



Agency Priority Goal Action Plan

# International Space Station

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# Overview

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## Goal Statement

- Use the International Space Station (ISS) as a testbed to demonstrate the critical systems necessary for long-duration missions. Between October 1, 2017, and September 30, 2019, NASA will initiate at least eight in-space demonstrations of technology critical to enable human exploration in deep space.

## Challenge

- Develop and demonstrate the systems required to ensure the health and safety of crew and fill critical gaps in capabilities that will be needed for long-duration deep space missions.

## Opportunity

- The ISS is the only long-duration, permanently crewed microgravity platform of its kind available to provide the relevant space environment and integrated space systems architecture necessary to demonstrate key technologies and operations concepts enabling long-duration deep space missions.
- The research occurring on the ISS will not only help NASA prepare to send astronauts into deep space, but may also provide tangible benefits to people on Earth.

# Goal Structure & Strategies

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Achievement of this goal will require close coordination between NASA's Advanced Exploration Systems (AES) and International Space Station (ISS) program, as well as other NASA programs developing exploration-enabling technologies.

AES is developing technologies that require testing on the ISS. Its strategies include:

- Pioneering innovative approaches to rapidly develop prototype systems, advance key capabilities, and validate operational concepts.
- Collaborating with other government agencies and leveraging public-private partnerships to reduce risk and cost for all partners involved.
- Using an open architecture approach that minimizes unique developments, so that each experiment leaves something behind that subsequent experiments can build upon.

Additionally, the ISS program is developing technology demonstration hardware for environmental control and life support that will upgrade existing capabilities based on lessons learned from ISS operations, as well as provide new capabilities that will be needed for deep space exploration.

The ISS program will arrange for transportation, integration, and testing of the deep space technology demonstrations on the space station. It will ensure that the crew has adequate time for research activities after maintaining ISS systems, sleep, exercise, hygiene, and other personal activities. Furthermore, the ISS program will ensure sufficient operation time to demonstrate reliability for technologies for deep-space exploration.

NASA is targeting the delivery and initiation of testing of three to five deep space exploration technology demonstrations on the ISS per year in FY 2018 and 2019.

# Summary of Progress – FY18 Q3

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- The Thermal Amine Scrubber is one of several candidate technologies for provision of more reliable carbon dioxide (CO<sub>2</sub>) removal. This demonstration payload is fully assembled and performance testing is underway. Flight hardware was originally planned for delivery in 3rd quarter FY 2018, but has been delayed to 1st quarter FY 2019.
- The ISS Refabricator, which will be the first integrated 3D Printer and Recycler, completed ground testing. This is a Small Business Innovation Research (SBIR) with the company Tethers Unlimited, Inc. (TUI). The flight unit was delivered to Johnson Space Center in May 2018 for integration in preparation for launch to the ISS later this year.
- In May 2018, Johnson Space Center Life Support engineers performed a fitcheck with the Double Toilet Stall hardware in the Space Vehicle Mockup Facility (SVMF). The SVMF contains a full scale mock up of the ISS that is used to train upcoming crew members and assist engineers with hardware designs and verifications. The Double Toilet Stall provides privacy enclosures for the Waste and Hygiene Compartment (WHC) and for the Universal Waste Management System (UWMS) demonstration that will be installed in Node 3 in FY 2019.
- In June 2018, several candidate urine funnel designs to be used with the UWMS were delivered to ISS on Northrup Grumman (Formerly Orbital-ATK) Commercial Resupply Services – 9 (NG-9). These designs will be evaluated by the ISS crew in preparation for the upcoming UWMS demonstration.

# Key Milestones

NASA follows an “alternative form,” or milestone-based, approach to reporting on its goals. Following are key quarterly milestones that NASA tracks in support of this goal:

