

**SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

HEARING CHARTER

**“A Review of NASA’s Plans for the International Space Station and Future
Activities in Low Earth Orbit”**

July 10, 2019
10:00 A.M.
2318 Rayburn House Office Building

PURPOSE

The purpose of the hearing is to examine NASA’s plans for the International Space Station and future activities in low Earth orbit, and associated issues.

WITNESSES

- **Mr. William Gerstenmaier**, Associate Administrator, Human Exploration and Operations Mission Directorate, National Aeronautics and Space Administration
- **The Honorable Paul Martin**, Inspector General, National Aeronautics and Space Administration
- **Mr. Eric Stallmer**, President, Commercial Spaceflight Federation
- **Professor Joanne Irene Gabrynowicz**, Emerita, University of Mississippi, Editor-in-Chief, Emerita, Journal of Space Law

OVERARCHING QUESTIONS

- *What are the key challenges for the current and near-term operations and utilization of the International Space Station?*
- *What are the options for transition of the International Space Station and its activities to an alternative model of operation or to a commercial space station, and to what extent is NASA exploring those options?*
- *What are the key questions and issues regarding NASA’s low Earth orbit development plan?*
- *What are the implications of NASA’s plans for the International Space Station and low Earth orbit for enabling the human exploration of deep space?*

BACKGROUND

The International Space Station (ISS) is the world's only crewed orbiting space laboratory. The U.S.-led ISS partnership is governed by an intergovernmental agreement and includes Japan,

Canada, Russia, and several countries in the European Space Agency. The first module of the ISS, the Russian-built, but NASA-owned, Functional Cargo Block node (Zarya), was launched in 1998 to provide power, storage, propulsion, and station keeping for the ISS. That same year, the U.S. launched the Unity module, providing environmental control, life support, and docking ports allowing other modules to be added. Russia launched the Zvezda Service Module in 2000, which provided crew living quarters. Human occupation of the ISS began in 2000. Crew have occupied the ISS continuously since then, allowing the U.S. and Russia to acquire nearly 20 years of continuous human operations in low Earth orbit (LEO). Other ISS partners, including Europe and Japan, have launched additional modules and facilities to support the ISS and to carry out research. Assembly of the ISS was completed in July 2011.

Since 2011, NASA's focus has been on utilization of the ISS for research and technology demonstrations. Congress designated the U.S. segment of the ISS as a national laboratory in the NASA Authorization Act of 2005.¹ The ISS National Laboratory has access to 50 percent of ISS resources (e.g., crew time, power, and cargo transportation) and encourages utilization of the ISS by private entities and other Federal government agencies. Congress authorized extensions of ISS operations in 2010 and 2017 through at least 2024. U.S. taxpayers have invested approximately \$87 billion in the development, assembly, and operations of the ISS.²

International Space Station Transition Report

The NASA Transition Authorization Act of 2017 directed NASA to work with its partners and stakeholders to *“develop a plan to transition in a step-wise approach from the current regime that relies heavily on NASA sponsorship to a regime where NASA could be one of many customers of a low Earth orbit non-governmental human space flight enterprise.”*³

In March 2018, NASA issued an International Space Station Transition report detailing its plans for low-Earth orbit beyond 2024, including the potential for ending direct U.S. financial support for the ISS in 2025 and for transitioning NASA's low-Earth orbit activities to commercial platforms.⁴ The report states that the ISS is expected to be structurally sound until at least 2028.

The ISS Transition report states that *“[a]n on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program in support of current and future deep space missions. NASA is also using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions.”*

The Transition report further states that *“NASA's vision for LEO is a sustained commercial LEO human space flight marketplace where NASA is one of many customers.”* That vision is one in which privately-owned or operated platforms and associated crew and cargo transportation capabilities to low Earth orbit are supported by commercial revenue. The ISS Transition report

¹ Pub. L. No. 109-155, “National Aeronautics and Space Administration Authorization Act of 2005,” December 30, 2005.

² NASA OIG, “Nasa's Management of the Center for the Advancement of Science in Space”, IG-18-010, January 11, 2018.

³ Pub. L. No. 115-10, “National Aeronautics and Space Administration Transition Authorization Act of 2017,” March 21, 2017.

