Streamlined Well Construction Eliminates 71 Days of Rig Time, Saving Consortium USD 90 Million

HALLIBURTON SETS NEW DEEPWATER BENCHMARK IN BRAZIL'S DEEPWATER LIBRA FIELD

LIBRA FIELD, BRAZIL

CHALLENGES

- Stuck bottomhole assembly (BHA) from salt drilling and salt creep
- Managing salt risks during cementing
- Coring performance in hard carbonate formation
- Dynamic reservoir evaluation
- Safety and economic risks of deepwater operations

SOLUTIONS

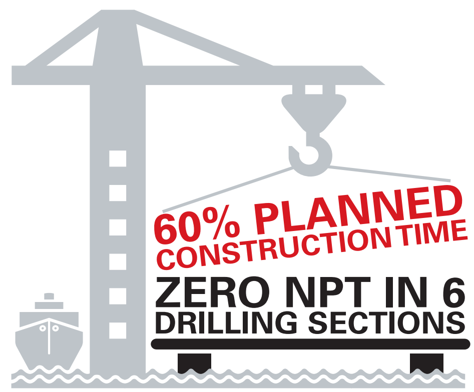
- Engineered BHA configuration to minimize energy loss and reduce bit wear
- ADT® drilling optimization service and creep control to identify and mitigate salt creep effects
- iCem® service analysis for cement slurry design for salt section
- SaltShield™ cement to minimize salt impact on slurry rheology
- RockStrong™ coring system to mitigate vibration and abrasion in hard formation
- RezConnect® well testing system to ensure safe and controlled operations

RESULTS

- More than 71 days of rig time saved
- Zero nonproductive time (NPT) in six drilling sections
- Well completed in 60% of planned time
- Approximately USD 90 million in savings for the consortium, setting a new benchmark for the Libra ultra-deepwater exploration field
- Zero safety or environmental incidents

OVERVIEW

In November 2014, the Libra Consortium in Brazil drilled the first pre-salt well in the Libra field at a water depth of 1,963 meters (6,440 feet). Drilling and constructing an ultra-deepwater well with a very thick salt zone and a hard carbonate reservoir presented specific challenges and included significant risks and costs.



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Drilling long extensions of salt can be problematic and result in instances of of stuck bottomhole assemblies (BHAs). One mitigating technique is to drill the section quickly and with a large borehole. Halliburton used an optimized drilling BHA that included a polycrystalline diamond compact (PDC) bit, an at-bit reamer, and a Geo-Pilot® 9600 rotary steerable system. This BHA configuration reduced the energy loss to the drilling system, thereby minimizing bit wear and allowing for faster drilling of the salt section while reducing the risk of getting stuck.

Salt creep, the closing of the borehole in the salt zone due to its inherent plasticity, is one of the reasons these sections are problematic. Close real-time monitoring is critical for anticipating and quickly addressing any downhole issues during drilling. Halliburton used Applied Drilling Technology (ADT®) and Applied Fluids Optimization (AFO) to monitor parameters mass specific energy, effective circulation density, and bit torque and drag to proactively adjust drilling parameters in zones where the invasive salt began to cause the drillstring to stick. This geomechanic creep-control method combined with the enhanced BHA design helped to reduce the anticipated time for drilling through the salt section by 12 days.

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In some cases, the salt can react with cement slurries, forming a gel. This hinders the ability to effectively pump the cement in the annular and can drastically change the curing characteristic of the slurry. In addition, salt creep or other mechanisms of formation deformation could damage the cement sheath and/or casing. The analytical Halliburton iCem® service was used to optimize cement job parameters. SaltShield™ cement blend was developed

for salt formations to ensure slurry rheology during pumping and to maintain its integrity for the life of the well. Benefits included reduced nonproductive time (NPT).

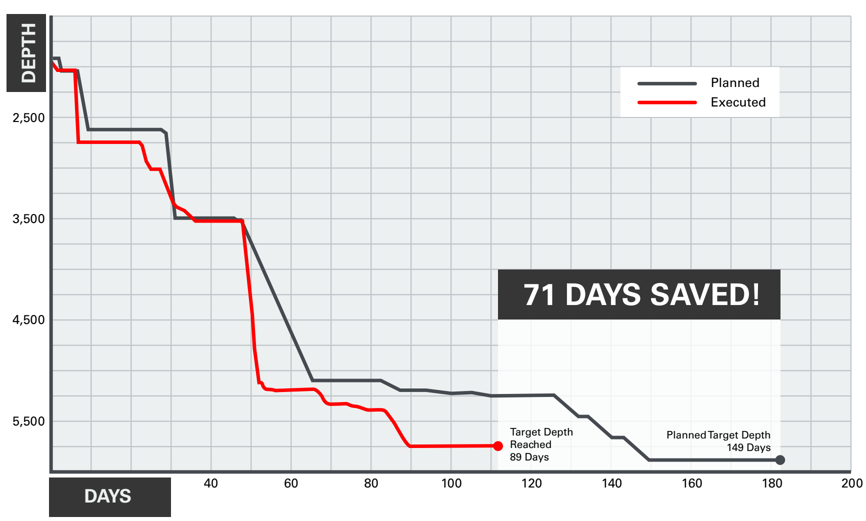
After drilling through the salt zone, the hard carbonate reservoir below presented several additional challenges. Vibration and abrasion during coring in these hard formations can significantly reduce core recovery efficiency, resulting in extra runs, NPT, and additional costs.

Halliburton used the RockStrong™ coring system to reduce the impact on performance from large vibrations. The system decouples the shaft from the outer barrel to isolate the barrel from typical vibrations. It also includes a spring-loaded spacer to absorb axial vibrations. Its deployment resulted in only two runs in the 12¼-inch reservoir section, recovering 27 meters (89 feet) and 36 meters (118 feet), respectively. This represented a recovery efficiency of 99.5%, and resulted in eight days of saved rig time.

After completing the drilling, Halliburton deployed the RezConnect™ well testing system to evaluate the reservoir during the drillstem test (DST). This is the industry's first fully acoustically actuated DST system, which ensures reliable real-time data while running in hole (RIH) and pulling out of hole (POOH) from downhole sensors. In addition, it alleviates the need for applying annulus pressure to operate tools by using acoustic telemetry. The result was a highly controlled and safe testing operation, complete with redundancy options that provided uninterrupted reservoir insight during the entire operation.

Halliburton provided integrated project management across multiple product service lines to streamline these individual technologies in a well construction solution that could reduce overall consortium costs. The end result was a 60% reduction of the planned well construction time, or 71 days of rig time. The methods and technologies introduced have become the benchmark for executing wells in the pre-salt carbonates of the extensive Libra field.

Well Execution Timeline



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