PROJECT FACT SHEET

CONTRACT TITLE: Acquisition of Borehole Seismic Data Behind Production Tubing/Reducing Certain Seismic Data Acquisition Costs Through Shaped Charges (PARTNERSHIP)

ID NUMBER: P-40

B&R CODE: AC1005000

CONTRACTOR: Lawrence Livermore National Laboratory

ADDR: P.O. Box 808, L-170
Livermore, CA 94550

DOE HEADQUARTERS PROGRAM MANAGER:
NAME: Edith C. Allison
PHONE: 202/ 586-1023

DOE PROJECT MANAGER:
NAME: Purna C. Halder
LOCATION: NPTO
PHONE: 918/ 699-2084
E-MAIL: phalder@npto.doe.gov

CONTRACT PROJECT MANAGER:

NAME: S. Christian Simonson
PHONE: 510/ 422-6569
FAX: 510/ 422-3389
E-MAIL: simonson2@llnl.gov

PROJECT SITE
CITY: Livermore **STATE:** CA
CITY: **STATE:**
CITY: **STATE:**

CONTRACT PERFORMANCE PERIOD:
6/20/1996 to 3/31/1999

PROGRAM: Supporting Research
RESEARCH AREA: Partnership/Computational Technology
PRODUCT LINE: ADIS

FUNDING (1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	530	750	1280
FISCAL YR 1999	0	500	500
FUTURE FUNDS	0	0	0
TOTAL EST'D FUNDS	530	1250	1780

OBJECTIVE: Design one or more shaped charges for use in seismic source applications for geophysical prospecting with aim of improving data quality and reducing undesirable environmental effects.

PROJECT DESCRIPTION:

Background: If improvements could be made in data quality while reducing undesirable environmental effects, it could lead to expansion in the use of explosive sources for field operations in difficult terrain. As acquisition costs constitute 80%-90% 0f the total cost of new seismic data, marginal cost reduction can bring large benefits.

Work to be Performed: Under this project, the design of one or more shaped charges for these applications will be done by LLNL using a combination of computational simulations and diagnosed experiments. LLNL continuum mechanics simulations, or hydrocodes, will be used to calculate the interaction of explosives with the liner material and the interaction of the resulting shaped charge jet with the ground, as well as the interaction of the explosive shock waves with the environment. These hydrocode simulations will be used to evaluated shaped charge design and effectiveness, including the distribution of energy computed into body waves, surface waves, and air waves. LLNL will fabricate and load experimental prototypes, which will be subjected to shaped charge characterization tests at LLNL's Site 300. Diagnostics will include high-energy and low energy flash x-rays; high-resolution, high-speed optics; laser interferometry for surface velocity histories; pressure-blast gauges; and time-of-arrival pins, as required, to observe the function of the explosive device and its interaction with the surrounding environment and the ground. Three potential applications of shaped charges will be investigated to reduce seismic acquisition costs: 1. Replace an omnidirectional surface or air charge with a shaped charge. 2. Replacing heavy drilling equipment by using a shaped charge to drill shallow shot holes. 3. Employing shaped charges in shallow shot holes.

PROJECT STATUS:

Current Work:

Scheduled Milestones:

Amend designs for surface shaped charge, shot hole drilling charge, shaped charge in shallow shot hole	04/98
Fabricate and load charges for experimental test and field tests	06/98
Conduct experimental tests of charges coupled to geologic media	08/98
Full field test and evaluation	09/98
Conduct field tests	10/98
Review field tests results, prepare final report	12/98

Accomplishments: The expected performance of alternative seismic charge designs was evaluated using calculations made with the LLNL hydrodynamic simulation program, Cale. Based on these calculations, a shaped charge design was chosen to be fabricated as an experimental prototype. While these calculations were in progress, an opportunity arose for a field test of a modified commercial design, which was similar in geometry to the new prototype, but without the shaped charge liner. The modifications were carried out by an industrial partner, and the field tests were carried out, using a commercial charge as a basis for comparison. Based on this fabrication and test experience, the design of the experimental prototype was modified to conform to industrial manufacturing capabilities. Prototype charges were fabricated at LLNL, loaded with high explosive by our industrial partner, and field tested in a second series of tests, using the same comparisons charge. Analysis of the seismic records from the field test is in progress. In phase 1 of the project, completed in FY 97, a shaped charge in the form of a platter charge was designed at LLNL using a B-Division continuum mechanics simulation code., or hydrocode, together with material models for the charge components and typical geological media. Prototype platter charges were fabricated in LLNL shops and field tested in Wyoming. An inversion disclosure, DOE Patent case No. S-86,937(RI-13756), 'Platter Charge for Seismic Source,' was submitted in November 1996.

A variety of shaped charge configurations were calculated and their efficiencies compared in coupling the high explosive energy into the formation around a shallow shot hole. Using the Cale continuum mechanics simulation code, the jetting actions of various explosive cross-sections were calculated with respect to their coupling of energy into the geological formation surrounding a cylindrical shallow shot hole. Two favorable effects were noted , one being the introduction of shear stresses in the rock and other being the slowing down of the characteristic rapid time scale for the high explosive detonation toward the slower frequencies detected by seismic instruments.

In 3-D, two charge designs of a new shape were generated and run with the continuum mechanics code Ale3D (parallel version).

Using the results of extensive computer analysis, designs for several test charges were completed. The charges are intended to be emplaced in a 3.5 inch drill hole. The charge designs have special features which are calculated to increase the effectiveness of these charges relative to a plain cylinder of HE. The project is now completed.