Deepwater solutions to be presented at conference

DYNAMIC LOADING

THE AUTHOR WILL examine the imposed longitudinal dynamic loads on deepwater landing strings due to drilling vessel response to ocean heave. By considering the drilling vessel and the landing string as a combined vibration system, the author will also provide proof that determining the natural frequency of the landing string alone is justified for a wide range of expected wave periods. Additionally, sensitivities to mud, friction and structural damping effects are considered. The analysis determines the added axial force applied to the landing string as a function of vessel heave period for given landing/casing string geometric and mechanical constraints.

In a reasonable range of expected wave periods (2-8 seconds), the results confirm at least two resonant frequencies for free-end boundary conditions and nominally at least one resonant frequency for fixed-end boundary conditions. Depending on the effects of damping, imposed loads on the landing string are shown to be as much as 5-10 times higher than the calculated static stretch load based on Hooke's Law at peak heave amplitude. The importance of such an evaluation is discussed in light of the fact that landing long, heavy, large diameter casing strings from dynamically positioned drillships in deep water has become quite common.

Evaluation of Heave Induced Dynamic Loading on Deepwater Landing Strings (IADC/SPE 87152) **D Everage**, **S E Ellis**, **N Zheng**, **T H Hill Associates Inc**.

WELLBORE ENLARGEMENT

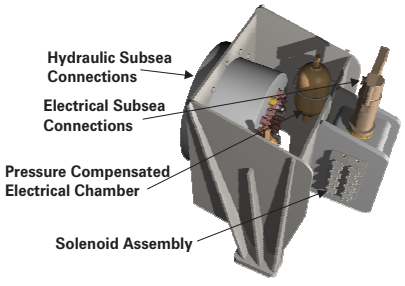
The success of deepwater exploration and development operations is greatly dependent on utilizing larger OD casing to reach the ever-increasing depths of today's prospects. An operator utilized new hole enlargement technology to simultaneously drill and enlarge a wellbore to facilitate the installation of a multiple string casing program in the deepwater Gulf of Mexico.

The authors will present a case study detailing how proper planning and the utilization of new hole enlargement technology matched with a rotary steerable system culminated in the successful execution of this critical well construction operation. As part of the planning process, hydraulics analyses and BHA stabilization optimizations using special computer software will be discussed. Also to be presented is the application of a new design concentric reamer in a deepwater tight clearance casing program that enlarged more than 18,000 ft of four different sized wellbore.

Wellbore Enlargement for a Deepwater Casing Program: Case Study and Developments (IADC/SPE 87153) **D F Courville**, **R D Childers**, **Smith International Inc**.

WELL DESIGN

A major exploratory campaign is being carried out off the southeast cost of Brazil. More than 150 wells will be drilled during the next two years in water depths from 3,280 to 9,200 ft.



A newly patented electro-hydraulic (EH) control system has been developed that can be retrofitted to existing installed all-hydraulic subsea control systems, utilizing the existing driller's and toolpusher's panels, pump/accumulator unit, UPS, most of the rig's wiring and both subsea pods. IADC/SPE 87156

These deepwater exploratory wells were designed taking into account safety, well data reliability and well cost. Various innovations were implemented including a new casing design that reduced the number of casing sections from five to three, a new improved deepwater wellhead system and an optimized drilling fluid system.

The innovative approach adopted to drill the wells significantly reduced the total drilling time, which was important due to the shortage of deepwater drilling vessels in the current market. A field case reporting a well construction, including design and complete operations from spud to TD will be presented.

Innovative Design for Deepwater Exploratory Wells (IADC/SPE 87154) **J C Cunha**, **Y Irokawa**, **Petrobras**.

TESTING BOPS

Pressure testing BOPs with synthetic based mud (SBM) requires additional testing time as a result of PVT influences associated with SBM. They are especially pronounced in deepwater and high pressure test environments.

The project was motivated by an effort to minimize the waiting time at the rig during a BOP test. The primary objective was to demonstrate that the pressure decline signature of the fluid is quantified by the fluid PVT behavior, mechanical influences and thermodynamic behavior during pressurization and subsequent cool down. The second key objective was to demonstrate that the pressure decline resulting from a leak is detectable.

The authors will present salient aspects of the data acquisition, the data interpretation, and the modeling techniques.

Advanced Analysis Identifies Greater Efficiency for Testing BOPs in Deepwater (IADC/SPE 87155) **C Franklin**, **M L Payne**, **BP**; **U B Sathuvalli**, **Blade Energy Partners**; **R Vargo**, **Halliburton Energy Services**.

BOP CONTROL

Industry standards (API and MSS) require ram BOPs to close within 30 seconds and annular BOPs within 45 seconds. Subsea BOP response times associated with all-hydraulic piloted control systems are controlled by a number of factors, but the hydraulic pulse time to pressure up and bleed off the $^{3}/_{16}$-in. ID pilot lines to shift the subsea control pod pilot valves is very hose-length dependent. Thus, the pulse time to shift the pod pilot valves is fairly constant regardless of the water depth, given that the umbilical length remains constant.

