Case histories provide valuable operating lessons

EXPERIENCE IS A GOOD teacher. And case histories to be discussed at the 2002 IADC/SPE Drilling Conference in Dallas, 26-28 Feb, reinforce the value of lessons learned from real world operations.

Two sessions of case histories are to be chaired by **B Pini**, **Saipem SpA** and **D A Mueller**, **BJ Services Co**.

CORING RECORD

A North Sea coring record was set by **Conoco UK Ltd (CUKL)** and **Baker Hughes INTEQ (BHI)** on 20 Jan, 2001. A 179-ft core was cut and recovered in 6-in. hole from the Rotliegendes formation in the Southern North Sea.

IADC/SPE paper 74509, "North Sea Coring Record Attained By Step Change Application Modeling," describes the operation. It was prepared for the Conference by **M R Niznik** and **S Akram**, Conoco (UK) Ltd; and **A Norrie**, Baker Hughes Inteq.

In the project, in-depth operational planning was deemed critical for high percentage core recovery. Offset core viewing by a multi-discipline well team was undertaken in an effort to identify potential coring hazards. Physical testing of offset cores was then used to establish low-end rock strength, which is crucial in long barrel applications.

The rock strength data in conjunction with other relevant data sets were used to model the length of core that could be safely cut without the potential for the core to fail under its own weight.

The coring operation was executed with the selected coring assembly and 179 ft of high quality core was recovered. Subsequent testing and analysis was performed on the core, which satisfied all evaluation requirements.

CUKL and BHI have successfully applied these planning techniques on a number of other wells resulting in significant improvements in coring efficiency, recovery and core quality.

HPHT MOON PROSPECT

Planning for the deep vertical exploration well in shallow waters off the West Coast of India began more than a year ahead of drilling operations. The well was targeted to 4,500 m to explore the deep Eocene-Paleocene objectives in a 4-way closure. Bottom hole pressure was expected to be in excess of 12,000 psi and formation temperatures were predicted to exceed 400 degrees F.

> **"The successful drilling and formation evaluation of the (HPHT Moon) well has... highlighted the critical importance of mud hydraulics, HPHT rheology, temperature modeling and real time detection of pressure transition zones."**
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> **IADC/SPE paper 74507**

IADC/SPE paper 74507 describes the design exercise for the well. "Drilling the HPHT Moon Prospect Exploration Well," was prepared by **K Ghosh**, **V K Wali**, **S Bansal**, **A Jaggi** and **D W Oglesby**, **Enron Oil and Gas India Ltd**.

The pore pressure and fracture pressure profile developed from seismic velocities was used as the basis of well design. Highly refined synthetic mineral oil mud was selected for the 12 ¼-in. and 8 ½-in. sections for which prior environmental clearance was received from the federal government.

Gas solubility in oil mud, its effect on kick detection, variation in downhole mud hydrostatic pressures due to compression and thermal expansion of fluid trapped in casing annuli were important considerations, the authors report.

The jackup rig was modified to prepare for HPHT drilling. This included upgrading BOP equipment, high pressure choke and kill lines, special elastomers for fluid end of mud pumps, upgrading of cementing unit and redesign of the atmospheric mud gas separator.

The successful drilling and formation evaluation of the well has validated the efficacy of the design philosophy and highlighted the critical importance of mud hydraulics, HPHT rheology, temperature modeling and real time detection of pressure transition zones.

SMALL FIELDS

The Glitne field is the smallest field developed in the Norwegian Continental Shelf. The field was discovered in 1995 and a plan for development was in place in June 2000.

The development solution became 4 horizontal production wells and a combined water and waste gas injection well. The wells were drilled from conventional PGB's with reuse of old Christmas trees and completed with production risers to an FPSO through a swivel.

IADC/SPE paper 74508 describes the challenges of this field.

The paper, "Cost Effective Subsea Drilling Operation on the Smallest Norwegian Field Development," was prepared for the Conference by **H Blikra**, **R Andersen**, **H Hoser** and **J Vestvik**, **Statoil**; and **H Berg**, **Schlumberger**.

The economics of this small project were very dependent on a well-executed drilling and completion operation. The drilling and completion budget was 70-80% of the total field investment costs.

The cost effective drilling and completion operations were very successful, and the rig performed the most effective subsea drilling operation in Statoil, according to the author.

The 4 production wells, placed within a 10-m distance, were batch drilled, and TD of the first 4,300-m MD horizontal well was reached in 17.1 days. The overall drilling of the 5 wells resulted in a performance of 203 m drilled per day.

APPLYING TECHNOLOGY

IADC/SPE paper 74521 reviews the challenges and the technical and financial successes experienced while drilling in the Lennox field in the Irish Sea sector of the UK Continental Shelf.

"Staged Applications of New Drilling Technology and Techniques to Achieve Optimal Reservoir Performance and Well Productivity in a Difficult and Challenging Environment," was prepared for the Conference by **G M Gillespie**, **Sperry-Sun Drilling Services**; and **J Downie**, **BHP Petroleum**.

