ROTORCRAFTS FOR MARS EXPLORATION. J. Balaram[1] and P. T. Tokumaru[2], [1]Jet Propulsion Laboratory, California Institute of Technology, balaram@jpl.nasa.gov, [2]AeroVironment Inc.

Rotorcraft mobility provides a number of useful capabilities to potential Mars mission including scouting science locations, examination of potential rover routes, science instrument deployment to difficult terrain locations, and sample cache retrieval. In this presentation we present some recent results relating to the design and test of Mars rotorcraft mobility elements. We also discuss aspects of the rotorcraft system and mission design as they relate to on-board autonomy for controlled flight, power and energy management, and the design of the thermal and power elements.

We describe successful tests of a Mars rotor airfoil that were recently conducted in the JPL 10-foot pressure chamber under Mars ambient conditions. The airfoil was designed and fabricated at AeroVironment Inc. Torque and thrust data were collected over a range of rotor RPMs, chamber pressures and airfoil blade angles. Test results confirm that vertical take-off and landing flight on Mars is feasible, and that the lift performance closely matches predicted analytical CFD results. The resulting airfoil design can be used as part of a dual co-axial rotorcraft vehicle architecture which we describe together with some of the associated flight control issues.

Operating a rotorcraft in the Martian environment also presents additional system and mission design challenges. Significant on-board autonomy is required for rotorcraft takeoff, horizontal flight, station-keeping, on-board landing site selection, and safe landing. A robust low-mass, high-performance computational architecture is required to support this level of autonomy. In addition, a thermal design is required to provide for overnight survival and safe temperatures during flight. An energy (solar) harvesting system is required to allow daily flight operations. We briefly discuss these design issues, associated trade spaces, and an example point system design.