

Evaluating Three Active Thermal Architectures for Exploration Missions

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Mass and cost are typically the two biggest challenges facing space craft designers. Active thermal control systems for crewed space-craft are typically among the more massive and costly systems on the vehicle. A study was completed evaluating three different thermal control system architectures to evaluate overall performance, mass and cost for a typical exploration mission profile. The architectures that were evaluated were 1 - a two-loop system using an internal liquid loop interfacing with an external liquid loop and flow loop with flow through radiators; 2 – a-single loop architecture with flow through radiators utilizing a regenerative heat exchanger and heater; and 3 - a single-loop architecture with heat pipe radiators. Environmental conditions, calculated for a given lunar exploration mission, and mission heat load profiles, generated based on previous Orion time lines, were evaluated through the phases of the on orbit mission. Performance for each of the architectures was evaluated along with the resultant mass of each system. Recommendations include adding a thermal topping system to lunar missions due to the extreme hot environments encountered in near-lunar approaches.