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Significant Challenges Remain for Access, Use, and Sustainment of the International Space Station

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Highlights

Highlights of GAO-12-587T, a testimony before the Committee on Science, Space, and Technology, House of Representatives

NASA

Significant Challenges Remain for Access, Use, and Sustainment of the International Space Station

Why GAO Did This Study

Construction of the International Space Station (ISS) required dedication and effort on the part of many nations to be successful. Further, the funding necessary to accomplish this task was significant, with the United States alone directly investing nearly $50 billion in its development. As construction of the on-orbit laboratory is complete, now is the time for the United States and its partners to make use of this investment and recently, Congress took steps to extend the life of the ISS until at least 2020.

GAO has cautioned for years that NASA should ensure it has a capability to access and utilize the space station following retirement of the space shuttle in 2011. We have highlighted the challenges associated with transporting cargo and crew to and from the ISS, as well as the difficulties NASA faces in ensuring the ISS supports its purpose of scientific research and in safely operating the station. Some risks have been realized. For example, commercial vehicles are significantly behind schedule—with the first launch to the space station planned for 2012.

GAO's statement today will focus on the progress NASA has made and the challenges the agency faces in accessing, ensuring full utilization of, and sustaining the ISS. To prepare this statement, GAO relied on prior relevant work on the ISS and NASA's commercial cargo and crew efforts and conducted a limited amount of additional work to update planned flight information.

View GAO-12-587T. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

NASA plans to use international partner and new domestic commercial launch vehicles to access, utilize, and sustain the International Space Station from 2012 through 2020. However, the agency faces challenges in transporting cargo and crew to the ISS as well as ensuring the station is fully utilized. NASA's decision to rely on the new commercial vehicles to transport cargo starting in 2012 and to transport crew starting in 2017 is inherently risky because the vehicles are not yet proven and are experiencing delays in development. Further, NASA does not have agreements in place for international partners to provide cargo services to the ISS beyond 2016. The agency will also face a decision regarding the need to purchase additional seats on the Russian Soyuz vehicle beyond 2016, likely before commercial vehicles have made significant progress in development, given the three-year lead time necessary for acquiring a seat. This decision is further complicated because restrictions prohibit NASA from making certain payments to Russia in connection with the ISS unless the President makes a determination. Further, NASA currently expects to transport all cargo needed by the ISS in 51 flights through 2020, but if international partner agreements and commercial service contracts do not materialize as the agency plans for the years beyond 2016, the situation could lead to a potential cargo shortfall.

If NASA can access the station, it will next be challenged with fully utilizing the ISS national laboratory for its intended purpose—scientific research. To take steps to meet this challenge and consistent with a 2009 GAO recommendation, in 2011 NASA selected an organization to centrally oversee ISS national laboratory research decision-making. It is too soon, however, to determine whether this organization is ensuring full scientific utilization of the ISS. Regardless of the efforts of the management body, as GAO noted in a 2009 report, constraints on crew time for conducting science could also impact full utilization.

If NASA can overcome its challenges related to accessing the station, it has reasonable approaches in place for estimating spare parts and assessing the structural health of the space station. These approaches provide NASA with increased assurance that the agency will have sufficient spares and will put mitigations in place to effectively and safely utilize the space station.

International Space Station

Source: NASA.

Chairman Hall, Ranking Member Johnson, and Members of the Committee:

Thank you for inviting me here today to discuss utilization of the International Space Station (ISS). The construction of the ISS is a significant technical achievement. In essence, the National Aeronautics and Space Administration (NASA) and its international partners have assembled and constructed a skyscraper-sized laboratory in low-earth orbit. This achievement involved dedication and effort on the part of all participating nations and individuals. With construction completed and a full crew of six astronauts on-board, the ISS stands poised to deliver scientific breakthroughs enabled by its unique capabilities. The potential of the ISS program to deliver on the promise of scientific discovery, however, is inextricably linked to NASA's ability to safely access, sustain, and fully utilize the laboratory in orbit.

