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Extended Reach: New Generation Frontier Drilling Rigs

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Abstract

As access to the world's known energy reserves is constrained, interest in exploration and development of remote regions continues to grow. A common feature of frontier development is a fragile environment and high operating costs requiring unique operating methods. In instances where offshore reservoir targets lie near remote shorelines, extended reach technology and experienced people have minimized the impact of drilling operations on the environment while still allowing development of reserves in these sensitive areas. Since high departure wells are more complex and expose the rig, crew, BHA and tubulars to a unique set of drilling variables, cost effective operations require higher equipment specification, drilling and tripping control, and reliability.

Downhole ERD technologies have focused on overcoming drag forces that prevent pipe from sliding, and rotating friction which increases torque requirements while drilling (1). Throw ratios of today's ERD wells have increased three-fold by employing purpose built drilling rigs, special techniques for running casing, high torque top drives and drill pipe connections, high capacity, high pressure mud pumps and large drill strings. Nevertheless, well trajectories being planned today have such departures and complexity that feasibility risk is a critical part of the evaluation prior to investing in these projects. This risk in large part is determined by the rig design and capacity to drill these "Extreme Reach" well designs. To best leverage today's directional drilling technology and successfully drill reservoir targets previously beyond technical limits, the right drilling rig is therefore required.

ERD rig technology addresses extreme tubular lengths, offline stand building, increased power and hydraulic requirements to reach total depth. This paper focuses on aspects of land rig design, procedures and operations which enable us to continue to drill more complex well trajectories with still higher departures. Especially in a period of new land rig construction, the design and specification of extreme reach drilling rigs will become increasingly important as frontier regions are developed. Successful delivery of these new designs can open new markets previously considered un-drillable with the existing, available rig fleet.

Early experience

There are numerous examples of how extended reach drilling technology has advanced. Prudhoe Bay's original multi-well development drilling programs from pad-based surface locations required directionally drilled well trajectories to reach bottomhole targets from a small surface area. Improved BHA technology at the time and increased rig hydraulic capacities enabled extended reach drilling where horizontal displacement was at least twice that of vertical depth. Besides increasing well productivity, the technique served mainly as an environmental system to limit location impact and avoid surface "obstacles" (2).

Improvement of directional drilling technology and departure limits drove progressively smaller pad size. New rig designs were therefore required to fit the rig on site while still allowing transportation access and simultaneous drilling and production activities. Elimination of pits and new cantilever designs were also implemented to fit the rig between more tightly spaced wellheads.

Ten years ago in China, reserves from the Xijiang 24-3 offshore field in the South China Sea were upgraded after revised seismic interpretation provided several new locations, but with bottom hole locations requiring departures beyond technical limits at the time. By 2006, 13 ERD multilateral wells were drilled from the 24-3 Platform. The first extended reach well drilled in 1997 was a world record at the time with measured depth of 9,238 meters and horizontal displacement 8,063 meters. Constructing the initial wells on this platform was a considerable challenge as they were drilled prior to the introduction of commercial rotary steerable technology.

"One of a Kind" Projects

Successfully designing, fabricating and operating special purpose drilling rigs in remote environments is a unique process but all such projects have common features:

- Challenging well design