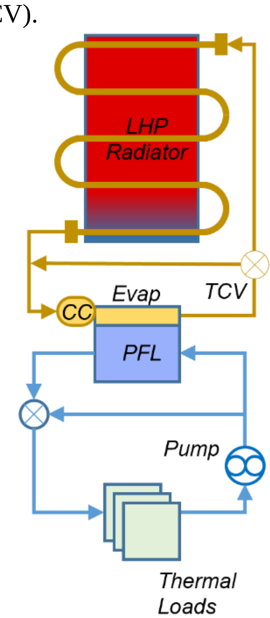
Hybrid Thermal Control System for Extreme Thermal Environments. W. E. Johnson[1], R. G. Schunk[1], K. E. Daniel[1], and J. T. Farmer[1], [1]NASA Marshall Space Flight Center, 4487 Martin Rd, Huntsville, AL 35812. (Contact: William.e.johnson-1@nasa.gov)

Introduction: NASA's return to the moon brings about many challenges, including issues with survival on the Lunar surface. In order to be sustainable, assets such as landers, rovers, and habitats must be usable for more than a single mission duration. One of the key challenges with sustainability is designing adequate thermal control systems that allow for surface systems to survive both during the day and the Lunar Night.

The extreme thermal environments on the Lunar surface are a challenging design space for thermal engineers. At equatorial regions the Lunar noon can be very hot, requiring systems with high heat rejection to the environment. At polar regions, such as those targeted by the return to the moon, the daytime temperatures are more moderate. During the Lunar night, however, temperatures plummet and can approach -200 degrees Celsius. Such temperatures are formidable and require specialized thermal control systems to allow surface assets to surface the long night.

Hybrid Thermal Control System: Marshall Space Flight Center (MSFC) has been developing a hybrid thermal control system that can be utilized for various surface assets that must survive in extreme lunar environments. This scalable system is targeted for human-rated systems and utilizes a combination of a pumped fluid loop and a loop heat pipe (LHP) with thermal control valve (TCV).



Pumped fluid loops (PFL) have a long heritage of use in human rated systems. They can collect large amounts of waste heat and transport it over long distances in rovers, habitats, and other systems. By utilizing a non-toxic working fluid in the habitable volume the PFL is easily serviceable by the crew and does not pose a risk during any unexpected leaks or failures.

The addition of a LHP for the exterior heat transport and rejection adds several benefits to the system for extreme environment survival. The quantity of LHPs can be tailored to optimize heat rejection for different systems and allows for large radiative surfaces. By utilizing a TCV in combination with the LHP, there can be high heat transfer during the daytime with minimal heat transfer during the night. The TCV passively controls the amount of heat transfer through the LHP based on the environmental temperature.

Prototype Development and Testing: A prototype PFL has been fabricated and tested at MSFC. This PFL allowed for checkout testing of the pump, sensors, and valves necessary to operate and monitor the system.

The permanent PFL is currently being assembled. Once finished, it will be integrated with a LHP manufactured by Advanced Cooling Technologies. The combined system will then be tested at MSFC to characterize heat transfer and control capability. The LHP will be placed in a thermal vacuum chamber with the PFL in the adjacent ambient environment. Heat will be input to the PFL to simulate waste heat. The LHP evaporator has channels that the PFL will be plumped through to transfer heat from the PFL to the LHP to be rejected. Testing is scheduled to take place in October and results will be included in the final poster.