Armando: The Final Subcritical Experiment in th Series

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Excerpted from LA-14202-PR

Introduction

Armando was the final subcritical experiment (SCE) in the Stallion series series of experiments (Vito/Etna, Mario, Rocco, and Armando) were desi high-explosive (HE) driven properties of cast and wrought plutonium; th materials being representative of the materials produced via the differen processes employed at Rocky Flats and LANL. Specific properties investig production, spall features, and surface temperatures. Ejecta is defined a particulate matter "ejected" from the surface of a solid when a strong sh with the surface. Spall is a general term for bulk material failure near the created by a strong shock interacting with the surface. Both of these phe upon the material properties: material strength, grain size, impurities, et strength and temporal profile of the shock pressure. The surface temper important constraint upon the final state of the shock-driven metal that a full understanding of the behavior of the material.

Vito/Etna was a joint experiment conducted with the Aldermaston Weapo (AWE) located in the United Kingdom that concentrated on ejecta. Rocco separate cast and wrought experiments that examined the phenomena c suite of point diagnostics. These diagnostics provided either specific time at a single spatial point or a continuous time record of some material pro spatial point. Armando was designed to complement and extend the mea Rocco and Mario by combining the two experiments into a single package radiographing the behavior at two separate times along equivalent lines paraphrased paradigm is: a picture is worth a thousand pins.

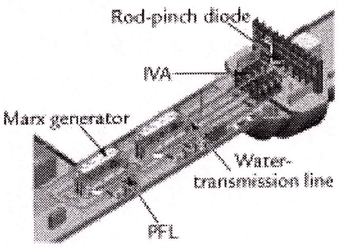
Diagnostics and Package Composition

HE diagnostics equivalent to those used on Rocco and Mario were implen identical HE performance. These consisted of a series of shorting switche microwave interferometer strip laid out symmetrically on the HE package detonation times and velocities. Point VISARs (Velocity Interferometer S Reflector) and optical pyrometers (that provide a measure of the surface were also implemented to verify equivalent behavior of the surface prope diagnostic for Armando was x-ray radiography along two equivalent axes Physics packages identical to the Rocco and Mario packages were combir package (6-sides or High-Energy X-ray) vertically separated with the fre one another. This geometry allows for exactly equivalent radiographs to two materials at the same time in their evolution. The third axis of the H for VISAR/pyrometry access.

within a 3 ft diam (inside diameter) containment vessel. This vessel and
that houses the scintillator and camera system are placed within a "zero
a large bulkhead completely sealing off the end of the U1a.05 drift. Thin
windows in the bulkhead and vessel allow the x-rays to pass through the
containment vessel with minimal attenuation. Originally designed so as t
room, fielding the experiment within a containment vessel allows for the
room for multiple experiments and provides multiple redundant containn

The Cygnus sources extend down the drift externally to the zero room. T
of a Marx bank system contained in large oil-filled tanks that pulse-charg
forming lines (PFL). The output of the PFL is a short pulse (~ 60 ns), larg
MV) electrical pulse that propagates down an 8 in. diam, water-filled, coa
line. This electrical pulse is coupled into the inductive voltage adder (IVA
voltage in parallel to produce a 2.25 MV, low-impedance drive pulse for t
diode. This last stage of voltage addition is accomplished in a high-vacuu
diode operation. The expertise of Sandia National Laboratories (SNL) and
Sciences Division (PSD) were instrumental in applying the technology de
realize a robust and flexible pulse-powered driver capable of operating re
underground.

Figure 2. Layout of Cygnus x-ray sources in U1a.05 drift. Confinement vessel and camera box are not shown in this view.



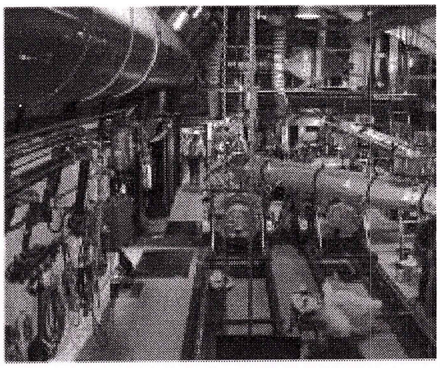


*Figure 3. A view of the U1a.05 drift. The "zero
bulkhead is seen with the two IVA structures fed
water-filled coaxial transmission lines in the fore*

Radiography and Detector Systems

The radiography employed on Armando represents a significant advance
performance of medium-energy radiography. It has been the result of a
Laboratory effort involving LANL, SNL, Bechtel Nevada (BN), the Naval R
(NRL), AWE, Titan/PSD, and Mission Research Corporation (MRC). Many
been combined to lead to this advance in performance, but perhaps the
been the effective realization of the rod-pinch diode originally developed
pinch has a similar geometry to standard x-ray diodes in use in industria
sources for several decades. However, researchers at NRL realized that w
low impedance (Z), the diode would transition from classic space charge
into magnetically limited (ML) flow whereby the electrons would be trans
of the central anode rod and then "pinch" producing a very bright, small

reproducible manner.

The detector system is equally innovative. It combines technologies developed for Dual-Axis Radiographic Hydrodynamic Test (DARHT) and proton radiography to create a very high-resolution imaging system. It functions by converting the x-rays transmitted through the experimental package into visible light in a tiled LSO (lutetium oxyorthosilicate) scintillator. The light produced is transported by a low-f/# lens system to a LN_2-cooled charged-coupled-device (CCD) chip that captures and records the image. In order to preserve ma resolution, the combined CCD camera system is not gated; all time resol derives from the flash nature of the illuminating x-ray pulse. While provi resolution, this technique introduces a risk to the experiment, in that the camera combination must be maintained in a light tight configuration thr detonation and long enough thereafter (~ 90 s) for the information to be CCD camera system to a remote data logging computer.

Results

The results of Armando have provided valuable data for stockpile stewar diagnostics demonstrated identical performance of the HE detonation in a Rocco, Mario, and Armando cast and wrought. The VISAR measurement the measured surface velocity was reproduced within error bars. The rad detailed subsurface data on the spalled material with a resolution and pr unobtainable. Radiographic data was obtained at two times allowing com VISAR data. The inferred velocity was in excellent agreement, further en in the accuracy of the results.

Acknowledgment

A great many people in many divisions (Physics, Dynamic Experimentati Sciences and Applications, Material Science and Technology, Applied Phy Materials Technology, Health, Safety, and Radiation Protection, and Eartl Environmental Sciences) at LANL worked in a very productive partnershi PSD, NRL, MRC, and BN to develop the technology and execute the Arma possible to call out every individual in this format, but their efforts and d project are deeply appreciated.

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