



SPACE AND AERONAUTICS SUBCOMMITTEE

HEARING CHARTER

“ISS and Beyond: The Present and Future of American Low-Earth Orbit Activities”

Wednesday, February 14, 2024

10:00 AM

2318 Rayburn House Office Building

Purpose

The hearing will examine the current state of low-Earth orbit (LEO) activity and discuss NASA’s future LEO plans. This hearing will also provide the Committee with insight into NASA’s end-of-life planning for the International Space Station (ISS) as well as the status of commercial space station development.

Witnesses

- **Mr. Kenneth Bowersox**, Associate Administrator, Space Operations Mission Directorate, National Aeronautics and Space Administration
- **Dr. Mary Lynne Dittmar**, Chief Government and External Relations Officer, Axiom Space
- **Dr. Robert J. Ferl**, Co-Chair, Committee on Biological and Physical Sciences in Space, The National Academies of Sciences, Engineering, and Medicine
- **Mr. Dylan Taylor**, Chairman and CEO, Voyager Space

Overarching Questions

- What are NASA’s plans for the future of human spaceflight in LEO and how will NASA transition from the ISS to commercial space stations?
- What are NASA's plans for maintaining, operating, and deorbiting the ISS?
- How is NASA prioritizing research aboard the ISS to maximize its utility before decommissioning?

Background

The United States has maintained a continuous human presence in LEO for over 20 years through the ISS program.¹ Construction of the ISS began on November 20, 1998, with the launch of the Zarya module. The first humans (two Russians and one American) occupied the ISS two years after the initial launch.² An additional 41 assembly flights culminated in completion of the ISS in July of 2011, producing a station comprised of 43 modules and elements which supports a 7-person crew.

International Participation

ISS is the product of a partnership of five space agencies: NASA, Roscosmos (Russia), the Japanese Aerospace Exploration Agency (JAXA), the Canadian Space Agency (CSA), and the European Space Agency (ESA). The United States and Russia are the primary hardware owners and operators, but ESA, Japan, and Canada have also contributed significant elements of the ISS (the Columbus module, the Kibo module, and a robotic arm, respectively). ISS has hosted nationals from 22 countries and facilitated projects from researchers in over 100 countries.

ISS international collaboration is governed by the Intergovernmental Agreement (IGA), an agreement between the 15 member countries of the five partner space agencies that dictates terms of use for the station.³ NASA also has executed a series of bilateral agreements with participating space agencies related to ISS operations.

Research in Low Earth Orbit

ISS provides a unique opportunity for scientific research. The station's location in LEO provides researchers with access to a continuous microgravity environment, as well as opportunities for Earth observation and the ability to leverage the extreme conditions of outer space. ISS research serves two main NASA objectives: benefitting future deep space exploration by helping NASA understand and prepare for the complications of living and working in space, and supporting a range of space-based basic and applied research.

For example, NASA's Ring Sheared Drop experiment builds on progress from terrestrial Alzheimer's research, utilizing the station's microgravity environment to study amyloid formation in unique ways and contributing to future treatment development.⁴ In 2021, researchers aboard the ISS observed non-premixed cool flames that burned gaseous fuel for the first time. This builds on past station flame research, including the discovery of non-premixed cool flames on the station in 2012.⁵ A comprehensive overview of research on the ISS can be found on NASA's website.⁶

¹ Tracy McMahan, *From Dream to Reality: Marshall Space Flight Center's Role in Developing Space Stations*, NASA (2016), https://www.nasa.gov/humans-in-space/space-stations/#_ftn13

² NASA, *Space Station Facts and Figures*, <https://www.nasa.gov/international-space-station/space-station-facts-and-figures/>

³ Agreement Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998. Available at:

https://aerospace.org/sites/default/files/policy_archives/Space%20Station%20Intergovernmental%20Agreement%20Jan98.pdf

⁴ NASA, *Space Station Leads to Breakthroughs in Human Health on Earth* (2022), <https://www.nasa.gov/missions/station/space-station-leads-to-breakthroughs-in-human-health-on-earth/>

⁵ NASA, *Cool Flames Created During a First for International Space Station Research* (2021),

<https://www.nasa.gov/missions/station/cool-flames-created-during-a-first-for-international-space-station-research/>

⁶ NASA, *Station Research and Technology*. Available at: <https://www.nasa.gov/international-space-station/space-station-research-and-technology/>

Commercial Activities

The NASA Authorization Act of 2005 designated the U.S. portion of the ISS as a national laboratory to increase the utilization of the ISS by other federal entities and the private sector.⁷ The NASA Authorization Act of 2010 later directed NASA to contract with an entity to manage the ISS National Lab (ISSNL), prompting the agency to enter into a cooperative agreement with the Center for Advancement of Science in Space (CASIS).⁸ CASIS manages all non-NASA U.S. research on the ISS, and at least 50 percent of the research capacity and crew time on the ISS is dedicated to these ISSNL experiments.

