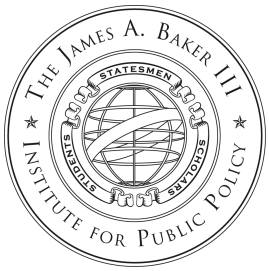

James A. Baker III Institute for Public Policy
Rice University

Return to Reality: Why a Space Shuttle Program is Vital to the Survival of the International Space Station

By

George W.S. Abbey

Baker Botts Senior Fellow in Space Policy
James A. Baker III Institute for Public Policy
Rice University

October 26, 2011

For more than 10 years, space crews from the United States, Russia, and other countries have successfully lived and worked year-round in six-month shifts on the International Space Station (ISS), where they have conducted scientific research. In the coming years, that work will continue, but with a crucial safeguard missing: a space shuttle fleet that provides adequate logistic support and gives human beings a unique capability to fix the space station's guidance system and rocket thrusters in the event of a failure.

At 9:00 a.m. EDT (1300 GMT) on August 24, 2011, a Soyuz booster carrying a Progress supply ship was launched from the Baikonur Cosmodrome in Kazakhstan. It was Russia's 44th such cargo mission to the ISS. Communications were lost about six minutes into the nine-minute ascent of the three-stage Soyuz rocket. The core stage of the Soyuz had shut down and separated about five minutes after liftoff, leaving the four-nozzle engine of the upper stage to burn its mixture of kerosene fuel and liquid oxygen for the final boost needed to achieve the proper orbit. Separation of the Progress was expected at 9:09 a.m. EDT (1309 GMT), at which time the ship would start its two-day automated chase to rendezvous and dock with the station. At about 325 seconds into the flight, and shortly after the third stage was ignited, the vehicle itself commanded an engine shutdown due to an engine anomaly. Unable to achieve its planned orbit, and given the trajectory and energy of the spacecraft at the time of engine shutdown, the vehicle crashed in the Altai region of the Russian Federation.

The 24-foot-long craft was bringing nearly three tons of supplies to the station. The "dry" cargo tucked aboard the Progress amounted to 2,777 pounds of food, spare parts, life-support gear, and experiment hardware. The Progress's refueling module carried 2,050 pounds of propellant to be transferred into the Russian segment of the complex that supplies the station's maneuvering thrusters. The vessel also had 926 pounds of water and 110 pounds of oxygen and air.

With the retirement of the U.S. space shuttles, the Soyuz is the only rocket capable of sending crews to orbit. Liftoff of a new crew to the ISS had been planned for September 21, 2011, following a planned landing on September 8, 2011, of the three-person Expedition 28 crew returning to Earth. That launch schedule was thrown into disarray by the crash of the unmanned supply craft into the remote Siberian wilderness. The upper stage of the unmanned rocket

carrying the Progress supply ship that failed was similar to the upper stage used to launch astronauts. The launch of the next manned Soyuz mission to the ISS has been postponed until November 13, 2011.

The Russian Federal Space Agency (Roscosmos) has also announced another manned Soyuz launch scheduled for December 21, 2011, and has set tentative dates for the launch of two more unmanned Progress supply ships—October 30, 2011, and January 26, 2012.

The Soyuz capsules docked to the space station are certified to last only 200 days in orbit, due to the degradation over time of the hydrogen peroxide used to fuel the spacecraft's thrusters. The return of one of the two capsules docked to the space station when the rocket failed was pushed back a week. Delaying much longer than that would have run into the spacecraft's certification limit of 200 days, as well as the constraint that the Soyuz capsules must land during daylight. The next opportunity for a daytime landing would have been in late October, beyond the 200-day limitation. Russian cosmonauts Andrei Borisenko and Alexander Samokutyayev and NASA astronaut Ronald Garan returned safely from the ISS on September 15, 2011, leaving a crew of three onboard: Russian cosmonaut Sergei Volkov, NASA's Michael Fossum, and Satoshi Furukawa of Japan's JAXA space agency. They are currently scheduled to remain onboard the ISS until their planned return to Earth on November 21, 2011, due to the 200-day time limitation of their Soyuz spacecraft.

All of the new Russian launch dates are predicated on finding the cause of the August 24, 2011, Soyuz booster failure, making any necessary changes, and testing and verifying the acceptability of the changes to support the newly announced schedules. A delay in the planned manned November 13, 2011, launch would almost certainly mean the space station would have to be left unmanned after the current crew returns to Earth on November 21—the first such interruption in nearly 11 years.

