



NASA SBIR 2009 Phase I Solicitation

X2.05 Spacecraft Thermal Control Systems

Lead Center: JSC

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

Future spacecraft will require more sophisticated thermal control systems that can dissipate or reject greater heat loads at higher input heat fluxes while using fewer of the limited spacecraft mass, volume and power resources. The thermal control system designs also must accommodate the harsh thermal environments associated with these missions. Modular, reconfigurable designs could limit the number of required spares.

The lunar environment presents several challenges to the design and operation of active thermal control systems. During the approximately 2 hour lunar orbit, the environment can range from extremely cold to near room temperature. Polar lunar bases will see unrelenting cold thermal environments, as will the radiators for Martian transit spacecraft. In both cases the effective sink temperature will approach absolute zero.

Innovative thermal management components and systems are needed to accomplish the rejection of waste heat during these future missions. Advances are sought in the general areas of radiators, thermal control loops, thermal system equipment, and EVA thermal control.

Systems with enhanced thermal mass may be required to deal with the lunar orbital environment. Variable emissivity coatings (near unity emissivity with the ability to reduce emissivity by at least a factor of ten), clever working fluid selection (a freezing point approaching 150K), or robust design could be used to prevent radiator damage from freezing in cold environments at times of low heat load.

Part of the thermal control system in a habitable volume is likely to be a condensing heat exchanger, which should be designed to preclude microbial growth. Small, highly reliable, heat pumps could be used to provide 278 K cold fluid to the heat exchanger, allowing the loop temperatures to approach 300 K, thus reducing the size of the radiators.

Future space systems may generate waste heat in excess of 10 kW which could either be rejected or redirected to areas which require it. Novel thermal bus systems which can collect, transport (over a distance of ~30 meters), and

provide heat for components are sought. The system should be highly flexible and adaptable to changes in equipment locations. Possible systems include single and two-phase pumped fluid loops, capillary-based loops, and heat pumps. Innovative design of the loops and components is needed.

Historically spacesuits have used water sublimators to provide heat rejection. Development of a low-venting or non-venting regenerable individual life support subsystem(s) concept for crewmember cooling and heat rejection is desired. Systems that integrate spacesuit thermal control systems with other life support tasks, such as removal of expired water vapor and CO₂ are highly desirable. Interests include low cost lightweight spacesuit compatible freezable radiators for thermal control and variable conductance flexible EVA spacesuit garments that can function as a radiator or as an insulator as required. Sensible heat loads average 300 W and peak at 800 W. Spacesuit cooling garments have water flow rates of approximately 100 kg/hr.