

Performance improvement and evaluation methods outlined

—G J Riley, Anadrill

IADC/SPE 59202

The Economic Viability of Multilateral Wells

Several factors contribute to the economic success of a multilateral project:

- Technological advances and refinements in multilateral drilling and completion systems;
- Increased operator and service-company experience with multilateral installations;
- Complexity of the drilling program;
- Effective contingency planning prior to the commencement of drilling operations.

This paper examines multilateral wells in the North Sea and reviews their true economic impact. The paper proposes a balanced score card for tracking and benchmarking the economic performance of these wells. The paper also discusses suggestions for enhancing the probability of both the economic and the technical success of multilateral wells.

—J P. Oberkircher,
Sperry-Sun Drilling Services

IADC/SPE 59203

Step Change Improvement in Drilling Performance—Repeatable World-Class Performance Is Possible

When depletion strategies for BP Amoco's Valhall field on Norway's continental shelf required the drilling of ERD wells, problems appeared which threatened the project economics. Average trouble costs approached 35% and occasionally exceeded 50%, while some projects failed to reach their objectives. Sound principles for aligning the operator/supplier team were applied to a very challenging ERD well following 2 successful applications on exploration wells. Starting with a slot recovery which historically took 29 days being completed in 18, the ERD well concluded 31 days (30%) ahead of past performance. It is clear that reorganization of a select group of operating and service company candidates into an aligned team really made a difference. This

paper will describe the challenge, the transformation and the result.

—J P de Wardt, De Wardt and Co
—A Cook and R W Smook,
BP Amoco Norge



IADC/SPE 59206: This paper describes the coordinated approach to planning and execution that was implemented to maximize all operational efficiencies for an exploration well drilled in the Peruvian rain forest.

IADC/SPE 59204

To the Limit and Beyond: The Secret of World Class Extended Reach Drilling Performance at Wyth Farm

The paper describes how the extended reach drilling team at BP Amoco's Wyth Farm development on the South coast of England met the challenge of drilling and completing technically advanced ERD wells in an increasingly difficult cost and performance focused environment. The key element in this success was the ability to continue developing new technology, while at the same time adopting a technical limit approach to performance delivery.

The paper will draw on the experience of 3 ERD wells drilled from August 1998 to August 1999; M-14, a 9,600-m water injection well; M-15, a multilateral well with one lateral drilled to 8,900-m and the second to 6,700 m; and M-16, a world-record breaking ERD well drilled to 11,278 m.

—T Meader and F Allen, BP Amoco plc

IADC/SPE 59205

Delivering World Class Exploration Drilling: Integration of Design, Planning and Execution

The paper will describe the evolution over the last 2 years of the organisational structures, systems and processes that have allowed delivery of what was promised to management, with outstanding results over a 5-well exploration drilling programme involving 3 different rigs and teams.

Risk assessment is a key thread that runs through the whole story—how risk assessment is used right at the start of the project to identify high-level risks that then drive the priorities of the long-lead technical studies. This risk assessment parallels conceptual well design and evolution of the well objectives. The risk register is further extended as the planning progresses.

Getting the fundamentals of the well's conceptual design right is the foundation of the detailed operational planning phase. Key to the success of the planning and execution of the well is the full integration of the drilling contractor and all service suppliers, into a comprehensive planning effort.

Detailed planning ensures flawless operation and efficient recovery from setbacks. The paper will describe the organisational processes that involve the rig team in the planning and deliver a detailed plan for the execution of the work.

The paper will present the results of the 5 wells that have been delivered using this approach.

—J Thorogood, M D Jackson and O H Thorsen, BP Amoco Norge

IADC/SPE 59206 (ALTERNATE)

Integrated Management Approach Meets Environmental/Operational Goals for Exploration Well Drilled in Peruvian Rain Forest

This paper describes the coordinated approach to planning and execution that was implemented to maximize all operational efficiencies for a remote exploration well drilled in the rainforest of southern Peru. This synergistic approach enabled the operator to meet

all environmental and operational objectives.

Drilling fluids, solids control, and waste management were managed as a single entity, allowing the drilling personnel to focus entirely on complex downhole and logistical issues. In the planning stages of the well, the integrated process took into account the sensitive environment of the drilling location to develop an applicable site design, techniques to monitor for environmental compliance and to establish individual roles and responsibilities.

Environmental and drilling efficiency objectives were met during the execution of the drilling program. The management processes employed in this well could be applied in other environmentally sensitive locations to minimize drilling wastes, while maintaining drilling efficiencies.

—C C Elsborg and B Whitney,
Mobil Drilling Technology
—A F Wilde, M-I Drilling Fluids Co

IADC/SPE 59207 (ALTERNATE)

Deliver the Limit: A Practical Approach to Breakthrough Performance

Deliver the Limit (DTL) was introduced within Shell Expro at the beginning of 1999 in order to substantially improve Well Delivery Performance without compromising safety, the environment or well objectives.