Following the release of NASA's initial transition plan, the agency established a Commercial LEO Program office at Johnson Space Center. In 2019, NASA published the NASA Plan for Commercial LEO Development.⁹ The plan creates a framework, detailing the steps that NASA plans to take in the short-, mid-, and long-term to support commercial development.

In the near-term, NASA developed a five-part plan of action building off the past two decades on the ISS. NASA plans to: (1) establish ISS commercial use and pricing policy; (2) enable private astronaut missions to ISS; (3) initiate process for commercial development of LEO destinations; (4) seek out and pursue opportunities to stimulate demand; and (5) quantify NASA's long-term needs for activities in LEO.

NASA has taken several steps to complete this five-part plan. In June 2019, NASA updated policies governing activity on the ISS by expanding access for commercial and marketing activities on the station.¹⁰ The scope of permissible activity is limited, however, to those that either: require the unique microgravity or space environment to enable manufacturing, production or development of a commercial application; have a connection to NASA's mission; or support the development of a sustainable low-Earth orbit (LEO) economy. In tandem with the issuance of updated activity guidelines, NASA released updated pricing policies for commercial ISS activities.¹¹

The updates to the ISS commercial and marketing policy also addressed private astronaut missions (PAM), allowing for up to two 30-day PAMs to the station annually. Two years later, Axiom and NASA signed an agreement allowing the company to fly four private citizens to the ISS for approximately one week. In April 2022, Axiom launched their first PAM – Ax-1.¹² Axiom and NASA have signed four PAM agreements, most recently in August 2023 for Ax-4, the companies fourth PAM planned to launch no earlier than August 2024.

⁷ ISS Cooperative Agreement Independent Review Team, "A Strategy for the Future of the International Space Station (ISS) National Laboratory (ISSNL) and Commercial Low-Earth Orbit (LEO) Development," February 4, 2020. Available at: <https://www.nasa.gov/wp-content/uploads/2023/09/iss-cooperative-agreement-irt-final-report.pdf?emrc=8afc82>

⁸ *Id.* At 7

⁹ NASA, "NASA Plan for Commercial LEO Development: Summary and Near-Term Implementation Plans," June 7, 2019. Available at: https://www.nasa.gov/wp-content/uploads/2019/05/commleodevt_plan_6-7-19_final-links-new.pdf?emrc=4bc361

¹⁰ William H. Gerstenmaier, "NASA Interim Directive (NID): Use of international Space Station (ISS) for Commercial and Marketing Activities," NID 8600.121, June 6, 2019. Available at: https://www.nasa.gov/wp-content/uploads/2022/05/nid_8600_121_tagged.pdf?emrc=567d62

¹¹ NASA, *ISS Commercial and Marketing Pricing Policy* (2019), <https://www.nasa.gov/humans-in-space/commercial-and-marketing-pricing-policy/>

¹² Axiom Space, *Ax-1 mission launches successfully; 4 private astronauts en route to space station* (2022), <https://www.axiomspace.com/news/ax-1-mission-launches-successfully-4-private-astronauts-en-route-to-space-station>

Station Health and Lifespan

NASA originally designed the ISS “with a life expectancy of 15 years [and] a safety factor of two, meaning it could operate to 30 years after the 1998 launch of its first segments.”¹³ As a result, initial timelines for the station planned for a 2015 retirement. The NASA Authorization Act of 2005 directed the NASA Administrator to assemble and operate the ISS “as long as the Administrator determines that the Shuttle can safely enable the United States to do so.”¹⁴ Congress later required the continued operation of the ISS through at least 2020 in the NASA Authorization Act of 2010.¹⁵ The Commercial Space Launch Competitiveness Act of 2015 further required that the ISS continue operations through at least 2024.¹⁶ Most recently, provisions within the CHIPS and Science Act required NASA to operate the ISS through September 2030.¹⁷

International partners generally have aligned with these extensions; JAXA, ESA, and CSA have all approved their respective ISS operations through 2030. Russia confirmed its support for the ISS through 2028.¹⁸ NASA officials report that Roscosmos attributes the two-year difference to its agency planning processes; Roscosmos planning related to the ISS operates in four-year increments and most recently extended the station from 2024 to 2028.¹⁹ It’s uncertain whether Roscosmos will participate in the ISS beyond 2028.

