Design and Development of a Sub-Zero Fluid System for Demonstration of Orion's Phase Change Material Heat Exchangers on ISS

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ABSTRACT

NASA's Orion Multipurpose Crew Vehicle's Exploration Mission 2 is expected to loiter in Lunar orbit for a relatively long period of time. In low Lunar orbit (LLO) the thermal environment is cyclic – extremely cold in the eclipse and relatively hot near the subsolar point. Phase change material heat exchangers (PCM HXs) are the best option for long term missions in these environments. A PCM HX allows a vehicle to store excess waste energy by thawing a phase change material such as n-pentadecane wax. During portions of the orbit that are extremely cold, the excess energy is rejected, resolidifying the wax. Due to the inherent risk of compromising the heat exchanger during multiple freeze and thaw cycles, a unique payload was designed for the International Space Station to test and demonstration the functions of a PCM HX. The payload incorporates the use of a pumped fluid system and a thermoelectric heat exchanger to promote the freezing and thawing of the PCM HX. This paper shall review the design and development under took to build such a system.