

Integration Drives Performance and Accelerates Learning Curve in Russian Arctic Project

HALLIBURTON TEAM DELIVERS EIGHT HORIZONTAL WELLS 36 DAYS AHEAD OF DRILLING PLAN

RUSSIA

CHALLENGES

- » Remote region with no roads and minimal infrastructure
- » Harsh arctic climate conditions
- » Geological uncertainties
 - Coal beds
 - Hard stringers/high vibration
- » Gas migration
- » Compliance with quarantine guidelines due to global pandemic

SOLUTION

- » Comprehensive mobilization plan including sufficient quantity of backup tools
- » New GeoTech® bit design with latest GEOMETRIX™ shaped cutters
- » JetPulse® high-speed telemetry system with compression data transmission technology
- » Advanced BHA modeling
- » Ninety-day crew shifts

RESULTS

- » Saved 36 days on the project delivery time
- » Executed entire Halliburton operation with < 1% NPT and zero HSE incidents
- » Achieved high drilling performance benchmarks
- » Increased well construction rate by 26%

OVERVIEW

To increase production, Novatek has selected Halliburton as a main service provider to drill horizontal wells with lateral sections up to 1500 meters long for the Yamal LNG well construction project in the Yuzhno-Tambeyskoye gas field. The Yamal LNG project is one of the largest production projects in the world, with proven and probable reserves estimated at 926 billion cubic meters. The field is located in the remote area of Sabetta in Russia's Yamal Peninsula within the polar circle in the estuary of the Ob River – a wild, remote region that is frozen seven to nine months a year and where winter temperatures can drop as low as -50°C.

Leveraging Halliburton Project Management's (HPM's) "4P" framework – People, Process, Platforms, and Partners – was the key to improving operational efficiencies and maximizing drilling performance. The HPM team started with a coordinated effort focused on planning logistical solutions to mobilize equipment and materials to the remote area.

During execution, the HPM team partnered with Halliburton product service lines (PSLs) – including Drill Bits and Services,

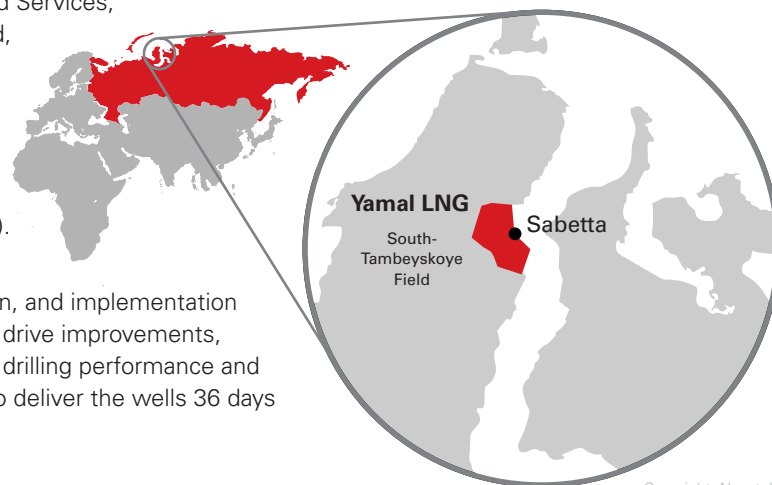
Sperry Drilling, Baroid, and Cementing – in a joint effort to provide solutions to mitigate downhole problems, and to optimize rates of penetration (ROPs).

The outcome of this proactive collaboration, and implementation of lessons learned to drive improvements, resulted in enhanced drilling performance and enabled Halliburton to deliver the wells 36 days ahead of plan.

FACING DRILLING CHALLENGES IN A HARSH ARCTIC ENVIRONMENT

Among the challenges that Halliburton faced were extremely low temperatures and a very remote location with no accessible roads. Diligent planning for any potential mobilization issues was crucial to meet spud dates, decrease well construction time, and deliver producing wells on time.

Since the drilling was carried out from a new pad, geological challenges, such as the presence of coal beds, posed a risk of wellbore collapse, which could lead to potential stuck



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pipe and loss of a bottomhole assembly (BHA). The presence of hard stringers posed a risk of high vibrations that could have resulted in low ROP and bottomhole tool failures.

Also, while drilling through a number of gas formations, the customer had experienced low cementing quality, resulting in gas migration. This required remedial cementing operations with additional costs and materials.

Additionally, due to the global COVID-19 pandemic, the Halliburton team had to quickly meet the unexpected challenges of complying with quarantine guidelines and protecting the crews against this virus without adversely affecting the project's schedule.

IMPLEMENTING INNOVATIVE SOLUTIONS TO MITIGATE GEOLOGICAL CHALLENGES

Harsh arctic conditions and the remoteness of the field required detailed and considerable logistical efforts. For this purpose, during planning, the HPM team engaged a logistics specialist and mobilized cementing materials and drilling fluids, as well as heavyweight drilling equipment weeks ahead of the project's start. Advanced mobilization was optimized using sea transport. To mitigate execution risks, and to also ensure seamless and timely well delivery, all drilling equipment was mobilized with several backup equipment units.

Drilling in Yuzhno-Tambeyskoye field is associated with high variations of facies and lithology. Common challenges are related to the presence of thick carbon layers, uncertainty of gas/water contact (GWC), complexity in estimating porosity and permeability, and the structural composition of formations. Therefore, a team of multidisciplinary experts from across Halliburton PSLs analyzed and identified areas of opportunity to optimize the well construction time.

