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The International Space Station (ISS) and the Administration's Proposal to End Direct NASA Funding by 2025

Introduction

The Trump Administration's FY2019 budget for the National Aeronautics and Space Administration (NASA) proposes to end direct NASA funding of the International Space Station (ISS) by 2025. Budget documents state that industry "could potentially continue to operate certain elements or capabilities." Some reports have characterized this proposal as commercialization of the ISS. Under the Administration's plan, NASA would focus its human spaceflight activities on the Moon and deep space; it would rely on commercial partners for its research and technology demonstration needs in low Earth orbit.

This CRS In Focus provides background on the ISS, its governing international agreements, its planned service life, the ongoing commercialization of U.S. ISS access, and current commercial use of the ISS. It concludes with a brief discussion of congressional options.

Figure 1. The International Space Station, viewed from space shuttle *Endeavour* in 2011.

Source: NASA.

What Is the ISS?

The ISS orbits Earth about every 90 minutes at an altitude of about 240 miles. This altitude is considered low Earth orbit. For comparison, many telecommunications satellites are in geosynchronous orbits at an altitude of about 22,000 miles, while the distance to the Moon is about 240,000 miles.

The ISS is composed of crew living space, laboratories, remote manipulator systems, solar arrays to generate electricity, and other elements. Overall, it is roughly the size of a football field. Its pressurized living and working spaces have about the same volume as the interior of a Boeing 747. Rotating crews have occupied it continuously since November 2000.

As well as providing facilities for research and technology development in low Earth orbit, the ISS serves as a test bed and stepping stone for future human exploration missions to more distant destinations. Through February 2017, ISS research had resulted in 1,395 publications in scientific journals and 422 papers presented at scientific conferences. NASA claims benefits that range from new surgical technology to improvements in water purification. At a congressional hearing in 2017, a University of Florida scientist described the ISS as "a critical, unique, and extraordinarily capable research platform."

The ISS is currently the only operational component of NASA's human spaceflight program. Astronaut transport to and from the ISS is provided by Russian spacecraft and, in the future, U.S. commercial providers. NASA's plans for future human exploration of space focus on the Moon and other destinations beyond Earth orbit, for which a new rocket and capsule are now in development. The first crewed flight of those new systems is expected in 2023.

International Cooperation on the ISS

The framework for international cooperation on the ISS is the Intergovernmental Agreement on Space Station Cooperation, which was signed in 1998 by representatives of the United States, Russia, Japan, Canada, and 11 European countries. The agreement is implemented through memoranda of understanding between NASA and the Russian Federal Space Agency (Roskosmos), the Japanese Aerospace Exploration Agency (JAXA), the Canadian Space Agency (CSA), and the European Space Agency (ESA). Additional agreements exist with several other international partners.

The ISS components built and operated by NASA, JAXA, CSA, and ESA are known as the U.S. operating segment. They include laboratories, connecting nodes, an airlock, docking ports, storage space, and external systems such as solar arrays and a manipulator arm. The components built in Russia and operated by Roscosmos are known as the Russian operating segment. They include crew living quarters, storage space, airlocks, and docking ports.

ISS Service Life

For most of the last decade, ISS operations were scheduled to continue only through FY2016. Statutory authority for continued U.S. operation of the ISS was extended through at least FY2020 by the NASA Authorization Act of 2010 (P.L. 111-267, Sec. 503(a)) and through at least FY2024 by the U.S. Commercial Space Launch Competitiveness Act (P.L. 114-90, Sec. 114(b)). In each case, NASA conducted engineering reviews, with oversight by the Government Accountability Office and the NASA Inspector General, to

identify and mitigate any safety and reliability concerns arising from the extension of the ISS's service life. The extensions also required negotiations and agreements between NASA and its international partners.

Commercialization of ISS Access

NASA used to rely on the space shuttle to carry U.S. cargo and crews to and from the ISS. The shuttle fleet was retired after the final flight of *Atlantis* in July 2011. Since then, ISS cargo has been carried by Russian, European, and Japanese spacecraft, and starting in 2012, by two U.S. commercial providers—Space Exploration Technologies (SpaceX) and Orbital ATK—under NASA contracts. In 2016, NASA awarded a contract to Sierra Nevada Corporation as a third provider for ISS cargo missions starting in 2020.

