This presentation is made to identify stress levels associated with the extreme loads that occur when landing very heavy casing strings in deep water wells.

SPE/IADC 105524

The Evolution of a TAML L-4 Multilateral System to Meet the Challenges of a BP Deepwater Subsea Well. K. Horne and R. Allam, BP; M. Glaser and P. Chandler, Weatherford; T. Scharf, Schlumberger.

This paper details the development trials carried out on a multilateral system to meet the needs of drilling and completing a subsea multilateral producer in the North West Area Development (NWAD) of the Schiehallion field, about 175 km west of the Shetland Islands. The selected multilateral system consists of a hollow whipstock, which is perforated through after the completion is installed. The perforating system was not new technology but still required substantial qualification due to the unique construction of the well. The test programme culminated in a full-scale stack-up of the intelligent completion within a test well followed by the perforating and quantifying of the debris generated and captured.

SPE/IADC 104698

Trapped Annular Pressure — A Spacer Fluid that Shrinks. B. Bloys and M. Gonzalez, Chevron; R. Hermes, Los Alamos National Laboratory; R. Bland, R. Foley and R. Tijerina, Baker Hughes Drilling Fluids; J. Davis and T. Cassel, Baker Oil Tools; J. Daniel, I. Robinson and F. Billings, Lucite International; R. Eley, ICI.

In deepwater and other wells, fluids trapped in casing annuli above the top of cement are heated by warm produced oil and gas, and thermal expansion can create pressures of 10,000 psi or more, which can cause the collapse of casing and tubing strings. A new mitigation method has created a water-based spacer fluid that will be used just ahead of the cement. The spacer contains 20-25% of emulsified methyl methacrylate monomer (MMA). Upon polymerization, the MMA phase shrinks by 19%, alleviating pressure from thermal expansion.

SPE/IADC 105881

Study of Gelation and Freezing Phenomena of Synthetic Drilling Fluids in Ultra-Deepeater Environments. R.A. Gandelman, R.A.F. Leal, J.T. Gonçalves, A.F.L. Aragão, R.F. Lomba and A.L. Martins, Petrobras.

Linear paraffin-based invert emulsions are frequently used as non-aqueous drilling muds offshore Brazil. Fast and non-progressive gelation is desired to prevent drilled solids sedimentation during pumps off while avoiding excessive pressure peaks when circulation is resumed. Gelation tendencies are normally higher at low temperatures typical of deepwater risers. Additionally, excessive pressures and/or difficulties to resume circulation have been observed drilling in water depths greater than 1,800 m.

The paper shows the results of an experimental study to evaluate the rheological behavior and gelation properties of non-aqueous drilling muds below 4°C and pressures up to 5,000 psi. The study aimed to quantify pressure effects on freezing temperatures and to develop representative methodologies for the evaluation of thyxotropic properties of such fluids.

Technical Session 7: Bit Technology

SPE/IADC 105017

Development and Utilization of a Bit-Based Data Acquisition System in Hard Rock PDC Applications. P. Pastusek, E. Sullivan and T. Harris, Hughes Christensen.

Drill bits are iteratively developed to meet performance objectives such as aggressiveness, durability, stability, steerability, etc. The transition from one iteration to the next occurs when dull bits are examined, run data is analyzed and the inferences are implemented as revisions to the bit design and/or the operating parameters. Experience shows that the efficiency of the process depends on the appropriateness and significance of the data collected.

One way to improve the significance of the data is to implement a special-purpose data acquisition system within the bit. The paper describes an effort to develop, validate and utilize a bit-based module designed to monitor accelerometer and magnetometer sensors and to record selected data.

SPE/IADC 104388

Successful PDC/RSS Vibration Management Using Innovative Depth-of-Cut Control Technology: Panna Field, Offshore India. A. Jaggi and S. Upadhaya, BG India; A.R. Chowdhury, Hughes Christensen.

The operator has been active in the Panna Field for several years drilling a main horizontal and 2 laterals through a window milled in pre-existing 9 5/8-in. casing. Initially, the operator used RSS/MWD to geosteer the BHA to the target formation. However, previously chosen PDC bits were causing severe lateral vibrations, stick slip and BHA whirl, resulting in multiple downhole tool failures. An in-depth study revealed the BHA was exposed to severe stick slip and lateral vibrations. There were also regular

instances of BHA whirl and severe acceleration and deceleration caused by stick slip.

