Z-Pinch Power Plant Shock Mitigation Experiments and Analysis*

Salvador B. Rodríguez[1], Vincent J. Dandini[2], Marcos A. Modesto-Beato[3], and Virginia L. Vigil[4]

[1]Sandia National Laboratories, Albuquerque, NM, sbrodri@sandia.gov
[2]Sandia National Laboratories, Albuquerque, NM, vjdandi@sandia.gov
[3]Sandia National Laboratories, Albuquerque, NM, mamode@sandia.gov
[4]Sandia National Laboratories, Albuquerque, NM, vlvigil@sandia.gov

The Z-Pinch Power Plant (ZP-3) is a technological spin-off of the Z Pinch Facility located at Sandia National Laboratories. ZP-3 is a unique, inertially confined, fusion energy concept in which high yield targets will be ignited to fusion, yielding bursts of energy in the 1 to 20 gigajoule range. In particular, a 60 to 100 million-amp pulse in a dynamic Hohlraum results in a magnetic pinch and an extreme X-ray pulse that compresses the deuterium-tritium fuel pellet, resulting in fusion. The fusion reaction yields an energetic burst that consists principally of neutrons, gamma rays, and charged particles. These particles travel through an evacuated space inside the chamber to a series of flibe walls that are separated by additional vacuous regions (~ 2,632 Pa). The particles deposit their energy within the first few mm of the flibe walls. Flibe 1) provides tritium generation for subsequent fusion (via a Li-slow neutron reaction), 2) is a shock wave attenuator, and 3) absorbs neutrons, thus shielding the ZP-3 chamber, which will be designed to survive for 30 to 40 years of operation. In shielding the chamber, the flibe is heated by the highly energetic neutrons. This heat is ultimately extracted by the ZP-3 thermal cycle in order to generate electricity.

In this paper, we will discuss the small-scale shock attenuation experiments being conducted for by Sandia. Our focus will be on the optimization of thick liquid wall streams, with the goal of maximizing shock attenuation as a function of material properties (we may ultimately use a different coolant than flibe), wall thickness, number of walls, and material voiding. In addition, we will also assess the capacity of foamed flibe or some similar material that can fill the entire chamber (as opposed to walls separated by vacuous gaps). We will proceed by benchmarking codes such as BUCKY and ALEGRA with experimental data. We will explore the code's strengths and weaknesses for modeling of the appropriate phenomena. Depending on our findings, new models may be recommended, and if time permits, developed. Finally, we will explore small-scale experiment scalability to the full-scale ZP-3.

* This work sponsored by Sandia National Laboratories, a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.