Since July 2011, ISS crews, including U.S. astronauts, have been carried exclusively by Russian *Soyuz* spacecraft, at a cost of up to $82 million per seat. NASA has contracted with two U.S. companies—SpaceX and Boeing—to transport U.S. astronauts to and from the ISS. Both companies plan crewed demonstration flights in late 2018, followed by operational flights with crews starting in 2019.

Commercial Use of the ISS

In an effort to increase use of the ISS by other federal agencies and the private sector, the NASA Authorization Act of 2005 (P.L. 109-155, Sec. 507) designated the U.S. portion of the ISS as a national laboratory. The NASA Authorization Act of 2010 subsequently directed NASA to contract with a nonprofit organization to manage the ISS national laboratory (P.L. 111-267, Sec. 504). In 2011, NASA selected the Center for the Advancement of Science in Space (CASIS) as the ISS national laboratory managing organization.

From FY2012 through FY2017, CASIS issued 30 solicitations and awarded 187 projects. In FY2017, more than 50% of payloads launched to the ISS national laboratory involved commercial entities. In addition, several facilities on the ISS are commercially operated. For example, Nanoracks LLC operates a system that can deploy small satellites from the ISS, rather than by rocket launched directly from Earth, and Made In Space, Inc., operates an onboard facility for additive manufacturing ("3-d printing"). A 2017 study by two University of Indiana researchers found that ISS experiments are more likely to result in patents or publication in high-impact journals if they have non-NASA principal investigators. Commercial partners generally do not contribute to ISS operating costs, however, and in many cases, CASIS awards grants to facilitate non-NASA projects. In January 2018, the NASA Inspector General found that "without significant change, CASIS likely will fall short of advancing NASA's goal for a commercial economy in low Earth orbit."

Commercialize, Extend, or Terminate?

As Congress evaluates the Administration's proposal, it may wish to consider three options: commercializing all or part of the ISS or its operations, extending the ISS's service life under continuing NASA management, or simply ending ISS operations. As required by the NASA Transition Authorization Act of 2017 (P.L. 115-10, Sec. 303), NASA reported in March 2018 on its plans for the future of the ISS. The report advocated a transition to greater commercial planning and execution of ISS activities, but it rejected the phrase "commercializing the ISS."

Full or partial commercialization might help to stimulate and diversify the commercial space industry in low Earth orbit, while freeing up funds for human space exploration beyond Earth orbit, other NASA activities, other federal programs, or deficit reduction. In these respects, the goal of greater commercialization appears consistent with NASA's reliance on commercial providers for ISS cargo and crew access and NASA's ongoing encouragement of commercial use of the ISS. On the other hand, while a variety of companies are interested in using ISS facilities, there is little sign as yet of commercial interest in taking over ISS operations as a whole. Some analysts question whether the ISS would make sense as a commercial venture, especially considering the involvement of multiple international partners. Some form of public-private partnership might be easier to achieve than full commercialization; the details of such arrangements remain to be explored.

According to the NASA Inspector General, the United States has spent $87 billion since 1993 (in today's dollars) to build and operate the ISS, and is projected to spend an additional $3 billion to $4 billion annually supporting ISS operations through 2024. (NASA's total budget in FY2018 is $20.7 billion.) For some in Congress, maximizing the return on these investments may suggest extending the service life of the ISS beyond 2024. Return on investment was a key factor in the congressional decisions to extend operations through FY2020 (in 2010) and through FY2024 (in 2015). On the other hand, some stakeholders may see the ongoing annual cost of ISS operations as a reason to bring federal support to a close. For example, a 2014 National Research Council report concluded that "a continuation of flat budgets ... limits human spaceflight to [low Earth orbit] until after the end of the ISS program." As noted above, service life extension would require engineering analysis of safety and reliability issues, some of which is already under way, as well as agreements with NASA's international partner agencies.

At some point, whether or not ISS operations continue past FY2024, the ISS will reach the end of its useful life. To mitigate the risk of creating hazardous orbital debris, U.S. policy and international guidelines require that defunct spacecraft be disposed of by one of three methods: direct retrieval, maneuvering to a storage orbit, or atmospheric reentry. The ISS is far too large to retrieve directly. NASA analysis in 2010 determined that for safety, technical, and cost reasons, atmospheric reentry would be preferable to "parking" in a storage orbit. However, whereas smaller objects burn up harmlessly in the atmosphere on reentry, the ISS would require a controlled reentry to ensure a safe splashdown. The details of this option would require additional planning and likely the development or modification of a special de-orbit vehicle.

Daniel Morgan, Specialist in Science and Technology Policy

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