EXPENDABLE COOLING FOR A ONE-DAY VENUS LANDER. M. T. Pauken[1], C. J. Fernandez[2] and S. M. Jeter[2], [1]Jet Propulsion Laboratory, 4800 Oak Grove Blvd, M/S 125-123, Pasadena, CA 91109, mpauken@jpl.nasa.gov, [2]Georgia Institute of Technology, School of Mechanical Engineering, 771 Ferst Drive, Atlanta, GA 30332.

Introduction: A novel thermal architecture of a Venus Lander mission using an expendable coolant system to enable a day-long surface mission has been developed. This thermal control system design will make possible a Venus surface mission with capabilities far exceeding those of any previous mission by allowing “human-in-the-loop” science.

Previous exploration of the Venus surface by the Soviet Venera Landers had operating lifetimes less than 2 hours. Even recent proposals for Venus surface exploration such as the Surface and Atmospheric Geochemical Explorer (SAGE) had a proposed operating lifetime limit of 3 hours. Imagine a Venus Lander operating long enough for scientists to review Lander surface imaging data and guide instruments to specific targets rather than getting data collected blindly by autonomous instrument placement. A one-day mission is possible with an expendable coolant system as part of the vehicle thermal architecture to remove heat from electronics and the structural shell.

The thermodynamic and heat transfer property data for candidate expendable coolant fluids including ammonia, water, aqua-ammonia mixtures were collected for thermal system performance evaluation. Thermodynamic and heat transfer process analytical models of the expendable coolant system and the Venus Lander thermal subsystem were developed. The analytical tools were used to develop specifications for the required insulation thickness on the exterior and interior of the vessel structure, the mass and volume of solid-liquid phase change materials in the Lander, the mass and volume of the expendable coolant and its associated heat exchangers.

Parametric studies were performed on the expendable coolant system and the Lander Thermal subsystem to determine relationships between resisting heat flow into the Lander (affected by insulation thickness/mass) and energy storage capacity using solid/liquid phase change materials and heat rejection capacity using expendable coolants. The goal of the parametric study was to trade mass and volume allocations between insulation, phase change materials and expendable coolant to maximize Lander operating lifetime.