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NASA

Challenges in Completing and Sustaining the International Space Station

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the challenges faced by the National Aeronautics and Space Administration (NASA) on the International Space Station (ISS) and the Space Shuttle. NASA is in the midst of one of the most challenging periods in its history. As part of its Vision for Space Exploration, NASA is simultaneously developing a range of new technologies and highly complex systems to support future exploration efforts, completing assembly of the space station, and retiring the space shuttle. This is NASA's biggest transition effort since landing humans on the moon more than 3 decades ago and then initiating the Space Shuttle Program a few years later. Taken together, these efforts create significant challenges in terms of managing investments, launch and other facilities, workforce, international partners, and suppliers. Clearly, any delays or problems in completing and sustaining the space station itself, may well have reverberating effects on NASA's ability to ramp up efforts to develop technologies needed for future exploration or to support other important missions.

GAO has undertaken a body of work related to NASA's transition efforts that include NASA's industrial supplier base, its workforce challenges, development of new crew and cargo spacecraft, and NASA's assembly and sustainment activities related to the ISS. My statement today focuses on the preliminary results of on-going efforts, as well as other GAO work completed to date. Specifically, I will address the following challenges: (1) executing plans to use the shuttle to complete the ISS; (2) maintenance of the shuttle workforce through retirement of the shuttle; and (3) filling the gap between the shuttle and new NASA-developed vehicles to service the ISS. NASA's ability to overcome these challenges will be critical to ensuring the availability of the International Space Station as a viable research entity into the future. While some of these results and findings are preliminary, many have been echoed in other studies and identified by NASA itself. Our work is being conducted in accordance with generally accepted government auditing standards.

Background

NASA plans to finish assembling the ISS in fiscal year 2010 and operate the station until 2016. The station is scheduled to support 6-person crew capability as early as 2009. The shuttle was to be the primary means for ISS re-supply and crew rotation. NASA's international partners were planning to augment the shuttle's capabilities with their cargo and crew spacecraft. Following the Columbia disaster in 2003, the President set a new "vision" for NASA that called for the shuttle's retirement in 2010 upon

completing ISS assembly. As part of the Vision, NASA is developing new crew and cargo vehicles, with the crew vehicle currently scheduled to be available in the 2015 timeframe. One of the vehicles—the Crew Exploration Vehicle—will carry and support only crews traveling to low earth orbit and beyond and will also be capable of ferrying astronauts to and from the ISS. However, since these systems are not scheduled to become operational until 2015, NASA plans to rely on international partners and commercial providers to make up the 5-year gap in ISS logistics and crew rotation resulting from the shuttle retirement.

Aggressive Launch Schedule for Space Shuttle

As we have begun our review of ISS assembly, several issues related to NASA's space shuttle manifest have come to our attention. First, the shuttle planning manifest dated January 2007 projects that NASA will launch 16 missions before retirement of the shuttle in 2010—one of those has already been launched. Of the 15 remaining missions, one will service the Hubble Telescope and 2 are designated as contingency missions. Assuming the contingency flights are included, on average, NASA will need to launch one shuttle every 2.7 months—an aggressive schedule when compared to recent launch timeframes. In the past, with three shuttles, NASA launched a shuttle every 3.7 months on average after the Challenger accident in 1986. Since the Columbia accident in 2003, NASA has averaged 10.8 months between launches.¹ For the remainder of calendar year 2007, NASA has three launches planned, which will total four missions for the year. Due to vehicle traffic constraints, the minimum required time between shuttle launches to ISS is 35 calendar days, so while the manifest is aggressive, it is achievable.

Additionally, the current shuttle manifest leaves little room for unexpected delays caused by weather damage or launch debris, which have proven to impact the shuttle launch schedule significantly. For example, in 2007, hail damage to the external fuel tank caused an unexpected three month delay in a shuttle launch. While there are limits to the planning NASA can do for such events, the tight schedule constraints leave little room for significant delays as a result of such occurrences.

As evidence of the increasing pressure NASA is experiencing with regard to the shuttle manifest, the ISS program office is planning for certain cargo

¹These values represent the time between the launch date of the flight that resulted in loss of the shuttle and the launch date of the next subsequent flight.

elements to be launched on the two final shuttle flights even though NASA, as an agency, still considers these flights contingency missions. NASA is also being forced to consider the possibility of canceling delivery of some portions of the ISS. Specifically, NASA determined that if the schedule slips, the Cupola observatory and the Node 3 connector built for hardware, oxygen and waste storage may be slipped to contingency flights. If that occurs and those flights do not launch, those elements may not be assembled on ISS as originally planned.

