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Statement of
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Space Operations

before the

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

Chairman Palazzo and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the status of NASA's commercial cargo efforts, which the Agency has divided into two programs – the Commercial Orbital Transportation Services (COTS) Program and the Commercial Resupply Services (CRS) Program.

Under COTS, NASA has helped fund the development of commercial cargo systems, and under CRS, NASA has entered into contracts to procure future cargo transportation services to and from the International Space Station (ISS). Together and along with NASA's initial Commercial Crew Development efforts, NASA is continuing to expand the opportunity for commercial access to space, thereby creating multiple means for NASA to access low-Earth orbit (LEO). Additionally, by investing in these commercial efforts, NASA is helping to facilitate the commercial uses of space, to help lower costs for commercial space services and to spark an engine for long-term U.S. job growth in the aerospace industry.

My testimony today will outline the progress made by our COTS and CRS partners: Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (OSC). Both companies competed as part of separate competitions under COTS and CRS, and were initially selected for the COTS development phase in 2006 and 2008, respectively, and later for the CRS phase in December 2008.

NASA is pleased with the steady progress both companies continue to make in their cargo development efforts. While both companies have experienced technical and schedule challenges to date, that is not uncommon with major aerospace development efforts. However, there still remain significant challenges to developing reliable, regular cargo transportation to the ISS. We need to anticipate and be prepared for the inevitable start-up challenges associated with a technologically ambitious endeavor, such as cargo delivery to the ISS.

We anticipate that the final COTS demonstration flights will conclude by early 2012. The first CRS resupply flights are also planned take place in 2012, thereby providing a critical capability that will enable us to maintain the ISS following the retirement of the Space Shuttle, thereby providing a critical capability that will enable us to maintain the ISS following the retirement of the Space Shuttle.

Commercial Orbital Transportation Services

In 2005, NASA established the Commercial Crew and Cargo Program Office at Johnson Space Center. The objectives of the Program, which oversees the COTS projects, is to further the implementation of U.S. space policy with investments to stimulate the commercial space industry, facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities with the goal of achieving safe, reliable, cost-effective access to LEO, and create a market environment in which commercial space transportation services are available to Government and private sector customers. NASA believes the eventual availability of safe, reliable and economical service to LEO through the private sector will help NASA achieve the Nation's space exploration goals following retirement of the Space Shuttle, thereby allowing NASA to focus on developing new space transportation capabilities to support exploration beyond LEO.

As part of COTS, NASA entered into partnerships using funded Space Act Agreements (SAAs) with emerging and established space transportation providers to demonstrate the delivery of cargo to an on-orbit destination. The SAAs include a schedule of performance milestones that each partner is expected to achieve along with a fixed milestone payment to be made upon successful completion of performance. These milestones culminate in a flight demonstration where the participant's vehicle will launch, rendezvous and berth with the ISS as the demonstration testbed, and re-enter or return safely to Earth. If a partner does not complete a milestone, as defined in the SAA, and to NASA's satisfaction, they are not paid. Should a milestone be missed, NASA would ascertain the cause of the failure, evaluate partner progress made and determine whether additional efforts are in the best interest of the Government. NASA does not pay for a milestone until the work has been completed successfully.

It is important to understand that both NASA and the partners themselves act as investors during the development and demonstration of commercial cargo services under COTS. The partners (and their other private investors) are investors because they partake in the financial burden, and stand to reap the financial benefits of developing a proven commercial space transportation capability that they can sell to NASA and other customers. NASA's intended benefit is the future availability of commercial providers, to enable less expensive cargo-transportation costs and elimination of the operations burden for routine LEO transportation.

Currently, NASA has two funded COTS partners, SpaceX and OSC. NASA signed funded SAAs with SpaceX in 2006 and with Orbital in 2008. Prior to awarding a funded SAA to OSC, NASA had an SAA with Rocketplane Kistler (RpK). However, RpK failed to meet certain negotiated milestones. In October 2007, after working with RpK for several months, NASA decided that it was in the best interest of the Agency to terminate the RpK agreement and re-compete the remaining funding. After the re-competition, NASA selected OSC for a funded SAA in February 2008.

