NASA SBIR 2014 Phase I Solicitation

H10 Ground Processing & ISS Utilization

The Human Exploration and Operations Mission Directorate (HEOMD) provides mission critical space exploration services to both NASA customers and to other partners within the U.S. and throughout the world: assembling and operating the International Space Station (ISS); ensuring safe and reliable access to space; maintaining secure and dependable communications between platforms across the solar system; and ensuring the health and safety of astronauts. Activities include ground-based and in-flight processing and operations tasks, along with support that ensures these tasks are accomplished efficiently and accurately, and enable successful missions and healthy crews. This topic area, while largely focused on operational space flight activities, is broad in scope. NASA is seeking technologies that address how to improve and lower costs related to ground and flight assets, and maximize the utilization of the ISS for both in-situ research and as a test bed for development of improved space exploration technologies. A typical flight focused approach would include:

- Phase I - Research to identify and evaluated candidate technology applications to demonstrate the technical feasibility and show a path towards a hardware/software demonstration. Bench or lab-level demonstrations are desirable.
- Phase II - Emphasis should be placed on developing and demonstrating the technology under simulated flight conditions. The proposal shall outline a path showing how the technology could be developed into space-worthy systems. For ground processing and operations tasks, the proposal shall outline a path showing how the technology could be developed into ground or flight systems. The contract shall deliver a demonstration unit for functional and environmental test in at the completion of the Phase II contract and, if possible, demonstrate earth based uses or benefits.

Subtopics

H10.01 Recycling/Reclamation of 3-D Printer Plastic for Reuse

Lead Center: MSFC

Participating Center(s): ARC, JSC, KSC

The subtopic seeks to develop innovative concepts to support the development of recycling/reclaiming technologies for Acrylonitrile Butadiene Styrene (ABS) plastic parts in space, thus providing viable solutions for self-sustained additive manufacturing capability with plastic materials.

As the National Aeronautics and Space Administration (NASA) destinations push farther beyond the limits of low Earth orbit, the convenience of fabricating components and equipment on the ground to quickly resupply missions will no longer be a reasonable option. Resupply is difficult during deep space missions; it requires a paradigm shift in the way the Agency currently relies on an Earth-based supply chain for spares, maintenance, repair, and hardware design models, including those currently on the International Space Station (ISS). With the ISS program extension, there is a high likelihood of necessary replacement parts. This is a unique opportunity to begin changing the current model for resupply and repair to prepare and mature technology for deep space exploration missions.

3-D printing, formally known as “Additive Manufacturing”, is the method of building parts layer-by-layer from data files such as Computer Aided Design models. Data files with tool and part schematics can be pre-loaded onto the device before a launch, or up-linked to the device while on-orbit. 3-D printers currently scheduled for on-board ISS use will employ extrusion-based additive manufacturing, which involves building an object out of plastic deposited by the melting of feedstock by an extruder head. The plastic extrusion additive manufacturing process is a low-energy, low-mass solution to many common needs on board the ISS.

The 3-D Printing in Zero-G “3-D Print” Technology Demonstration and the Additive Manufacturing Facility (AMF) plan to utilize the commercial 3-D printing standard 1.75mm ABS filament as feedstock on ISS. To truly develop a self-sustaining, closed-loop on-orbit manufacturing process that will result in less mass to launch and increased on-demand capability in space, a means of recycling and reclaiming the feedstock is required. This SBIR seeks technologies that can take ABS parts analogous to those which could be printed on ISS (maximum size of 6cm x 12 cm x 6 cm) and demonstrate recycling/reclamation capability of the part back into 1.75mm filament feedstock.

This subtopic seeks innovative technologies in the following areas:

- ABS part reclamation - decomposing a plastic part (maximum size of 6 cm x 12 cm x 6 cm) and reconstitution into 1.75mm (±0.1mm) diameter wire spools, pellets, or other forms that can be fed into an extrusion device.
- Production of recycled plastic filament while maintaining repeatable, consistent filament diameter of 1.75mm with ±0.1mm tolerance.
- Methods to avoid bulging of feedstock as the filament is created.
- Gravity-independent filament spooling capability: drawing the filament onto a feedstock spool as it is being created without relying on gravity to guide the filament. Goal for spool dimension should be 156mm OD, 48mm ID, 43mm wide.
- Environmental containment for Foreign Object Debris (FOD) and material off-gassing.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II hardware/software demonstration with delivery of a demonstration unit for NASA testing at the completion of the Phase II contract. Demonstration of the Engineering Unit at the end of Phase II may lead to an opportunity for a Phase III contract for a Flight Unit.

