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Best practices emerging for ERD wells

Once again, experience proves to be the best teacher as operators find success at the end of a long string.

By DICK GHISELIN, Senior Editor

Progress in extended reach drilling (ERD) continues to amaze. The industry has broken the 40,000-ft (12,200-m) barrier and is hungry for more.

Recently, BP announced a contract with Parker Drilling Co. to build a new land drilling rig on BP's Endicott field drilling pads on Alaska's North Slope. The rig design will incorporate Parker's extensive ERD experience but will be owned by BP. Drilling is expected to begin in 2010. The target — BP's Liberty offshore discovery in Foggy Island Bay — lies about 20 miles (32 km) east of the Prudhoe Bay complex. According to the company, Liberty development will require ERD wells stretching as far as 8.3 miles (13.3 km) from the surface location to tap a reservoir around 11,000 ft (3,354 m) deep. This ambitious goal tops the current North Slope record for ERD by 24,175 ft (7,370 m).

The confidence to attempt such a drilling feat comes from two sources: personnel competency and drilling technology. Parker combines a strong reputation for designing and manufacturing purpose-built extreme-capability drilling units with arctic ERD well construction experience on Russia's Sakhalin Island, where a land-based rig drills ERD wells under the Sea of Okhotsk.

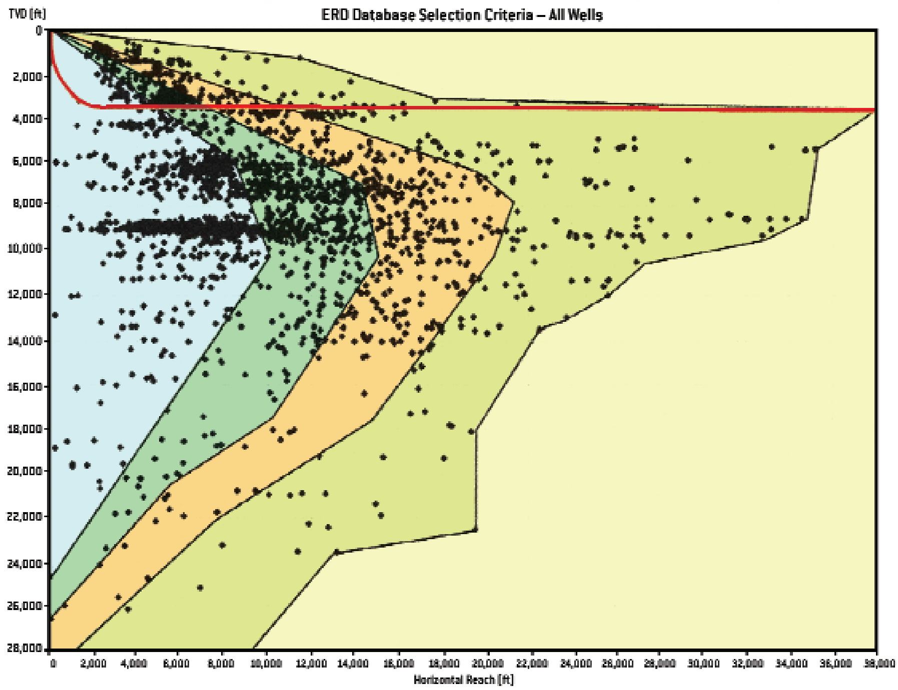

Figure 1. The worldwide ERD database will take on a new profile if BP is successful stepping out 8.3 miles (13.3 km) on its Liberty field development project.

Successful ERD

There's more to drilling a successful ERD well than building a giant rig. The current world record ERD well was drilled under the Persian Gulf by Transocean's GSF 127 jackup, a fairly standard drilling unit.

Delving into the best practices cupboard for ERD, one finds several items that have nothing to do with the rig. Prior planning and geomechanical modeling of the rock to be drilled are every bit as important to success as the choice of rig and equipment. Drillstring and bottomhole assembly (BHA) designs must be a perfect match with the intended wellbore trajectory to minimize torque and drag. Drilling fluid design must be optimum to control the well while providing maximum lubricity and cuttings transport qualities, as well as minimizing formation damage. Logging-while-drilling (LWD) data must provide high-quality relevant information to support steering decisions. And telemetry and control systems must be able to maintain reliable communication with the BHA to deliver timely drilling parameters and formation evaluation data to surface as well as the downlinking capability to execute steering decisions.