Both SpaceX and OSC continue to make progress in developing their cargo transportation systems, based in part on NASA's financial and technical assistance, coupled with that of the industry partner's own financial contributions and technical expertise. NASA sees no reason to doubt either company's ability to achieve its desired objectives – that of demonstrating commercial cargo delivery to and from LEO. Both partners have aggressive, success-oriented schedules, and are facing challenges typical of a spaceflight development program. Both partners have experienced some milestone delays. However, these milestone delays are not unexpected, and have not required any additional NASA funding of specific milestones, since the partners are paid only fixed amounts for achieving milestones. Development costs beyond NASA's milestone payments have been borne by the companies and/or other investors.

A detailed schedule of each partner's COTS progress is provided as Attachment 1.

A review of what has occurred since SpaceX signed its COTS agreement with NASA in August 2006 shows that:

- To date, SpaceX has completed 25 of 40 negotiated milestones for COTS work, receiving $298 million out of a potential $396 million, including augmented funding.

- On December 8, 2010, SpaceX successfully completed the first COTS demonstration flight, demonstrating launch of the Falcon 9 booster, separation of the Dragon spacecraft and completion of two orbits, orbital maneuvering and control, reentry, parachute decent and spacecraft recovery after splashdown in the Pacific Ocean.

- SpaceX's remaining demonstration flights for NASA are scheduled for November 2011 and January 2012. NASA is reviewing a SpaceX proposal to accelerate the third demonstration flight test objectives, which include berthing to the ISS, during the second demonstration flight. Initial safety and technical assessments are expected to be completed by the end of May to enable a decision on berthing with the ISS on the earlier mission.

A review of what has occurred since OSC signed its agreement with NASA in February 2008 shows that:

- To date, OSC has completed 21 of 31 negotiated milestones for COTS work, receiving $221.5 million out of a potential $288 million, including augmented funding.

- Recently, OSC began integration and testing of its Cygnus Service Module and Taurus II launch vehicle.

- OSC is expected to complete its maiden test flight of the Taurus II launch vehicle from the new launch pad at the Wallops Flight Facility (WFF) in Virginia in October 2011, and its demonstration flight for NASA in December 2011.

Overall, NASA has invested $552 million in the COTS effort, which includes funding invested with the two current funded partners, as well as funding that was invested with Rocketplane Kistler that was terminated for failure to perform in 2007. By the conclusion of the COTS effort, NASA anticipates it will have invested $800 million in the COTS project – not including in-kind and infrastructure support that NASA has provided to the COTS partners. The $800 million includes the original $500 million authorized for COTS milestone payments and programmatic administrative costs, plus $300 million for augmented cargo milestone payments and associated administrative costs to help accelerate technical development, conduct flight tests and develop ground infrastructure, as authorized by the NASA Authorization Act of 2010 and funded under the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112-10). To be clear, this augmented funding is being used for additional content and risk reduction measures, and therefore represents additional content and new work.

In total, NASA anticipates providing SpaceX and OSC $128 million each in augmented funding via modifications to their respective funded COTS SAAs and via the CRS contract during FY 2011, utilizing Exploration funds under the FY 2011 Full-Year Continuing Appropriations Act. To date, NASA has executed three SAA amendments (known as Quarter 1, Quarter 2, and Quarter 3/4 augmentations) for each COTS partner with respect to the augmentation milestones authorized by the NASA Authorization Act of 2010. These amendments outline the milestones that each partner must successfully complete before receiving associated NASA funding:

- For SpaceX, the augmentation milestones and associated funding will improve the chance of mission success by adding ground and flight testing, accelerating development of enhanced cargo capabilities, or further developing the ground infrastructure needed for commercial cargo capabilities. More specifically, the additional SpaceX milestones include rendezvous and proximity operations sensor testing, system level spacecraft testing (thermal vacuum electromagnetic interference, and acoustic testing), and infrastructure improvements at the launch, production and test sites.

- For OSC, the augmentation milestones and associated funding will support a maiden test flight of the Taurus II in the October 2011 timeframe, thereby helping to significantly reduce the risks associated with a new launch vehicle development. The milestones also enable additional software and control system testing.

