



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 – FY18 Q4



- Astrobee is behind schedule due to engineering issues that surfaced during build of the certification unit. Astrobee is the next generation free-flying robot for intravehicular activities that will succeed the Synchronized Position Hold Engage and Reorient Experimental Satellites (SPHERES) and consists of three robots (funded by AES) and a docking station (funded by the Space Technology Mission Directorate). NASA is now planning to launch the docking station on Northrop Grumman Commercial Resupply Services mission 10 (NG-10) and the Astrobee robots on NG-11 next spring. Commissioning should be complete by the end of FY 2019 (original planned date was 9/30/18).
- The radio frequency identification (RFID) Enabled Autonomous Logistics Management (REALM)-2/Astrobee Ground Integration Test was completed. REALM-2 mobile sparse zone readers will fly as a payload on Astrobee to demonstrate the capability to provide greater coverage across the ISS and better resolution on locating items.
- The thermal amine scrubber successfully completed testing in the Payload Rack Control Unit (PRCU) at MSFC, and is now in a 350-hour burn-in test at UTC Aerospace Systems (UTAS). Target launch is now SpaceX Commercial Resupply Services mission 17 (SpX-17).
- The toilet stall that will be used with the Universal Waste Management System (UWMS) is launching on NG-10 and will be integrated in Node 3 and await arrival of the UWMS, targeted for late FY 2019. Additionally, the design team is evaluating crew feedback on the candidate urine funnel designs that were delivered to ISS on NG-9.



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/ Outlook	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 Astrobees free-flyer. 	FY 2018 Q2	Yellow	⇒	<ul style="list-style-type: none"> Delayed. Astrobees 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 ISS 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).
<ul style="list-style-type: none"> Complete CDR of miniature CO₂ scrubber. 	FY 2019 Q1	Green	⇒	<ul style="list-style-type: none"> On track
<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 March 2019 (FY19 Q2)
<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 remains on track. REALM-2 will fly with Astrobees prior to FY19 Q4
<ul style="list-style-type: none"> Complete assembly of Saffire-V and 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	Green	⇒	<ul style="list-style-type: none"> On track Saffire-V and VI will be available for Oct. 2019 launch. Assembly complete in Nov. 2018 (FY19 Q1)



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>.