question and answer period before the House Committee on Science, Space, and Technology, Hearing Titled "An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2014," April 24, 2013.

“We have asked for, and I think Bill Gerstenmaier, the head of the Human Exploration Operations Mission Directorate, has stated over and over that this is the amount of money that we need to deliver SLS on the date and time that we said, 2017 for the inaugural mission...”⁹

Following this hearing, the members of the Committee submitted additional questions for the record to follow up on these statements. In response to a related question from Space Subcommittee Chairman Palazzo, he stated:

“The FY2014 President’s Budget Request....provides the necessary funding profile required to keep SLS, Orion, and EGS moving forward to achieve EFT-1 in 2014, EM-1 in 2017, and EM-2 in 2021.”¹⁰

Despite these statements, the Government Accountability Office (GAO) recently noted: “According to the program’s risk analysis...the agency’s current funding plan for SLS may be \$400 million short of what the program needs to launch by 2017.”¹¹

Orion Multipurpose Crew Vehicle (Orion)

The Orion is NASA’s next generation human exploration vehicle. It will have the capability to carry astronauts to the Moon and Mars and will be the first deep space human exploration vehicle to launch since the Apollo program.

Orion consists of a crew module, service module, stage adapter, and launch abort system. The crew module is 16 ½ feet in diameter and nearly 11 feet in length with a mass of about 19,000 lbs. It is approximately 50 percent larger (by volume) than the Apollo capsule. The crew module can carry a crew of four for up to 21 days in space. There are other configurations of crew that would allow longer or shorter durations based on mission profile and crew needs. Additional habitation modules will need to be developed in the future for larger crews as NASA carries out longer-duration missions.

On December 5, 2014, Lockheed Martin launched the Orion on a United Launch Alliance Delta-IV Heavy launch vehicle under an FAA licensed commercial space launch. This test, dubbed EFT-1, was meant to provide engineers with data about systems critical to crew safety such as heat shield performance, separation events, avionics and software performance, attitude control and guidance, parachute deployment, and recovery operations to validate designs of the spacecraft before it begins carrying humans to new destinations in deep space. Under the terms of its contract with NASA, Lockheed Martin is required to provide a preliminary report with flight data within 90 days of the test.

EFT-1 is the first in a series of test flights for Orion and SLS. The next test, Exploration Mission-1 (EM-1), is scheduled for no later than 2018 and will include the first launch of the SLS with the Orion. Like EFT-1, EM-1 will not be crewed, but will test critical life support systems. The final test, Exploration Mission-2 (EM-2), will launch in 2021 and will include the

⁹ *Ibid.*

¹⁰ Answers to Questions for the Record from NASA Administrator Charles F. Bolden regarding House Committee on Science Space and Technology Hearing Titled “An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2014,” October 28, 2013.

¹¹ Space Launch System - Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability. Government Accountability Office, Retrieved at <http://www.gao.gov/products/GAO-14-631>

SLS and Orion. It will have at least two crewmembers aboard. That flight will take astronauts to lunar orbit and back and will be the first time humans have been to the Moon since Apollo.

Despite a near-flawless EFT-1 mission, the Orion program has not been without its challenges. In an interview recently published in *Space News*, Orion Program Manager Mark Geyer was quoted as saying, “We’re struggling to make December 2017, and I have a lot of challenges to make that date.”¹² The reasons for this, as reported, included technical and schedule delays with various components of Orion including the heat shield and service module, which is being developed in coordination with European partners. Last January, the Director-General of the European Space Agency Jean-Jacques Dordain stated: “I have committed to NASA that the PDR [Preliminary Design Review] will not cause a delay in the delivery of the service module.”¹³

Further complicating potential schedule delays, the President’s budget request for the Orion is consistently lower than NASA’s own cost estimates to maintain mission milestones. In the FY13, FY14, and FY15 budget requests, the Administration asked for reductions of \$175.1 million, \$87 million, and \$144.2 million respectively.¹⁴ Had Congress agreed to the requests compared to the enacted appropriation, the Orion program would have incurred over \$400 million in reductions, and would likely face longer potential delays.

Key Questions

1. What are the true funding needs and schedule expectations for the development of the SLS and Orion Programs?
2. How can NASA, the Administration, and Congress mitigate the risks to these programs and ensure their timely and sustainable development?
3. What impact has NASA’s treatment of termination liability had on the development of the SLS and Orion programs?
4. How has NASA’s direction to manage the SLS and Orion programs based on the President’s budget request rather than Continuing Resolution levels, which are higher, impacted the programs?
5. How does management of these programs compare to management of other large-scale development programs within the federal government?
6. How does the budget formulation process at NASA, including procedures and standard practices for producing funding requests for large-scale programs, differ from that of other agencies?
7. What did NASA learn from the commercial test launch of the Orion in EFT-1 and what do the preliminary findings and data demonstrate?
8. What is NASA’s progress towards meeting key schedule milestones including a flight test of the SLS in fiscal year 2018?

¹² “NASA Officials: Orion ‘Challenged’ To Make 2017 Launch Date,” *Space News*, August 11, 2014. <http://www.spacenews.com/article/features/41554news-from-aiaa-space-2014-nasa-officials-orion-%E2%80%98challenged%E2%80%99-to-make-2017>

¹³ Peter De Selding, “ESA Promises NASA that Orion Service Module Delay Won’t Hold up 2017 Launch,” *Space News*, January 17, 2014. Accessed at <http://www.spacenews.com/article/civil-space/39138esa-promises-nasa-that-orion-service-module-delay-won%E2%80%99t-hold-up-2017-launch>

¹⁴ President’s Budget Requests for Fiscal Year 2013, Fiscal Year 2014, and Fiscal Year 2015.