To enhance overall bit/BHA stability, a new style 8 ½-in. PDC was implemented with innovative depth of cut control (DOC) technology and enhanced stability features. The result was a significant reduction in stick slip, lateral vibration and BHA whirl.

SPE/IADC 105906

Extreme Drilling Environment Forces Evolution of Rotary Steerable Systems and Rotary Steerable Bit Technology. B. Cox and L. Romo, BP; B. Champion and O. Maung, Schlumberger; K. Card and S. Barton, ReedHycalog.

Wells drilled in the Tuscaloosa Trend near Baton Rouge have long been recognized for the extreme nature of the HPHT operating environment and potential for well control problems. The current focal point concerns drilling the highly abrasive formations contained within the intermediate and drilling liner sections to depths of about 20,000 ft. These sections are a major cause of bit, directional tool and drill string failures. The directional complexity of the wells has increased exponentially in recent years; new drills are therefore primarily directional.

This paper focuses on the improvements which have been achieved over a 5 year period due to the implementation of Powered Rotary Steerable Systems (PRSS) coupled with Rotary Steerable Bit Technology. The step change in performance has been evidenced by a D/10K reduction from 86 to 55.

SPE/IADC 105885

Optimization of Deep Drilling Performance: Benchmark Testing Drives ROP Improvements for Bits and Drilling Fluids. A. Judzis, A.D. Black and H.A. Robertson, TerraTek; R. Bland, Baker Huges Drilling Fluids; D.A. Curry and M.J. Meiners, Hughes Christensen; T.C. Grant, US DOE.

This paper will present laboratory-measured drilling performance of full-scale bits at 10,000 psi borehole pressure, cuttings volume estimates, apparent cuttings size distributions, mud properties and the influence of bit and mud design on drilling performance, cuttings and near borehole characteristics. Findings include:

- Mudding up decreased PDC drilling efficiency and penetration rates in sandstone by 90% for both water- and oil-based systems with little sensitivity to ending mud weight or blade count.
- TCI and impregnated bit penetration rates at these pressures were an additional 70-90% slower than PDC bits.
- Cuttings from Carthage Marble and Mancos Shale appear to be compressed agglomerates of fine particles. Carthage Marble cuttings had low compressive strengths.
- Test results indicated that opportunities for improvements in bit design and smart HPHT drilling fluids are possible.

SPE/IADC 105522

Drilling Without WOB, Dream or Reality? An Effective Field Test by Total Angola. C. Simon, DrillScan; D. Goyallon and J.P. Poloce, Total; H. Sellami and L. Gerbaud, Ecole des Mines de Paris; A. Dourfaye, Varel Europe.

PDC bit modeling and single cutter analysis have enabled a new generation of cutting structure based on the optimization of a specific interactive cutting mode that generates, by the only drilling action of the cutters, an axial force oriented in the drilling direction: a negative weight on bit. This paper presents the application of this new PDC bit design and show that WOB can be strongly reduced in a large range of formations. This new bit technology has the potential to increase bit performance, specifically in operating conditions where power is available but WOB is limited due to friction, buckling or reduced vertical depth.

SPE/IADC 105898

Application of Small Vibration Logging Tool Yields Improved Dynamic Drilling Performance. D. Perez, R. Lockley, A.J. Clarke and C.M. Hanley, ReedHycalog.

The drill bit is often assigned as the cause of downhole vibration/instability and frequently bears the scars of dynamic drilling problems. Historically bit manufacturers have used a combination of dull grades and surface data to speculate on cause and effect of downhole events with insufficient attention to what may be occurring in between. This paper discusses the implementation of a vibration logging tool and its flexibility for placement of multiple tools in various locations. Specific field cases will be presented, including validation of pre-run dynamics modeling software, up to 6 distributed measurements in one drillstring, rotary steerable tools, concentric and eccentric hole opening tools, and response of different BHA configuration.

Technical Session 8: Tubulars I

SPE/IADC 105026

Catastrophic Drill String Failures Caused by Downhole Friction Heating — An Increasing Trend. L. Hehn, M. Jellison, K. Wyble and R.B. Chandler, Grant Prideco; J. Shepard, GlobalSantaFe.

