SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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ROBUST, EFFICIENT, SEMI-ACTIVE THERMAL CONTROL SYSTEM CONCEPT FOR A LUNAR ISRU ROVER

Abstract

In-Situ Resource Utilization (ISRU) has become increasingly important in the advancement of space exploration, with the expectations of increasing mission efficiency by reducing the amount of consumables required to be transported from Earth. One example of an upcoming ISRU mission, led by the National Aeronautics and Space Administration (NASA), is the Resource Prospecting Mission (RPM). In support of this potential lunar ISRU objective, under the direction of the Canadian Space Agency (CSA), Neptec Design Group and its partners have developed a preliminary rover concept of a Lunar Tele-Operated ISRU Platform (LTOIP) with the objective of transporting the NASA RPM payload on the lunar surface.

The LTOIP rover concept is a natural evolution of the Artemis Jr. rover, which has already demonstrated success at the NASA-led ISRU Analogue Mission Simulation in Hawaii, 2012. However, where the Artemis Jr. rover was specifically designed for Earth-based operations, the LTOIP rover concept has been tailored to accommodate the harsh lunar thermal environment. In particular, the Design Reference Mission (DRM) for the RPM specifies that samples are to be collected in Permanently Shadowed Regions (PSR) where surface temperatures may be as low as 40K. Furthermore survival throughout the 14-day lunar night would require the rover to endure prolonged exposure to these extremely cold temperatures.

As such, the LTOIP rover concept has been structured around the thermal management system necessary to minimize uncontrolled heat loss and maximize thermal dissipation (when required). In efforts to minimize cost and maximize robustness, the unique thermal control system (TCS) of the LTOIP rover does not require moveable solar panels, nor does it require radioisotope heater units (RHU). Instead, the LTOIP rover concept TCS uses a combination of sophisticated insulation, strategically placed thermal planes, variable conductance heat pipes (VCHP), three (3) thermal switches and precise radiators, to control the component temperatures. Since the only active components (thermal switches) of this system are contained within the Warm Electronics Box (WEB) of the chassis, the risk of failure is significantly reduced. It is expected that the proposed concept TCS would require less than 15W to maintain critical systems within their operating limits during either prospecting into a PSR or survival during the lunar night.

This paper will outline the proposal for a robust, efficient and semi-active thermal control system concept for a Lunar ISRU rover which could be used for the NASA Resource Prospecting Mission.