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

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ABSTRACT INFORMATION

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Unclassified Abstract

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

Waterhammer transients have the potential to adversely impact propulsion system design if not properly addressed. Waterhammer can potentially lead to system plumbing, and component damage. Multi-thruster propulsion systems also develop constructive/destructive wave interference which becomes difficult to predict without detailed models. Therefore, it is important to sufficiently characterize propulsion system waterhammer in order to develop a robust design with minimal impact to other systems.

A risk reduction activity was performed at Marshall Space Flight Center to develop a tool for estimating waterhammer through the use of anchored simulation for the Robotic Lunar Lander (RLL) propulsion system design. Testing was performed to simulate waterhammer surges due to rapid valve closure and consisted of twenty-two series of waterhammer tests, resulting in more than 300 valve actuations. These tests were performed using different valve actuation schemes and three system pressures.

Data from the valve characterization tests were used to anchor the models that employed MSCSoftware.EASY5 v.2010© to model transient fluid phenomena by using transient forms of mass and energy conservation. The anchoring process was performed by comparing initial model results to experimental data and then iterating the model input to match the simulation results with the experimental data. The models provide good correlation with experimental results, supporting the use of EASY5 as a tool to model fluid transients and provide a baseline for future RLL system modeling.

This paper addresses tasks performed during the waterhammer risk reduction activity for the RLL propulsion system. The problem of waterhammer simulation anchoring as applied to the RLL system is discussed with results from the corresponding experimental valve tests. Important factors for waterhammer mitigation are discussed along with potential design impacts to the RLL propulsion system.