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JANNAF
PIB / 11th MSS / 9th LPS / 8th SPS
Joint Subcommittee Meeting
5 – 9 December 2016

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* **Title:** Wave Amplitude Dependent Engineering Model of Propellant Slosh in Spherical Tanks

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Unclassified Abstract (250 – 300 words; do not include figures or tables)

* Liquid propellant slosh is often a concern for the controllability of flight vehicles. Anti-slosh devices are traditionally included in propellant tank designs to limit the amount of sloshing allowed during flight. These devices and any necessary supports can be quite heavy to meet various structural requirements. Some of the burden on anti-slosh devices can be relieved by exploiting the nonlinear behavior of slosh waves in bare smooth wall tanks. A nonlinear regime slosh model for bare spherical tanks was developed through a joint analytical and experimental effort by NASA/MSFC. The developed slosh model accounts for the large damping inherent in nonlinear slosh waves which is more accurate and drives conservatism from vehicle stability analyses that use traditional bare tank slosh models. A more accurate slosh model will result in more realistic predicted slosh forces during flight reducing or removing the need for active controls during a maneuver or baffles in the tank design. Lower control gains and smaller or fewer tank baffles can reduce cost and system complexity while increasing vehicle performance. Both Computational Fluid Dynamics (CFD) simulation and slosh testing of three different spherical tank geometries were performed to develop the proposed slosh model. Several important findings were made during this effort in addition to determining the parameters to the nonlinear regime slosh model. The linear regime slosh damping trend for spherical tanks reported in NASA SP-106 was shown to be inaccurate for certain regions of a tank. Additionally, transition to the nonlinear regime for spherical tanks was only found to occur at very large wave amplitudes in the lower hemisphere and was a strong function of the propellant fill level in the upper hemisphere. The nonlinear regime damping trend was also found to be a function of the propellant fill level.

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- Direct questions to Shelley Cohen, by phone at 410.992.7302 x 215, or email to scohen@erg.jhu.edu.

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