Drillstring failures caused by friction heating of BHA components and drillpipe have increased dramatically over the last several years. In one failure mode, the drillpipe is heated above a critical transformation temperature accompanied by a rapid decrease in tensile strength. Subsequently, the component fails under a tension loading, well below the rated strength of the drillstring.

This paper addresses the features of a downhole heating failure, including the material attributes that can be used to identify the phenomena. Guidelines and operating practices that can be employed to minimize the occurrence of these costly and potentially dangerous failures are discussed.

SPE/IADC 105930

Special Issues in the Stress Analysis of Casing Strings in Steam Injection Wells: Mathematical Development and Design. R. Garside, TNK-BP; P.D. Pattillo and P.D. Pattillo II, BP; U.B. Sathuvalli, Blade Energy Partners.

The design and development of steam injection fields is a mature subject. Since the strings in these wells invariably experience inelastic loading, issues such as the effects of temperature on the static and cyclic material properties become important. Due to the high temperatures involved, miscellaneous issues such wellhead loading gain prominence. Data on the cyclic thermal properties of OCTG steels is rare in oil field literature.

This paper presents a comprehensive mathematical model of casing strings subjected to thermal loads in steam injection wells. The model includes the effects of temperature on material properties and the effects of wellbore curvature and pre-stress during the heating cycle. Several counter-intuitive aspects of the casing stress state during cooling /unloading are examined by an analytical model and finite element analyses. Test data and the mathematical models are used to determine the stresses in the casing at different points in the life of the well via a generic example design.

SPE/IADC 104497

C125 Casing — A Viable Solution for HPHT in Mild, Sour Service Applications. B.E. Urband, Grant Prideco; S. Morey, BP.

A considerable demand for exploring and developing deep, HPHT reservoirs has brought forth the need for high-strength tubulars with adequate sulfide stress cracking (SSC) resistance.

This paper details the results of testing to explore the possibilities of using 125 ksi specified minimum yield strength (SMYS) casing in sour or mildly sour environments. The SSC resistance of the 125 ksi material was evaluated utilizing the NACE TM0177 96 1 test Method A and test Method D. This paper also details the key manufacturing steps necessary to produce a high-strength SSC-resistant tubular product.

SPE/IADC 105717

Strain-Based Design of Tubulars for Extreme Service Wells. J. Nowinka and T. Kaiser, Noetic Engineering; B. Lepper, Shell.

This paper presents fundamental concepts for strain-based design of tubular strings in extreme temperature applications and HPHT wells. Strain-based design utilizes material capacity beyond its elastic range to overcome economic and technical hurdles. The relevant concepts are illustrated by examples from analytical and experimental investigation of casing material for thermally stimulated wells operated by Shell Canada Ltd in Western Canada.

SPE/IADC 105855

First Gas Field Developed Using Exclusively Dope-Free Casing and Tubing Connections — Statoil Snøhvit. G. Carcagno and T. Castiñeiras, Tenaris; D.J. Eiane, Statoil.

The recent development of dope-free solutions for tubing and casing premium connections provides a real and proved alternative to traditional thread compounds and proprietary environmentally free solutions. Among other advantages, the dope-free solution can solve the legal limitations to operate with standard compounds in very environmentally sensitive areas. This paper describes the concept and features of a fully dry dope-free solution, and the first extensive field experience of this solution in the Snovhit field of Statoil in the Barents Sea.

Technical Session 9: Geomechanics

SPE/IADC 105405

Assuring Stability in Extended Reach Wells — Analyses, Practices and Mitigations. S.M. Willson, S.T. Edwards, N. Last, BP; A. Crook and A. Bere, Rockfield Software; D. Moos and P. Peska, GeoMechanics International.

The paper describes state-of-the-art approaches for assuring wellbore stability in high-angle extended-reach wells. While the step-out lengths of proposed ERD wells are becoming more challenging, wellbore stability assurance technologies are developing at an equal pace. Incremental step out increases are no longer required, and it is now quite reasonable to plan 10 km ERD wells on the basis of a limited number of vertical or near vertical appraisal wells. The paper reviews the prior art of ERD wellbore stability, focusing on the Wytch Farm, Valhall and