The Goldeneye appraisal well was the first implementation of DTL in the UKCS and achieved a breakthrough in performance. The Transocean John Shaw drilled the well in 21.6 days against an original AFE time, reflecting historical offset performance, of 35 days and a Technical Limit target time of 15 days. The final well cost was \$3.0 million, vs a \$4.5 million budget.

The Technical Limit Times were reduced into 100± discrete tasks, which were individually analysed to see where efficiencies could be made and “ideal” timings generated. A detailed analysis of the actual performance was performed, highlighting areas for improvement and emphasizing successes so that the lessons can be transferred.

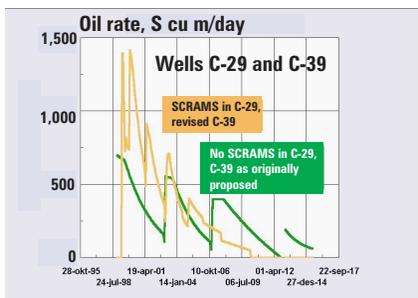
—J A Jones,
Transocean Integrated Services
—P Poupet, Shell UK E&P

Completion designs: Papers focus on multilaterals, recompletions

IADC/SPE 59209

A New Selective Lateral Reentry System

Since the mid-1990s, a major Middle Eastern operator has been exploiting short-radius horizontal technology to maximize oil recovery from existing wells. However, the operator’s recovery efforts were somewhat hampered by not



IADC/SPE 59210: SCRAMS was used to recomplete a Statfjord well. The system featured a surface-controlled downhole choke system.

having through-tubing access to the short-radius lateral. This problem has been solved with the introduction of a new selective lateral reentry system.

The new system allows for reentry into the lateral via wireline or coiled tubing. Utilizing isolation and commingling sleeves, the operator can control production from both the mainbore and the lateral. Reentry whipstocks (deployed by wireline or coil tubing) allow logging, acidizing, and sand-fill cleanout.

—W M Rivenbark,
Halliburton Energy Services
—M I Al-Sowaigh and Y A Al-Furaidan,
Saudi Arabian Oil Co

IADC/SPE 59210

Intelligent Recompletion Eliminates the Need for Additional Well

Gulfaks well C-29 had produced from the Lunde formation for several years before plans for a new drainage point in the Statfjord formation was launched. The Statfjord formation was accessible in C-29 but different pressure regimes, PIs and expected watercuts ruled out regular commingled production. A recompletion introducing a surface controlled downhole choke system was pro-

posed as a solution with the potential saving of a dedicated Statfjord well as the objective. This was to be a world’s first recompletion utilising such technology in this application.

The SCRAMS system, incorporating a number of adjustable downhole chokes independently controlled from surface, would provide this particular well with the means of simultaneous production.

The well was suspended with the old perforations secured with a shearable plug and the new perforations covered by a kill pill. The derrick was skidded over the well and the old completion pulled. The completion was successfully run, and the well is currently a commingled producer with all downhole systems functioning and communicating as planned.

—O H Lie, Statoil A/S
—W N Wallace,
Halliburton Energy Services

IADC/SPE 59211

World’s First Downhole Flow Control Completion of an Extended-Reach, Multilateral Well at Wytch farm

This paper describes the world’s first downhole flow control completion of an Extended Reach Drilling multilateral well at Wytch Farm.

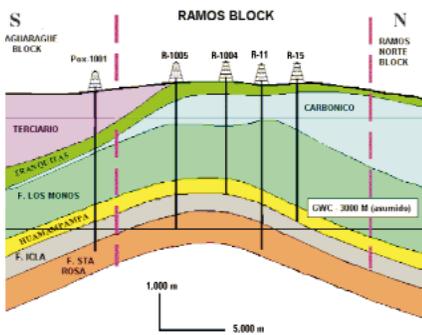
All technical objectives were successfully met without any safety incident, resulting in some world records which will be described in detail in the paper. The design is sound and the equipment used is fit for purpose. Team work and open thinking are key factors for success.

—H Gai, BP Amoco plc

IADC/SPE 59212

First Multilateral Application in a Deep Devonian Gas Field in the North of Argentina

The purpose of the paper is to show the first experience in drilling a multilateral well in a depleted highly fractured Devonian reservoir in the North of Argentina (Salta province). The well was drilled and a dual completion device was run successfully to produce 1 M cu m gas from each one of the 2



IADC/SPE 59212 details the first multilateral well completed in a depleted highly fractured Devonian reservoir in the North of Argentina.

branches of the well. The total cost of the well was \$18 million, compared to the \$13 million for a single vertical well in the same field. The KOP for the first branch was at 2,815 m with a length of 1,001 m (TMD). For the second one the KOP was 2,763 m with a length of 951 m (TMD). The well was completed as a MLT level 4 with the possibility to be changed to a level 5 in the future. A new whipstock technology was applied in the country for the first time.