A newly patented electro-hydraulic (EH) control system has been developed that

can be retrofitted to existing installed all-hydraulic subsea control systems, utilizing the existing driller's and toolpusher's panels, pump/accumulator unit, UPS, most of the rig's wiring and both subsea pods. The EH concept centers around running electrical lines to critical solenoid functions (rams, annulars and connector releases) and hydraulic lines to all other non-critical functions. A module consisting primarily of solenoids and hydraulic/electrical connectors is packaged to fit on top of the existing all-hydraulic control pod. The overall "kit" has been designed to be placed aboard the rig and BOP stack during a long rig moves thus not requiring any shipyard time.

Fast Response Retrofittable Ultra-Deepwater BOP Control System (IADC/SPE 87156) **M A Childers**, **J Curtiss**, **Atwood Oceanics**; **M M Buckley**, **Cameron Drilling Systems**.

RISK ANALYSIS

Many of the latest generation of ultra-deepwater rigs included emergency BOP control capabilities, sometimes referred to as secondary intervention systems. Such systems represent the last line of defense in containing a well. Building on installations that have been in service for many years, these capabilities range in functionality and purpose from providing an alternate means to operate BOP functions in the event of total loss of the primary control system to assisting personnel during incidents of imminent equipment failure or well control problems. They can be actuated automatically or manually. They can utilize components of the primary BOP control system or be totally independent. With as many permutations as there were rigs built, an understanding of the capabilities and limitations that exist on a particular rig is of critical importance in assessing the risks associated with a drilling program.

While there currently are no standard terms in use to describe the essential attributes of systems, the author will recommend definitions and terms for a common understanding. The defined terminology will be used to compare and contrast system parameters, identifying various system strengths and weaknesses for use in risk analyses.

Risk Analysis of Emergency BOP Control Systems to Ensure Desired Results (IADC/SPE 87157) **J P Sattler**, **WEST Engineering Services Inc**.

TAUT-LEG MOORING

As exploration moves into greater water depths, the use of traditional catenary mooring systems requiring long and heavy mooring lines becomes too costly. As a result the offshore industry has adopted the taut leg mooring system as the best alternative. The essence of the system is a smaller footprint, light weight mooring lines and anchoring points that withstand both horizontal and vertical loads. This technology is based on the use of synthetic mooring ropes and drag embedded vertically loaded anchors (VLA's). The choice for a taut leg mooring system in deep water, including VLA's and polyester rope, results in a more economic solution.

Since 1998 some 60 Stevmanta VLA's have been installed in water depths exceeding 1,000 m primarily for permanent moorings. The new VLA anchors allow the use of drag embedment type anchors for use with taut leg moorings. The anchors are very light, easy to handle, install and recover.

The author will discuss the latest on the use of drag embedded VLA anchors, for temporary mooring systems in deep to ultra-deepwater locations. Discussion will include the economics of drag embedded VLA's versus suction piles; taut leg mooring system principles; history of taut-leg mooring; installation and retrieval of VLAs; safety factors; improvements to accommodate rig moorings; and a case study.

Taut Leg Moorings Using Polyester and VL Anchors (IADC/SPE 87158 – Alternate) **T Adnevall**, **Moorwest Inc**.

DRIFT OFF ANALYSIS

In support of the Gnarlyknots-1 well drilled by the Glomar Jack Ryan dynamically positioned drillship in 4,308 ft of water in early 2003, drift-off riser analysis was carried out to establish watch circles for the emergency disconnect sequence (EDS).

Drift-off analysis of the vessel and riser system is a key element to the successful management of the riser on a dynamically positioned drillship, as it deals with protecting the equipment in case of the potential loss of vessel power.

At this well site, high sea states combined with wind and current conditions dictate that drilling should be carried out in accordance with well-specific operating criteria. During the planning phase, extensive discussion was held between the operator and the drilling contractor to establish well-specific operating criteria. Riser analysis of the drift-off scenarios was used to establish these criteria in an effort to avoid potentially exceeding allowable limits in the riser and conductor pipe. As the drilling progressed, the well-specific operating criteria were applied to actual metocean conditions being encountered. The authors will describe the drift-off analysis carried out for this well and how it was applied to facilitate the drilling operations.

Drift-Off Analysis to Support EDS/Riser Management in Deep Water in the Great Australian Bight (IADC/SPE 87160 – Alternate) **J N Brekke**, **D Moorthy**, **M A Wishahy**, **GlobalSantaFe**; **E O'Sullivan**, **MCS International**.

CEMENTING

As an alternative to standard energized fluids, special cementing systems based on packing volume fraction and ratios of sized particles have been used with success in water depths exceeding 6,000 ft in the Gulf of Mexico. The author will provide case histories and discuss the use of these systems for a wide range of deepwater situations. The systems are specially designed to provide optimized gel and compressive-strength development in low temperature environments while allowing the thickening time to be tailored to any wellbore geometry.

Slurry volumes from 1,500 to 2,500 bbl have been pumped without incident. Their intrinsically low permeability and porosity at both the slurry and set cement stages provide resistance to external attacks and influx of water or gas. In addition, these systems are tested and pumped using standard equipment. Extra personnel are not required.

Cementing Deepwater, Low Temperature Gulf of Mexico Formations Prone to Shallow Flows (IADC/SPE 87161 – Alternate) **P Rubinstein**, **R F Keese**, **Schlumberger**; **J O'Leary**, **BP**.