⁴ NASA, “International Space Station Transition Report”, March 30, 2018.

notes that NASA's Commercial Resupply Services, Commercial Crew Program, and the ISS National Laboratory are helping enable this vision.

The report laid out the following principles to ensure access to LEO:

- *“Continuity among NASA’s LEO, deep space exploration, and development and research activities and missions toward expanding human presence into the solar system;*
- *Expanding U.S. human spaceflight leadership in LEO and deep space exploration, including continuity of the relationship with our current ISS international partners;*
- *Increase platform options in LEO to enable more ISS transition pathways, security through redundant capabilities, and industrial capability that can support NASA’s deep space exploration needs;*
- *Spur vibrant commercial activity in LEO;*
- *Maintaining critical human spaceflight knowledge and expertise within the Government in areas such as astronaut health and performance, life support, safety, and critical operational ground and crew experience;*
- *Continuing to return benefits to humanity through Government-sponsored basic and applied on-orbit research;*
- *Continuing Government-sponsored access to LEO research facilities that enable other Government agencies, academia, and private industry to increase U.S. industrial competitiveness and provide goods and services to U.S. citizens; and*
- *Continuing to reduce the Government’s long-term costs through private industry partnerships and competitive acquisition strategies.”*

The plan identified that the options for the eventual future of the ISS include *“transitioning the operations of the ISS platform to private industry, augmenting it with privately developed modules, combining portions of the ISS with a new private platform, or deploying a new free-flying platform and de-orbiting the ISS.”*

In trying to project the future landscape of LEO, NASA's ISS Transition Plan notes a low degree of certainty that private industry will have sufficient capabilities *“to satisfy NASA’s needs and requirements”* and *“whether or not a viable commercial market [will have] matured in LEO that is not dependent on Government support.”*

In June 2019, as part of its plans for transition of the ISS and its activities to low Earth orbit market in which NASA is one of many customers, NASA released three documents:

- NASA Plan for Commercial LEO Development *“to achieve a robust low-Earth orbit economy from which NASA can purchase services as one of many customers”;*
- NASA Interim Directive: Use of International Space Station (ISS) for Commercial and Marketing Activities, which describes the activities that will be allowed by private entities on the ISS; and

- A pricing policy, which sets the cost for ISS resource utilization, including, for example, power, trash disposal, crew time, stowage, and crew supplies, by private companies.

FY 2020 President’s Budget Request for LEO and Spaceflight Operations

Budget Authority (in \$ millions)	Actual FY 2018	Enacted FY 2019	Request FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
International Space Station	1493.0	--	1458.2	1448.5	1449.4	1352.6	1315.7
Space Transportation	2345.8	--	1828.6	1854.1	1814.5	1746.2	1727.2
Space and Flight Support (SFS)	910.3	--	848.9	891.9	905.7	911.8	914.5
Commercial LEO Development	0.0	--	150.0	175.0	200.0	225.0	225.0
Total Budget	4749.2	4639.1	4285.7	4369.5	4369.5	4235.5	4182.3
Change from FY 2019			-353.4				
Percentage change from FY 2019			-7.6%				

In the Administration’s Fiscal Year (FY) 2019 budget request, NASA proposed “to end direct Federal funding for the ISS in 2025.” The FY 2020 budget request no longer specifies a date, though it continues to support the goal where NASA is one of many customers of a commercial LEO marketplace. The Administration’s FY 2020 budget proposal requests nearly \$4.3 billion for LEO and Spaceflight Operations. The budget lines for the International Space Station and Space Transportation comprise the proposed budget ISS-related operations, maintenance, research, and crew and cargo transportation.

- **International Space Station** includes the Systems Operations and Maintenance and ISS Research, including funding for the ISS National Lab and NASA’s research programs.
- **Space Transportation** contains the cost of both the Commercial Crew Program and the Crew and Cargo Program to the ISS and includes crew seats bought from Russian Roscosmos State Corporation.
- The **Space and Flight Support (SFS)** budget line funds Space Communications Networks and Support.
- The **Commercial LEO Development** line funds NASA’s efforts to transition its presence in LEO to that of one customer among many in commercially owned and operated regime.

