Integrated Services Provide Wellbore Assurance for First ERD Well in Baltic Sea

Geomechanics analysis improves efficiency for Lukoil in unstable offshore formation

**CHALLENGE**
Drill challenging sections with inclinations higher than 80° in an extended-reach (ERD) exploration well and perform an openhole sidetrack in the 6-in section after a coring run.

**SOLUTION**
Design a BHA that includes the PowerDrive X6* rotary steerable system (RSS), a full suite of LWD services, a PDC drill bit customized using the IDEAS* integrated drillbit design platform, and the MEGADRIL† oil-base drilling fluid system.

**RESULT**
- Constructed the first ERD exploration well in the Baltic Sea.
- Drilled and cased the challenging trajectory while maintaining borehole stability.
- Increased ROP in all sections compared with the nearest offset ROP.

**Deliver first extended-reach well in Baltic Sea**
Lukoil, one of the largest oil producers in Russia, was drilling the first ERD exploration well in the Baltic Sea, offshore Kaliningrad. The main challenge in planning Well D-41 was the severe wellbore instability issues experienced in the nearest offset wells. Because of these unstable conditions, the company considered any well with an inclination above 43° too challenging to drill in the reservoir.

After analyzing four types of well profiles, Lukoil planned Well D-41 with an inclination of approximately 80° in the 6-in [152-mm] horizontal. The company needed to drill a 12¾-in [311-mm] section, an 8½-in [216-mm] section, and a 6-in section with safety and efficiency in mind while steering through the challenging formations. Drilling the 6-in section included a coring run after which Lukoil planned to perform an openhole sidetrack.

**Maintain borehole stability in complex trajectory**
A team of Schlumberger drilling experts provided Lukoil with a geomechanical model that determined the best well trajectory. The team also provided an engineered drilling system with real-time LWD technologies and a workflow to maintain borehole stability.

To mitigate any geomechanics-related issues that could result in NPT while delivering optimal drilling parameters, an integrated BHA was designed with the PowerDrive X6 push-the-bit RSS for full directional control while rotating the drillstring in the narrow hole sizes and a PDC drill bit from Smith Bits, a Schlumberger company. A combination of LWD services consisting of the arcVISION* array resistivity compensated service, adnVISION* azimuthal density neutron service, sonicVISION* sonic-while-drilling service, and EcoScope* multifunction logging-while-drilling service† was also included in the BHA design. These services were selected to deliver wellbore stability and pore pressure analysis.

The chart compares the average ROP achieved in the nearest offset wells in the field offshore Kaliningrad with the average ROP achieved in Well D-41 using the Schlumberger integrated drilling system.
The real-time measurements they provided were used to establish the mud-weight boundaries needed to safely drill the challenging trajectory without costly delays or incidents.

The MEGADRIL oil-base drilling fluids system from M-I SWACO, a Schlumberger company, was selected to address hole stability issues. The MEGADRIL system reduces rheological properties and improves hole cleaning capabilities.

**Increase ROP with improved drilling efficiency**

Using these integrated technologies to inform decision making and improve drilling performance, Lukoil was able to drill and case the narrow sections in the first ERD exploration well in the Baltic Sea at an inclination greater than 80°. There were no wellbore stability incidents.

After coring through the 6-in section, Lukoil was able to kick off from the cement plug and land in the reservoir.

High-quality data acquired by the ImPulse integrated MWD platform and adnVISION service were used to evaluate the reservoir and characterize formation porosity and lithology in real time. The sonicVISION data were also used to improve real-time monitoring of the wellbore while positioning the casing.

Finally, the EcoScope service provided multiple LWD sensors at fast logging speeds as ROP increased in the sections. In the 6-in section, ROP increased by approximately 30%. In the 12¼-in section, ROP increased more than four times the ROP of the nearest offset well, and in the 8½-in section, ROP increased 10 times more than the nearest offset well.

Lukoil plans to drill more high-angle wells in the surrounding area using this proven Schlumberger integrated drilling system.

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