National Aeronautics and Space Administration

Office of the Administrator
Washington, DC 20546-0001

April 2, 2014

The Honorable Steven Palazzo
Chairman
Subcommittee on Space
Committee on Science,
Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

I was pleased by the interest expressed by you, Ranking Member Edwards, and other Members of the Subcommittee, during the March 27 Subcommittee hearing, in obtaining more information about NASA's overall human exploration strategy, including the Asteroid Redirect Mission (ARM), which will serve as a proving ground for the technologies that will ultimately take our Nation to Mars. I would like to personally offer additional NASA briefings for Members and staff.

In the course of the ongoing FY 2015 budget briefings, NASA staff has been briefing the Congress on International Space Station (ISS) research and exploration-related activities, supported by commercial crew and cargo services, ARM, and overall exploration planning toward Mars. As I highlighted during my testimony, these elements link together to form the backbone of our exploration plan to reach Mars. I think it is important that we continue to share this information with the Congress not just in the context of an annual budget request, but as the integrated, long-term plan that it is. In that vein, I asked my staff to schedule an overall exploration briefing as soon as possible for the Committee and I am pleased that it is scheduled for April 3. I also plan to conduct an Exploration Workshop in the near future at NASA Headquarters to bring in the broader community; invitations will be extended to Members and staff. This event will precede day-long exhibits on NASA Exploration on June 11, in the Rayburn Building.

As you are aware, NASA has been executing an integrated human and robotic exploration strategy leading to the human exploration of Mars. The capabilities required for a human mission to Mars have been understood for some time. The implementation steps and investments, partner approaches, and technical pathways to Mars are varied. NASA is building our strategy around a series of tangible milestones, key decision points, and activities that lead forward toward a human mission to Mars. We are also tightly coupling the planning of our science and technology portfolios with this strategy, where appropriate. Overall, consistent with the NASA Authorization Act of 2010, NASA is building a space

exploration architecture based on capabilities that will support multiple missions and destinations, enable private access to, and the private use of space, and complement and advance other NASA, national, and international objectives and goals. This architecture is intended to be sustainable and affordable over the long-term;—it must be realistic within budgets only modestly higher in the future than projected today. This endeavor must also be innovative, including on-ramps for new technologies, new approaches, and other space players.

I touched on some new developments in our implementation of this strategy during my testimony on March 27. I want to take this opportunity to share a few more. The Administration's recent decision to extend ISS operations through at least 2024 contributes importantly to our overall space exploration architecture, allowing NASA to complete much of the research and technology development activities aboard the ISS necessary to enable planned long-duration human missions beyond low-Earth orbit. It is imperative that we have a U.S. capability for crew and cargo to access and foster these critical activities. As you know, I am fully committed to returning human spaceflight launches to American soil with U.S. spacecraft and ending our sole reliance on Russia to access ISS. Extension of ISS operations through at least 2024 will also help strengthen the commercial space market that is emerging with the successful implementation of our commercial cargo program and the progress being made on commercial crew.

NASA's Human Research Program continues to develop biomedical science, technologies, countermeasures, diagnostics, and design tools to keep crews safe and productive on long-duration space missions. A detailed matrix of these human research requirements that are planned for the implementation on ISS over the next decade and their relationship toward future deep space exploration will be presented when our team meets with the Committee this week. As an example of both the technology demonstration and exploration partnership aspects of the ISS, NASA is preparing for an extended duration, year-long human mission to explore human adaptation to space. The mission, which will involve NASA Astronaut Scott Kelly and Cosmonaut Mikhail Kornienko of the Russian Federal Space Agency, is slated to launch in March 2015.

As I pointed out in my testimony, NASA is making strong progress in fielding other critical components of a long-term exploration strategy. The flight test milestones driving the schedule include the uncrewed Exploration Flight Test-1 (EFT-1) later this year, the first uncrewed launch of *Orion* and Space Launch System (SLS) on Exploration Mission-1 (EM-1) in FY 2018, and the first crewed launch of *Orion* and SLS on Exploration Mission-2 (EM-2) in FY 2021-2022. EFT-1 is an important and challenging flight test that serves as a pathfinder to validate innovative approaches to space systems development and manufacturing. The EFT-1 flight test will demonstrate spacecraft post-landing recovery procedures and develop the launch vehicle adapter, which will also be used on EM-1 and EM-2. It will also allow us to test the heat shield at about 85 percent of lunar re-entry velocity, protecting the vehicle from temperatures near 4,000 degrees Fahrenheit. The EFT-1 flight test will significantly reduce or eliminate 10 of the top 16 risk drivers for the first crewed flight (EM-2). It will also demonstrate 47 percent of the design, development, test, and evaluation (DDT&E) and 50 percent of the software needed for EM-2. EFT-1 will not

only test hardware and software, but it also is testing key processes which will be needed for the crewed flight on EM-2.