NASA Inspector General Report on the Management of Utilization of the ISS

In July 2018, NASA’s Office of the Inspector General (OIG) released the results of an audit of the ISS to assess NASA’s progress in maximizing the utilization of the ISS.⁵ The audit focused on NASA’s use of the ISS to accomplish its human exploration objectives and evaluated options and challenges associated with transitioning the ISS to commercial operation. The audit found that “each year the Station remains operational costs NASA roughly half of the Agency’s annual human spaceflight budget--an outlay that may limit funding for development of systems needed to visit the Moon and other destinations beyond low Earth orbit.”

⁵ NASA OIG, “Nasa’s Management and Utilization of the International Space Station”, IG-18-021, July 30, 2018.

In order to ensure that NASA is positioned to complete its critical human health research and technology demonstration projects and to provide a safe transition and disposition of the ISS, the report had the following recommendations:

1. *“To the extent practicable, establish plans for additional one-year missions to the ISS;*
2. *Ensure development of a contingency plan for each human health risk not scheduled to be mitigated prior to 2024, such as identification of alternate testing platforms, impact of health risks for astronauts, and impact to the mitigation schedule;*
3. *Develop a contingency plan for each exploration-enabling technology demonstration not scheduled to be fully tested by 2024, such as identification of alternate testing platforms, impact to technical risk of exploration systems, and impact to the technology demonstration schedule;*
4. *Complete all end-of-mission critical systems and open work related to nominal and contingency deorbit operations;*
5. *Develop options for obtaining supplemental emergency deorbit propellant support from U.S. commercial vehicles.”*

NASA agreed with the recommendations and described planned corrective actions to the OIG.

NASA Inspector General reports on the Management of Non-NASA Research on the ISS

Pursuant to the NASA Authorization Act of 2010, in 2011, NASA awarded a 10-year Cooperative Research and Development Agreement (CRADA) to the Center for the Advancement of Science in Space (CASIS), a non-profit organization, to manage non-NASA research on the ISS.⁶ In 2017, NASA extended the CRADA to September 2024. The agreement is worth a total of \$196 million over the 2011-2024 period.

According to the FY 2018 ISS National Lab Annual Report *“185 new-to-space users in the areas of life sciences, physical sciences, technology development, and remote sensing have been awarded the opportunity to conduct investigations onboard the ISS National Lab. In total, 241 projects have been directly sourced by the ISS National Lab (135 of which represent commercial users), and dozens of other projects sourced by commercial partners and education programs have also been added to the ISS National Lab manifest.”*⁷ Additionally, CASIS attracted more than \$150 million in non-NASA funding from FY 2012 through FY 2018.

NASA OIG audits have found that CASIS has experienced challenges in expanding non-NASA users of the ISS. A 2018 OIG report² found that CASIS *“has underperformed on tasks important to achieving NASA’s goal of building a commercial space economy in low Earth orbit.”* As a result, *“CASIS has not fully met a majority of the goals and expectations set out by NASA. Of the nine performance categories we assessed, CASIS met expectations in only two: research pathways and science, technology, engineering, and mathematics (STEM) education.”* CASIS also *“failed to ensure a balanced portfolio of research projects from theoretical to basic to*

⁶ Pub. L. No. 111-267, “National Aeronautics and Space Administration Authorization Act of 2010,” October 11, 2010.

⁷ “ISS National Lab: FY18 Annual Report”, <https://ar2018.issnationallab.org/>

applied research as required by the cooperative agreement. CASIS failed to meet expectations in ... utilization of crew time for National Lab research and outreach.”

Additionally, the OIG found that “NASA failed to actively oversee CASIS’s technical performance and ... has not developed an overall strategy identifying the achievements or outcomes expected from CASIS through the end of its cooperative agreement nor has the Agency provided guidance or set expectations for CASIS’s performance.”

