NASA STTR 2011 Phase I Solicitation

T6.01 Affordable and Sustainable Crew Support and Protection

Lead Center: JSC

This STTR sub-topic seeks to advance the state-of-the-art in spacecraft life support, thermal control, extra-vehicular activity and habitation systems, leading toward the ability to sustain a crew in space for years with minimal supplies launched from Earth. Atmosphere, water and waste all need to be regenerated with highly reliable systems to reduce or eliminate the need to launch parts and supplies to maintain the systems. The crew must also be protected from the dangers of the deep space environment. During extra-vehicular activity, this poses additional difficulties. Specific challenges areas where NASA is soliciting new ideas are described below.

Wastewater Reuse

Recycling of wastewater from gray and black water sources with minimal mass, power, volume and expendables is needed. Source separation of hygiene wastewater and urine water may be assumed. A particular challenge is the stabilization of urine to prevent odor and fouling of systems without the use of hazardous chemicals. Any stabilization system should be compatible with the extraction of nearly 100% of the water from brine if concentrated wastewater is created by primary processors.

Improved Thermal Control

Long life (>1 year) active thermal control systems are needed that can operate over a wide range of heat loads in a wide range of thermal environments. Reduced freezing point (

Also, water/ice phase change heat exchangers are needed to accommodate thermal management in environments that vary from very cold to warmer than room temperature. A successful design will efficiently transfer heat into and out of the water while managing the location of the ice and void space. The heat exchanger should be capable of ten thousand freeze/thaw cycles without damage.

Robust Extra-Vehicular Activity

A state of the art Extra Vehicular Activity (EVA) space suit is made of multiple layers of fabrics with a hard upper torso and metal bearings. These fabric layers provide physical and mechanical protection for the astronaut, as well as thermal isolation and pressurization for EVA in vacuum. There are several materials development advances that could significantly revolutionize space suit design. These advances consist of combining some of the functions provided by the current suit layers into fewer layers or using new materials to improve suit sizing methods. There is a need not only to improve existing properties of the space suit such as flame retardancy or decreased mass but also add new properties such as microbial growth resistance, selective permeability, static build-up resistance, improved MMOD protection, and radiation shielding. These improvements would increase mission safety and the useful life of the space suit. Increased radiation protection could increase the number of hours crew members spend performing EVAs over their career. Materials that reduce charge build up or decrease shock hazards would alleviate risks associated with interfacing different vehicles or performing EVAs in a plasma environment. Materials that are self healing could improve astronaut protection by detecting punctures and small cuts and even repairing suit damage. In addition, there is a need for micrometeorite shielding technology of the crew during EVAs.

Vacuum Regenerable Trace Contamination Control for spacesuits is also sought. A spacesuit is a small, closed environment in which the atmosphere is continually recycled. Therefore, a means of removing air borne trace contaminants is needed to protect the health of the crew member during an Extravehicular Activity (EVA). The primary contaminants in question for space suit applications are thought to be ammonia and formaldehyde, and the Spacecraft Maximum Allowable Concentrations (SMAC) for these contaminants are 7 mg/m^3 and 0.3 mg/m^3, respectively. Expected generation rates for these two contaminants are approximated at ~80 mg of ammonia and ~0.3 mg of formaldehyde during an 8 hour EVA. The current Portable Life Support System (PLSS) concept uses a CO_2 and humidity control technology that regenerates with a 3 to 10 minute vacuum cycle. A trace contamination control technology that could regenerate with this same vacuum cycle, that minimizes mass, power, and system pressure drop is desired.