NASA SBIR 2018 Phase I Solicitation

Z2.01 Thermal Management

Lead Center: JSC

Participating Center(s): GRC, GSFC, JPL, MSFC

Technology Area: TA14 Thermal Management Systems

NASA seeks new technologies that will facilitate low mass and highly reliable thermal control systems for exploration vehicles. Broad topics of interestÂ include development of: high efficiency lightweight radiators, advanced heat exchangers and cold plates, condensate separators with inlet air/water volume ratios greater than 99:1 and outlet separation efficiency of greater than 95%, phase change materials with optimized thermal capacity to structural mass ratios, high heat flux acquisition and transport devices, variable heat rejection technologies, closed-loop space suit thermal systems, high efficiency miniature pumped fluid systems, and improved thermal math modeling tools. Of particular interest in this solicitation are thermal control technologies that serve an integrated vehicle level function at a net mass benefit, those that enable human missions to Mars, and those enabling more than 24 hours of operation on the surface of Venus.Â

Integrated Spacecraft Solutions

The development of the systems required for spacecraft operations generally focus on providing a single primary function. Here, novel thermal control hardware that provides additional vehicle level functionality at a net mass benefit is sought. A concept of interest is body mounted radiators that provide effective micrometeoroid protection for deep space vehicles. Such a radiator must continuously provide its thermal control function while tolerating the micrometeoroid environment of cis-lunar space. The integrated radiator/micrometeoroid shield should have a radiator fin-efficiency better than 0.95. The shielding approach taken should provide a similar level of module and radiator flow tube protection as is currently in use on the International Space Station (ISS). The shielding configuration for ISS modules is 2 mm thick Al Alloy 6061 T6 stood off from the pressure vessel. The radiator tube shielding is a 1.2 mm thick aluminum bumper above a 4.75 mm gap, followed by a second 0.3 mm aluminum bumper over the flow tube. Another concept of interest includes flexible radiator solutions that could be integrated with existing inflatable structures. Flexible radiator solutions should meet a fin efficiency of at least 0.85 and provide radiative optical properties consistent with the current state of the art.Â

Enabling Thermal Control Technologies Missions to Mars

Operating large vehicles on the Martian surface presents unique challenges on a number of vehicle systems. During the entry, descent, and landing phase of the mission spacecraft surfaces are expected to experience incident heat loads up to 3.5 W/cm^2 for up to 5 minutes over the course of entry. These heat fluxes result in radiative equilibrium temperatures between 500 K and 900K. As a result, vehicle components must either be isolated from these loads or tolerate the loads by design. Large pumped fluid loop radiators, as the currently exist, were not designed to tolerate these types of external loads. Here NASA seeks new highly efficient radiator designs that are capable of surviving the described entry environment. Radiator designs should target mass to area ratios better than 5.4 kg/m^2. In addition to external loads experienced through the entry phase, the vehicle must also be capable of managing its own heat load. Concepts that incorporate both external environment tolerance and vehicle thermal management are desired.Â

Thermal Systems for Surface Missions to Venus

Proposals are sought for enabling thermal technology systems for the in-situ planetary exploration of deep atmosphere and surface environments. A driving scenario is exploration of the surface of Venus through the use of long-lived (> day) landers. Venus features a dense, CO_2 atmosphere completely covered by clouds with sulfuric acid aerosols, a surface temperature of 760K, and a surface pressure of 90 atmospheres. Thermal technologies are needed that permit more than 24 hours of operation of internal components within a 1 m diameter pressure vessel while minimizing resources consumed by the thermal system. A total systems approach must be considered that may include, but are not limited to, novel insulation, energy storage, heat pumping, and expendable coolant systems. The thermal system should be capable of providing heat management for 150 W of average internal dissipation. The entire assembly initial temperature can be assumed to be 273K and the maximum allowable temperature of internal equipment is 343K. Proposals must include a detailed description of the assumptions, thermal model, and bases of estimate for mass and power consumption of the technologies being put forward. Phase I results should include analytical proof-of-concept and provide a feasibility and development assessment of novel thermal control technologies. Phase II results should include development and testing of a prototype system or key piece of enabling technology identified in the Phase I effort.