The OIG made seven recommendations to the Associate Administrator for Human Exploration and Operations (HEO) to improve the effectiveness of the CRADA with CASIS. They also recommended that the Associate Administrator of HEO develop a performance plan for CASIS, evaluate them semiannually, and ensure that the plans include metrics and targets for each category. NASA concurred or partially concurred on all recommendations, but took exception with the OIG’s methodology to assess CASIS’s performance and with the OIG’s assessment being partially based off CASIS’s ability to attract external funding. While NASA concurred with the OIG’s recommendation to “establish goals for CASIS raising non-NASA funds to offset operating expenses”, the OIG says that NASA’s comments are unresponsive. Therefore, this recommendation remained unresolved.

Commercialization of the ISS and LEO

In 2017, the Institute for Defense Analyses Science and Technology Policy Institute (STPI) published a NASA-sponsored study, “Market Analysis of a Privately Owned and Operated Space Station”.⁸ In the report, STPI identified 21 activities that could generate revenue on a commercial space station in LEO. These activities fell into five categories:

- *“Human habitat or destination for private space flight participants or government astronauts*
- *Activities supporting the satellite sector, especially on-orbit assembly of satellites*
- *Manufacturing products and services for use in space and on Earth, specifically high-grade silicon carbide and exotic fiber optic cable*
- *Research and development (R&D), testing, and Earth observation*
- *Media, advertising, and education”*

The report found that “[t]he low estimate for total annualized revenues from activities conducted on a space station is \$528 million; and the high estimate is \$1,255 million”, but with the caveat that “[t]hese revenues are highly uncertain and based on extrapolations of current views since they are for revenues 10 years from 2016.” However, according to the report, “Venture capitalists whom [STPI] interviewed noted that the projections of revenues and costs are so uncertain that they would have no interest in financing a space station until projected revenues from these activities show signs of materializing.”

⁸ Institute for Defense Analyses Science and Technology Policy Institute, “Market Analysis of a Privately Owned and Operated Space Station”, March 2017.

STPI found that “it is unlikely that a commercially owned and operated space station will be economically viable by 2025.” It then identified three ways that the federal government might participate in an at least partially commercialized space station:

- **Public-private partnership:** The federal government acts as an investor to a space station owner and operator, which may or may not be a commercial entity.
- **Advance purchase or lease agreements:** The federal government purchases services before the station is fully ready at prices below the future market rate.
- **Direct purchases:** The federal government purchases services after the space station is ready at market rate.

Spacesuits

NASA astronauts use spacesuits, officially called Extravehicular Mobility Units (EMUs), to carry out space walks. The EMUs currently in use to support U.S. crew on ISS space walks were developed more than 40 years ago and are well past their 15-year design life.⁹

In 2017, the NASA OIG conducted an audit of NASA’s management of current spacesuits and development of the next generation of spacesuits.⁹ As of 2017, NASA had spent more than \$200 million on developing new spacesuits despite remaining “years away from having a flight-ready spacesuit capable of replacing the EMU or suitable for use on future exploration missions.” The OIG found that “only 11 of the 18 original EMU Primary Life Support System units – a backpack-like structure that performs a variety of functions required to keep an astronaut alive during a spacewalk – are still in use, raising concerns that the inventory may not be adequate to last through the planned retirement of the ISS. Given these issues, NASA will be challenged to continue to support ISS needs with the current fleet of EMUs through 2024, a challenge that will escalate significantly if Station operations are extended to 2028.” A major impediment to NASA’s spacesuit development that is cited in the OIG report is the lack of a formal plan and specific destinations for future NASA missions. Different mission profiles (e.g., low Earth orbit, the Moon, and Mars) require different spacesuits.

The OIG recommended that NASA:

- “(1) develop and implement a formal plan for design, production, and testing of the next-generation extravehicular activity (EVA) spacesuits in accordance with the exploration goals of the Agency, crew needs, and the planned retirement of the ISS in 2024;
- (2) conduct a trade study comparing the cost of maintaining the current EMU spacesuit and developing and testing a next-generation spacesuit; and
- (3) apply lessons learned from operations of existing EVA and launch, entry, and abort spacesuit systems to the design of future exploration spacesuit systems to ensure mitigation of non-life-threatening health risks or other injuries that could impair mission objectives.”

NASA concurred with the IG’s recommendations and described corrective actions it would take to the OIG.

⁹ NASA OIG, “Nasa’s Management and Development of Spacesuits”, IG-17-018, April 26, 2017.