Although Boeing, the prime ISS contractor, certified the U.S. segments of the ISS for operations through 2028, the station is showing its age.²⁰ The ISS experienced pressure leaks in the Russian segment and experienced loss of attitude control on two separate occasions in 2021.²¹ The ISS requires continuous maintenance, replacements, and upgrades to many of the station’s systems to remain safely operational. In 2021, the NASA OIG reported that of the \$3 billion that NASA spends on the ISS each year, \$1.1 billion of that total covers annual ISS operations and maintenance costs. The report highlighted that while the top line remained stable, “systems maintenance and upgrade costs trended upward 35 percent in the same 5-year period.”²² NASA likely will have to continue dedicating an increasing number of resources to maintenance operations alone.

NASA’s ISS Transition Planning

As the ISS aged, Congress began considering its future. The NASA Transition Authorization Act of 2017 directed the agency to “develop a plan to transition in a stepwise approach from the current regime that relies heavily on NASA sponsorship to a regime where NASA could be one

¹³ NASA OIG, “NASA’s Management of the International Space Station and Efforts to Commercialize Low Earth Orbit,” IG-22-005, November 30, 2021. Available at: <https://oig.nasa.gov/docs/IG-22-005.pdf>

¹⁴ National Aeronautics and Space Administration Authorization Act of 2005, Pub L. No. 109-155 (2005)

¹⁵ National Aeronautics and Space Administration Authorization Act of 2010, Pub L. No. 111-267 (2010)

¹⁶ U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90 (2015)

¹⁷ Chips and Science Act, Pub. L. No. 117-167 (2022)

¹⁸ Jeff Foust, *Russia commits to ISS extension to 2028*, SpaceNews (2023), <https://spacenews.com/russia-commits-to-iss-extension-to-2028/>

¹⁹ Jeff Foust, *NASA open to extending ISS beyond 2030*, SpaceNews (2023), <https://spacenews.com/nasa-open-to-extending-iss-beyond-2030/>

²⁰ NASA OIG, “Examining the Future of the International Space Station,” Testimony before the Senate Subcommittee on Space, Science, and Competitiveness, May 16, 2018. Available at: <https://oig.nasa.gov/docs/CT-18-001.pdf>

²¹ *Id.* at 20

²² *Id.* at 13

of many customers of a low-Earth orbit non-governmental human space flight enterprise.”²³ The Act also charged NASA with identifying the “barriers preventing the commercialization of low-Earth orbit, including issues relating to policy, regulations, commercial intellectual property, data, and confidentiality, that could inhibit the use of the ISS as a commercial incubator.”

NASA also released an International Space Station Transition Report in March 2018. The report details the guiding principles of a potential transition, highlights NASA’s planned approach, and identifies the agency’s initial efforts for the transition. NASA updated this report in January 2022, detailing NASA’s future goals for LEO and providing an implementation strategy through the end of the ISS, as well as a post-ISS plan.²⁴ The 2022 Transition Report notes that “the ISS is now entering its third and most productive decade of utilization, including research advancement, commercial value, and global partnership.”²⁵ As part of this ‘decade of utilization’ NASA aims to complete research vital to NASA’s future deep space exploration and also utilize the station to lay a foundation for a commercial future in LEO. The report also emphasizes the importance of maintaining and expanding international partnerships following the transition to commercial LEO space stations.

Further, NASA’s ISS transition plan calls for the orderly and timely deorbit of the ISS following the transition to commercial space stations. A process which will require cooperation among the station’s partners. NASA has previously stated that ISS deorbit “is a shared responsibility of all five space agencies through partner contributions based on mass percent ownership by agency.”²⁶

To meet this objective, the agency issued a request for information for a deorbit spacecraft from industry in August of 2022.²⁷ NASA followed this with a request for proposals in September 2023 and updated the solicitation in December 2023, adding an option for proposals to request cost-plus contracts for development and production.²⁸ The deadline for NASA’s current solicitation is in February 2024, with the agency expecting to issue an award by June. Along with the solicitation, NASA began requesting funding for the effort in the Fiscal Year 2024 (FY24) Agency Budget Request. Specifically, “the FY 2024 budget request includes \$180 million in funding for development of an ISS de-orbit vehicle.”²⁹ NASA currently estimates that, in total, the ISS deorbit vehicle will cost approximately \$1 billion³⁰

Commercial Low-Earth Destinations Program

To generate potential future options for NASA to procure commercial LEO services as a customer, NASA initiated the Commercial LEO Destinations (CLD) program. The CLD program supports the development of commercially owned and operated space stations that

²³ National Aeronautics and Space Administration Transition Authorization Act of 2017, Pub. L. No. 115-10 (2017)

²⁴ NASA, “International Space Station Transition Report,” January 2022. Available at: https://www.nasa.gov/wp-content/uploads/2015/01/2022_iss_transition_report-final_tagged.pdf?emrc=4c4497