Now that ISS construction is finished, NASA and the ISS program face three major challenges, which will be the focus of my testimony. First and foremost, NASA must be able to transport cargo and crew to and from the ISS. Second, NASA must ensure that the management of the ISS national laboratory results in effective utilization of the station for its primary purpose—scientific research. Finally, NASA must ensure that replaceable spares are available and that the ISS is structurally sound and can safely continue operations.

We have been reporting on the difficulties associated with sustaining the ISS in the post-space shuttle era since May 2005 when we first recommended that NASA take actions to determine the best available options for supporting the station after shuttle retirement.[1] In July 2006, we expressed our initial concerns regarding NASA's acquisition strategy for the shuttle's replacement, the human spaceflight system known as Constellation, because of lack of a sound business case based on resources that are matched to requirements, a stable design, and well-defined cost estimates.[2] Since 2008, we have cautioned that the use of international launch vehicles is only a back-up and a less-capable means

[1] GAO, *NASA: More Knowledge Needed to Determine Best Alternatives to Provide Space Station Logistics Support*, GAO-05-488 (Washington, D.C.: May 18, 2005).

[2] GAO, *NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge*, GAO-06-817R (Washington D.C.: July 17, 2006).

of supporting the station, as well as raised concerns about the ambitious schedules for the vehicles being developed under NASA's Commercial Crew and Cargo Program.[3] In a November 2009 report, we iterated our concerns that limited international partner vehicle capacity and potential delays in planned commercial vehicle development could impede efforts to maximize utilization of all ISS research facilities.[4] In 2011 reports and testimony, we observed that commercial cargo launch development remained behind schedule and, even when coupled with international partner launch capacity, may not cover all of the ISS anticipated needs beginning in 2014.[5] Further, we reported that the funding provided for NASA's commercial crew efforts was significantly less than expected, as other priorities such as the Space Launch System received increased funding.

In preparing this statement, we relied on our prior reports and testimonies, including those related to NASA's management of commercial launch vehicle development, the agency's acquisition approach for commercial crew transportation, and ISS sustainment and utilization.[6] We also conducted a limited amount of additional audit work in March 2012 to update information on planned commercial cargo and international partner flights. Our prior work in these areas, as well as the work conducted to support this statement, was performed in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient and appropriate evidence to provide a reasonable basis for our findings and

[3] GAO, *NASA: Challenges in Completing and Sustaining the International Space Station*, GAO-08-581T (Washington, D.C.: Apr. 24, 2008) and *NASA: Commercial Partners Are Making Progress, but Face Aggressive Schedules to Demonstrate Critical Space Station Cargo Transport Capabilities*, GAO-09-618 (Washington, D.C.: June 16, 2009).

[4] GAO, *International Space Station: Significant Challenges May Limit Onboard Research*, GAO-10-9, (Washington D.C.: Nov. 25, 2009).

[5] GAO, *Commercial Launch Vehicles: NASA Taking Measures to Manage Delays and Risks*, GAO-11-692T, (Washington, D.C.: May 26, 2011); *International Space Station: Approaches for Ensuring Utilization through 2020 Are Reasonable but Should Be Revisited as NASA Gains More Knowledge of On-Orbit Performance*, GAO-12-162, (Washington, D.C.: Dec. 15, 2011); and *National Aeronautics and Space Administration: Acquisition Approach for Commercial Crew Transportation Includes Good Practices, but Faces Significant Challenges*, GAO-12-282, (Washington, D.C.: Dec. 15, 2011).

[6] GAO-05-488; GAO-06-817R; GAO-08-581T; GAO-09-618; GAO-10-9; GAO-11-692T, GAO-12-162; and GAO-12-282.

conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

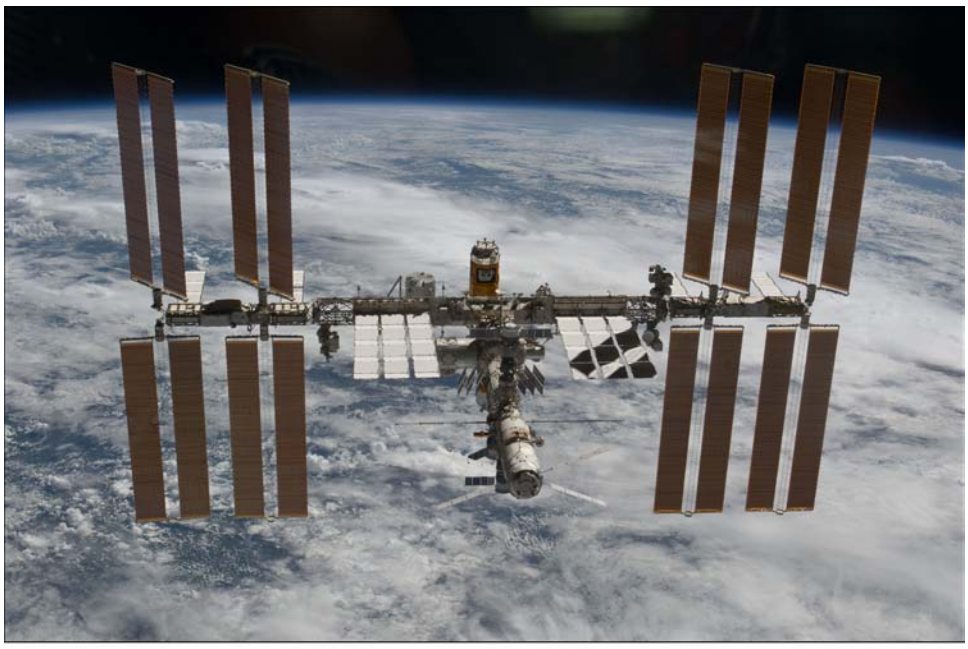
Background

The ISS program began in 1993 with several partner countries: Canada, the 11 member nations of the European Space Agency, Japan, and Russia. From 1994 through 2010, NASA estimates that it directly invested over $48 billion in development and construction of the on-orbit scientific laboratory, the ISS. NASA intended ISS assembly to be complete much sooner than it was. For example, in 1995, NASA expected to ISS assembly to be finished by June 2002, whereas the agency actually completed assembly in 2010. With ISS expected to be in use only through 2015, this slower pace shortened the amount of time NASA had available to take advantage of the significant monetary investment and to fully utilize the station. As a result, the NASA Authorization Act of 2010 required the NASA Administrator to take all actions necessary to ensure the safe and effective operation of the ISS through at least September 30, 2020. [7]

The ISS is the largest orbiting man-made object. (See fig. 1) It is composed of about 1 million pounds of hardware, brought to orbit over the course of a decade. The ISS includes (1) primary structures, that is, the external trusses which serve as the backbone of the station and the pressurized modules that are occupied by the ISS crew, and (2) functional systems made up of replaceable units, that is, systems that provide basic functionality such as life support and electrical power that are made of modular components that are replaceable by astronauts on orbit.

[7] National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267 § 503.

Figure 1: International Space Station



Source: NASA.

The ISS was constructed to support three activities: scientific research, technology development, and development of industrial applications. The facilities aboard the ISS allow for ongoing research in microgravity, studies of other aspects of the space environment, tests of new technology, and long-term space operations. The facilities also enable a permanent crew of up to six astronauts to maintain their physical health standards while conducting many different types of research, including experiments in biotechnology, combustion science, fluid physics, and materials science, on behalf of ground-based researchers. Furthermore, the ISS has the capability to support research on materials and other technologies to see how they react in the space environment.

NASA planned for the space shuttle to serve as the means of transporting crew, hardware, and supplies to the ISS through the end of the station's life. However, in 2004, President George W. Bush announced his Vision for Space Exploration (Vision) that included direction for NASA to develop new spaceflight systems under the Constellation program to replace the space shuttle as NASA's primary spaceflight system. The Vision also included provisions for NASA to pursue commercial alternatives or

providing transportation and other services to support the ISS after 2010.[8] NASA established the Commercial Crew and Cargo Program in 2005 to facilitate the private demonstration of safe, reliable, and cost-effective transportation services and purchase these services commercially. When the Constellation program was cancelled in 2010, the commercial vehicles became NASA's primary focus for providing cargo and crew transportation to the ISS. The success of commercial efforts became even more important in 2010 when Congress authorized the extension of space station operations until at least 2020 from 2015, and the President directed that NASA transition the role of human transportation to low-earth orbit to commercial space companies.