Milestone Summary				
Key Milestone	Milestone Due Date	Milestone Status	Risk/Trend	Comments
<ul style="list-style-type: none"> <li>Initiate integration activities for Thermal Amine for carbon dioxide (CO<sub>2</sub>) removal demonstration.</li> <li>Announce selections for fabrication laboratory (FabLab) solicitation.</li> </ul>	FY 2018 Q1	Green	n/a	<ul style="list-style-type: none"> <li>Both milestones have been completed</li> </ul>
<ul style="list-style-type: none"> <li>Complete integration of Astrobee free-flyer.</li> </ul>	FY 2018 Q2	Green	→	<ul style="list-style-type: none"> <li>Astrobee on-track for FY19 Q1 deployment</li> <li>Completed Extravehicular Mobility Unit (xEMU) Demonstration System Requirements Review (SRR)</li> </ul>
<ul style="list-style-type: none"> <li>Deliver Refabricator hardware to recycle 3-D printed parts on ISS.</li> <li>Complete Brine Processor Assembly (BPA) Critical Design Review (CDR).</li> <li>Begin Bigelow Expandable Activity Module (BEAM) extended mission.</li> </ul>	FY 2018 Q3	Green	n/a	<ul style="list-style-type: none"> <li>BPA CDR completed March 2018</li> <li>Refabricator hardware delivered on May 31, 2018</li> <li>BEAM extended</li> </ul>
<ul style="list-style-type: none"> <li>Launch Thermal Amine for CO<sub>2</sub> removal.</li> <li>Deliver Hybrid Electronic Radiation Assessor (HERA) for lifetime testing on ISS.</li> <li>Demonstrate augmented reality for executing ISS treadmill maintenance procedures.</li> <li>Complete plan for Bionutrient flight experiment.</li> </ul>	FY 2018 Q4	Yellow	↓	<ul style="list-style-type: none"> <li>Thermal Amine now planned for SpaceX CRS-16 (FY19 Q1)</li> <li>HERA on-track</li> <li>Augmented reality for treadmill now in Increment 58/59 (FY19 Q3)</li> <li>Bionutrient on-track, but tight schedule</li> </ul>
<ul style="list-style-type: none"> <li>Complete CDR of miniature CO<sub>2</sub> scrubber.</li> </ul>	FY 2019 Q1	Green	→	<ul style="list-style-type: none"> <li>On track</li> </ul>
<ul style="list-style-type: none"> <li>Deliver Spacecraft Atmosphere Monitor for launch.</li> </ul>	FY 2019 Q2	Green	→	<ul style="list-style-type: none"> <li>Will be delivered March 2019 (FY19 Q2)</li> </ul>
<ul style="list-style-type: none"> <li>Deliver Universal Waste Management System (UWMS) unit to ISS.</li> <li>Demonstrate RFID Enabled Autonomous Logistics Management (REALM)-2 with Astrobee free-flyer.</li> </ul>	FY 2019 Q3	Green	→	<ul style="list-style-type: none"> <li>On track</li> </ul>
<ul style="list-style-type: none"> <li>Complete assembly of Saffire-V and VI spacecraft fire safety flight experiments.</li> <li>Complete ground demonstration of miniature CO<sub>2</sub> scrubber core technology.</li> <li>Complete FabLab Preliminary Design Review (PDR).</li> <li>Deliver miniature CO<sub>2</sub> scrubber flight hardware.</li> </ul>	FY 2019 Q4	Green	→	<ul style="list-style-type: none"> <li>On track</li> <li>Saffire-V and VI will be available for Oct. 2019 launch. Assembly complete in Nov. 2018 (FY19 Q1)</li> </ul>

 Unchanged
  Improving
  Deteriorating

# Data Accuracy and Reliability

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## Verification and Validation:

- NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including materials from the Advanced Explorations Systems (AES) and International Space Station (ISS) program reviews, project schedules, and other program-internal documents. NASA also issues press releases for its major technology demonstration experiments.

## Data Source(s):

- Press releases and program-internal documents indicating whether or not NASA has initiated its planned in-space technology demonstrations.

## Level of Accuracy Required for Intended Use:

- Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

## Data Limitations:

- NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information.

## How the Agency Compensates for Data Limitations:

- Not applicable.

# Additional Information

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## Contributing Programs

### NASA Program Activities:

- International Space Station (ISS) program: Develops environmental control and life support technology demonstrations for testing on ISS; facilitates integration of research payloads on ISS; and manages crew time on the ISS, as well as the contracts for Commercial Resupply Services, which deliver science and technology payloads and crew resupply to the ISS. Will manage contracts for commercial crew transportation services when they become available.
- Advanced Exploration Systems (AES): Develops prototype technology demonstrations for testing on the ISS, including in the areas of environmental control, life support, radiation protection, and fire safety.
- Other NASA programs, including Human Space Flight Operations, the Division of Space Life and Physical Sciences Research and Applications, the Exploration Research & Technology organization, and Space Communications and Navigation, support ISS operations and develop exploration technology demonstrations.

### Other Federal Activities:

- Federal Aviation Administration: Issues licenses that allow the launch of cargo flights to the ISS and entry back to the ground.

### International Partners:

- Crew transportation services are currently provided by Roscosmos, the Russian Federal Space Agency; and cost-sharing partners include the Canadian Space Agency (CSA), European Space Agency (ESA), and Japan Aerospace Exploration Agency (JAXA).
- Cargo transportation services are provided by Orbital Sciences Corporation, Space Exploration Technologies Corporation, ESA, JAXA, and Roscosmos; and cost-sharing partners include CSA, ESA, and JAXA.

## Stakeholder/Congressional Consultations

NASA held an International Space Station Stakeholder Workshop on Aug. 9, 2017, in Washington, D.C. A summary for the workshop can be found at <https://www.nasa.gov/content/international-space-station-stakeholder-workshop>.