



**Human Space Flight Capabilities**

**pursuant to  
Section 611(a) of the NASA Authorization Act of 2008 (P.L. 110-422)**

**April 2009**

## BACKGROUND

This document responds to Section 611(a) of the NASA Authorization Act of 2008 (P.L. 110-422) directing NASA to report on the lack of a U.S. human space flight system to replace the Space Shuttle upon its planned retirement. The specific requirements of this report are outlined below.

### **SEC. 611. SPACE SHUTTLE FLIGHT REQUIREMENTS.**

*(a) REPORT ON U.S. HUMAN SPACEFLIGHT CAPABILITIES.—Section 501(c) of the National Aeronautics and Space Administration Authorization Act of 2005 (42 U.S.C. 16761(c)) is amended by striking the matter before paragraph (1) and inserting the following: ‘Not later than 90 days after the date of enactment of the National Aeronautics and Space Administration Authorization Act of 2008, the Administrator shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Science and Technology of the House of Representatives a report on the lack of a United States human space flight system to replace the Space Shuttle upon its planned retirement, currently scheduled for 2010, and the ability of the United States to uphold the policy described in subsection (a), including a description of—’.*

Section 501 of the NASA Authorization Act of 2005 (P.L. 109-155) states:

### **SEC. 501. SPACE SHUTTLE FOLLOW-ON.**

- (a) POLICY STATEMENT.—It is the policy of the United States to possess the capability for human access to space on a continuous basis.*
- (b) PROGRESS REPORT.—...[Not applicable to this report]...*
- (c) COMPLIANCE REPORT.—If, 1 year before the final planned flight of the Space Shuttle orbiter, the United States has not demonstrated a replacement human space flight system, and the United States cannot uphold the policy described in subsection (a), the Administrator shall transmit a report to the Committee on Science of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate describing—*
- (1) strategic risks to the United States associated with the failure to uphold the policy described in subsection (a);*
  - (2) the estimated length of time during which the United States will not have its own human access to space;*
  - (3) what steps will be taken to shorten that length of time; and*
  - (4) what other means will be used to allow human access to space during that time.*

## 1.0 STATUS AND PLANS FOR U.S. HUMAN SPACE FLIGHT POST SPACE SHUTTLE RETIREMENT

Pursuant to U.S. Space Exploration policy and direction in the NASA Authorization Acts of 2005 and 2008 (P.L. 109-155 and P.L. 110-422, respectively), the Agency plans to retire the Space Shuttle in 2010 after completing the assembly of the International Space Station (ISS). Retiring the Space Shuttle will free personnel, infrastructure, and funding resources for development of a new generation of space transportation systems developed by NASA and by the commercial sector. These new systems will enable the United States and its international partners to take advantage of the full potential of the ISS; pave the way for human missions to the Moon, Mars,

and destinations beyond; and secure U.S. leadership in space science and technology well into the 21<sup>st</sup> century.

### **1.1 Ares I and Orion**

The Ares I Crew Launch Vehicle and the Orion Crew Exploration Vehicle are new human space flight vehicles being developed by NASA. The Ares I/Orion system will enable the capability to carry out human missions beyond low-Earth orbit and will also be capable of providing crew transportation and rescue services to the ISS. Ares I/Orion is being designed to increase safety beyond Shuttle capabilities and decrease the risks for the loss of crews or the spacecraft.

The Initial Operational Capability (IOC) for Ares I, defined as the first crewed flight of Orion to the ISS, is targeted for March 2015. The Full Operational Capability (FOC) for Orion, defined as the date when the spacecraft is able to transport crew to the ISS; remain for up to 180 days; serve as a crew rescue vehicle; and safely return crew from the station to Earth, is scheduled for 2016. An unmanned test flight of the Ares I configuration (Ares I-X) is scheduled for launch later this year.

