Neutron Generator Standoff Studies

by **M. U. Anderson, H. D. Radloff, L. E. Voelker, E. S. Hertel, M. E. Kipp**

Motivation—Neutron generators are a critical component of nuclear weapon systems. They must be isolated from effects of the high explosive detonation until a pre-determined function time. This isolation time from detonation effects is termed standoff time. Standoff time is measured experimentally during functioning of an inert nuclear weapon system by detonating the high explosives and then measuring the arrival time of destructive shock waves at the neutron generator region during the hydrodynamic implosion of the weapon system. These measured arrival times at the generators are then compared to the weapon designer's specifications to determine if the neutron generators have sufficient standoff time in order to function before being destroyed.

Traditional methods of measuring standoff include self-powered piezoelectric crystals and remotely-powered shorting switches. Piezoelectric crystals provide accurate measurements of shock wave arrival time and amplitude at the expense of disturbing shock wave propagation beyond the crystal. The shorting switches provide a less accurate arrival time without information about shock amplitude.

Accomplishment—We have used piezo-electric polymer (PVDF) shock gauges in recent hydrodynamic weapon tests yielding previously unattainable experimental data. These thin (25 micron), non-intrusive gauges provided data on shock wave amplitudes and arrival times at key locations within the weapon system without disturbing the shock wave propagation. The measured data are crucial for assessing adequate standoff and functioning of vital components as well as for improving and validating numerical simulations. These recent tests were conducted at flash X-ray facilities at Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL). They were designed and performed in collaboration with SNL/CA, LANL and LLNL researchers. The gauges which employ the piezoelectric polymer film polyvinylidene fluoride (PVDF) as the active, time-resolved sensing element were developed by Organization 1152 and represent a unique diagnostic capability for shock wave phenomena.

The experimental results have been analyzed and compared to numerical simulations of shock propagation through the experimental structure. The simulations, performed at SNL, were done in 2-D and 3-D geometries as part of the Advanced Strategic Computing Initiative (ASCI). Some differences between the simulations and the experimental measurements are providing a basis for improving the simulation capabilities in the complex geometry involved.

Significance—The availability of the thin film, non-intrusive, self-powered PVDF piezoelectric shock gauges is providing a needed new capability for diagnosing the performance of weapon components and systems. For the present standoff application, these gauges in combination with traditional piezoelectric crystal gauges and shorting switches have provided a critical set of data on shock amplitudes and arrival times which are challenging and improving our predictive capabilities.

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