

Testing of Mars Retropropulsion Concepts in the Langley Unitary Plan Wind Tunnel

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Future Mars human lander missions will require using retrorockets beginning at supersonic conditions, something which has never been done before at Mars. Significant aerosciences challenges exist due to interactions between the retrorocket exhaust plumes, the freestream flow, and the vehicle that alter the aerodynamic behavior. Historical retropropulsion ground and flight data do not provide a basis for calibrating the computational uncertainties for aerodynamic interference forces and moments on proposed Mars descent vehicles, either because of insufficient data or dissimilar vehicles geometries and/or conditions. A new retropropulsion wind tunnel test was conducted in the NASA Langley Unitary Plan Wind Tunnel in order to address some of the deficiencies of previous tests and to provide a basis for computational model comparisons on relevant geometries. The test included improvements in model design and measured data. Two sub-scale model geometries derived from full-scale vehicle concepts were tested: a blunt low lift-to-drag vehicle and a more slender geometry. The first model includes variations in nozzle parameters that were estimated to have first-order effects on the measurements: location, pointing direction, size, and exit-to-throat area ratio. Both models were instrumented with discrete steady and unsteady pressure sensors on the aerodynamic and interior flow path surfaces. The heats shields of both models also were covered with pressure sensitive paint that effectively measures a steady pressure distribution in an otherwise unsteady flow field. This pressure distribution was integrated over the surface geometry in order to estimate the steady aerodynamic force and moment coefficient contribution from the painted surfaces; this approach was used as a replacement for using a flow-through balance. This paper will cover the test objectives, model design, test matrix, and available test results for each model configuration at different freestream Mach numbers, model attitude, and non-dimensional thrust magnitude. A subsequent publication will cover uncertainty quantification of the test data and comparisons to computational fluid dynamics model results.

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