Finally, NASA officials explained that since only the shuttle is large enough to deliver certain large Orbital Replacement Units (ORUs) to the ISS, they must be launched prior to retirement of the shuttle. These ORUs are replacement segments for those segments operating on the ISS that fail or reach the end of their life. The officials noted that NASA originally planned to use the shuttle to launch and retrieve certain large ORUs that are critical for ISS operations. After being brought back to Earth, the plan was to repair and refurbish the ORUs and return them to service on the ISS. However, with the shuttle no longer available to transport those ORUs after 2010, NASA changed its strategy for providing them to ISS from a refurbishment approach to a “launch and burn” approach. They suggested that under the new strategy, NASA would build enough ORUs to cover the ISS planned mission life and use them up over time. Large ORUs that originally were to be launched and returned on the shuttle would have to be pre-positioned on the ISS before the shuttle retires.

There is still much to be worked out with NASA’s change in strategy for positioning ORUs to cover the space station's planned mission life. For example, the program office is still assessing the implications of restarting production lines to produce additional spares. This involves examining whether the right equipment, materials, expertise, and data is still available—an endeavor that the ISS program office acknowledged would be challenging. We will continue to monitor changes to the shuttle manifest as they occur.

Shuttle Workforce Challenges

The space shuttle workforce currently consists of approximately 2,000 civil service and 15,000 contractor personnel. NASA must maintain a workforce with necessary critical skills to manage the shuttle program through its completion. In response to GAO recommendations, NASA has undertaken several initiatives to attempt to address its potential workforce drain.

In 2005, we reported that NASA had made limited progress toward developing a detailed strategy for sustaining a critically skilled shuttle workforce to support space shuttle operations. We reported that significant delays in implementing a strategy to sustain the shuttle workforce would likely lead to larger problems, such as funding and failure to meet NASA program schedules. Accordingly, we concluded that timely action to address workforce issues is critical given their potential impact on NASA-wide goals such as closing the gap in human spaceflight. At the time we performed our work several factors hampered the ability of the Space Shuttle Program to develop a detailed long-term strategy for sustaining the critically skilled workforce necessary to support safe space shuttle operations through retirement. For example, the program's focus was on returning the shuttle to flight, and other efforts such as determining workforce requirements were delayed. In our report, we recommended that NASA begin identifying the Space Shuttle Program's future workforce needs based upon various future scenarios. Scenario planning could better enable NASA to develop strategies for meeting future needs. NASA concurred with our recommendation. The agency acknowledged that shuttle workforce management and critical skills retention will be a major challenge as it progresses toward retirement of the space shuttle and as such has acted to respond to our recommendation.

For example, since we made our recommendation, NASA developed an agency wide strategic human capital plan and developed workforce analysis tools to assist it in identifying critical skills needs. NASA also developed a human capital plan specifically for sustaining the shuttle workforce through the retirement and, then transitioning the workforce. According to agency officials, currently NASA is mapping the available skills of the Space Shuttle workforce with the skills it will need for future work so that it can better plan and implement workforce reassignments. NASA's senior leaders recognize the need for an effective workforce strategy in order to sustain the shuttle workforce through the shuttle's retirement, which coincides with the completion of the ISS. Clear, strong executive leadership will be needed to ensure that the risks associated with the transition of the shuttle workforce are minimized.

Filling the Gap between the Shuttle and New NASA-Developed Vehicles to Service the International Space Station

NASA has several options for filling the gap between the shuttle, which will retire in 2010 and new NASA-developed vehicles that are not expected to come on-line until 2015. The first relies on new vehicles developed within the U.S. commercial space sector. The second relies on vehicles developed by international partners—both new and legacy systems. There are considerable challenges with all options NASA is examining.

NASA Dependence on Commercial Development

NASA is working with the commercial space sector to develop and produce transport vehicles that can take equipment and ultimately crew to and from the space station during the gap between the space shuttle and the crew launch vehicle. Rather than buy these vehicles outright, NASA plans to help fund their development and purchase transportation services or perhaps even the vehicles themselves when they are needed. This program is known as Commercial Orbital Transportation Services (COTS). Currently, NASA has seven COTS agreements—all are in the initial phases of raising private funds for the development. NASA funding has been provided to two companies, Rocketplane Kistler (RpK) and Space Exploration Technologies (SpaceX). NASA has signed five more Space Act Agreements which facilitates sharing technological information, but these agreements are unfunded by NASA.

There are two phases to the COTS program, the first phase entails technical development and demonstration and the second phase may include the competitive procurement of orbital transportation services for ISS logistical support. NASA officials noted that both RpK and SpaceX met their first milestone to demonstrate financial progress by obtaining private funding. However, RpK missed its second milestone in May 31, 2007 and had to renegotiate its Space Act Agreement milestone with NASA.