NASA Faces Challenges Transporting Cargo and Crew to and from the ISS

The greatest challenge facing NASA is transporting cargo and crew to and from the ISS to make effective use of the ISS. NASA plans to rely on ISS international partner and new commercial launch vehicles to transport cargo and crew to and from the ISS until at least 2020. NASA hopes to begin using new commercial cargo vehicles in 2012 and crew vehicles to transport astronauts to and from the ISS beginning in 2017. NASA's decision to rely on the new commercial vehicles is inherently risky because the vehicles are still in development and not yet proven or fully operational.

NASA Plans to Use International Partner and Commercial Flights but International Agreements Are Not in Place and Commercial Vehicles Remain Unproven

NASA is relying on 51 flights of international partner and commercial vehicles to transport cargo to the ISS from 2012 through 2020, but agreements for international flights after 2016 are not in place and the commercial vehicles are unproven. NASA has agreements in place with the European and Japanese space consortiums for their respective vehicles—the European Automated Transfer Vehicle (ATV), and the Japanese H-II Transfer Vehicle (HTV)—to conduct cargo resupply missions beginning in 2012 through 2016. The ATV and HTV are unmanned vehicles that have flown to the ISS, and carry such items as

[8] In 2004, President George W. Bush established a new space exploration policy—*A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration* (Vision)—which called for the retirement of the space shuttle and development of a new family of exploration systems to facilitate a return of humans to the moon and eventual human spaceflight to Mars.

hardware and water.[9] NASA's current plans anticipate employing a total of 12 international partner launches—8 from 2012 to 2016 and 4 from 2017 through 2020. NASA does not have agreements in place for international partners to provide cargo services to the ISS beyond 2016. NASA plans to use the ATV for a number of cargo flights through 2014, but no longer anticipates its use after that time. NASA plans to use HTV for a number of cargo flights through 2016, but its negotiations with the Japanese partners for flights beyond 2016 are in their infancy.

NASA also plans to use two types of domestic commercial launch vehicles to maintain ISS from 2012 through 2020. Development of these vehicles—the Falcon 9 and Antares[10]—was fostered under a NASA-initiated effort known as Commercial Orbital Transportation Services. These vehicles are being developed by private industry corporations—Falcon 9 by SpaceX and Antares by Orbital Sciences Corporation. In late 2008, NASA awarded contracts to both companies to provide cargo transport services to the ISS. Only SpaceX will be able to safely return significant amounts of cargo to earth, such as the results of scientific experiments. NASA anticipates that SpaceX will begin providing that capability in 2012.

Commercial vehicles are essential to sustaining and utilizing the ISS. As table 1 indicates, SpaceX and Orbital are scheduled to fly 20 (71 percent) of the 28 launches NASA plans through 2016 and follow-on commercial resupply vehicles are expected to fly 19 (83 percent) of the 23 launches from 2017 through 2020.[11]

[9] In 2008 and 2009, the ATV and HTV vehicles respectively flew to the ISS and docked at the station to demonstrate their capabilities. In 2011, both vehicles again launched. These flights were the second for both systems.

[10] The Antares was previously known as the Taurus II.

[11] NASA has awarded contacts to SpaceX and Orbital for cargo resupply services to the ISS through 2016. Planned follow-on commercial resupply vehicles are the vehicles NASA will use for flights beyond those currently under contract.

Table 1: NASA's Planned Vehicle Launches for 2012 to 2020 to Resupply the ISS as of March 2012

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Vehicles										
ATV	1	1	1							**3**
HTV	1	1	1	1	1	1	1	1	1	**9**
SpaceX	2	2	2	3	3					**12**
Orbital	1	2	1	2	2					**8**
Follow-on commercial resupply						5	5	5	4	**19**
Total	**5**	**6**	**5**	**6**	**6**	**6**	**6**	**6**	**5**	**51**

Source: GAO analysis of NASA data.

Note: NASA does not have contracts with commercial providers or negotiated agreements with international partners for flights from 2017 through 2020.

