

**Statement of
William H. Gerstenmaier
Associate Administrator for Human Exploration and Operations
National Aeronautics and Space Administration**

before the

**Subcommittee on Science and Space
Committee on Commerce, Science, and Transportation
U.S. Senate**

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss NASA's human spaceflight efforts. The Human Exploration and Operations (HEO) Mission Directorate encompasses NASA's human spaceflight activities in Low-Earth Orbit (LEO), the development of exploration vehicles to take astronauts beyond LEO, research and technology development efforts to enable deep space exploration, and 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. The Agency is developing spaceflight capabilities to send humans to an asteroid by 2025 and on to Mars in the 2030s. We are building the world's most powerful rocket, the Space Launch System (SLS), and a deep space exploration crew vehicle, the Orion Multi-Purpose Crew Vehicle (MPCV). American astronauts are living and working in space on board the International Space Station (ISS), conducting an expanding research program with an array of partners. By partnering with American companies, we are resupplying the ISS and launching these missions from U.S. soil, and we are on track to send our astronauts to space from American shores in just the next few years.

The International Space Station: Frontier of Research and Technology Development in LEO

The ISS, with its international crew of six orbiting Earth every 90 minutes, is an unparalleled asset for the conduct of research and technology development in a unique, microgravity environment. The ISS has transitioned from an era of assembly to one where our full focus is on operations and research to: 1) improve our ability to live and work in space, including enabling human exploration beyond LEO; 2) develop a demand-driven commercial transportation and research market in LEO; 3) enable science, engineering research, and technology development in the fields of Earth, space, life (biological and human research), and physical sciences; and 4) derive tangible benefits for folks on Earth. As of September 2012, 1,549 experiments had been conducted aboard ISS, involving more than 1,500 scientists from 68 countries, resulting in more than 588 scientific publications. The first results from the Alpha Magnetic Spectrometer (AMS) experiment on ISS were announced at CERN (the European Organization for Nuclear Research) on April 3, 2013. This cosmic ray particle physics detector will increase our knowledge of physics and astrophysics, and help address the mysteries of dark matter.

The ISS is enabling advances in science and research that benefit humanity today and hold the promise for further advances and discoveries. For example, research onboard ISS has already assisted coastal disaster recovery efforts across the globe through Earth imaging sensors. Research is also contributing to understanding many ailments faced by the elderly, including bone loss (osteoporosis), immune system

degradation, and loss of balance. The ISS is also conducting technology demonstrations and development efforts to advance human and robotic exploration beyond LEO and serving as the foundation for an international exploration partnership. We are grateful to Congress for extending NASA's exception under the Iran, North Korea, Syria Non-proliferation Act (INKSNA), which will allow the Agency and its international partners to continue to operate ISS through at least 2020.

Working closely with the ISS Program, HEO's Space Life and Physical Sciences Research and Applications (SLPSRA) Division advances our knowledge of biological and physical sciences, and the 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. The progress in science and technology driven by this research is expected to have broad impacts on Earth as it advances our ability to support long-duration human exploration. SLPSRA also serves as NASA's liaison to the non-profit Center for the Advancement of Science in Space (CASIS), which is now managing the ISS National Laboratory for research being done on ISS by the academic and commercial organizations participating in the evolving utilization of LEO space for innovative new purposes.

NASA's plans for the coming year on ISS include preparing for an extended duration, year-long human-crewed mission to explore human adaptation to space, continuing to utilize the ISS for technology demonstrations enabling future exploration, and the addition of three Earth Science instruments that will exploit ISS capabilities to study winds over the oceans and the movement of dust, smoke, and pollution through the atmosphere.

The Space Technology team at the Johnson Space Center in Texas is working to increase capabilities for the Robonaut 2 demonstration on ISS and further the Agency's development of next-generation tele-robotics systems. In addition, Space Technology is using the SPHERES satellites on ISS to demonstrate autonomous rendezvous and docking techniques and liquid slosh dynamics which serves to validate mission design for both spacecraft and launch vehicles.

There are two U.S. companies supporting the ISS under Commercial Resupply Services (CRS) contracts. Space Exploration Technologies (SpaceX) was awarded 12 cargo flights to the ISS, and Orbital Sciences Corporation (Orbital) was awarded 8. SpaceX executed its first cargo mission to the ISS in October 2012 using the Falcon-9 rocket and the Dragon spacecraft, successfully delivering cargo and returning scientific samples to Earth. Recently, SpaceX successfully completed its second CRS mission. The Dragon spacecraft lifted off from Cape Canaveral Air Force Station in Florida on March 1, 2013, carrying about 1,268 pounds (575 kilograms) of supplies and investigations. On March 26, it returned about 2,668 pounds (1,210 kilograms) of science samples, equipment and education activities. Orbital's first contracted cargo resupply mission under CRS is slated for later this year. Orbital launched its Antares rocket this past Sunday from the new Mid-Atlantic Regional Spaceport Pad-0A at the Agency's Wallops Flight Facility in Virginia. The test flight was the first launch from the pad at Wallops and was the first flight of Antares, which delivered the equivalent mass of a spacecraft, a so-called mass simulated payload, into Earth's orbit.

