Characterization of the Scale Model Acoustic Test Overpressure Environment using Computational Fluid Dynamics

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The Scale Model Acoustic Test (SMAT) is a 5% scale test of the Space Launch System (SLS), which is currently being designed at Marshall Space Flight Center (MSFC). The purpose of this test is to characterize and understand a variety of acoustic phenomena that occur during the early portions of lift off, one being the overpressure environment that develops shortly after booster ignition. The pressure waves that propagate from the mobile launcher (ML) exhaust hole are defined as the ignition overpressure (IOP), while the portion of the pressure waves that exit the duct or trench are the duct overpressure (DOP). Distinguishing the IOP and DOP in scale model test data has been difficult in past experiences and in early SMAT results, due to the effects of scaling the geometry. The speed of sound of the air and combustion gas constituents is not scaled, and therefore the SMAT pressure waves propagate at approximately the same speed as occurs in full scale. However, the SMAT geometry is twenty times smaller, allowing the pressure waves to move down the exhaust hole, through the trench and duct, and impact the vehicle model much faster than occurs at full scale. The DOP waves impact portions of the vehicle at the same time as the IOP waves, making it difficult to distinguish the different waves and fully understand the data. To better understand the SMAT data, a computational fluid dynamics (CFD) analysis was performed with a fictitious geometry that isolates the IOP and DOP. The upper and lower portions of the domain were segregated to accomplish the isolation in such a way that the flow physics were not significantly altered. The Loci/CHEM CFD software program was used to perform this analysis.