Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Nonlinear Dynamics of a Spring-Supported Piston in a Vibrated Liquid-Filled Housing: I. Analysis J.R. TORCZYNSKI, T.J. O'HERN, J.R. CLAUSEN, Sandia National Laboratories — The nonlinear dynamics of a piston supported by a spring in a vibrated liquid-filled housing is analyzed. The liquid is viscous, and the flow passages are narrow and depend on piston position. Ordinarily, the piston motion is highly damped. However, if bellows are added to both ends of the housing, then the piston, liquid, and bellows can execute a collective motion that forces relatively little liquid through the flow passages and thus has low damping and a strong resonance. At this frequency, the motion is large, and the nonlinearity from the flow passages produces a net force on the piston that can cause it to compress its spring. This nonlinear dynamical system is analyzed using a perturbation expansion of the Navier-Stokes equations, and the perturbation results are compared to corresponding ALE Navier-Stokes simulations. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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Date submitted: 07 Jul 2016 Electronic form version 1.4