# NASA SBIR 2015 Phase I Solicitation

## H3.03 Spacecraft Cabin Atmosphere Quality and Thermal Management

**Lead Center: MSFC**

**Participating Center(s): ARC, GRC, GSFC, JPL, JSC, KSC, LaRC**

Advances in spacecraft atmospheric quality management are sought to address cabin ventilation and flow delivery to air scrubbing equipment, suspended particulate matter removal and disposal, and volatile trace chemical contaminant removal. Methods to separate particulate matter from both the cabin atmosphere and from Environmental Control and Life Support (ECLS) system process gas streams are sought. Interest in humidity control and separation processes within life support system processes are of interest. Specifics regarding areas of interest in spacecraft atmospheric quality management are the following.

### Multifunctional Filtration Techniques

Techniques and methods are sought leading to compact, low power, autonomous, regenerable bulk particulate matter separation and collection techniques suitable for general cabin air purification. The particulate matter removal techniques and methods must accommodate high volumetric flow rates up to 11.3 $m^3$/minute, yet possess pressure drop <125 Pa. Filtration performance equivalent to HEPA rating is desired. Configurations incorporating multi-stage filtration that separate and optimize regeneration and capturing efficiency functionalities may be considered. The particulate matter separation and collection technique must be suitable for seamless integration into a spacecraft cabin ventilation system from a volumetric perspective. The techniques and methods must safely store and enable easy disposal of collected particulate matter by the crew while minimizing exposure during the disposal operation.

Combination of the particulate matter separation and collection technique with techniques possessing high removal capacity for volatile chemical contaminants, with a focus on light polar organic compounds (e.g., ethanol and acetone) and linear and cyclic siloxanes, is of interest. The volatile chemical contaminant removal techniques must accommodate high volumetric flow rates up to 11.3 $m^3$/minute and possess pressure drop <125 Pa. The technique must provide for a minimum 1 year service life and a goal of 3 years.

### ECLS System Process Gas Filtration Techniques

Techniques and methods leading to compact, regenerable methods for removing particulate matter generated in ECLS system process equipment such as carbon formation reactors and methane plasma pyrolysis reactors. Filtration performance approaching HEPA rating is desired for ultrafine particulate matter with minimal pressure drop. The gas filter should be capable of operating for hours at high particle loading rates and then employ techniques and methods to restore its capacity back to nearly 100% of its original clean state through in-place and autonomous regeneration or self-cleaning operation. Compact storage of the particulate matter after it is collected is as important as the effective collection. The device must minimize crew exposure to accumulated particulate matter and enable easy particulate matter disposal.

**Process Gas Phase Moisture Removal and Collection**

Innovative technologies are sought to dehumidify a hot, humid airstream and remove and collect the product as condensate for further processing. The airstream pressure is between 0.2 and 1.0 atmospheres, its temperature is 150Â°C and it is saturated with water vapor. The dewpoint of the airstream must be reduced to 10Â°C and the condensed liquid that results must be completely removed. Cooling at ambient temperature and electrical power and are available. Both the electric power and liquid carryover must be minimized.

Future human spacecraft will require more sophisticated thermal control systems that can operate in severe environments ranging from full sun to deep space and can dissipate a wide range of heat loads. The systems must perform their function while using fewer of the limited spacecraft mass, volume and power resources. Advances are sought for microgravity thermal control in the following areas:Â

- Heat rejection systems and/or radiators that can operate at low fractions of their design heat load in the cold environments that are required for deep space missions. Room temperature thermal control systems are sought that are sized for full sun yet are able to maintain setpoint control and operate stably at 25% of their design heat load in a deep space (0 K) environment. Innovative components, working fluids, and systems may be needed to achieve this goal.
- Lightweight non-venting phase change heat exchangers are sought to ameliorate the environmental transients that would be seen in planetary (or lunar) orbit. Heat exchangers that have minimal structural mass and good thermal performance are sought. The goal is a ratio exceeding 2/3 phase change material mass and 1/3 structural mass.
- Two-phase heat transfer components and system architectures that will allow the acquisition, transport, and rejection of waste heat loads in the range of 100 kW to 10 megawatts are sought.
- Non-toxic working fluids are needed that are compatible with aluminum components and combine low operating temperature limits (<250K) and favorable thermophysical properties - e. g., viscosity and specific heat.

Technologies are expected to be raised from TRL2 to TRL 3/4 during Phase I. Minimum deliverables at the end of Phase I are analysis/test reports, but delivery of development hardware for further testing is desirable. In addition, the necessity and usefulness of moving on to a Phase II should be demonstrated. Technologies would be expected to be matured from TRL 3/4 to TRL 5 during a potential Phase II effort. Expected deliverables for a Phase II effort are analysis/test reports and prototypic hardware.Â