Commercial Resupply Services

The ISS has transitioned from the construction era to an operations and research era, with a six-person permanent crew, three major science labs, and an operational lifetime through at least 2020. The ISS is the largest crewed spacecraft ever assembled, measuring 243 by 356 feet, with a habitable volume of over 30,000 cubic feet and a mass of 846,000 pounds, and is powered by arrays which generate over 700,000 kilowatt-hours per year. The ISS represents a unique research capability, aboard which the United States and its partner nations can conduct a wide variety of research in biology, chemistry, physics and engineering fields that will help us better understand how to keep astronauts healthy and productive on long-duration space missions. In addition to conducting research in support of future human missions into deep space, astronauts aboard the ISS will carry out experiments with terrestrial applications.

While the ISS is serviced by a fleet of cargo vehicles, including the Russian Progress vehicle, European Automated Transfer Vehicle (ATV), and Japanese H-II Transfer Vehicle (HTV), NASA will be depending on U.S. industry to provide resupply services to and from the Station following the retirement of the Space Shuttle. On December 23, 2008, NASA awarded CRS contracts to OSC and SpaceX for the delivery of cargo to the ISS after the retirement of the Shuttle. The companies will enable operation of vehicles that can: 1) fly to the ISS orbit; 2) operate in close proximity to the ISS and other docked vehicles; 3) dock to ISS; and, 4) remain docked for extended periods of time. NASA anticipates that both providers will have their systems operational in 2012.

The CRS contracts are firm-fixed price, Indefinite Delivery Indefinite Quantity procurements with a period of performance through Dec. 30, 2015. The contract allows the contractor to make deliveries for one year following the end of the period of performance. This allows the contractors adequate time to complete missions ordered for CY 2015 that may move into CY 2016. The contracts are based on milestone payments scheduled in terms of months from launch, and the payment plan must meet the current requirements of the payment clause. For example, total milestone payments through Mission Integration Review shall not exceed 50 percent of the mission cost. The contracts allow the flexibility to add or modify mission payments in the work plans to accommodate specific mission tasks. Under Federal Acquisition Regulation (FAR) Pt. 12 commercial services contracts, payments are viewed as financing payments to the contractor. The government pays incrementally for an end item service to avoid the cost of financing that would be levied in the overall mission price if payment was not made until the end. This is a standard practice for launch services contract. Even though these are financing payments, the CRS contractors are required to demonstrate that they are making key progress toward providing the service and therefore the payments are typically tied to major reviews or manufacturing milestones.

NASA ordered 12 CRS flights valued at $1.59 billion from SpaceX.

- SpaceX will provide pressurized and unpressurized upmass and return services.

- SpaceX currently has completed 14 funding milestones for the four CRS missions in process in FY 2011. In addition, one more CRS mission may be turned on if progress continues. Finally, two milestones in support of COTS demonstration cargo have been paid.

- The schedule margin that existed when the CRS contracts were initially awarded has gotten smaller over the last two years. Parallel development and mission activities have been challenging for a relatively small company that depends heavily on in-house capabilities, yet both cargo and external integration activities have begun and are proceeding. This next year will demonstrate the company's ability to manage multiple missions. The first SpaceX CRS flight is currently scheduled for late January 2012, and the company is currently slated to fly three CRS missions each fiscal year from 2012 through 2015. The January 2012 date is dependent on SpaceX's successful completion of its COTS demo flights.

To date, NASA has paid SpaceX $181 million for 14 CRS mission milestones and $4.8 million for two demonstration cargo milestones (the latter from the above-mentioned augmentation funding).

NASA ordered eight CRS flights valued at $1.88 billion from OSC.

- OSC will provide pressurized upmass and disposal services.

- OSC currently has completed seven additional funding milestones for three CRS missions in process in FY 2011.

- OSC uses a different mission model than the in-house focused work of SpaceX – one which involves using proven suppliers. The distributed network of suppliers helps with the multiple mission flows, and OSC has demonstrated an understanding of cargo and mission integration interfaces and processes.

- The company is relying on NASA assets at Stennis Space Center in Mississippi (for engine testing) and Wallops Flight Facility (for launch vehicle processing and integration).

- The first OSC CRS flight is currently scheduled for the end of the first quarter of calendar year 2012, and the company is currently slated to fly two CRS missions each fiscal year from 2012 through 2015.

To date, NASA has paid OSC $273 million for 11 CRS mission milestones and $7.5 million for two demonstration cargo milestones (the latter from the above-mentioned augmentation funding).

