

Space Launch System Base Heating Test: Environments and Base Flow Physics

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The NASA Space Launch System (SLS) vehicle is composed of four RS-25 liquid oxygen-hydrogen rocket engines in the core-stage and two 5-segment solid rocket boosters and as a result six hot supersonic plumes interact within the aft section of the vehicle during flight. Due to the complex nature of rocket plume-induced flows within the launch vehicle base during ascent and a new vehicle configuration, sub-scale wind tunnel testing is required to reduce SLS base convective environment uncertainty and design risk levels. This hot-fire test program was conducted at the CUBRC Large Energy National Shock (LENS) II short-duration test facility to simulate flight from altitudes of 50 kft to 210 kft. The test program is a challenging and innovative effort that has not been attempted in 40+ years for a NASA vehicle. This presentation discusses the various trends of base convective heat flux and pressure as a function of altitude at various locations within the core-stage and booster base regions of the two-percent SLS wind tunnel model. In-depth understanding of the base flow physics is presented using the test data, infrared high-speed imaging and theory. The normalized test design environments are compared to various NASA semi-empirical numerical models to determine exceedance and conservatism of the flight scaled test-derived base design environments. Brief discussion of thermal impact to the launch vehicle base components is also presented.

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