DOE technology manager lauds microhole technology

Nina M. Rach
Drilling Editor

New drilling technologies are getting a push from government funding; industry needs to "pull" them into implementation, says Roy Long, manager of E&P technology at the Strategic Center for Natural Gas and Oil, Tulsa.

Government funding for upstream research and development often reduces the risk involved in adopting new technologies. SCNGO, an arm of the National Energy Technology Laboratory (NETL), which is in turn part of the US Department of Energy, has a mission to develop increasingly efficient solutions to engineering challenges, help independent operators and small businesses, and maintain the US oil and gas industry.

Long says maintaining the petroleum industry is important for job creation and security–every upstream job in oil and gas creates seven jobs downstream.

But, in an exclusive interview with OGJ, he pointed out that commodity-oriented petroleum operating companies have become less involved in R&D and exploration, which are seen as lacking shareholder value.

The trend is for operators to purchase and adapt low-risk, proven technologies, or participate in joint industry programs to share the risk of development. But if we can take the risk out, with the right tools and enough subsurface data, "we can engineer anything," said Long.

The Drilling Engineering Association (DEA) is one such industry effort to develop areas of common interest, Long said. It was formed in 1983 to advance new technology related to drilling wells. Long gave an overview of the microhole technology program and Rocky Mountain Oilfield Technology Center (RMOTC) field activities at a DEA research operations forum in November 2004.

According to NETL, 407 billion bbl of discovered oil in the US onshore is nonrecoverable with current drilling and production technologies; 218 billion bbl of that is 5,000 ft or shallower.

Focus on MHT

Microhole technology (MHT) projects have Long's full attention these days.

DOE budgets about $3 million/year to fund the microhole systems program, investigating new concepts for miniaturized drilling systems to explore and exploit domestic US shallow (<5,000 ft depth) hydrocarbon reservoirs that are uneconomic to develop with conventional drilling systems.

By reducing the size of the borehole (3½-in. to 4¾-in. diameter) and miniaturizing the downhole equipment, engineers hope to reduce the cost of drilling and simplify access to drill sites. Microholes can be drilled from portable, lightweight, coiled tubing rigs at lower cost than conventional boreholes. "The scope of microhole technology is to drive down drilling costs and reduce exploration risk," he said.

Smaller and more portable equipment means a potentially smaller environmental footprint, something that has not changed much in the history of modern land drilling. The last step-change was the introduction of directional drilling from pads.

Microholes are volumetrically smaller and, in tandem with zero-discharge mud systems, will produce much less waste, a big environmental advantage.

The core research program is being funded in two MHT solicitations. The first set of projects focuses on field demonstrations and development of technology that uses coiled-tubing drilling:

- Demonstrations of existing 4¾-in. commercial microhole technology.
- Built for-purpose microhole coiled-tubing rig (Schlumberger IPC,

"The scope of microhole technology is to drive down drilling costs and reduce exploration risk."

—Roy Long, E&P technology manager, US DOE's Strategic Center for Natural Gas and Oil

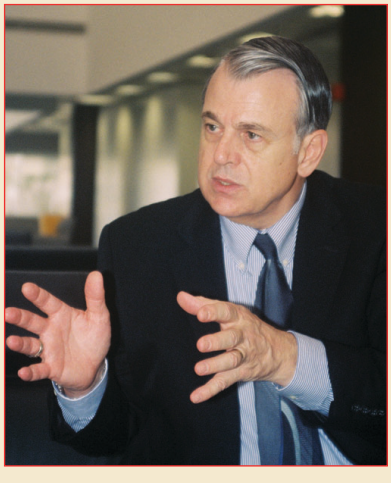

Photo by Bob Williams

Reprinted with revisions to format, from the February 21, 2005 edition of **OIL & GAS JOURNAL**

New R&D grants expand the future of microhole technology

In January, the US Department of Energy announced new grants for 10 microhole technology projects to be managed by the Office of Fossil Energy's National Energy Technology Laboratory (NETL).

Total value of the projects is nearly $14.5 million, with the DOE providing $7.7 million and industry partners contributing $6.8 million. The petroleum industry will assume about 47% of the cost, demonstrating its strong commitment to these advanced technologies and suggesting strong future support for their commercialization and adoption.