### **1.2 Commercial Orbital Transportation Services (COTS)**

NASA has established the Commercial Orbital Transportation Services (COTS) project to stimulate the emerging private sector launch providers who plan to offer cargo and potentially crew services to the ISS. NASA initiated the COTS project in 2006, and will invest \$500M over five years in the initial components of COTS, designated as Capabilities A to C, that are dedicated to the development of an automated cargo vehicle. A subsequent phase of the program, Capability D, is intended to support the development of crew transportation, but is not currently funded.

Two companies, Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation have funded Space Act Agreements with NASA as part of the COTS project to demonstrate cargo transportation to ISS. At this time, SpaceX plans to demonstrate cargo supply to ISS by 2010, and Orbital Sciences Corporation by 2011. The actual purchase of cargo services to ISS is being conducted through the separate ISS Commercial Resupply Services (CRS) procurement effort. NASA recently awarded CRS contracts to SpaceX and Orbital Science Corporation for cargo delivery beginning as early as late 2010. There is no planned back-up capability for ISS commercial cargo. Timely commercial cargo capability is critical for effective ISS operations. Without commercial cargo capability, the crew size and research operations planned for ISS would need to be reduced.

## **2.0 TRANSPORTATION REQUIREMENTS FOR ISS**

After the Shuttle retires in 2010, astronauts from the United States and our international partners will continue to work productively aboard ISS. The Station will host its first 6-person crew as early as mid-2009 and they will conduct research and operational activities in the American *Destiny*, Europe's *Columbus*, and Japan's *Kibo* laboratories. NASA research on the Station will be focused on experiments to increase our understanding of the effects of the microgravity environment on the human body and to enable the development of countermeasures to address the challenges of long-duration space flight. The United States and its partners will also use the Station as an engineering test bed to evaluate hardware, technologies, and systems needed for future human space missions, and to allow crew members to gain experience in robotic operations

using the Canadian Special Purpose Dexterous Manipulator, or *Dextre*. The ISS will also serve as a node to test delay-tolerant Internet protocols that are critical for the development of space communication systems that will be needed for distant robotic probes in the future.

As a National Laboratory, the Station will support research sponsored by other Federal agencies and by private enterprise. The National Institutes of Health and the U.S. Department of Agriculture have signed Memoranda of Understanding with NASA to conduct innovative research onboard ISS. The Ad Astra Rocket Company has signed a Space Act Agreement with NASA to investigate and test ion engines on the Station.

The research and activities cited above will require a transportation system to routinely and reliably deliver crew and cargo to the Station, as well as a rescue capability. NASA is obligated to provide crew transportation and rescue capability not only for U.S. astronauts, but also for crewmembers from Canada, Europe, and Japan. The Space Shuttle will support crew and cargo logistics requirements through 2010. Based on the current schedule, the first delivery of cargo to ISS by a commercial provider through the ISS CRS contracts will occur as early as late 2010. The Ares I/Orion system is scheduled to begin crew services in 2015. If NASA were to fund Capability D in the COTS program, the Agency has estimated that it would take 3-6 years to develop and qualify a commercial crew capability; industry has estimated that it would take 2-4 years to develop and qualify a capability.

After the Shuttle retires in 2010, and until a credible commercial crew transport provider or the Ares I/Orion system becomes operational, the United States will continue to rely on Russian Soyuz spacecraft to transport crew, and serve as a rescue vehicle for ISS. The Russian Federal Space Agency (Roscosmos) is under contract with NASA to provide these services through spring of 2012, and discussions are ongoing to extend this contract through June 30, 2016. These discussions are authorized under the exception to the Iran, North Korea and Syria Nonproliferation Act (P.L. 106-178, as amended, [50 U.S.C. 1701 note]) provided by Section 125 of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (P.L. 110-329). NASA will purchase comprehensive Soyuz support, including all necessary training and preparation for the launch, crew rescue, and landing, consistent with U.S. obligations to Canada, Europe and Japan. The Agency does not purchase Soyuz launches or the spacecraft themselves, but rather a "seat" or crew rotation service.

