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TOWARDS THE GENERATION OF EMPIRICAL THERMAL FLUX DATASETS FOR THE IMPROVEMENT OF ENGINEERING-LEVEL DESTRUCTIVE RE-ENTRY SIMULATIONS

Abstract

The experimental simulation of planetary entry scenarios has always been a significant technical challenge for space agencies and private industry alike. The ability to simulate the low density, high Mach number flows which are characteristic of atmospheric entry is highly valuable to the design of entry vehicles and the assessment of debris survivability alike.

The Oxford Low Density Wind Tunnel (LDWT) at the University of Oxford's Osney Thermofluids Laboratory has the ability to produce a vacuum with a pressure of the order of 0.1 Pa, and a core test flow Mach number inside the test section of up to 6 using its contoured hypersonic nozzle (which is cooled to control boundary layer growth). This paper describes commissioning activities performed for the LDWT following an extensive refurbishment wherein the facility's vapour diffusion pump was serviced and its instrumentation updated to include a full 3D traverse system for wake surveys and variable attitude heat flux experiments, and a large number of low range pressure transducers.

Furthermore, the details of the tunnel's ability to simulate steady state heat flux are elaborated upon. The details of experiments designed to improve the accuracy of time-expedient engineering-level debris survivability assessment methods are presented, wherein the rarefied flow over geometric primitives in the slip regime is simulated. From these data, edge heating rates at varying angles of incidence are extracted, such that fast, object-oriented analyses of space debris may be refined, and hence, survivability of objects may be more accurately assessed.