Promoting the Development of American Commercial Crew and Cargo Systems

NASA's Commercial Spaceflight efforts support the development of safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO. A top priority for NASA and the Nation is to affordably and safely launch American astronauts and their supplies from U.S. soil, ending our reliance on foreign providers and bringing that work back home.

In the area of cargo transportation system development, SpaceX has successfully completed its Commercial Orbital Transportation Services (COTS) efforts, and only two activities remain for Orbital

under the COTS program: launch vehicle test flight and ISS cargo mission demonstration. Orbital plans to conduct a demonstration flight of the Antares with the Cygnus spacecraft to the ISS this summer under the COTS effort, prior to commencing contracted cargo resupply flights to ISS, as noted above.

The Commercial Crew Program (CCP) aims to facilitate the development of a U.S. commercial crew space transportation capability by 2017, and full funding of the FY 2014 request is essential to restore a human spaceflight capability to the United States in this timeframe. Reduced funding will delay the operational availability of domestic commercial services, extending the period during which NASA will be solely reliant on international partners to provide crew transportation and rescue services to the ISS. Since initiating this program in 2009, NASA has conducted two Commercial Crew Development (CCDev) competitions for industry to advance commercial crew space transportation system concepts and mature the design and development of elements of the system. In August of 2012, NASA announced new agreements with three American companies – Boeing, Sierra Nevada and SpaceX – to develop and demonstrate the next generation of U.S. human spaceflight capabilities under the Commercial Crew Integrated Capability (CCiCap) program. Between now and May 2014, NASA’s partners will continue to perform tests and mature their integrated designs. Certification of these systems has begun in parallel under a separate Federal Acquisition Regulation-based contract known as the Certification Products Contract (CPC). NASA anticipates releasing a draft Request for Proposals (RFP) for phase two of this effort in July of this year, with the final RFP to follow in October 2013. Once commercial crew transportation systems are certified by NASA, the Agency plans to procure transportation services from commercial entities for NASA-sponsored personnel to and from the ISS.

Preparing to Send Astronauts Beyond LEO into Deep Space

Because our commercial space partners continue to make rapid and cost-effective progress toward meeting the Agency’s requirements for access to the ISS and to LEO, NASA is able to focus its human exploration resources to develop the deep space capabilities represented by the SLS and Orion MPCV. NASA’s exploration efforts include the Orion MPCV spacecraft, SLS heavy-lift launch vehicle, and Exploration Ground Systems (EGS) infrastructure required to support crewed missions of exploration into deep space, including a mission to send astronauts to an asteroid that has been redirected into a stable orbit around the Moon.

Orion will carry four astronauts to, and support operations at, destinations in our solar system for periods of up to 21 days. Exploration Flight Test-1 (EFT-1), an uncrewed, atmospheric entry test mission of the Orion to test spacecraft systems, is on track for launch in FY 2014. EFT-1 will see Orion conduct two orbits of Earth and reenter the atmosphere at a high speed characteristic of a returning deep space exploration mission. The test will provide valuable data about the spacecraft’s systems, most importantly, its heat shield. The flight test article for this mission is already in place at the Kennedy Space Center and being readied for this test. In 2012, NASA signed an agreement with the European Space Agency (ESA) for ESA to provide a service module for the Orion spacecraft’s Exploration Mission-1 in 2017. The new agreement is in accordance with existing International Space Station (ISS) agreements and builds on NASA’s existing strong cooperative relationship with ESA on ISS and other activities. It continues and expands international collaboration as humans explore new frontiers in the solar system.

The heavy-lift SLS will initially be capable of lifting 70-100 metric tons before evolving to a lift capacity of 130 metric tons. The SLS will use a liquid hydrogen/liquid oxygen propulsion system, with a Core Stage utilizing existing Space Shuttle Main Engines for the initial capability. While the first two SLS launches will feature five-segment solid rocket boosters (SRBs) based on the Space Shuttle SRBs, NASA is looking to the future and Advanced Boosters, which may be either solid or liquid rockets. For the upper stage, SLS will use an Interim Cryogenic Propulsion Stage (ICPS) for the first two exploration missions. NASA is evaluating the appropriate phasing of advanced boosters and upper stages to meet

mission architecture needs and within the budget. Later missions will use an upper stage to realize the 130-metric-ton capability beyond 2021.

Exploration Ground Systems (EGS) will develop the necessary infrastructure and procedures at the Kennedy Space Center to prepare, assemble, test, launch, and recover the Exploration architecture elements. EGS will focus on the launch complex as an integrated, multi-use capability to enable more efficient and cost-effective ground processing, launch and recovery operations.