Intense attention to detail starts from the beginning. Experience has shown that taking care to drill a gun-barrel straight vertical section pays off handsomely when building the curve and lateral sections. Using rotary steerable systems eliminates slide drilling and optimizes penetration rates while ensuring that the drill string is always turning while drilling. Augmenting rotary speed by including a mud motor in the BHA allows higher bit rotational

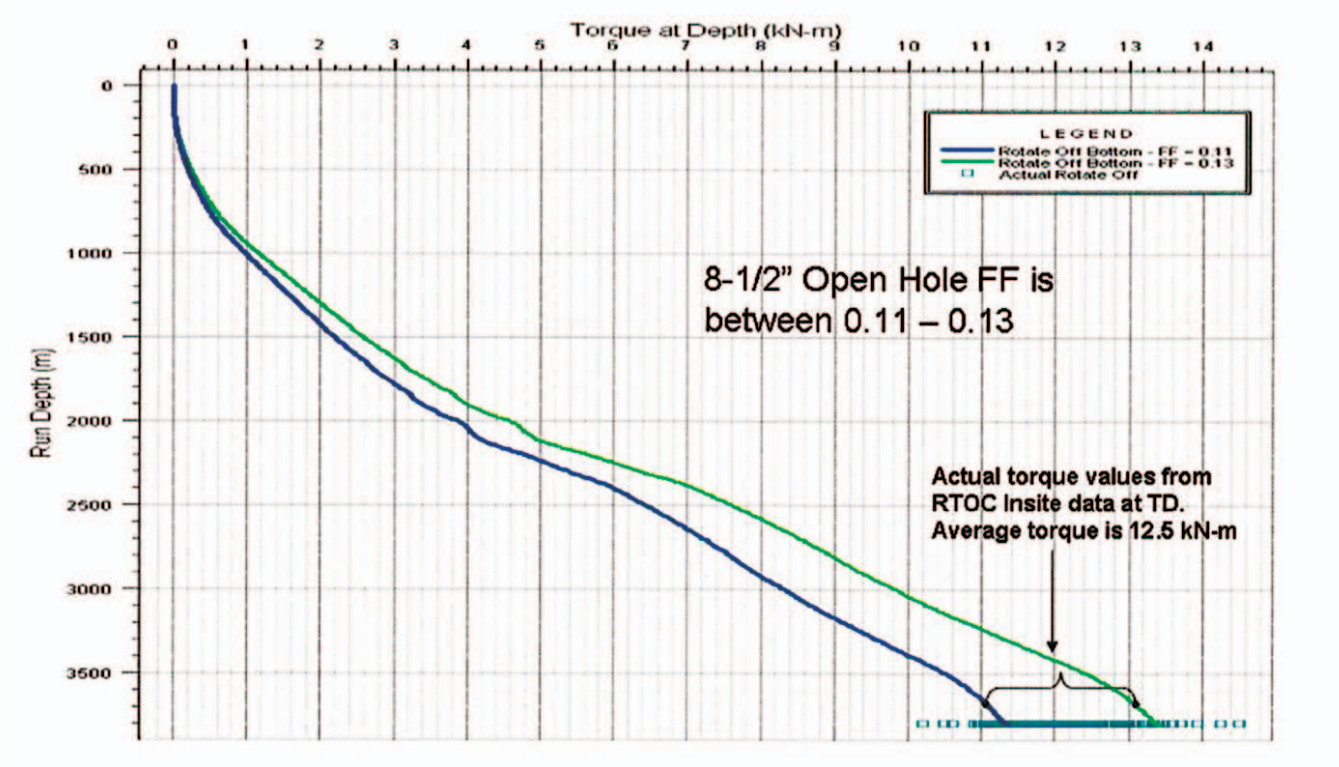

Figure 2. Rotational torque calculations in both oil-based mud (blue) and cement slurry (green) compare favorably with actual measured torque on bottom when special low-friction centralizers are used.

speeds without overtaxing the top drive and facilitates penetration rate, especially in the far reaches where weight-on-bit is limited.

Precise geosteering in ERD wells is not a luxury. It is a necessity. Even one misstep that causes the drillers to pull back and sidetrack can prevent an ERD well from reaching its planned total depth (TD). For this reason, LWD strings must be designed to include measurements that allow directional drillers to identify bed boundaries, faults, fluid contacts, and other drilling hazards in time to steer away from them. Fortunately, several excellent boundary mapping tools exist that can help guide the directional drillers.

If successful, the BP ERD wells at Liberty field will take their place among other record-setters, starting with the BP Wytch Farm development, Total's Austral field wells in Argentina, and ExxonMobil's wells at Sakhalin Island (Figure 1). These wells were similar in that they were all drilled from land drillsites. The current record belongs to Maersk Oil Qatar in the Al Shaheen field and is the only one drilled from an offshore rig.