²⁵ *Id.* at 24

²⁶ Mark Garcia, NASA Seeks Proposals from US Industry for Station Deorbit Spacecraft (2023), <https://blogs.nasa.gov/spacestation/2023/09/20/nasa-seeks-proposals-from-us-industry-for-station-deorbit-spacecraft/>

²⁷ The request is available at: <https://sam.gov/opp/74252cfe7d49416abae0977fe4fd503c/view>

²⁸ The solicitation is available at: <https://sam.gov/opp/ef2b9c84c9c44b4e8f0db9cd8059fd08/view>

²⁹ NASA, “Fiscal Year 2024 President’s Budget Request” Available at: <https://www.nasa.gov/nasa-fiscal-year-2024-budget-request/>

³⁰ Jeff Foust, NASA planning to spend up to \$1 billion on space station deorbit module (2023), <https://spacenews.com/nasa-planning-to-spend-up-to-1-billion-on-space-station-deorbit-module/>

NASA envisions providing services to a range of customers, including the agency. NASA intends to complete the program in two award phases to ensure continuity between the ISS and a commercial station.

During the first phase, awardees will “formulate and design commercial low-Earth orbit destination capabilities suitable for potential government and private sector needs.”³¹ In December 2021, NASA signed three CLD agreements covering phase 1 to: a Blue Origin and Sierra Space Partnership (Orbital Reef); a consortium of Nanoracks, Voyager Space, and Lockheed Martin (Starlab); and Northrop Grumman. In 2023, the pool of CLD providers shrunk to two as Northrop withdrew from their agreement, opting to join the Nanoracks group.³² The agency modified the two remaining CLD contacts in 2024 by reallocating the Northrop Grumman funding to them.³³ NASA expects this phase to continue through 2025.

Following the design phase, “the agency intends to certify for NASA crew member use commercial low-Earth orbit destinations from these and potential other entrants, and ultimately, purchase services from destination providers for crew to use when available.”³⁴ NASA’s current schedule for the certification phase includes a 2-year transition period, beginning in 2029. The transition period will allow NASA to maintain the ISS during the agency’s initial commercial station service procurements.

In addition to this funding, NASA awarded Axiom Space a contract in February 2020 to develop a space station. Unlike the other CLD providers, Axiom intends to initially dock their station to the ISS and eventually separate, operating independently. Along with these funded agreements, NASA also supports several other providers station development through unfunded agreements as part of NASA’s Collaborations for Commercial Space Capabilities-2 project.³⁵

NASA OIG Report on NASA ISS Management and LEO Commercialization Efforts

NASA’s Office of Inspector General issued a report in November 2021 examining the costs and risks associated with continued ISS operations.³⁶ The audit also evaluated NASA’s commercial development plans. The following are excerpts from the OIG’s report:

- “Whether in response to an emergency or at the end of its useful service life, NASA and its partners will need to decommission and deorbit the ISS—a technically complex and costly operation requiring international participation and a critical decision on timing.”
- “Under the Agency’s current plans, both health risk mitigation and technology demonstrations will not be complete by 2030 [...] Consequently, a substantial gap between the Station’s retirement and the introduction of a new, commercial destination in low Earth orbit would force NASA to accept a higher level of health risk or delay start dates for long-duration, deep space human exploration missions.”

³¹ NASA, *NASA Selects Companies to Develop Commercial Destinations in Space* (2021), <https://www.nasa.gov/news-release/nasa-selects-companies-to-develop-commercial-destinations-in-space/>

³² NASA, *NASA Partners Combine Efforts for Low Earth Orbit Commercial Station* (2023), <https://www.nasa.gov/humans-in-space/commercial-space/nasa-partners-combine-efforts-for-low-earth-orbit-commercial-station/>

³³ NASA, *NASA Adjusts Agreements to Benefit Commercial Station Development* (2024), <https://www.nasa.gov/humans-in-space/commercial-space/leo-economy/nasa-adjusts-agreements-to-benefit-commercial-station-development/>

³⁴ *Id.* at 31

³⁵ NASA, *Seven US Companies Collaborate with NASA to Advance Space Capabilities* (2023), <https://www.nasa.gov/news-release/seven-us-companies-collaborate-with-nasa-to-advance-space-capabilities/>

³⁶ *Id.* at 13

- “We found that the Agency’s near-term actions show promise, with NASA’s recent efforts resulting in market interest and growth, especially for private astronaut missions. However, NASA faces significant challenges with fully executing the plan in time to meet its 2028 goal and avoid a gap in availability of a low Earth orbit destination. Challenges of commercialization include limited market demand, inadequate funding, unreliable cost estimates, and still-evolving requirements.”