Nevada Test Site

Big Explosives Experimental Facility February 2003

WATUSI was the largest high-explosive experiment conducted at BEEF. It was equivalent to 40,000 pounds of TNT.

Introduction

The Big Explosives Experimental Facility (BEEF) is located in Area 4 of the Nevada Test Site. It is one of the nation's premier hydrodynamic research and development testing facilities. It consists of two underground bunkers, one above ground structure containing primary diagnostic facilities, and three blast protective enclosures allowing for diagnostic assessment equipment. The facility is capable of up to a 70,000 pound TNT equivalent physics experiment providing for the study and investigation of explosive characteristics, impacted materials, and high-explosives pulsed power.

✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧

Facility Description

The facility consists of two earth-covered, two-foot thick steel reinforced concrete bunkers, which were built to monitor atmospheric tests at Yucca Flat in the 1950s. They were found to be ideally configured to accommodate a control and camera bunker. The facility has been used to conduct several conventional high-explosives experiments using a test bed that provides sophisticated diagnostics such as high-speed optics and x-ray radiography, while operating personnel are present in the bunker.

View of BEEF showing the blast berm.

In order to conduct large conventional high-explosive experiments while operating personnel are present in the control bunker, it first had to be certified as safe. To achieve this, scientists conducted *Popover* -- a series of high explosive (up to 7,800 pounds) tests which were detonated 27-feet from the bunker's buried outer wall.

The test data was used to develop an effects profile that defined the relationship of the high-explosive charge size and detonation point to blast effects, such as overpressure, bunker wall strain, dynamic response (acceleration), and noise amplitude. Together these results demonstrated that the bunker would provide a safe working environment.

Support Missions

Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) use the facility for hydrodynamic testing of advanced technologies in support of the nation's Stockpile Stewardship Counter-proliferation and Demilitarization programs.

For the Stockpile Stewardship Program, proof tests of components or development of technologies occurs.

Counterproliferation projects encompass developing technologies that could render safe, a nuclear weapon produced by proliferate countries or terrorists.

Demilitarization projects may include experimental validation of scale-source characterization models for the disposal of obsolete U.S. Department of Defense munitions or propellants.

Shaped Charge Tests

In early 1997, LLNL successfully tested a shaped charge that penetrated 3.4 meters (11.22 feet) of high-strength armor steel. The largest diameter precision shaped charge ever built produced a jet of molybdenum that traveled several meters through the air before making its way through successive blocks of steel. A shaped charge, by design, focuses all of its energy on a single line, making it very accurate and controllable. When size is added to that accuracy, the effect can be dramatic.

A shaped charge is a concave metal hemisphere or cone (know as a liner) backed by a high explosive, all in a steel or aluminum casing. When the high explosive is detonated, the metal liner is compressed and squeezed forward, forming a jet whose tip may travel as fast as 10 kilometers per second (6.2 miles per second). Shaped charges were first developed after World War I to penetrate tanks and other armored equipment. The most extensive use today is in the oil and gas industry where they open up the rock around drilled wells.

Diagnosing an Experiment

LLNL scientists use a variety of complementary diagnostic tools during the experiments with shaped charges. X-radiography produces shadowgraphs that provide experienced researchers with information about the jet's velocity, density, and mass distribution. A rotating-mirror framing camera, a kind of motion picture camera, can shoot millions of frames per second. A typical shaped-charge jet-formation experiment lasts less than 30 microseconds, and the framing camera is usually set to record an image about once every microsecond. The exposure time for the framing camera may be anywhere from 100 to 200 nanoseconds (1,000 nanoseconds in a minute).

The newest tool is the image-converter (IC) camera, which was developed by LLNL. A pulsed ruby laser is synchronized with the IC camera frames to provide illumination of the shaped charges. The electronic image tube that acts as the shutter for each image frame converts the photons of laser light reflected by the shaped charge to photoelectrons. These photoelectrons are accelerated by a high-voltage pulse onto a phosphor, where they are reconverted to photons that are then transmitted to the film. With exposure times of just 15 to 20 nanoseconds (up to ten times shorter than the framing camera) and a band-pass filter mounted on the camera to exclude extraneous light, the IC camera has supplied the first truly high-resolution images of the formation and early flight of a shaped-charged jet.

✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧ ✧

For more information, write or call:
U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Office of Public Affairs
P.O. Box 98518
Las Vegas, NV 89193-8518
phone: 702-295-3521
fax: 702-295-0154
email: nevada@nv.doe.gov
http://www.nv.doe.gov

DOE/NV – 711 - REV 1
FEBRUARY 2003