- **Geoprober Drilling Inc.**, Houston. This project calls for drilling three wells with an innovative composite coiled-tubing drilling system. The aim is to confirm the capability of drilling low-cost, shallow slim or microhole exploration wells in water depths ranging up to 10,000 ft.

Cost savings, projected at 59% over that for conventional wells, would come by use of a smaller drilling vessel and by elimination of the need to deploy and retrieve a large riser—essentially a large-diameter pipe that is the extension of the wellbore in deep waters (DOE share: $1 million; project duration: 12 months).

- **Gas Technology Institute**, Des Plaines, Ill. This project entails a proposal to field test a next-generation microhole coiled-tubing rig. The MOXIE experimental rig was fabricated by Coiled Tubing Solutions, Dallas, specifically for coiled tubing and microhole drilling to 5,000 ft subsurface. First deployed for initial testing in a Kansas gas field last year, the rig was able to drill 280–400 fph.

GTI will assess field tests and lead a technology-transfer program. Expected benefits from this technology include 28–38% lower drilling costs per well, decreased waste generation, reduced environmental impacts, and increased production from existing fields (DOE share: $1 million; project duration: 12 months).

- **Confluent Filtration Systems LLC**, Houston. Researchers will seek to develop a revolutionary elastic-phase, self-expanding tubular technology called CFEX. CFS's goal is to develop self-expanding well casings to any diameter, leading to improved methods and feasibility of monobore drilling and well construction (DOE share: $1 million; project duration: 36 months).
- **Tempress Technologies Inc.**, Kent, Wash. The goal of this project is to develop a small, mechanically assisted, high-pressure water-jet drilling tool. A downhole intensifier would boost the pressure that can be delivered by coiled tubing, maximizing drilling rates. That in turn would overcome the limited reliability, power, and torque of small-diameter drill motors, a major hurdle for microhole drilling reliability (DOE share: $800,000; project duration: 24 months).
- **CTES LP**, Conroe, Tex. Researchers will focus on improving the performance and reliability of microhole coiled-tubing drilling bottomhole assemblies while reducing the cost and complexity associated with drilling inclined or horizontal well sections deeper than 2,000 ft. This would be accomplished by an induction of vibration along the coiled-tubing drill string in order to eliminate the need for a downhole drilling tractor to mitigate friction.

The goal is to enable operators to economically use coiled tubing to drill microhole sections greater than 3,000 ft in horizontal wells, which typically offer production rates two to three times greater than those for vertical wells (DOE share: $700,000; project duration: 24 months).

- **Technology International Inc.**, Kingwood, Tex. This project entails developing and testing an effective downhole drive mechanism and a novel drill bit for drilling with coiled tubing.

The high-power turbodrill will deliver efficient power at relatively high revolutions per minute and low bit weight. The more durable drill bit will employ high-temperature cutters that

Sugar Land, Tex.).

- Self-contained zero discharge drilling-mud system (Bandera Petroleum Inc., Tulsa).
- Microhole coiled-tubing bottomhole assemblies (three projects: smart steering and LWD system developed by Baker Hughes Inteq, Houston; radar navigation and radio data transmission systems developed by Stolar Research Corp., Raton, N.M.; and a downhole drilling tractor developed by Western Well Tool Inc., Anaheim, Calif.).
- Microhole completion and production equipment (through-tubing artificial lift system developed by Gas Production Specialists LLC, Lafayette, La.).

Latest awards

The second round of solicitations for microhole technology development, was posted in August, and the application period closed Oct. 6, 2004, for projects in four subject areas:

- Area 1A—Field demonstration (2 awards).
- Area 2A—Advanced monobore concept (1 award).
- Area 2B—Microhole coiled tube bottom hole assemblies (6 awards).
- Area 2C—Microhole completion and production equipment (1 award).

Awards for 10 projects were announced Jan. 22, 2005; they are also listed on the DOE's industry interactive procurement website (IIPS; see box).

"This is the first solicitation round for demonstrations of advanced technology that might…significantly reduce costs for exploration and development," Long said. "Within 3 years, we'll know whether we have commerciality for most of these technologies."

Designer seismic, 4D data

The microhole technology initiative includes development of new economic seismic methodologies for reservoir imaging. Low-cost microholes allow vertical seismic data to be collected where needed, without interrupting production.

can drill hard and abrasive rock in 3½-in. boreholes (DOE share: $800,000; project duration: 24 months).