NASA plans to launch Orion on the uncrewed Exploration Mission-1 test flight in 2017, and the first crewed flight of SLS/Orion – Exploration Mission-2 –in 2021. These two missions will test and demonstrate these systems, which will be used to send a crew to visit an asteroid which has been redirected into a stable lunar orbit. It should be noted that these dates are dependent on the full funding of the President’s FY 2014 budget request for the Human Exploration and Operations Mission Directorate. Together, SLS, Orion MPCV, and EGS represent a critical step on the path to human deep space exploration.

NASA’s Advanced Exploration Systems (AES) Division is pioneering approaches for rapidly developing prototype systems, demonstrating key capabilities, and validating operational concepts for future human missions beyond LEO. Activities focus on crewed systems for deep space, and robotic precursor missions that gather critical knowledge about potential destinations in advance of crewed missions. Major products include systems development for reliable life support, asteroid capture mechanism risk reduction, deep space habitats, crew mobility systems, advanced space suits, and autonomous space operations. As prototype systems are developed, they are tested using NASA ground-based facilities or flight experiments on the ISS. The AES Division works with the Space Technology Mission Directorate to infuse technologies into exploration missions, and with the Science Mission Directorate on robotic precursor activities.

An Integrated Exploration Mission

The President’s Fiscal Year 2014 budget request continues to implement the bi-partisan strategy for space exploration approved by Congress in 2010, a plan that advances U.S. preeminence in science and technology, improves life on Earth, and protects our home planet, all while helping create jobs and strengthening the American economy. This budget reflects current fiscal realities by aligning and leveraging relevant portions of NASA’s science, space technology, and human exploration capabilities to achieve the President’s challenge of sending astronauts to an asteroid by 2025.

As part of the agency’s overall asteroid strategy, NASA is planning a first-ever mission to identify, capture, and redirect an asteroid into orbit around the Moon. The overall mission is composed of three separate and independently compelling elements: the detection and characterization of candidate near-Earth asteroids; the robotic rendezvous, capture, and redirection of a target asteroid to the Earth-Moon system; and the crewed mission to explore and sample the captured asteroid using the Space Launch System (SLS) and the Orion crew capsule. This mission represents an unprecedented technological challenge -- raising the bar for human exploration and discovery, while helping protect our home planet and bringing us closer to a human mission to Mars in the 2030s.

Each mission element will heavily leverage on-going activities across the Human Exploration and Operations, Space Technology, and Science Mission Directorates. We are currently working to align on-going activities across these directorates to affordably achieve the objectives while we plan this mission. Progress will continue conditional on feasibility and affordability. Funding provided within the President’s FY2014 budget request will augment our existing activities in Space Technology, Science, and Human Exploration and Operations to: enhance our near-Earth asteroid detection and characterization

assets; accelerate advanced solar electric propulsion development; and design and test capabilities to capture a small asteroid in space.

Conclusion

NASA, with our commercial and international partners, has embarked on a new phase of human space exploration and development. In LEO, we are beginning to see the real benefits of the efforts of many nations to construct the ISS. The Station has now entered its research phase, and the recently announced initial results from AMS reflect just one area in which this unique microgravity laboratory is producing results. This phase, which will continue through at least 2020, will benefit NASA's exploration goals, but also go beyond this by enabling other governmental and non-governmental entities to conduct wide-ranging experiments that we anticipate will result in a variety of terrestrial benefits. This is best reflected in the slogan incorporated into the ISS Expedition 34 crew patch: "Off the Earth...For the Earth."

All of this research will be supported by a new way of doing business: the use of commercially provided services rather than Government-owned vehicles to transport crew and cargo from Earth to LEO and back again. We are also working aggressively to bring the new domestic commercial cargo providers on board. Private enterprise and affordable commercial operations in LEO will enable a truly sustainable step in our expansion into space — a robust, vibrant, commercial enterprise with many providers and a wide range of private and public users will enable U.S. industry to support NASA and other Government and commercial users safely, reliably, and at a lower cost. NASA is proud to help in laying the groundwork for the emerging LEO space economy.

The cost-effective commercial systems will enable NASA to focus its own development efforts on the Orion MPCV and SLS, which will send NASA astronauts on missions of exploration beyond LEO. These systems will be flexible enough to support many different mission scenarios, in the decades to come. One of NASA's greatest challenges will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. Our commercial crew program will reduce the cost of U.S. access to low Earth orbit while ending our sole reliance on other nations for delivering crew to the International Space Station. We must also plan and implement an exploration enterprise with costs that are credible and affordable for the long-term. We are committed to developing an affordable, sustainable, and realistic next-generation human spaceflight system that will enable human exploration, scientific discovery, broad commercial benefits, and inspirational missions that are in the best interests of the Nation. Technology development is a critical enabler for cost-effective exploration and we are committed to the development of the necessary technologies required to explore our solar system. We need your continued support for this effort.

Mr. Chairman, I would be happy to respond to any question you or the other Members of the Subcommittee may have.