—L E Piosco and H V Eguia,
Pluspetrol E&P SA

IADC/SPE 59213 (ALTERNATE)

A Proven Liner Floatation Method for Extended-Reach Wells

This paper introduces a floatation method of running cemented liner into a world-record extended-reach well. Preliminary work revealed that based on the very shallow true vertical depth and the long horizontal measured depth, the string weight would decrease as the liner was run into the hole. Eventually, if corrective techniques were not applied, the liner could no longer be run into the hole, since set-down weight was limited to the block weight of the drilling rig.

After all forces acting inside, outside, above, and below the liner and liner hanger were quantified, a solution was reached, enabling the liner to be floated into place. This concept is not entirely unique, but the method by which it was implemented, as well as introduction of friction-reducing subs for the drillstring and friction-reducing liner centralizers for rotating while cementing, added to the overall success of this job.

—C White, S Webster and A Elrick,
Weatherford Completion
and Oilfield Svcs

Case histories II: Downhole motors, rotary steerables, tough formations

IADC/SPE 59215

Competitive Performance Drilling with High-Speed Downhole Motors in Hard and Abrasive Formations

Due to its hydrodynamic function principle the power output of a turbodrill is not linear with the flow rate. A 20% reduction in mud flow reduces the power output by 50%, which drastically reduces ROP in all deep wells, slim holes or lost circulation situations, where it is not possible to operate the BHA with full flow rate. Furthermore, the use of hydrodynamic power sections does not allow a clear indication of the bit RPM for the optimum operating point or bit stalling via standpipe pressure readings. To overcome these operational difficulties a special high speed positive displacement motor (PDM) was developed. This motor combines the advantages of turbo drills (high bit speed, low sensitivity with regards to temperature) with the advantages of PDMs (RPM proportional to flow rate and nearly independent of loading).

The paper discusses case histories from Asia, South America and Europe.

—M Reich and A H Picksak,
Baker Hughes Inteq GmbH

IADC/SPE 59216

Unintentional Compensator Lockup Risks, Consequences and Measures

Unintentional compensator lock-up is a well known and industry-wide problem, which has received recent attention, following several severe incidents in the North Sea. As similar systems are used worldwide, there is no reason to believe that the failures seen in the North Sea are isolated occurrences. There may, however, be some correlation with the severe sea conditions experienced, especially during the winter months, but most geographical areas have such seasons. When using the crown compensator during normal drilling operations, the consequences of an un-intentional lock-up may be limited. When the rig is rigidly attached to the seabed in connection with e.g. drill stem testing or subsea completions or interventions, the consequences can be much more

severe. This paper briefly examines the consequences of three such incidents and details the risk and consequence reducing measures implemented to combat the problem.

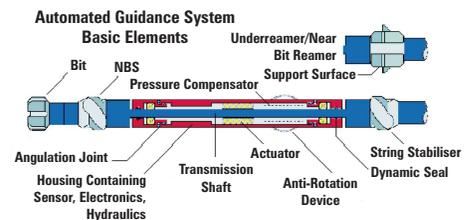
—D Storegjerde, Statoil A/S

—B A Berntsen, Amerada Hess Norge A/S

IADC/SPE 59217

Use of a Rotary Steerable Tool at the Valhall Field, Norway

The paper will mainly be a case history of several rotary steerable tool runs at the Valhall field offshore Norway. At Valhall the focus has been in the overbur-



IADC/SPE 59217: The AGS system was used in 5 wells in the Valhall field and made a total of 8 bit runs. Although none of these runs reached the casing point, 2 set world records of more than 2,000 m.

den section. The reason for concentrating on the overburden at Valhall is because of the weak and fractured shale with its instability problems.

The AGS tool has been used in 5 wells in the Valhall field and has made a total of 8 bit runs. Although none of these runs have made it to casing point, 2 of the runs have set world records of more than 2,000 m and were regarded as major successes.

—S Kinn and M Slater, BP Amoco Norge
—P Allen,

Cambridge Drilling Automation Ltd

IADC/SPE 59218

The Application of Rotary Closed-Loop Drilling Technology to Meet the Challenges of Complex Wellbore Trajectories in the Janice Field

In the case of the Janice Field in Block 30/17a of the North Sea, it became apparent following field appraisal that

to effectively exploit the reservoir it was necessary to drill complex 3D well trajectories. Such wells would require significant directional work with large associated costs.

After careful consideration the operator, **Kerr-McGee Oil (UK) plc**, determined that the application of Rotary Closed Loop Steerable (RCLS) technology was part of the appropriate technical and economic solution.