• **Ultima Labs Inc.**, Houston. This project is intended to combine existing technologies for measurement-while-drilling (MWD) and logging-while-drilling (LWD) into an integrated, inexpensive measurement system to facilitate low-cost coiled tubing drilling of small-diameter (3½ in.) wells at depths shallower than 5,000 ft.

MWD and LWD, while costly, have become crucial tools for oil and gas operators in sustaining drilling and well-completion efficiencies. Two prototypes are to be delivered, ready for field testing (DOE share: $800,000; project duration: 36 months).

• **Baker Hughes Oilfield Operations Inc.**, Houston. Researchers will seek to provide a critical tool essential for an effective modular coiled-tubing drilling system: a wireless system to help steer drilling in a microbore. The use of such "smart" wells—which have grown in acceptance by industry because of their inherent efficiencies and cost savings—might otherwise limit microholes to a smaller range of locations and reservoir types.

Plans call for developing a downhole bidirectional communication and power module and a surface coiled-tubing communication link (DOE share: $800,000; project duration: 24 months).

• **Gas Technology Institute**. An important goal for advancing coiled-tubing drilling of microholes is to improve the rate of penetration by 25–60%, thereby cutting drilling costs by up to 40%. This project entails designing, developing, and evaluating a counter-rotating motor drilling system ideally suited for reducing costs associated with drilling wells targeting unconventional gas.

By concentrating the weight on the drill bit in a smaller area and by addressing the limited torque on a coiled-tubing drill string, this research would increase the effectiveness of coiled-tubing drilling (DOE share: $600,000; project duration: 24 months).

• **Confluent Filtration Systems LLC**. Another major concern for microhole drillers is the damage caused to casing from sand that infiltrates the drill string. This is especially problematic in small-diameter wellbores. Accordingly, there is a great need for downhole sand screens that are versatile and robust while being suited for a variety of drilling environments.

This project is designed to prove and develop a concept for a self-expanding, high-flow sand screen that could be constructed from a wide range of materials. Plans call for ultimately deploying the technology in a demonstration well (DOE share: $200,000; project duration: 24 months).

In November, Long told OGJ that VSP data acquired in a 1,000-ft microhole in October 2004 looked good and would be processed in first-quarter 2005. In spring 2005, he said, one or two more microholes will be drilled, providing additional data across a fault. Microholes can also provide dedicated, permanently installed reservoir-monitoring systems to monitor and optimize improved oil recovery (IOR) processes.

Work is under way at Sandia National Laboratory in Albuquerque, N.M., to develop miniature downhole instrumentation using MEMS (microelectromechanical sensors) technologies.

Commercial activities

Industry representatives see several potentially viable industrial applications arising from the microhole technologies initiative, using coiled-tubing drilling to drill:

• Shallow development wells in one-third the space of a traditional rig.

• Reservoir and seismic data holes to obtain 4D data without disrupting production.

• Shallow reentry wells for deep perforations, lateral seismic imaging, or vertical flooding.

• Deep exploration tails to extend existing wellbores and evaluate additional potential zones.

Industry is already embracing fast, lightweight, drilling apparatus to drill cost-effectively, particularly in western Canada's shallow gas and CBM markets, said Long. Nabors Industries Ltd. is building two hybrid CTD rigs in Canada and plans to bring one to the US.

Long also pointed to a November announcement by Calgary's Ensign Resource Service Group Inc. about building 10, state-of-the-art automated drill rig (ADR)-1000-CT coiled-tubing drill rigs. These will be capable of working with coiled tubing up to 3½-in. diameter or conventional jointed pipe.

Delivery will begin in second-quarter 2005.

Other drilling initiatives

Long is also interested in the area of new materials for drilling.

DOE is funding Pennsylvania State University and Dallas-based Dennis Tool Co. to develop small-diameter prototype coiled tubing by microwave processing (heating and densifying or sintering) powdered metal. The result will be many segments fused by microwave heating (diffusion bonding) to produce a continuous coil.

This first prototype will be ¾-in. diameter and 1,500 ft long. Long said that mechanical tests of short test lengths will be made by a third-party vendor later this year.

They will attempt to verify the superior strength and flexibility (significantly longer life) of the coiled tubing made by the joining of the individual sections.

