



Agency Priority Goal Action Plan

# International Space Station

**Goal Leader:** Sam Scimemi, Director, International Space Station Division

**Deputy Goal Leader:** Kevin Metrocavage, International Space Station Operations Manager



## 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.



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 – FY19 Q4

NASA completed this priority goal by launching eight technologies that will support upcoming long-duration missions.

- Throughout FY 2019 Q4, NASA, along with our International and Commercial partners (through the Commercial Resupply Services [CRS]), successfully delivered scientific investigations and cargo in a timely and efficient manner.
  - In Q4, CRS missions SpX-18 and HTV-8 were launched in July and September respectively delivering ~13,000 pounds of upmass combined. This upmass puts the cumulative delivered upmass for FY19 at approximately 39,000 pounds total.
  - The steady stream of resupply missions enabled ISS crew members to an average of ~74.5 hours/week of Utilization, exceeding the planned 35 hours/week. Hardware brought up enabled the recent series of P6 battery upgrade spacewalks.
- Crew rotation capabilities continue as scheduled. USOS crew restored to planned capacity.
  - Following an unexpected abort of the Soyuz 56S mission early in FY19 Q1, there was a period of several months with a limited USOS crew. Later in FY19 Q1 (December), the Soyuz returned safely to flight. On the next crewed mission (Soyuz 58S in March 2019), the ISS was back to it's expected capacity. A third successful Soyuz (59S in July 2019) was the final crewed mission of FY19. This regular cadence of crew-rotation missions, along with CRS missions, enables effective ISS utilization.
- In FY 2019, NASA initiated at least eight technology demonstrations.

Technology Demonstrations in FY19	
<ul style="list-style-type: none"><li>○ Aerosol Sampler</li><li>○ Combination Acoustic Monitor</li><li>○ Refabricator</li><li>○ Hybrid Electric Radiation Assessor</li></ul>	<ul style="list-style-type: none"><li>○ CHARPA filters for siloxane removal</li><li>○ Thermal Amine</li><li>○ Astrobee</li><li>○ Spacecraft Atmosphere Monitor (SAM)</li></ul>

# 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:

Key Milestone	Milestone Due Date	Milestone Status	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	<ul style="list-style-type: none"> <li>Both milestones have been completed</li> </ul>
<ul style="list-style-type: none"> <li>Complete integration of Astrobees free-flyer.</li> </ul>	FY 2018 Q2	Green	<ul style="list-style-type: none"> <li>Completed Astrobees integration. Crew now utilizing following arrival of free flyers on SpX-17 (FY19 Q3).</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	<ul style="list-style-type: none"> <li>BPA CDR completed FY 2018 Q2.</li> <li>Refabricator hardware delivered on FY 2018 Q3.</li> <li>BEAM mission 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	Green	<ul style="list-style-type: none"> <li>Thermal Amine installed and operating.</li> <li>HERA was delivered to ISSP by AES in Sept 2018 (and launched on SpX-16, FY19 Q1)</li> <li>Augmented reality for treadmill on-track for FY19 Q4.</li> <li>Bionutrient launched on NG-11 (FY19 Q3).</li> </ul>

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Key Milestone	Milestone Due Date	Milestone Status	Comments
<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>Mini-CO<sub>2</sub> scrubber CDR was completed (Nov 2018). A delta-CDR was completed in February 2019.</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>Spacecraft Atmosphere Monitor launched to ISS via SpX-18 (FY19 Q4).</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 Astrobees free-flyer.</li> </ul>	FY 2019 Q3	Green	<ul style="list-style-type: none"> <li>UWMS delivery to ISS targeted FY20 Q1. New stalls were delivered on NG-10.</li> <li>REALM-2 currently targeting NG-12 (FY20 Q1) launch to ISS.</li> </ul>
<ul style="list-style-type: none"> <li>Complete assembly of Saffire-V &amp; 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	Yellow	<ul style="list-style-type: none"> <li>Saffire-IV assembly completed in June 2019. Saffire-IV and V projected to be delivered for launch on NG-13 and NG-14 respectively.</li> <li>FabLab Preliminary Design Review (PDR) on schedule.</li> <li>Mini-CO<sub>2</sub> scrubber h/w delivery targeted for FY20 Q4.</li> </ul>



## 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.



## 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>.