—C Abbott, Kerr-McGee Oil UK Ltd, *et al*

IADC/SPE 59219 (ALTERNATE)

Improving Drilling Performance in Troublesome Clay Formations in the Heidrun Field

This paper describes a project which was initiated at the Heidrun Field offshore Norway, with the purpose of improving drilling in troublesome Tertiary clay formations. The problems typically appeared as packoff and losses during backreaming, tight spots etc. High mudweights and high KCl-content of the waterbased mud did not provide any improvement. Large amounts of cavings were reported. The project included an extensive data collection scheme (wireline logs, MWD, PWD, XLOT). In addition a core was cut and the material of the core was thoroughly characterized. Core testing included mechanical (consolidated-undrained triaxial tests) and petrophysical characterization (ESEM, CEC, density, porosity, specific surface etc).

—G Stjern, P Horsrud and A Agle, Statoil

IADC/SPE 59220 (ALTERNATE)

Problems in Drilling Through

Abnormal/Subnormal Pore Pressure of Post-Eocene Formations in the Potwar Area of Pakistan With Special Reference to Adhi Field

Drilling conditions in the Potwar basin of Pakistan are extremely tough, hazardous and challenging due to sudden reversal of pressure regime from near geostatic to near hydrostatic. This paper will first discuss the origin of these high pressure reversals. Then the experiences gained during the drilling of 12 wells in the Adhi field and how it led to the development of a methodology for predicting and handling these abnormal/subnormal pore pressures will be discussed.

—M Afzal and S A Rasool,
Pakistan Petroleum Ltd

Data management and analysis

IADC/SPE 59221

Problem Avoidance—Learning From Data Stored During the Drilling Process

This paper proposes improved data management processes, and identifies what further barriers need to be broken down. It looks at the value gained from importing the geological model from G&G applications for use in well planning and the real-time drilling process. It examines the need for an integrated suite of engineering programs that access a POSC/WIME compliant data model and are compatible with the Microsoft office environment.

—P J McGinley, Baker Hughes Inteq

IADC/SPE 59222

Drilling Optimization Using Drill Bit Seismic in the Deepwater Gulf of Mexico

The aim of this work was to extend the Drill Bit Seismic technique into the deep water Gulf of Mexico. An initial test was conducted on a moored rig using a hydrophone cable deployed in a sub-vertical configuration in 1,200 m of water.

As a consequence, a new hydrophone cable was developed for optimal vertical deployment in deep water. A further test was conducted on another **BP Amoco** well drilled by the same moored rig.

—P N Armstrong and M Kamata,
Schlumberger Oilfield Services
—R C Minton, BP Amoco plc

IADC/SPE 59227

Field Test Results for a Real-time Intelligent Drilling Monitor

The problems handled by a new Intelligent Drilling Monitor are kick, loss of circulation, plug, washout, loss of pump efficiency, and sensor error. IDM uses mathematical modeling, sequential statistical processing, and Artificial Intelligence to detect and diagnose faults.

—G P Corser, Marconi Aerospace
Defense Systems, *et al*

IADC/SPE 59225

The Use of Resistivity at the Bit Images and Annular Pressure While Drilling in Preventing Drilling Problems

Annular pressure while drilling can be essential in diagnosing wellbore failure, and the mechanism of failure, in addi-

tion to dynamic processes such as cuttings build-up.

An example from a horizontal well in the North Sea is used to illustrate how LWD resistivity images can be used in conjunction with annular pressure while drilling measurements to detect the onset of drilling induced fractures.

—I Rezmer-Cooper and T R Bratton,
Schlumberger Oilfield Services
—H Krabbe, Amerada Hess Corp

IADC/SPE 59226

Design at the Customer Interface. The Practicalities of Improving Established Benchmark Performance Prudhoe Bay, North Slope, Alaska

Design at the customer interface is a paradigm change in the communications chain from field applications, drilling engineering and drill bit design and application. Utilizing this concept combined with a focussed objective to improve PDC performance and make a step change in conjunction with established benchmark performance, this paper presents a brief overview of the Benchmarking process and builds on the engineered benchmarking process foundation.

The paper discusses how the operator was able to improve drilling efficiencies, reduce drilling costs and lower established benchmark performance targets by applying PDC technology into a predominant historical Rollercone application.

—J P Lewis,

Fairweather Technologies, *et al*

IADC/SPE 59228 (ALTERNATE)

Case History of Integrating Multisource Data for Pore Pressure Prediction

This report describes how drilling, logging, production, geophysical, and geological data was identified, acquired, and integrated to develop a representative pore pressure prediction prior to drilling a new well in the field. The final results include predictions of the most likely pressure vs depth profile and the maximum possible range of pressures. The well experienced no well-control incidents, reached its geologic objective, and set a field record drilling time for a well with 7-in. production casing.

J R Smith, Louisiana State University