First, to achieve all the well construction targets despite the geological challenges, and to allow timely decisions on adjusting the well trajectory without sacrificing ROP, it was decided to use expanded sets of logging data and geo-signals. This data, along with better subsurface mapping, allowed for an enhanced understanding of the geology and a reduction in uncertainty.

The JetPulse® high-speed telemetry system, in combination with compression data transmission, was implemented for the first time in Russia. This system ensured consistent and adjustable high-speed transmission of drilling parameters in real time, along with measurements for formation evaluation, resulting in improved drilling safety and efficiency (SPE-201869-MS).

Furthermore, to eliminate high vibrations while drilling through hard stringers, and to increase ROP in the 8¾-inch and 6-inch sections, the Halliburton team designed new customized GeoTech® PDC bits with the latest GEOMETRIX™ shaped cutters.

To mitigate all the risks with wellbore cleaning and instability, advanced hydraulic modeling and lab testing were conducted by the Baroid technical team. As a result, optimal flow rates and rheology parameters were determined for each section for safer drilling at maximum ROP. Additionally, the ADT® service was used for drilling performance optimization by monitoring operations versus roadmaps of the main parameters during drilling, reaming, tripping and casing/liner running operations.

To increase cementing quality and mitigate gas migration risks, WellLock® additives were successfully utilized to prevent gas migrations.

With the strict quarantine guidelines implemented in the field due to the global COVID-19 pandemic, the number of days between crew shifts was increased up to 90 days. Moreover, personnel were required to quarantine for two weeks before boarding their flights. All the field engineers adapted to these personal and professional challenges. The crews continued to work together – developing incredible resourcefulness in their strong dedication to service quality, despite the difficult and harsh arctic work environment, which was made even more difficult with the pandemic restrictions.

IMPLEMENTING EFFECTIVE SOLUTIONS ENABLES PROJECT TO BE DELIVERED AHEAD OF PLAN

Comprehensive planning, an efficient organizational structure, and the introduction of new technologies resulted in the safe and successful construction of eight horizontal wells in the Yuzhno-Tambeyskoye field.

Implementation of the compression data transmission technology in combination with the JetPulse™ high-speed negative pulse telemetry system, achieved the required data density and allowed prompt decisions to be taken under challenging geological conditions while drilling at ROP twice the average ROPs than while drilling with the positive pulse telemetry system through the pay zone of the reservoir. The average ROP in the lateral section of the last well in the pad was 26% higher than planned.

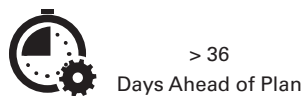
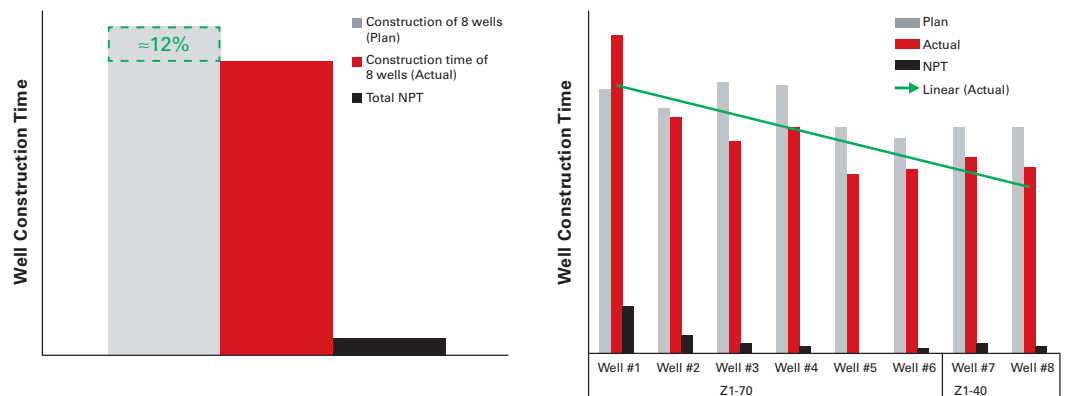
The new telemetry system allowed for expanding the possible flow rate range and for receiving a large amount of data from downhole tools. For example, the pressure-while-drilling (PWD) sensor constantly measured equivalent circulating density (ECD) and made it possible to promptly predict the wellbore conditions and to mitigate risks (SPE-201869-MS).

Furthermore, during the project execution, the increased data set let the multidisciplinary team of experts develop a set of drilling procedures aimed at flat time reduction through optimization of operation processes such as:

- » Decreasing the number of reaming operations before making connections
- » Reducing the time required for taking surveys and sending commands to the rotary steerable system (RSS)
- » Increasing tripping speed
- » Reducing the time for pumping cleaning sweeps
- » Eliminating the wiper trip before running the slotted liner

By effectively applying these key innovative solutions, along with the new bit designs, and by focusing on process execution, as well as on close collaboration with internal (cross-PSL) and external partners (the operator and rig contractor), the Halliburton project team was able to maximize drilling performance and accelerate the operator's production by saving 36 days on the project delivery time.

Along with the technological progress, it is important to note that the entire Halliburton operation was completed with < 1% non-productive time (NPT) and with zero health, safety, and environmental (HSE) incidents.



In addition to achieving 100% of the geological targets, invaluable practical experience was gained for the well construction in the Yuzhno-Tambeyskoye field. This project has been a clear example of how advanced technologies can push the boundaries of drilling efficiency and provide development of resources that seemed hard to reach until recently. Along with the achieved results, the acquired knowledge will be useful for developing technological solutions in terms of optimizing the time and cost of constructing future wells both in the Yamal region and in other oil and gas provinces of Russia and the CIS countries.

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