NASA has considerable insight into the progress that SpaceX and OSC are making during the demonstration missions and for the CRS milestones that have been given Authority to Proceed, or are in process. The program has weekly meetings with representatives of the companies to discuss schedule and technical issues. Both CRS providers are making progress on their missions, and this year will be key to demonstrating that their mission profiles are achievable. A number of challenges confront both CRS providers, as even successful new rockets tend to require adjustments following their initial launches. In addition, new spacecraft themselves require adjustments – both ATV and HTV required upgrades

between their first and second missions – and they must be integrated with their launch vehicles. Additional challenges arise from the difficulties inherent in mastering automated rendezvous, proximity operations, and docking with a crewed spacecraft. While these tasks have been demonstrated many times by the Russian Progress vehicle, and twice each by the European ATV and Japanese HTV, the technologies and techniques required for their achievement are difficult, but clearly not impossible, to develop.

All commercial cargo vehicles intended to dock or berth to the ISS must meet the same visiting vehicle standards for each of their ISS missions. These requirements are laid out in the ISS Visiting Vehicle Requirements document. These standards include requirements for automated rendezvous and joint proximity operations, physical and software interfaces, and overall safety. These requirements are consistent with those provided for the ATV and HTV. NASA has been working closely with the commercial partners through the demonstration phase and will continue to work with them through the CRS missions to ensure that each mission meets these requirements.

There is now little to no schedule margin for significant delays in the CRS missions, and this is a risk for consistent cargo resupply to the ISS. NASA is pre-positioning maintenance and logistics items on the final Space Shuttle mission as a contingency to mitigate any risk to ISS operations due to a delay in the availability of the CRS vehicles. The final Shuttle mission, STS-135, is targeted for launch in early July. During the STS-135 mission, Atlantis will carry the Raffaello multipurpose logistics module to deliver critical supplies, logistics and spare parts for the ISS, as well as a system to investigate the potential for robotically refueling existing spacecraft. This will help reduce the risk to ISS operations and maintenance should the CRS vehicles not meet their current launch dates. If the contracted commercial cargo services are not available at the beginning of calendar year 2012, there would be minimal impact to ISS operations. If commercial cargo services are not available by the end of calendar year 2012, there would be a reduction in utilization of the ISS. In that case, NASA would have to consider reducing the Station's crew size to three in order to conserve supplies; this would in turn result in a reduced ability to conduct research aboard ISS. The final Shuttle flight will give the ISS the flexibility to maintain a six-person crew into FY 2013 without any commercial cargo flights, effectively increasing the schedule margin by about a year.

Another risk reduction option is the availability of the ATV and HTV spacecraft. NASA already relies on bartered cargo transportation services provided by the European Space Agency and the Japanese Aerospace Exploration Agency using these vehicles, and such barter agreements could be used to ensure a limited U.S. cargo delivery capacity, on the currently planned vehicles, as a stop-gap measure until the CRS vehicles are operationally available. NASA has also purchased cargo delivery services from the Russian Space Agency through 2011, though there are no plans to extend this service beyond the end of this year.

NASA has contracted for a minimum of 40 metric tons of cargo delivered to the ISS from 2011 through 2015 under the CRS contracts, and the Agency plans to continue to rely on CRS for cargo transportation beyond FY 2015. This will require new contract action by NASA. NASA is counting on its CRS suppliers to carry cargo to maintain the ISS. It is hoped that these capabilities, initially developed to serve the Station, may find other customers as well, and encourage the development of further space capabilities and applications and the LEO economy.

Summary

Chairman Palazzo and Members of this Subcommittee, I would summarize by saying again that NASA is pleased with the steady progress both companies continue to make in their cargo development efforts. I

would also like to conclude my remarks by thanking you again for your continued support for NASA and its human spaceflight programs, including our commercial cargo efforts. I would be pleased to respond to any questions you or the other Members of the Subcommittee may have.

Biography

William H. Gerstenmaier
Associate Administrator for Space Operations

Graduated from East High School, Akron, OH in 1973; received a bachelor of science in aeronautical engineering from Purdue University, in 1977; and a Master of Science degree in mechanical engineering from the University of Toledo in 1981; and completed course work for a Ph.D. in dynamics and control with a minor in propulsion at Purdue University 1992 & 1993.