This plan relies on commercial vehicles meeting anticipated—not proven—flight rates. As we have previously reported, both SpaceX and Orbital are working under aggressive schedules and have experienced delays in completing demonstrations.[12] SpaceX flew its first demonstration mission in December 2010, some 18 months late, because of such factors as design issues and software development. Currently, SpaceX's next demonstration launch to the ISS has been delayed from November 2011 to late April 2012 because of additional testing and resolution of some technical issues such as electromagnetic interference. Likewise, Orbital experienced programmatic changes and developmental difficulties that led to multiple delays of several months' duration. In May 2011 testimony,[13] we noted that Orbital's inaugural demonstration mission had been delayed to December 2011. Currently, this flight has been delayed further to August or September 2012, primarily because of issues related to construction and testing of the launch pad at Wallops Island, Virginia. NASA has made efforts to accommodate delays in commercial vehicle development, including use of the final shuttle flight in July 2011 to pre-position additional ISS spares. However, if the commercial vehicle launches do not occur as planned in 2012, the ISS could lose some ability to function and sustain research efforts due to a lack of alternative launch vehicles to support the ISS and return scientific experiments back to earth.

[12] GAO-09-618.

[13] GAO-11-692T.

If the international partner agreements and commercial service provider contracts do not materialize as NASA plans for the years beyond 2016, this could lead to a potential cargo shortfall. As we reported in 2011,[14] NASA's strategic planning manifests showed that, when anticipated growth in national laboratory demands and margin for unforeseen maintenance needs are accounted for, the 56 flights NASA was planning for at the time of our review might not cover all of NASA's anticipated needs. These shortfalls amounted to a total of 2.3 metric tons—approximately the cargo that one SpaceX commercial vehicle will be able to transport to the ISS. As of March 2012, NASA has cut its planned number of flights from 2012 through 2020 from the 56 flights we reported to 51 flights. However, its current ongoing analysis is no longer projecting a cargo shortfall even with the decreased number of flights. According to an ISS program official, cargo estimates, particularly beyond 2013, are for planning purposes and could change as they are updated frequently based on launch vehicle availability and the ISS's need for spares.

NASA Lacks a Domestic Ability to Transport Crew to the ISS until at Least 2017

NASA faces two major challenges in transporting crew to the ISS—adjusting its acquisition strategy for crew vehicles to match available funding and deciding if and when to purchase crew seats on the Russian Soyuz in case domestic commercial crew vehicles are not available as planned in 2017. In 2010, President Obama directed NASA to transition the role of transporting humans to low-Earth orbit to commercial space companies. Consequently, in 2010 and 2011 NASA entered into funded and unfunded Space Act agreements[15] with several companies to develop and test key technologies and subsystems to further commercial

[14] GAO-12-262.

[15] Space Act agreements are transactions other than contracts, leases, and cooperative agreements. Congress granted NASA the authority to enter into these types of transactions in the National Aeronautics and Space Act of 1958 to give the agency greater flexibility in achieving its mission. Pub. L. No. 85-568, § 203(b)(5). Under a funded Space Act agreement, appropriated funds are transferred to a domestic partner, such as a private company or a university, to accomplish an agency mission. These agreements differ from Federal Acquisition Regulation (FAR) contracts in that they do not include requirements that generally apply to government contracts entered into under the authority of the FAR. Unfunded agreements accomplish the same goals but no appropriated funds are transferred. Under such agreements, the company can benefit from NASA's experience, guidance, and advice and NASA can gain insight into the company's system. For more information see GAO, *Key Controls NASA Employs to Guide Use and Management of Funded Space Act Agreements Are Generally Sufficient, but Some Could Be Strengthened and Clarified*, GAO-12-230R (Washington, D.C.: Nov. 17, 2011).

development of crew transportation services. NASA's intent was to encourage private sector innovation and to procure safe, reliable transportation services to the space station at a reasonable price. Under this acquisition approach, NASA plans to procure seats for crew transportation to the ISS from the private sector through at least 2020.