In 2014, NASA will make significant strides in SLS development. The first SLS vehicle for the EM-1 launch with *Orion* in FY 2018 is in production and assembly at the Michoud Assembly Facility. I invite you to lead a delegation of Committee Members to see the great work underway there in New Orleans. The testing of the Booster Qualification Motor-1 (QM-1) will occur this year with a test firing of the motor at ATK's facility in Promontory, Utah, and fabrication of the QM-2 motor will also be completed there. Manufacturing will begin on key components of the SLS vehicle to be used for the EM-1 mission, including Boosters, interim cryogenic propulsion stage (ICPS), and major components of the Core Stage (tanks, engine structure, intertank, and forward skirt), as well as the associated Structural Test Articles (STAs). Additionally, the Vertical Assembly Center at Michoud Facility will be completed this summer, as well as modifications to the A-1 Test Stand at the Stennis Space Center for testing of the RS-25 Core Stage engines. The SLS Program will conduct the detailed design review (Critical Design Review) for the Booster and Core Stage elements. The overall ground systems at Kennedy Space Center to support these efforts recently passed their Preliminary Design Review and are in preparation. These capabilities enable the United States to build upon, maintain, and extend its global leadership in space exploration and create new opportunities for international collaboration in space.

NASA will employ SLS and *Orion* for an important early human exploration mission to perform pioneering human operations further from the Earth than ever before, rendezvousing with, and returning samples from, an asteroid redirected to a stable orbit around the Moon by the robotic segment of the ARM. This mission allows for operations in the proving ground of cis-lunar space, where NASA can demonstrate key exploration technologies, build off of the skills learned from ISS, prepare the way to support lunar activities of our commercial or international partners, and build the skills and hardware needed for Mars-class missions. This mission represents a technological challenge – raising the bar for human exploration and discovery, while advancing detection of near-Earth asteroids and bringing us closer to human missions to Mars. The technologies needed for this mission, for example, in power, propulsion, guidance and navigation, life support, and EVA, will apply toward future human missions to Mars. We have already identified a number of candidate asteroids for this mission. We are also continuing to refine estimated costs and, at this time, we anticipate that the incremental cost of the mission, excluding launch vehicle, will be less than half of what the initial Keck Study projected. From cis-lunar space, NASA is examining how to leverage and partner with commercial and international robotic interests on the Moon. Our recent Lunar Cargo Transportation and Landing by Soft Touchdown (Lunar CATALYST) initiative and the Regolith and Environment Science and Oxygen and Lunar Volatile Extraction (RESOLVE), in-situ resource payload in our FY 2015 budget request reflect this part of the strategy; through these activities, we are exploring resource extraction techniques to use lunar material for propellant, which have application to Mars missions.

Lastly, with our robotic program, we continue to assess and learn about the technical and operational parameters needed for humans to operate in vicinity of and on the surface of Mars. NASA leads the world in this rich, inspiring area of study and exploration. We are again looking at using robotic missions to provide an understanding of the Martian atmosphere. This understanding is necessary to safely land human exploration class payloads on Mars. We are also investigating the possibility of flying a device to extract oxygen from the Martian atmosphere on the next robotic rover mission.

With an unfolding strategic presence throughout cis-lunar space, the operational and technological foundation for a sustained exploration path to Mars will be set. NASA has studied and considered Mars as the goal for exploration since its inception under the National Space Act of 1958 and I firmly believe the integrated approach we are now undertaking offers the best way to get there. I look forward to our continued discussions on our Nation's space exploration strategy.

Sincerely,

Charles F. Bolden, Jr.
Administrator

cc:

Chairman Lamar Smith
Ranking Member Eddie Bernice Johnson