NASA SBIR 2019 Phase I Solicitation

Z2.01 Spacecraft 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 & highly reliable thermal control systems for exploration vehicles. Of particular interest in this solicitation are thermal control technologies related to heat acquisition, transport, and/or rejection/storage that enable single-loop thermal control systems for long duration human spacecraft, precision thermal control technologies compatible with mechanically pumped two-phase flow thermal systems, and lunar lander technologies that can be matured from small scale vehicles to human class missions. Proposals are expected to provide analytical and/or empirical proof-of-concept at the end of a Phase I effort and result in technology delivery at the end of a Phase II effort. At the culmination of Phase II, deliverables could include thermal math modeling that has been correlated to new technology tests, test data, as well as delivery to NASA.

Single-Loop Enabling Technologies for Thermal Control of Human Spacecraft

Human spacecraft have historically utilized dual fluid loop system architectures that contain a benign internal fluid such as water and a hazardous external fluid such as ammonia. Here, technologies that enable a single-loop thermal control system for human class missions are sought. Technologies should be appropriate for integration into a vehicle that has a nominal load of 6-8 kW during crewed operations (approximately 10% of the year) and a nominal load of 1-2 kW during uncrewed dormancy periods (the remaining 90% of the year). Vehicle external environments can vary between deep space and one sun conditions. Solutions should not pose undue burden on other vehicle subsystems and have a useful life > 10 years of continuous operation. Proposed technologies and associated systems should have a tangible mass, volume, and power benefit over the current state-of-the-art. Currently, single-loop systems are traded against an external pump package’s approximately 100kg mass.

Mechanically Pumped Two-Phase Flow Thermal Control System Technology Development

NASA currently has a critical gap in two-phase mechanically pumped thermal management system technologies. NASA plans to extend its traditional single, liquid, phase mechanically pumped architectures to two-phase, liquid/gas systems. Technologies are sought that enable these two-phase mechanically pumped fluid loop architectures and provide high quality precision thermal control.

Of particular interest in this solicitation are two-phase system heat acquisition technologies that can accommodate heat fluxes of up to 5 W/cm^2 and provide instrument isothermalization of < 3°C over 1-m^2 areas with temporal accuracy <0.05° C/minute. Such technologies have significant value as they improve the consistency of scientific data collection. Novel approaches to evaporators, flow boiling cold plates, or other novel technologies are sought to provide this capability. All proposed technologies should provide a useful life of at least 15 years and minimize vehicle level impacts to mass, power, and volume. While not specifically sought in this subtopic, improvements in two-phase mechanical pump efficiency and useful life are desirable. See Subtopic S3.06 Thermal Control Systems for proposals directed to that area.

Lunar Lander Technology Development

Here, NASA is seeking focused efforts to develop small and mid-to-large lunar lander technologies that have the potential to mature into technologies compatible with human lunar exploration. Technologies should address a gap associated to long duration habitation on the lunar surface where temperatures range from -183° C in shadow regions (including night) to 100° C at the subsolar point. System technologies should be orientation insensitive; for example, lander side mounted radiators must provide their function regardless of lunar surface temperature condition. Additional difficulties include the deposition of dust that will degrade optical properties. Technologies are needed that allow a single mission to operate in all these environments. For example, keeping batteries between the ranges of 0-45° C during the day and night. Technologies should address mass, volume, and power usage relative to current solutions. Adding heaters can add significant vehicle mass to accommodate an additional power source and are not considered a novel architecture approach. Small size landers are around 500kg dissipating around 100W, to large size lander of 6000kg dissipating around 1kW. Human class landers are likely to have a variable heat load with an average of 4-6 kW which must be accommodated in all these environments.

NASA has plans to purchase services for delivery of payloads to the Moon through the Commercial Lunar Payload Services (CLPS) contract. Under this subtopic, proposals may include efforts to develop payloads for flight demonstration of relevant technologies in the lunar environment. The CLPS payload accommodations are yet to be precisely defined, however at least for early missions, proposed payloads should not exceed 15 kilograms in mass and not require more than 8 watts of continuous power. Smaller, simpler, and more self-sufficient payloads are more likely to be accommodated. Commercial payload delivery services may begin as early as 2020 and flight opportunities are expected to continue well into the future. In future years it is expected that payloads of higher mass and with higher power requirements might be accommodated. Selection for award under this solicitation will not guarantee selection for a lunar flight opportunity.

All of the technology developments listed above have relevance to NASA through the following projects: Lunar Gateway, Europa Clipper/Lander, Venus Landers, Lunar Landers, and long duration habitats (Moon, Mars. etc.).

References:

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