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SHOCK MITIGATION USING COMPRESSIBLE TWO-PHASE JETS FOR Z-PINCH IFE REACTOR APPLICATIONS

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Z-Pinch IFE reactor designs will likely utilize high yield targets (~10 GJ) at low repetition rates (~0.1 Hz). Appropriately arranged thick liquid jets can adequately protect the cavity walls from the target X-rays, ions, and neutrons. However, the shock waves and mechanical loadings produced by rapid heating and evaporation of incompressible liquid jets may be challenging to accommodate within a small reactor cavity. This investigation examines the possibility of using compressible liquid/gas jets as a means of limiting and mitigating the mechanical consequences of rapid energy deposition within the jets in a high-yield, low repetition rate, Z-Pinch IFE reactor system.

Experiments have been conducted to examine the effect of gas void fraction and nozzle/flow system design on the behavior and stability of the jets. An exploding wire system has been used to generate a shock wave at the center of downward flowing single- and two-phase jets. Experiments were conducted for different liquid velocities, void fractions, and shock strength. The transient pressure history at the wall of the surrounding enclosure was measured as the shock wave, attenuated by the intervening media, propagated to, and reflected from, the enclosure wall. The data show that stable coherent jets with relatively high void fractions (up to 25%) can be established and steadily maintained. Significant attenuation in shock strength was attained at relatively modest void fractions (~5%). The data obtained in this investigation can be used to validate the numerical models used by reactor designers to assess the mechanical response of the cavity walls, and the effectiveness of both single- and two-phase jets in mitigating the consequences of shock waves in high yield IFE reactor systems.