An intelligent well installation using Weatherford's Remotely Operated Sliding Sleeve (ROSS™). This technology epitomizes Weatherford's philosophy of reliable, cost-effective intelligent completion.

Intelligent Well Completion

the next steps

Weatherford's addition of CiDRA–OSS and its suite of downhole fiber optic sensing capabilities brings an added dimension to Weatherford's intelligent well strategy. This game-changing technology represents a major advance in both the volume and reliability of data that can be collected downhole and transmitted to the surface.

Weatherford's global presence, strong market position and downhole expertise are an excellent match for CiDRA's groundbreaking technology. The recent contract with BP in Alaska on the North Star project illustrates this. By contrast, on the North Star project, the first "entirely Weatherford controlled installation" work, all six wells were successfully completed with pressure and temperature monitoring equipment, As a direct result of this success, BP has placed an order for ten more optical pressure and temperature systems. Since then, another first single source "all Weatherford" project has been successfully completed for a major operator in the North Sea.

Operational Centers Provide Service

In order to focus on the implementation of the company's newly acquired fiber optic capabilities two new groups have been established, one in Aberdeen and one in Lafayette/Houston. These operating centers of excellence (OCE) will focus on the specification, project management and operational implementation of intelligent well systems. The Aberdeen group will serve the Eastern Hemisphere customers while the Lafayette/Houston group will serve North and South America. Each OCE is staffed with a team of specialists to cover every aspect of intelligent well completion. This represents a major investment in quality people which, combined with significant capital investment in interactive software systems, onshore facilities and installation equipment will put Weatherford in the forefront of this emerging market. These investments are already bearing fruit, in the past 18 months a total of 50 fiber optical sensors have been installed in approximately 20 fiber wells. It is expected that an additional 20 fiber wells will be completed in the next 6 months.

Reliability Distinguishes System

Weatherford defines an intelligent well as one in which there is permanently installed surface readout data acquisition and/or surface controlled downhole flow control devices. The early history of intelligent well completion technology has been somewhat checkered. Most of the early systems used downhole electronics. Data was monitored, and in some cases, processed downhole and the results transmitted to the surface. Though good data was often obtained, the longevity and reliability of the system was not acceptable and costs were prohibitive. As a result, the market for intelligent wells was limited to a handful of high value, high productivity wells.

For an intelligent completion to be successful it must provide good data both early and late in the life of the well, therefore long-term reliability is critical to lifetime field management. The value of an intelligent well with a surface-operated downhole flow control system is significantly diminished if the permanent monitoring element of the system has failed in early/mid-field life. If this is the case, data is not available to make a decision as to how and when to operate the flow controls. The Weatherford approach to intelligent wells is to keep all downhole equipment as simple and reliable as possible and to restrict data transmission to raw data only. The processing and interpretation of the data will be performed on the surface where newly developed software and opto/electronic demodulation systems techniques can be easily retrofitted long after

Fiber optic based sensing systems combined with robust hydraulically operated downhole flow control systems offer reliability and remote controlled production operation.

the completion has been installed. To this end, the following systems will form the core of the Weatherford offering in this market:

- All downhole monitoring of well parameters will be done with fiber optical sensors and raw optical data transmitted to surface via fiber optic cable.
- All downhole control will use hydraulic systems and standard control line for signal transmission.
- All electronics and software systems will be surface installed to make them readily accessible for maintenance and repair.

Weatherford believes implementing the basic principles of simplicity and reliability will enable intelligent completion to become more widely used, leading to an extended market for these systems.

Crawl, Walk, Run

Weatherford's development activity will focus on three basic principles: simplicity, reliability and driving cost out of the systems. These principles will make intelligent completion more economical for customers, thereby expanding the market for such systems.

Fiber Optic Devices

- Pressure and temperature monitoring—these are field proven and to date a total of 22 systems have been installed worldwide.
- Multi-phase flow meter-field trials of this device are now being successfully concluded. It is non-intrusive, non-restricting, and has no moving parts and thus is simple and reliable.
- In-well seismic—this system that will provide for better time based reservoir imaging is under development and field trials are currently in progress.

Hydraulic Devices

- The Remote Operated Sliding Sleeve (ROSS™)—a simple power close power open device using two separate control lines.
- The Hydraulic Controlled Addressing Unit (HCAU™)—a downhole logic device with two control lines, each of which can be indexed to any of nine outgoing lines, providing the capability to operate multiple downhole hydraulic devices with only two lines to the surface. Realizing a significant savings in system cost and installation risk.

An aggressive program of product development will continue with a focus on the following areas:

- Hydraulics and hydraulic devices.
- Distributed Temperature Service (DTS), which is a fiber optical sensor that enables monitoring across the reservoir section rather than in one position only.
- Subsea installation systems.
- Opto-electronics—continued improvement of the demodulation of optical signals and electronic processing and acquisition technologies.
- Cables and connectors including feed-through devices, tree penetrators, etc.

Weatherford plans to use a "crawl-walk-run" approach to establish firm building blocks for this enabling technology. Such a stepped approach is key in the marriage of fiber optic technology with standard oilfield technology where success will depend on the development of a common language and shared vision between many technical disciplines. Weatherford believes intelligent completion is the future of the industry and is leading the way with investments in equipment, technology and, most importantly, in a multi-disciplined team of experts. These experts understand both the technologically and operationally issues, and will rewrite the book on intelligent completion.

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Weatherford offers a range of components that provide integrated, remotely operated production monitoring and control.