Phase I Deliverables - Feasibility study with proposed path forward to develop Engineering Unit in Phase II; study should address how the design will meet flight certification, safety requirements, and operational constraints for spaceflight; and bench top proof-of-concept, including samples and test data, proving the proposed approach to develop a given product (TRL 3-5).

Phase II Deliverables - Functioning Engineering Unit of proposed product, along with full report of development and test data (TRL 5-6).

H10.02 International Space Station (ISS) Utilization

Lead Center: JSC

Participating Center(s): ARC, GRC, JPL, KSC, MSFC

NASA continues to invest in the near- and mid-term development of highly-desirable systems and technologies that provide innovative ways to leverage existing ISS facilities for new scientific payloads and to provide on orbit analysis to enhance capabilities. Utilization of the ISS is limited by available up-mass, down-mass, and crew time as well as by the capabilities of the interfaces and hardware already developed and in use. Innovative interfaces between existing hardware and systems, which are common to ground research, could facilitate both increased and faster payload development and subsequent utilization. Technologies that are portable and that can be matured rapidly for flight demonstration on the International Space Station are of particular interest.

Desired capabilities that will continue to enhance improvements to existing ISS research hardware include, but are not limited to, the below examples:

- Providing additional on-orbit analytical tools. Development of instruments for on-orbit analysis of plants, cells, small mammals and model organisms including Drosophila, C. elegans, and yeast. Instruments to support studies of bone and muscle loss, multi-generational species studies and cell and plant tissue are desired. Providing flight qualified hardware that is similar to commonly used tools in biological and material science laboratories could allow for an increased capacity of on-orbit analysis thereby reducing the number of samples which must be returned to Earth.
- Technologies that determine microbial content of the air and water environment of the crew habitat falls within acceptable limits and life support system is functioning properly and efficiently. Required technology characteristics include: 2 year shelf-life; functionality in microgravity and low pressure environments (~8 psi). Technologies that show improvements in miniaturization, reliability, life-time, self-calibration, and reduction of expendables are also of interest.
- Providing a Magnet Processing Module (MPM) for installation and operations in the Materials Science Research Rack (MSRR) would enable new and improved types of materials science investigations aboard the ISS. Essential components of the MPM include an electromagnet, which can provide field strength up to 0.2 Tesla and a high temperature insert, which can provide directional solidification processing capability at temperatures up to 1500 °C.
- Increased use of the Light Microscopy Module (LMM). Several additions to the module continue to be solicited, such as: laser tweezers, dynamic light scattering, stage stabilization (or sample position encoding) for reconstructing better 3-D confocal images.
- Instruments that can be used as infrared inspection tools for locating and diagnosing material defects, leaks of fluids and gases, and abnormal heating or electrical circuits. The technology should be suitable for hand-held portable use. Battery powered wireless operation is desirable. Specific issues to be addressed include: pitting from micrometeoroid impacts, stress fractures, leaking of cooling gases and liquids and detection of abnormal hot spots in power electronics and circuit boards.

For the above, research should be conducted to demonstrate technical feasibility and prototype hardware development during Phase I and show a path toward Phase II hardware and software demonstration and delivering an engineering development unit or software package for NASA testing at the completion of the Phase II contract that could be turned into a proof-of-concept system which can be demonstrated in flight.

Phase I Deliverables - Written report detailing evidence of demonstrated prototype technology in the laboratory or in a relevant environment and stating the future path toward hardware and software demonstration on orbit. Bench or lab-level demonstrations are desirable. The technology concept at the end of Phase I should be at a TRL of 3-6.

Phase II Deliverables - Emphasis should be placed on developing and demonstrating hardware and/or software prototype that can be demonstrated on orbit (TRL 8), or in some cases under simulated flight conditions. The proposal shall outline a path showing how the technology could be developed into space-worthy systems. The contract should deliver an engineering development unit for functional and environmental testing at the completion of the Phase II contract. The technology at the end of Phase II should be at a TRL of 6-7.