The International Space Station Independent Safety Task Force (IISTF)² reported in February 2007 that the design, development, and certification of the new COTS capability for ISS re-supply was just beginning. IISTF

²As required by the National Aeronautics and Space Administration (NASA) Authorization Act of 2005, Pub. L. No., 109-155 §801, the International Space Station Independent Safety Task Force was charged with assessing the vulnerabilities of the International Space Station.

stated that, “if similar to other new program development activities, it most likely will take much longer than expected and will cost more than anticipated.” Our work has generally found space and other complex system development efforts—including NASA-sponsored efforts—often encounter schedule delays and technical problems when they are seeking to obtain significant advances in technologies, move forward amid changing requirements or with other unknowns, and/or are managed without adequate oversight. In our opinion, risks may be high in these partnerships, given that the suppliers do not have long-standing relationships with NASA or other government agencies and the development of the COTS vehicles represent totally new endeavors for most of these companies. As such, it will be exceedingly important for NASA to establish sound program management and oversight controls over these endeavors, establish clear and consistent guidance, limit requirements changes, and ensure it has adequate visibility into the progress being made by the COTS suppliers. Our review will examine the extent to which these measures are being taken. As you know, GAO has identified contract management as a high risk area for NASA. Actions designed to enhance program management and oversight are being implemented, but it may take years to complete them. This may make it even more difficult for NASA to successfully manage and oversee its relationship with the COTS suppliers. If NASA relies on these development efforts without adequate oversight, the programs could fall short of cost and schedule estimates, result in downgraded performance, and ultimately impact overall sustainment of the ISS.

NASA Dependence on International Partners

NASA has suggested that some supply activities during the gap can be conducted by vehicles under development or currently in operation by international partners—specifically, Europe, Japan and Russia—but these vehicles have constraints. Our ongoing review will assess these constraints in greater detail.

To begin with, new vehicles being developed by the European and Japanese space agencies are very complex. Currently, the first test flight for the European vehicle is likely to happen in January 2008. The Japanese vehicle will not have its first operational flight until 2009. According to NASA officials, both the European and Japanese vehicle developments experienced technical hurdles and budgetary constraints, but both partners are committed to fulfilling their roles as partners in the ISS program. They do have confidence that the European vehicle will be available for ISS operations before retirement of the shuttle, but they are not as confident about the Japanese vehicle being ready by that time.

NASA reliance on these vehicles to augment re-supply activities after 2010 assumes that further delays in their development will not occur. NASA's expectation is that these vehicles will be developed in parallel with commercial developments. The agency's preference is to use commercially developed vehicles, rather than rely on the vehicles developed by the international partners to cover the capability gap after retirement of the shuttle fleet.

NASA also plans to continue working with Russia to provide crew and cargo support to the ISS, but this has been facilitated through an exemption to the Iran, North Korea and Syria Nonproliferation Act. Russian vehicles that were already operational were used to rotate crew and supply ISS during the period after the Columbia accident and a Russian Soyuz vehicle remains docked to the ISS continuously. The Iran, North Korea and Syria Nonproliferation Act exemption expires at the end of 2011, at which time any exchanges will be subject to the restrictions of the Act. However, if commercial development does not produce a usable vehicle by that date, the only vehicle that can support crew transportation is the Russian Soyuz spacecraft. According to NASA officials, the agency is planning to request a waiver to gain further exemption beyond 2011 if this situation occurs.

Additionally, there are challenges related to sharing knowledge with international partners due to restrictions by the International Traffic in Arms Regulation (ITAR). This was highlighted by the International Space Station Independent Safety Task Force, and NASA has been working to address the concerns laid out in that study. Over the years, GAO has identified weaknesses in the efficiency and effectiveness of government programs designed to protect critical technologies while advancing U.S. interests. While each program has its own set of challenges, we found that these weaknesses are largely attributable to poor coordination within complex interagency processes, inefficiencies in program operations, and a lack of systematic evaluations for assessing program effectiveness and identifying corrective actions. However, in reviewing in the Joint Strike Fighter, another complex international system development effort, we also identified actions that could be taken early in programs to prevent delays and other problems related to ITAR. Our review going forward will assess the degree to which challenges in this area remain.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions that you or the other members may have at this time.

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Acknowledgments**

For further questions about this statement, please contact Cristina T. Chaplain at (202) 512-4841. Individuals making key contributions to this statement include James L. Morrison, Brendan S. Culley, Masha P. Pastuhov-Purdie, Keo Vongvanith and Alyssa B. Weir.

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