Interestingly, according to a Maersk spokesman, the company was not trying to set a record. It had planned to drill through the Kharaib B and Shuaiba carbonates and the extremely thin Nahr Umr sandstone and, once that goal was achieved, continue to drill to maximize reservoir contact. In so doing, it made history.

The Maersk well provides a perfect example where the application of best practices pays off. Had the company not employed best practices for ERD drilling from the outset, it is highly unlikely a record would have been set. Advance planning and attention to detail during the course of well construction set the stage for a record performance.

The job is not done until the oil flows

Drilling a record-setting ERD well is one thing. Casing and completing it is another. Best practices combined with innovative equipment and experienced personnel are also essential ingredients for a successful completion.

An example comes from Sakhalin Energy, a consortium of Gazprom, Shell, Mitsui, and Diamond Gas Division of Mitsubishi, where attention to small details paid off while casing several 3-D directional wells in the Piltun-Astokhskoye project on Sakhalin Island.

Hitting casing points accurately is a major factor in successful directional well construction. A key enabler is the ability to rotate casing to bottom and while cementing to achieve uniform cement distribution around the casing and ensure hydraulic isolation.

While running a 7-in. liner to 12,464

ft (3,800 m), torque and drag loomed as potential problem areas (Figure 2). The solution in that case was installing special casing centralizers provided by Downhole Products PLC. The centralizers were installed at every liner joint for more than 3,280 ft (1,000 m). Characterized by a Teflon inner liner that makes rotation less difficult and Teflon-studded spiral blades that help the liner slide along inside the $9\frac{5}{8}$-in. intermediate casing,
the centralizers effectively reduced both torque and drag and helped the operator land the liner at TD (Figure 3). Once on bottom, the inner sleeves allowed the liner to be rotated easily while pumping cement and during precementing hole cleaning operations.

According to Kees Frederiks, senior well engineer, "The reduced friction permitted the liner string to rotate at TD while cementing, greatly improving the resulting cement bond quality. Effective zonal isolation is a very critical success factor toward the satisfactory delivery of our wells, especially those of our smart water injectors." Cement uniformity and bond quality were confirmed by ultrasonic imaging tools, cement bond, and variable density logs.

Additional challenges test engineering ingenuity

The ability to construct successfully ERD wells has spurred the adaptation of other technologies to exploit the new opportunities presented by these wells. At Alaska's West Sak development, ConocoPhillips, together with Baker Hughes and M-I Swaco, has successfully designed, built, and installed TAML (technical advancement of multilaterals) Level 4 completions together with sand management media in its ERDs.

The West Sak field lies within the Kuparuk River Unit and contains between 7 and 9 Bbbl of oil in place. The average production rate of West Sak wells did not justify their cost, so alternative drilling and completion techniques were implemented. Extended-reach dual-lateral wells with sand-exclusion screens were constructed and equipped with electrical submersible pumps (ESP). In this application, "extended reach" was defined by the well's unwrapped borehole lengths, not by the actual straight-line distance between the surface wellheads and TD.

The ability to produce two or more reservoirs from a single mother bore using dual lateral well construction proved economical, and several wells have been subsequently completed using this technology.

In Saudi Arabia's Ghawar field, Saudi Aramco, Welltec, and Schlumberger teamed up to successfully acid-stimulate an extended-reach well using coiled tubing (CT). One of the challenges inherent with CT is lockup that limits its ability to reach out laterally. By applying a powerful well tractor to pull the natural helical spiral profile out of the coil, engineers were able to successfully negotiate 8,922 ft (2,720 m) of horizontal exposed reservoir formation with a maximum inclination of 93º. While not a recent example, this case illustrates how complementary technology can overcome challenges presented by ERD well construction.

The advantages of ERD are well known. Constructing multiple wells to drain a large area from a single surface location makes economic as well as environmental sense. The ability to reach under surface areas like cities, frozen seas, or environmentally sensitive areas opens valuable reservoir prospects. In fact, if it ever comes to pass that the oil and gas industry is permitted to develop the Arctic National Wildlife Refuge, ERD will be the technique that enables maximum reservoir contact with minimum surface disturbance. Best practices will enable this work to be conducted safely and with best results. E&P

Figure 3. BladeRunner casing centralizers use Teflon-studded blades and liners to minimize sliding and rotational friction in ERD completions. (Image courtesy of Varel)


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