Conceptual Thermal Control System Design for a Lunar Surface Habitat

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NASA is currently considering a Surface Habitat (SH) to provide 30-60 day habitability for a crew of up to four to explore the Lunar surface at a South Pole location. The SH concept is comprised of an inflatable volume for the habitable space, a metallic airlock and a descent stage with access to a pressurized rover and other surface assets provided through an airlock. A conceptual architecture for the SH Thermal Control System (TCS) is presented with resource estimates. The TCS design employs a dual loop architecture with a water/propylene glycol mix for the internal crew spaces with a low temperature coolant utilized for the external loop. The internal loop is partitioned into low and moderate temperature service with a sublimator available for operational scenarios prior to thermal radiator deployment (or redeployment). Analytical models are utilized to optimize radiator geometry/orientation as well as the TCS internal/external loop architecture. Heritage hardware is utilized for the TCS concept wherever possible and low mass, dust tolerant, deployable/retractable thermal radiators (in partial gravity) present a technology challenge. The TCS must accommodate infrequent eclipse periods lasting up to 100 hours in duration and mitigation strategies to reduce the energy needed to maintain the SH and associated systems above survival temperature limits during this period are explored. Mitigation options include retractable or freeze tolerant radiators, other reconfigurable radiator geometries, alternate fluids, re-generable heat exchangers, temperature excursions, thermal energy storage and optimized inflatable optical properties. Finally, TCS sensitivity to SH Electrical Power System (EPS) growth is considered with both operational and dormant impacts quantified.