Residence:
Washington, DC

Marital Status:
Married to the former Marsha Ann Johnson, Houston, TX

Children:
Katie S., February 26, 1983, and Lora K., November 24, 1986.

Current Assignment:
William H. Gerstenmaier is the Associate Administrator for Space Operations at NASA Headquarters in Washington, DC. In this position, Gerstenmaier directs NASA's human exploration of space. He also has programmatic oversight for the International Space Station, Space Shuttle, space communications and space launch vehicles.

Special Honors and Awards:
Certificate of Commendation -1981, Certificate of Commendation -1987. Certificate of Commendation - 1991. NASA Exceptional Service Medal - 1992. Aviation Week & Space Technology Laurels Award for Outstanding Achievement in the Field of Space – 1996, Rotary Stellar Award -1997. NASA Exceptional Service Medal -1999. Senior NASA Outstanding Leadership Medal - 2001. Twice awarded the Aviation Week & Space Technology's Laureate Award for" Outstanding Achievement in the Field of Space." Meritorious Executive Presidential Rank Award for - 2003; Outstanding Aerospace Engineer Award, Purdue University - 2003, Distinguish Executive Presidential Rank Award – 2005; AIAA International Cooperation Award – 2005. The National Space Club Astronautics Engineer Award - 2006, National Space Club Von Braun Award – 2006; the Federation of Galaxy Explores, Space Leadership Award 2007, AIAA International Award 2006, the AIAA Fellow- 2007; Purdue University Distinguished Alumni Award and Honored at Perdue as an Old Master in the Old Masters Program 2008; and recipient of the 2010 Rotary National Award for Space Achievement's National Space Trophy (RNASA).

Experience:
1977-1980 Mr. Gerstenmaier began his NASA career at NASA Lewis performing aeronautical research. He was involved with the wind tunnel tests that were used to develop the calibration curves for the air data probes used during entry on the Space Shuttle.

1988-1990 Mr. Gerstenmaier headed the Orbital Maneuvering Vehicle (OMV) Operations Office, Systems Division at Johnson Space Center (JSC). He was responsible for all aspects of OMV operations at JSC, including development of a ground control center and training facility for OMV, operations support to vehicle development, and personnel and procedures development to support OMV operations.

1990-1992 Mr. Gerstenmaier was head of Space Shuttle/Space Station Freedom Assembly Operations Office, Operations Division. He was responsible for resolving technical assembly issues and developing assembly strategies.

1994-1995 Mr. Gerstenmaier was Chief, Projects and Facilities Branch, Flight Design and Dynamics Division, which oversaw all projects managed within the division including an upgrade of trajectory processes and software required for Space Shuttle ascent performance enhancements needed to support Space Station flights.

1995-1997 Mr. Gerstenmaier was Shuttle/Mir Program Operations Manager, serving as primary interface to the Russian Space Agency for operational issues. He negotiated all protocols used in support of operations during the Shuttle/Mir missions. In addition, he supported NASA 2 operations from Russia, January 1996 through September 1996 that included responsibility for daily activities as well as the health and safety of NASA crewmember on Mir. He scheduled science activities, public affairs activities, monitored Mir systems and communicated with the NASA astronaut on Mir.

1998-2000 In 1998, Mr. Gerstenmaier was named Manager, Space Shuttle Program Integration, responsible for the overall management, integration, and operations of the Space Shuttle Program. This included development and operations of all Space Shuttle elements, including the orbiter, external tank, solid rocket boosters, and Space Shuttle main engines as well as the facilities required to support ground processing and flight operations.

2000-2002 In December 2000, Mr. Gerstenmaier was named Deputy Manager, International Space Station Program. He shared associate responsibility for the day-to-day management, development, integration, and operation of the International Space Station. This included recommending and implementing Program policy; establishing and controlling scheduling; planning and directing the Program's development, test, production, and operations; managing the integration of all elements of the Program into a single operational system; ensuring effective cost control of the total Program; and establishing and controlling requirements and configuration.

2002-2005 As Manager, International Space Station Program, Mr. Gerstenmaier was responsible for the overall management, development, integration, and operation of the International Space Station. This included the design, manufacture, testing, and delivery of complex space flight hardware and software, and for its integration with the elements from the International Partners into a fully functional and operating International Space Station.

December 2010