

# **DOE/PTTC High Temperature, High Pressure Technology Integration Workshop**

## **Minutes**

June 22, 2006

Houston Brookhollow Crown Plaza

Houston, Texas

The Department of Energy/PTTC High Temperature, High Pressure Technology Integration Workshop was held in Houston on Thursday, June 22, 2006. Forty-nine people from the oil and gas and related technologies industry attended. The meeting was designed to provide a forum for the principal investigators of the projects in, and related to, the DOE Deep Trek Program to present project accomplishments, milestones and remaining tasks to interested industry parties and researchers in related areas. The goal of the meeting, besides to inform interested parties of the technology being developed, was to promote the interaction of the program investigators to insure project objectives support each other and the overall program objectives. The morning coffee, breaks, lunch and post-meeting period provided opportunity for individual discussions.

The meeting began with registration, coffee and networking from 7:30 to 8:00. Don Duttlinger, Executive Director of the Petroleum Technology Transfer Council called the meeting to order, discussed safety and logistics, and then introduced Roy Long, DOE Technology Manager, Oil and Gas Exploration for the National Energy Technology Laboratory. Long summarized the day's agenda and recent progress and highlights of the Deep Trek program. The remainder of the meeting consisted of Principal Investigators providing updates and milestones for nine Deep Trek ongoing projects as well as a preview of the planned Extreme Drilling Laboratory to be built in Morgantown. The highlights were:

- Terra Tek (Optimization of Deep Drilling Performance – Drilling in HP/HT Conditions, Arnis Judzis) Phase I high pressure drilling plan has been executed. Test conditions have been validated against actual performance in the Anadarko Basin and Tuscaloosa Trend. Key findings include superior performance of PDC and impregnated bits over roller cone bits and that baseline tests with water and base oil demonstrate high rates of penetration are possible before mudding up (which can reduce ROP by a factor of 10). Phase 2 will investigate HTHP rock and bit mechanics and alternative drilling fluid behavior.
- Honeywell, Inc. (Development of Silicon-on-Insulator (SOI) High Temperature Electronics, Bruce Ohme) The project goal is to develop SOI complementary metal-oxide-semiconductors (CMOS) for high temperature applications in measurement- and logging-while-drilling deep wells. The SOI technology overcomes the high temperature breakdown of standard transistors. Four chips will be developed: precision amplifier (PA), field programmable gate array (FPGA), 18 bit A-to-D converter, electrically-erasable programmable read-only memory (EEPROM), and a high temperature mixed signal process and tool kit. The PA and FPGA have met design objectives. A-to-D first pass design and

EEPROM demonstration is fully functional. All are expected to be commercial by 2007.

- Oklahoma State University (Development of a 275° C Downhole Microcomputer System (DMS), Chris Hutchens) The task of OSU's Mixed Signal Very Large Scale Integration (VLSI) Group is to employ the SOI and Silicon on Sapphire (SOS) technology to develop a microcomputer suitable for deep well electronic applications. The design of the megacells which will comprise the 68HC11 DMS is in progress. When complete, a third party will manufacture them into SOS chips. The final task of assembly and testing of the 68HC11 is expected in late 2006 and early 2007.
- GE Global Research (Harsh-Environment Solid-State Gamma Detector for Downhole Gas and Oil Exploration, Peter Sandvik) GE has modeled, designed and prototyped an avalanche photodiode (APD) scintillator detector system utilizing silicate carbide technology for the APD and crystals for the scintillator. Seventy five different crystals were evaluated for the scintillator. In Phase 2, the APD will be fabricated, full crystals developed for the scintillator, and the full system will be assembled and bench tested.
- APS Technology Inc. (Drilling Vibration Monitoring and Control System (DVMCS), Marty Cobern) In this project APS has designed and prototyped a DVMCS in three sections: the control assembly, the magnetorheological (MR) fluid valve assembly, and the spring and bearing assembly. The MR fluid has iron particles suspended in it that, when exposed to a magnetic field, form long chains in milliseconds, greatly increasing viscosity, so the tool is effective in keeping the bit on the rock face over a range of rotation and vibration speeds. The DVMCS has been successfully tested at Terra Tek's facility and subsequently modified and improved. The latest prototype will be tested at RMOTC in September 2006.
- Dexter Magnetics (Development of a High Pressure/High Temperature Downhole Turbine Generator, Tim Price) It is the goal of this project to produce a commercial turbine to power MWD, LWD and other downhole electronics in a high temperature, high pressure environment. The mechanical issues have been resolved in upgrading the housing, connections and o-rings of an existing turbine. The electronics being developed in other projects are not yet available, so Dexter proposes to replace the electronics with a mechanical voltage regulator. In Phase I the Management and Technology Assessment plans were completed. In Phase II the turbine and components to rectify and regulate the power will be designed and constructed.
- Schlumberger Technology Corp. (An Innovative High Temperature, High Pressure Measurement-While-Drilling (MWD) Tool, Jim Mayes) Schlumberger has designed, prototyped, and is testing an MWD bottom hole assembly capable of withstanding the extreme temperatures and pressures of deep wells. It is unique in that it is fully retrievable and reseatable by wireline, so tripping is not required

in the event of tool or battery failure. All of the tool subsystems have been tested to 200° C. The exterior has been tested to 35,000 psi (the electronics are protected in a pressure vessel). An experimental prototype has been built and a second is being assembled. They will be tested in a HTHP well soon.

- CSI Technologies, LLC (Supercement for Annular Seal and Long-Term Integrity in Deep, Hot Wells, Kevin Edgley) The project objectives are to determine the cement system properties that affect cement sealing integrity in HTHP wells, use that to develop, test and commercialize a Supercement. After a literature search, five systems, Portland and non-Portland, were identified as having potential when reinforced with reactive fibers. In Phase II, each was evaluated for performance in large scale mixing, shearing and drillout tests. As part of this phase, equipment was designed and built to perform direct tensile tests and to test annular seal and expansion under high pressure and temperature. Two of the systems, Resin and MgO, were used to plug over 50 wells and in one HTHP squeeze job and will receive full-scale field testing in Phase III.
- National Energy Technology Laboratory (NETL) (Extreme Drilling Laboratory (EDL), Ultra Deep Single Cutter Drilling Simulator (UDS) Vision, Purpose, and Capabilities, Mike Monahan) NETL will initiate new in-house research in FY07 as authorized by the Energy Policy Act of 2005. One element of that will be the development of the UDS to provide critical science needed to engineer effective and efficient drilling technologies viable at depths greater than 20,000 feet. EDL will employ both computational and physical simulation. The physical will consist of the UDS device, mud lab, rock lab and other equipment. The test cell will be rated to 30,000 psi and 300° C. While the facility will be owned by NETL, outside researchers will have access.
- Paulsson Geophysical Services, Inc. (A Robust MicroElectro-Mechanical System (MEMS)-Based Multi-Component Sensor for 3-D Borehole Seismic Arrays, Bjorn Paulsson) To image a 10 foot thick pay zone at 10,000 feet would require 500 hz P-waves, and 250 hz S-waves and 1,000 3-D arrays and would be very expensive. This project will develop "fourth generation" technology that would replace the geophones with small, inexpensive MEMS and the cables with twisted pairs with optical fiber. While the current arrays can withstand 25,000 psi and 200° C, the fiber optic/MEMS array would be less expensive and more reliable for permanent deployment. The prototype design is complete and will be built in Phase I. Phase II will include laboratory and field testing of the prototype.

The meeting concluded with a wrap-up led by Roy Long.