PROJECT FACT SHEET

CONTRACT TITLE: Multi-Phase Fluid Simulator for Underbalanced Drilling (PARTNERSHIP)

ID NUMBER: ACTI-105 **B&R CODE**: AB0555000	**CONTRACTOR**: Los Alamos National Laboratory **ADDR**: P.O. Box 1663 EES-4/MS D443 Los Alamos, NM 87545
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PROJECT SITE **CITY**: Los Alamos **STATE**: NM **CITY**: **STATE**: **CITY**: **STATE**:	**CONTRACT PERFORMANCE PERIOD**: 3/10/1995 to 3/31/2000 **PROGRAM**: Supporting Research **RESEARCH AREA**: Partnership/Computational Technology **PRODUCT LINE**: DCS

FUNDING (1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	0	0	0
FISCAL YR 1999	80	175	255
FUTURE FUNDS	0	0	0
TOTAL EST'D FUNDS	80	175	255

OBJECTIVE: Develop computational models to support areas in underbalanced drilling identified by the project's commercial participants including: Simulation of multi-phase compressible fluid flow in a coiled-tubing drilling system with emphasis on hydraulic/pneumatic power conversion, and well design and drilling system optimization. Develop experiments to verify simulations where published data are not suitable for verification. Produce complete models of air drilling systems and use models to design microdrilling systems, identify approaches for vibration and energy reduction technology, and minimize compressor size and fuel consumption.

PROJECT DESCRIPTION:

Background: The domestic drilling industry needs to reduce petroleum drilling costs and improve well productivity. Reducing the bottom-hole-pressure during drilling, increases penetration rates and induces positive flow that protects productive zones from infiltration of cuttings and fluids. Underbalanced drilling reduces the pressure on the drilled formations using low density drilling fluids such as air, mists, foams, or aerated drilling muds. Use of these fluids can increase drilling rate by 50 to 100%. Oil and gas producing rates are routinely increased by 25% to 50% when drill fluid invasion is reduced. Underbalanced drilling is particularly useful for drilling infill wells through depleted zones and for wells with long horizontal sections. Industry has developed simulation codes that are projecting wellbore pressures with increasing accuracy and are attempting to model cuttings transport in compressible drilling fluids and non vertical bores. The DEA 101 MudLite simulator is advancing a PC windows based, steady state simulator and a 3-D simulator is available from Roglands Research in Norway that can perform transient analysis. Neither program simulates downhole motor performance. The Petroleum Engineering Department at the University of Tulsa (UT) has developed a mathematical model of PDM performance for incompressible fluids and is developing a model of PDM performance for compressible fluids. They need performance data for PDM operation with compressible fluids to evaluate and verify their models.

Work to be Performed: Simulate multi-phase compressible fluid flow in a coiled-tubing drilling system with emphasis on both rotary and percussive hydraulic/pneumatic power conversion, fluid dynamics in horizontal annuli and in on-reel coiled-tubing, and well design and drilling system optimization. Address specific industry concerns related to the successful application of compressible fluids to coiled tubing, directional, slimhole, and microhole drilling including: motor or hammer performance, cuttings transport, separation and surging of fluids in reeled tubing, and bottom-hole-assembly resonance and vibration in low density, compressible drilling fluids.

PROJECT STATUS:

Current Work: An industrial drilling R&D support contract with Maurer Engineering Inc. (MEI) was modified to provide positive displacement (rotary drilling) motor (PDM) testing using air, air mists, and foam. MEI performed both water and air-mist and foam dynamometer tests using conventional PDMs and air power configured PDMs. Los Alamos provided 5 kHz data acquisition unit to motor flow pulsation and PDM vibration during the motor testing. The Petroleum Engineering Department at the University of Tulsa (UT) has developed a mathematical model of PDM performance for incompressible fluids and is developing a model of PDM performance for compressible fluids. The motor test data will be made available to UT for verification of their model. A thermodynamic analysis of an air-powered, PDM, drilling system is being developed. A simple, ideal (adiabatic, reversible) analysis is complete except for the cuttings lift component. More realistic component analyses will be substituted for the ideal components as they are developed by adding energy loss elements to the ideal components and verified using data produced from component experiments or extracted from published data where available. A search for publications on drilling vibration is underway.

Scheduled Milestones:

Complete modification of a commercial compressible fluid simulator to include a comprehensive motor performance model of algorithm	08/98
Final Report	09/98

Accomplishments: An open, non-proprietary testing program for rotary PDMs was developed, a statement-of-work was written, a support contract was modified, and a test loop was modified to provide for testing of small diameter positive displacement motors. The rotary PDM testing program is completed and data analysis and interpretation is underway. Test data from PDMs powered with compressible fluids, air, mist or foam will be used to verify models or produce new performance models if necessary. Informal collaboration with the petroleum engineering department at the University of Tulsa is established.