In 2011, we reviewed NASA's plans for contracting for additional commercial crew development efforts and found that the agency's approach employed several good acquisition practices including competitive contracting that—if implemented effectively—limit the government's risk. As we also noted in that report, NASA's funding level for fiscal year 2012 is almost 50 percent less than it anticipated when it developed its approach for procuring commercial crew services. Given this funding level, NASA indicated it could not award contracts to multiple providers, which weakened prospects for competition in subsequent phases of the program.[16] The main premise of its procurement approach to control costs—full and open competition for future phases of the program—therefore was likely no longer viable. Without competition, NASA could become dependent on one contractor for developing and providing launch services to the space station. Reliance on a sole source for any product or service increases the risk that the government will pay more than expected, since no competitors exist to help control market prices. As a result of this funding decrease, NASA adjusted its acquisition strategy. The agency now plans to enter into another round of Space Act agreements to further the development of commercial crew vehicles and has delayed the projected purchase of commercial crew transportation until 2017.

Additionally, the agency faces another looming challenge—a decision about if and when to purchase crew space on the Russian Soyuz vehicle. NASA will likely need to decide by the end of 2013 whether to purchase additional seats that might be needed beyond 2016 because the lead time for acquiring additional seats on the Soyuz is 3 years. However, in the 2013 time frame, NASA cannot be fully confident that domestic crew efforts will succeed because the vehicles will not yet have entered the test and integration phase of development. Furthermore, the decision to

[16] We reported in GAO-12-282 that, although private investment was anticipated from the commercial companies, without government investment, the commercial market for launch vehicles alone may not continue to grow and provide more than one contractor that would be able to compete for subsequent phases.

purchase crew seats on the Russian Soyuz is complicated by restrictions found in the Iran, North Korea, and Syria Nonproliferation Act.[17] These restrictions prohibit NASA from making certain payments to Russia in connection with the ISS unless the President makes a determination. NASA currently has a statutory exemption from this restriction that allows certain types of payments, but that exemption expires in 2016. According to NASA officials, the agency has begun working toward resolution of this problem, but the issue is not yet resolved.

NASA Faces Challenges Maximizing ISS Research Utilization

NASA's greatest challenge to utilizing the ISS for its intended purpose—scientific research—is inextricably linked with the agency's ability to carry scientific experiments and payloads to and from the ISS. International partner vehicles have much less cargo capacity than the space shuttle did to carry supplies to the ISS and no ability to return research payloads back to earth. The Russian Soyuz vehicle has some ability to transport research payloads back to earth, but the capability is minimal at only 132 pounds. As mentioned previously, SpaceX, however, will provide NASA with the capability to transport research payloads back to earth. Consequently, if the new commercial launch vehicles are not available as planned, the impact on ISS utilization could be dramatic. In the past, NASA officials have told us that the impact of failures or significant delays in developing the commercial cargo capability would be similar to the post-Columbia shuttle disaster scenario,[18] where NASA operated the ISS in a "survival mode" and moved to a two-person crew, paused assembly activities, and operated the ISS at a lower altitude to relieve propellant burden. NASA officials stated that if the commercial cargo vehicles are delayed, they would pursue a course of "graceful degradation" of the ISS until conditions improve. In such conditions, the ISS would only conduct minimal science experiments.

Nonetheless, NASA expects scientific utilization to increase since construction of the ISS is complete. The ISS has been continuously staffed since 2000 and now has a six-member crew. The primary objective for the ISS through 2011 was construction, so research utilization was not the priority. Some research was conducted as time and

[17] Pub. L. No. 106-178 (2000) (as amended), *codified at* 50 U.S.C. §1701 (note).

[18] This refers to the 2003 loss of the Space Shuttle Columbia, which resulted in NASA suspending shuttle flights until 2005 while investigations were under way.

resources permitted while the crew on board performed assembly tasks. NASA projects that it will utilize approximately 50 percent of the U.S. ISS research facilities for its own research. As we reported in 2009, however, NASA's scientific utilization of the ISS is constrained by limited crew time. Limiting factors include the size of the crew on board the station; the necessary division of crew work among many activities that include maintenance, operations, and research; and the need to share research facilities with international partners.