NASA will also rely on the transportation capabilities of Russia, the European Space Agency (ESA) and Japan to transport cargo to ISS. Russia's Progress vehicle has been providing cargo services to ISS through a contract with NASA. The ESA Automated Transfer Vehicle (ATV) had a successful initial flight in 2008. The Japanese HII Transfer Vehicle (HTV) is scheduled to have its first flight in 2009. ESA's and Japan's services are provided through barter agreements. It should be noted that NASA does not plan to continue to procure Progress cargo resupply services after 2011, opting instead to rely on U.S. commercial cargo delivery capabilities provided through Commercial Resupply Services contracts.

### **3.0 STRATEGIC RISKS**

Human space flight is important to America's political, economic, technological and scientific leadership. While United States defense and commercial space activities should be largely unaffected by the currently projected hiatus in the nation's capability to launch astronauts into space on U.S. launch vehicles, a longer transition will affect the broader space industrial base and raise other concerns in terms of managing workforce and retaining key capabilities. The

transition between current and future crew transportation systems will present a significant challenge to NASA's ability to sustain and preserve the core flight and ground operations workforce necessary to support U.S. human spaceflight exploration goals. The current plan envisions a five-year period between the last flight of the Space Shuttle and the first flight of Ares I/Orion during which the Nation will not have an independent domestic capability to carry crews into space unless a domestic commercial crew transportation capability emerges. Such a transition is not unprecedented and, if limited to a span of a few years, can be managed without putting the NASA's specialized and hard-earned crewed launch capabilities at permanent risk. However, a longer transition could have serious implications for U.S. aerospace capacity in key areas, such as large solid rocket motor production and rocket engine development.

#### **4.0 SHORTENING THE TRANSITION**

NASA has explored options to shorten the period in which the U.S. does not have a domestic capability to launch astronauts, including extending Space Shuttle operations past 2010, accelerating the development of the Ares I/Orion system, and supporting new commercial launch capabilities. These options address, but do not eliminate, the interval in U.S. human space launch capabilities, and do not fully alleviate the technical hurdles presented by the transition.

NASA will fly the Space Shuttle to complete the International Space Station and then retire the Shuttle in 2010. The revised manifest includes two flights previously defined as contingency flights, and an additional flight for the Alpha Magnetic Spectrometer (AMS) experiment, which may be conducted if it can safely and affordably be flown by the end of 2010 as directed in the NASA Authorization Act of 2008 (P.L. 110-422). NASA's Aerospace Safety Advisory Panel has recommended against extending the Shuttle program any further. Funds freed from the Shuttle's retirement will enable the Agency to support development of systems to deliver people and cargo to the International Space Station and the Moon. As part of this effort, NASA will stimulate private-sector development and demonstration of vehicles that may support the Agency's human crew and cargo space flight requirements.

NASA plans to have the first Human flight (Initial Operational Capability, IOC) of the Ares I/Orion in March 2015. NASA has limited flexibility to accelerate the development of new systems, but NASA is taking steps to enhance the robustness of the March 2015 IOC date. For example, NASA is:

- Strengthening program integration and systems engineering to identify areas to optimize efficiency;
- Developing a segmented crew cabin for the Orion Spacecraft;
- Deferring software required for the lunar program that is not needed for ISS operations to defer development costs;
- Conducting a content assessment activity to look at the activities within each project to ensure content is optimized to meet IOC; and,
- Reviewing the ground and flight test strategy in order to affirm an optimized set of flight test requirements.

The Constellation program is placing priority on tasks that focus on meeting the IOC commitment of March 2015.

## **5.0 SUMMARY**

During the transition between the Shuttle and Ares I/Orion, the ISS partnership will rely on the Russian Soyuz vehicle to provide the necessary ISS crew transportation and rescue services. It is NASA's intention to purchase commercial crew transportation and rescue services domestically once a viable U.S. commercial capability becomes available. However, the schedule for availability of an operational and certified commercial crew transportation capability is uncertain. To maintain U.S. leadership in human space exploration and operations, it is imperative that robust ISS operations continue after the retirement of the Shuttle. For the longer term, U.S. leadership in human space flight requires a space transportation system capable of transporting people to the Moon and beyond.