



Agency Priority Goal Action Plan

International Space Station

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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.



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 Q3



- Throughout FY 2019 Q3, 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 Q3, CRS missions NG-11 and SpX-17 were launched in April and May respectively delivering ~13,000 pounds of upmass combined. Combined with the Q1 and Q2 deliveries, approximately 26,000 pounds have been successfully delivered to the ISS so far in FY19.
 - The steady stream of resupply missions enabled ISS crew members to execute research (utilization activities), averaging ~69 hours/week of Utilization, exceeding the planned 35 hours/week.
- Crew rotation is based on the ability of the Soyuz spacecraft to remain on orbit and docked to the ISS.
 - Shortly after launch of a Soyuz spacecraft on October 11, 2018, there was an anomaly with the booster and the launch ascent was aborted, resulting in a safe landing of the crew and spacecraft in Kazakhstan.
 - Following the FY19 Q1 Soyuz anomaly, there was a short period of time with only three crew on board, however, there has been a successful crew rotation in December 2018 (55S return, 57S launch), launch in March 2019 (58S), crew return in June 2019 (57S), and the final FY 2019 launch (59S) is on scheduled for July 2019. These rotations support the full complement of six crew members onboard.
- Two in-space demonstrations of technology critical to enabling human exploration of deep space were initiated in FY 2018. In FY 2019 Q1, Q2, and Q3, NASA initiated five additional demonstrations.

Two Demonstrations Initiated in FY18	Five Initiated in FY19 Q1, Q2, and Q3
Aerosol Sampler	Refabricator, Hybrid Electric Radiation Assessor (HERA)
Combination Acoustic Monitor	CHARPA filters, Thermal Amine, Astrobee

- At least two more demonstrations are scheduled for initiation in FY19 Q4, and NASA is on-track to complete at least eight in-space demonstrations by the end of the reporting period, FY 2019.

On Track for Initiation FY19 Q4	Demonstrations that may be initiated before end of FY19 Q4
SAM Major Constituents Analyzer	RFID Enabled Autonomous Logistic Management (REALM) -2
	Spacesuit Evaporation Rejection Flight Experiment (SERFE)
	T2 Augmented Reality



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	Trend	Comments
<ul style="list-style-type: none"> Initiate integration activities for Thermal Amine for carbon dioxide (CO₂) removal demonstration. Announce selections for fabrication laboratory (FabLab) solicitation. 	FY 2018 Q1	Green	n/a	<ul style="list-style-type: none"> Both milestones have been completed
<ul style="list-style-type: none"> Complete integration of Astrobee free-flyer. 	FY 2018 Q2	Yellow	⇒	<ul style="list-style-type: none"> Delayed. Astrobee targeting FY19 Q4 commissioning. Completed Extravehicular Mobility Unit (xEMU) Demonstration System Requirements Review (SRR)
<ul style="list-style-type: none"> Deliver Refabricator hardware to recycle 3-D printed parts on ISS. Complete Brine Processor Assembly (BPA) Critical Design Review (CDR). Begin Bigelow Expandable Activity Module (BEAM) extended mission. 	FY 2018 Q3	Green	n/a	<ul style="list-style-type: none"> BPA CDR completed March 2018 Refabricator hardware delivered on May 31, 2018 BEAM extended
<ul style="list-style-type: none"> Launch Thermal Amine for CO₂ removal. Deliver Hybrid Electronic Radiation Assessor (HERA) for lifetime testing on ISS. Demonstrate augmented reality for executing ISS treadmill maintenance procedures. Complete plan for Bionutrient flight experiment. 	FY 2018 Q4	Yellow	⇒	<ul style="list-style-type: none"> Delayed. Thermal Amine has slipped to SpX-17 (FY19 Q2). HERA was delivered to ISSP by AES in Sept 2018 (and manifested on SpX-16, FY19 Q1) Delayed. Augmented reality for treadmill now Increment 58/59 (FY19 Q3) Delayed. Bionutrient will be delivered early December 2018, manifested on SpX-17 (FY19 Q2).

Trend Legend					
↑	Improving	⇒	No Change	↓	Declining



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<ul style="list-style-type: none"> Complete CDR of miniature CO₂ scrubber. 	FY 2019 Q1	Green	n/a	<ul style="list-style-type: none"> Mini-CO₂ scrubber CDR was completed (Nov 2018). A delta-CDR was completed in February 2019.
<ul style="list-style-type: none"> Deliver Spacecraft Atmosphere Monitor for launch. 	FY 2019 Q2	Green	↓	<ul style="list-style-type: none"> Will be delivered May 2019 (FY19 Q3) for a targeted launch on SpX-18 (FY19 Q3).
<ul style="list-style-type: none"> Deliver Universal Waste Management System (UWMS) unit to ISS. Demonstrate RFID Enabled Autonomous Logistics Management (REALM)-2 with Astrobees free-flyer. 	FY 2019 Q3	Yellow	⇒	<ul style="list-style-type: none"> UWMS delivery to ISS was targeted for FY19 Q4, but is now scheduled for launch in FY20 Q2. New stalls were delivered on NG-10. REALM-2 and Astrobees both launched on NG-11 (FY19 Q3).
<ul style="list-style-type: none"> Complete assembly of Saffire-V & VI spacecraft fire safety flight experiments. Complete ground demonstration of miniature CO₂ scrubber core technology. Complete FabLab Preliminary Design Review (PDR). Deliver miniature CO₂ scrubber flight hardware. 	FY 2019 Q4	Yellow	⇒	<ul style="list-style-type: none"> Assembly of Saffire V & VI is expected to be complete by December 2019 (FY20 Q1). Ground demonstration of Mini-CO₂ scrubber planned for FY19 Q4. FabLab Preliminary Design Review (PDR) on schedule. Delivery of Mini-CO₂ scrubber planned for FY20 Q2

Trend Legend					
↑	Improving	⇒	No Change	↓	Declining



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>.