Per statutory direction, NASA has opened the remaining facilities to other federal government entities and private industry and is operating the ISS as a national laboratory. As we reported in 2009, NASA may face challenges in the management and operation of ISS National Laboratory research.[19] There is currently no direct analogue to the ISS National Laboratory, and though NASA currently manages research programs at the Jet Propulsion Laboratory and its other centers that it believes possess similar characteristics to other national laboratories, NASA has limited experience managing the type of diverse scientific research and technology demonstration portfolio that the ISS could eventually represent.

To manage ISS National Laboratory research, as we recommended in 2009,[20] NASA selected a body in 2011 to centrally oversee ISS research decision-making. This body, the Center for the Advancement of Science in Space (CASIS), is charged with developing and managing a varied research and development portfolio based on U.S. national needs for basic and applied research; establishing a marketplace to facilitate matching research pathways with qualified funding sources; and stimulating interest in using the national lab for research and technology demonstrations and as a platform for science, technology, engineering, and mathematics education. CASIS has begun outreach efforts and has issued a Request for Information due back in March 2012 that seeks to identify and gather information from entities capable of serving as implementation partners. CASIS plans to develop an internal database from the information collected via this Request for Information, which will enable identification of entities that can support payload development needs according to their requisite areas of expertise. CASIS will refer to

[19] GAO-10-9.

[20] GAO-10-9.

this database when issuing solicitations for funded opportunities to support research payload activities. Since the establishment of CASIS as the management body of ISS research is relatively recent, we have not examined its effectiveness; therefore, it is too early for us to say whether it will be successful in ensuring full scientific utilization of the station as a national laboratory.

NASA Has a Reasonable Approach to Meeting the Challenge of Estimating ISS Spares and Assessing Structural Health and Safety

We recently reported[21] that NASA has an appropriate and reasonable approach in place to determine the spares needed for the ISS as well as to assess ISS structural health and safety. Estimating ISS spares and gauging the structural health and safety of the ISS are not simple challenges. Among the many factors to be assessed are the reliability of key components, NASA's ability to deliver spares to the ISS, the projected life of structures that cannot be replaced, and in-depth analysis of those components and systems that affect safety. While some empirical data exist, because the ISS is a unique facility in space, assessing its extended life necessarily requires the use of sophisticated analytical techniques and judgments.

NASA's approach to determining necessary spare parts for the ISS relies on a statistical process. The statistical process and methodology being used to determine the expected lifetimes of replacement units is a sound and commonly accepted approach within the risk assessment community that considers both manufacturers' predictions and the systems' actual performance. NASA also has a reasonable process for establishing performance goals for various functions necessary for utilization and determining through modeling whether available spares are sufficient to meet goals through 2020, but the rationale for establishing performance goals has not been systematically documented.

NASA is also using reasonable analytical tools to assess structural health and determine whether ISS hardware can operate safely through 2020. NASA currently anticipates that—with some mitigation—the ISS will remain structurally sound for continued operations through 2020. NASA also is using reasonable methodologies to identify replacement units and other hardware that could cause serious damage to the ISS if they were to fail. Through 2015, NASA plans to develop methods to mitigate issues

[21] GAO-12-162.

identified and expects to begin implementing corrective actions as plans are put in place.

Concluding Observations

In summary, although NASA has done a credible job of ensuring that the ISS can last for years to come, the question that remains is whether NASA will be able to service the station and productively use it for science. Routine launch support is essential to both, but the road ahead depends on successfully overcoming several complex challenges, such as technical success, funding, international agreements, and management and oversight of the national laboratory. Finally, if any of these challenges cannot be overcome, it will be contingent upon NASA to ensure that all alternatives are explored—in a timely manner—to make full use of the nation's significant investment in ISS.

Chairman Hall, Ranking Member Johnson, and Members of the Committee, this concludes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

Appendix I: GAO Contacts and Staff Acknowledgements

GAO Contacts

For questions about this statement, please contact me at (202) 512-4841 or chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this testimony.

Staff Acknowledgements

Individuals making key contributions to this statement include Shelby S. Oakley, Assistant Director; John Warren, Tana Davis, and Alyssa Weir.