December 2011 MSS/LPS/SPS Joint Subcommittee Meeting
ABSTRACT SUBMITTAL FORM

The submission of an abstract is an agreement to complete a final paper for publication and attend the meeting to present this information. Complete all information requested in the author and co-author information sections; the first author listed will receive paper acceptance notices and all correspondence. Abstracts must be submitted electronically; submittal instructions are located in the call for papers. **The abstract deadline date is June 13, 2011.**

ABSTRACT INFORMATION

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Unclassified Abstract

(250-300 words; do not include figures or tables)

NASA design teams have been investigating options for “detuning” Ares I to prevent oscillations originating in the vehicle solid-rocket main stage from synching up with the natural resonance of the rest of the vehicle. An experimental work started at NASA MSFC center in 2008 using a damping device showed great promise in damping the vibration level of an 8” resonant tank. However, the mechanisms of the vibration damping were not well understood and there were many unknowns such as the physics, scalability, technology readiness level (TRL), and applicability for the Ares I vehicle. The objectives of this study are to understand the physics of intriguing slosh damping observed in the experiments, to further validate a Computational Fluid Dynamics (CFD) software in propellant sloshing against experiments with water, and to study the applicability and efficiency of the slosh damper to a full scale propellant tank and to cryogenic fluids. First a 2D fluid-structure interaction model is built to model the system resonance of liquid sloshing and structure vibration. A damper is then added into the above model to simulate experimentally observed system damping phenomena. Qualitative agreement is found. An analytical solution is then derived from the Newtonian dynamics for the thrust oscillation damper frequency, and a slave mass concept is introduced in deriving the damper and tank interaction dynamics. The paper will elucidate the fundamental physics behind the LOX damper success from the derivation of the above analytical equation of the lumped Newtonian dynamics. Discussion of simulation results using high fidelity multi-phase, multi-physics, fully coupled CFD structure interaction model will show why the LOX damper is unique and superior compared to other proposed mitigation techniques.