Another area of drilling is wired pipe, enabling high-speed communications up drillpipe. Grant Prideco and its Utah-based diamond subsidiary Novatek Engineering Inc., have been working on intelligent pipe (www.intellipipe.com). Long believes this is going to revolutionize the amount of information available from downhole in a truly "real time" data-acquisition environment.

He sees it as one of the enabling technologies for managed pressure drilling, a technology gaining increasing interest in the offshore industry. Transfer rates of 1 million bits/sec and the ability to select which tools to in-

Oil and gas software available from NETL-SCNGO

Drilling Tools

Directional drilling spreadsheets
Pipe tally sheets

E&P Tools

CO_2 Prophet—water and CO_2 flood prediction
Frac-Explore
Risk analysis
Monte Carlo simulation
Neuro3—neural network
Tree2000—decision tree

EOR predictive models

CO_2 miscible flood
Chemical flood
In situ combustion
Polymer
Polymer-waterflood
Steamflood
Infill drilling

Simulators

BOAST—3D, three-phase black oil applied simulation tool
MASTER—miscible applied simulation techniques for energy recovery
Microbial transport
PC GEL—permeability modification
TRACRL—single-well chemical tracer test, residual oil saturation
UTCHEM—3D chemical flood

Databases

Crude oil analysis
NPC—US EOR potential

http://www.netl.doe.gov/scngo/Petroleum/Software/index.html

Career highlights

Roy C. Long is technology manager, exploration and production, for the Strategic Center for Natural Gas and Oil (SCNGO), Tulsa, an arm of the US Department of Energy Office of Fossil Energy's National Energy Technology Laboratory. His current work involves industry outreach and program planning for SCNGO's Office of Petroleum E&P technology program.

Employment

Following service in the US Air Force, Long joined the former Tenneco Oil Co. in 1978 as a petroleum engineer. He later worked for Petro-Lewis Corp., Bakersfield, Calif., and as an international drilling consultant.

During 1988-96, he worked for DOE at its Yucca Mountain, Nev., project office as principal investigator for the agency's coring technology development program.

Long transferred to NETL in Morgantown, W.Va., in 1996, where he served as project manager for the drilling, completion, and stimulation technologies in NETL's Strategic Center for Natural Gas, predecessor to SCNGO.

He left in 2001 for his current position.

Education

Long is a 1970 graduate of the US Air Force Academy and received his MS in petroleum engineering from the Colorado School of Mines. He is a member of ASME and SPE and has received his 25-year pin from SPE.

terrogate will allow unprecedented engineering possibilities. Long thinks real time seismic ahead of the bit could become a reality.

He pointed out that microhole "real time" focus is different from that of the U.C. Intellipipe being developed by Grant Prideco. Microhole long-term monitoring focuses on putting low-cost geophones in a number of strategically placed low-cost boreholes for VSP imaging (microholes dedicated to imaging only, so that production wells do not have to be shut in) of CO_2/EOR programs, not just for high-value wells or fields.

The scientific community has used long-term monitoring for years (proof that it's not too expensive). Ernie Majer and other researchers at Lawrence Berkeley National Laboratory are even beginning to see reservoir detail not previously recognized in some California geothermal reservoirs with passive seismic sources from the San Andreas Fault.

Long thinks the long-term seismic monitoring can be done relatively inexpensively both for EOR monitoring and possibly even for exploration, some day. The benefit is to get a "moving picture" instead of just an expensive snapshot in time.

Directional surveying

Long has a longtime interest in directional surveying development, in order to provide the smoothest possible turn with a minimum of doglegs. He developed a new approach to directional surveying and course correction using a sectional method, which he published with Bill J. Mitchell in 1992 in the Journal of Energy Resources Technology.

Long said he learned a great deal by comparing minimum curvature and radius-of-curvature solutions, noting that the radius of curvature, although referred to as a "circular arc" solution, interprets a helical path between all stations except those contained in either a vertical or horizontal plane.

The industry had not really pushed the limits of its technology on surveying, he says, although now he thinks horizontal well technology is beginning to instill more demanding requirements. Long considers Stockhausen and Lesso's three-part series on wellbore positional accuracies to be "one of the key directional surveying articles that have been published recently" (OGJ, Oct. 27, 2003, p. 51; Nov. 3, 2003, p. 50; Nov. 24, 2003, p. 61).

Directional surveying software and supporting documents are available on the SCNGO web site (see box). ✦