Redundant access[1] to the ISS, understood to be an important goal after the loss of the space shuttle *Challenger* in the 1986, was a primary consideration when Russia was brought into the

[1] Redundant access is having two independent space launch systems that can both fly to the ISS.

space station partnership in the 1990s. The inclination of the station was changed to 57 degrees in order to ensure their cooperation and launch vehicle support.[2] The wisdom of that decision and that redundancy on the part of both nations has ensured the presence of essential capabilities in the face of technical failures. After successive Russian Proton rocket failures in 1999, which temporarily halted Russian launches of ISS hardware, the shuttle served as the sole provider of heavy launch capability. After the *Columbia* accident in February 2003, Soyuz and Progress spacecraft were able to keep the ISS serviced and manned.

The benefits of that redundancy were apparently not long remembered with the Bush administration's decision to end the space shuttle program and leave the continued operation of the ISS totally dependent on one country's capability to launch and return crews and carry cargo. Spaceflight is far from routine, and space is not only a challenging environment but also a very unforgiving environment. Flying in space requires constant attention to detail. Problems occur, as it is not a perfect world. In flying humans in space, you must be right every time, as the consequences of being wrong are catastrophic.

The ISS is on the verge of being unmanned if Russia is unable to fly a replacement crew to the station in mid-November. The Soyuz spacecraft that is there is on the verge of running out of its orbital lifetime. The lighting constraints preclude a night-time landing under harsh winter conditions, so its departure from the ISS, with the three remaining crew members, is planned for November 21, 2011. Without three replacement crew members and another Soyuz spacecraft, the ISS will be unmanned. The space station was not designed to operate in an unmanned mode.

The last shuttle flight was in July. It took only a little over one month for the benefits of the redundant access provided by the space shuttle to become painfully apparent. In an article published in the *New York Daily News* on June 12, 2011, Chris Kraft and Scott Spencer

[2] The ISS's inclination is the angular distance of its orbital plane from the plane of the Earth's equator, stated in degrees. An inclination of 0 degrees means the spacecraft orbits the Earth at the equator, and in the same direction as the planet rotates. An orbital inclination of 57 degrees means the spacecraft orbits the Earth at an orbit inclined 57 degrees from the equator, covering all the Earth from 57 degrees north latitude to 57 degrees south latitude as it orbits the Earth.

expressed concern about the retirement, with no true replacement, of all the space shuttles.[3] They pointed out that to do so was extremely dangerous, expressing the concern that, even when manned, the numerous ISS backup systems offer little margin of safety in the event of damage from a fire, space junk impact, or a potential collision from the more frequent docking of manned and unmanned commercial spacecraft resupply missions.

Kraft and Spencer pointed out that if the life support, guidance systems, or rocket thrusters are damaged, the station could need a swift rescue mission to stay in orbit. They highlighted the unique capabilities of the space shuttle as a repair vehicle. A large number of spare parts needed for critical repairs have been stowed on pallets on the ISS, but none of them could be installed to repair and regain control and use of the $100 billion ISS if it is unmanned. Additionally, the Russian Soyuz and other commercial space capsules that are intended to replace the space shuttles lack the life-support systems needed for the multiple six-hour repair spacewalks. Only the space shuttles have the vital airlocks and life-support supplies—as well as the robotic arm that is needed to move the hardware necessary for the required two-person spacewalking repair crews.

Before the last scheduled shuttle flight lifted off, Kraft and Spencer said that an urgent discussion must take place between the United States and its ISS partners to keep the shuttle fleet in service in order to provide a vital safety margin for repairing the ISS in the event of a critical systems failure. That discussion becomes even more critical now that the ISS is on the verge of going unmanned. As they stated in their article, the space shuttle fleet provides the only insurance against a catastrophic reentry of the ISS. With such valuable equipment in orbit—and the dangers should that equipment fall to Earth—it is not wise to play Russian roulette in space. The decision to retire the space shuttle needs urgent reconsideration.

As Kraft and Spencer wrote, the loss of control of the ISS would mean a catastrophic reentry of the massive structure (the largest object ever placed in orbit, measuring over three football fields long and weighing more than 400 tons) into the Earth's atmosphere. The tons of falling debris that would survive reentry would pose an unprecedented threat to populated areas around the world.

[3] Christopher Kraft and Scott Spencer, "Why we must save the space shuttle: If the Int'l Space Station is disabled, we need a rescue fleet," *New York Daily News*, July 12, 2011.

It would be an international catastrophe that would have significant ramifications for foreign relations and liability for the United States, Russia, and the other countries that participate as partners on the ISS. It would also be a loss of the substantial investment that has been made by all these countries to build, launch, and assemble the largest and most complex development in the history of the world. The significant planned science and research would be lost and the loss of the ISS would negate the need for the fledging commercial spacecraft industry. There would be no need to continue funding these companies with no mission. In addition, it would severely impact this nation's creditability as a leader in space exploration. Perhaps it says something about the state of the country when we seem to be more concerned with placing our space shuttles in museums than we are in facing up to our international responsibilities as a spacefaring nation—a nation that once had the courage and capability to go to the moon and the good sense to provide dual redundancy for critical space assets.