Very hard and abrasive rocks charac-

Staged application of new technology in the Irish Sea brought these achievements:

- **6 km of 8 ½-in. hole section placed within a +/- 2-ft corridor;**
- **Two record breaking insert bit runs for the Lennox field;**
- **Three horizontal open hole side-tracks with a rotary steerable system;**
- **Quad-Combo logging with a rotary steerable system.**

IADC/SPE paper 74521

terise the Lennox reservoir and overlying formations. Bit selection has been generally limited to insert types, and steerable motor assemblies have been required to achieve the high-ratio MD/TVD stepouts necessary.

The authors cite two key challenges: To improve the directional drilling performance in these demanding formations; and to achieve tight TVD constraints in both target TVD and in maintenance of vertical depth within the reservoir.

The objectives also included successfully logging complex, multi-branched sections. Reservoir simulations indicated that the payoff in successfully meeting these drilling challenges was substantial.

A staged introduction of ever-more-complex "point-the-bit" techniques and technologies was employed. Milestone targets were set to monitor the deployments and to ensure that the target objectives were met.

The effort resulted in these significant achievements:

• 6 km of 8 ½-in. hole section placed within a +/- 2-ft corridor;

• Two record breaking insert bit runs for the Lennox field;

• Three horizontal open hole side-tracks with a rotary steerable system;

• Quad-Combo logging with a rotary steerable system.

The development of 3 horizontal open hole sidetracks with a rotary steerable system was also an industry first.

Quad-Combo logging with a rotary steerable system was a first in the UK. In addition to the technical success of the effort, BHP will realise a significant return on investment, the authors report.

PREDICTING STUCK PIPE

Stuck pipe used to be the major problem resulting in 80% of lost time during drilling in **Shell Petroleum Development Company Nigeria**, the major operator in the Niger Delta area.

A survey on borehole stability in the Eastern SPDC operations between 1996-1999 showed that 8 string-months were lost to hole instability problems.

During the period, 40 stuck pipe incidents were recorded in 70% of the wells accounting for over 80% of the lost time.

The alarming frequency of this industry problem made it necessary to find a solution. Subsequently a Stuck Pipe Risk Factor (SPRF) prediction tool was developed based on prevailing occurrence and existing data.

The tool is being used to predict the inherent risk of getting stuck in well planning and design stages. In addition, it is used for change control during drilling.

IADC/SPE alternate paper 74523 reviews the implementation strategy of the SPRF tool in the well engineering operation of SPDC-Nigeria. "An Innovative Approach to Stuck Pipe Reduction in the Niger Delta," was prepared by **M A Magaji, O A Amoo** and **O O Owoege**, Shell Petroleum Development Nigeria.

As a result of strict implementation of SPRF in all stages of well delivery processes, major stuck pipe incidents dropped to 7 in the year 2000 when a total footage 241,013 ft was drilled, compared to 27 incidents in 1999, when a total of 234,814 ft was drilled.

Similarly a 58% reduction in Non Productive Time (NPT) was recorded in year 2000 compared to 1999; resulting in 45% reduction in cost.

According to the authors, the SPRF tool has been accepted in SPDC as a reliable, fast and accurate way of simulating well design with the aim of eliminating the potential for stuck pipe problems. It is also extensively used at the well site for operational monitoring where significant lithological, formation pressure and rock mechanical properties changes are encountered.

WELLBORE STABILITY

IADC/SPE alternate paper 74510 describes the addition of a geomechanical component to the drilling and completion process for the North Sea's Hudson field.

"Wellbore Stability Issues When Drilling and Producing Horizontal Wells in the Hudson Field: A Case History," was prepared by **M Zambonini**, and **R Nutkins**, **Amerada Hess Ltd**; and **P McCurdy** and **J J Tovar D**, **Innovative Engineering Systems Ltd**.

Hudson field has been in production since 1993 and was developed using subsea wells. Located in block 210/24a, Hudson has been producing through the Tern platform at an average rate of 55,000 bfpd. The field produces from 7 wells of which 3 have horizontal sections of up to 1,950 ft.

Initial exploration and appraisal drilling encountered hole cleaning as well as wellbore stability problems, the authors report. An additional horizontal well was planned and its design required a careful review of the existing field conditions in order to ensure that reservoir pressure depletion did not cause wellbore stability problems.

Due to the success of the initial wells, a new horizontal well was also planned to be completed open hole. A geomechanical model of the field was developed and calibrated using drilling, reservoir and production data.

The model allowed the determination of a safe mud weight envelope for drilling the buildup and horizontal section through the reservoir.

A hole failure prediction and the potential for sanding was also generated to confirm that an open hole completion could still be used and that the well could be produced sand free.

The well was completed using a pre-perforated liner and brought on production in August 2000. Well test data indicate sand free production and reservoir pressure drawdown well below the critical level, the authors report.