

# Petrobras achieved record results with Halliburton drill bits in deepwater wells

Custom bit designs key to new benchmark performances in hard rock



## OVERVIEW

Petrobras wanted to save money and rigtime as it drilled offshore wells in southern Brazil. Previous attempts to drill through these hard formations achieved rates of penetration (ROP) of just four to six meters per hour. Petrobras wanted to increase the ROP and turned to Halliburton, who customized two drill bits to power through the carbonate formations of the pre-salt wells with low levels of vibrations in the downhole tools.

Halliburton set a new record by drilling one well with the 16-inch FM3653Z bit at a ROP of 10.4 meters per hour, saving Petrobras 16.5 days of drilling time and \$8 million USD. In another well, the 8 1/2-inch FXD74D bit drilled at a ROP of 7.2 meters per hour, saving 75 hours of drilling time. Petrobras was so impressed with the results, it's now using the Halliburton on-site Design at the Customer Interface (DatCI<sup>SM</sup>) process to develop bits for use in other wells.

CHALLENGE	SOLUTION
<p><b>Drill through hard pre-salt reservoir formations</b></p> <p>Petrobras needed bits capable of drilling the entire section into the pre-salt reservoirs of two wells with higher ROP. These sections were very complex, comprised of different layers with varying degrees of hardness.</p>	<p><b>SPARTA™ analysis software used to optimize drill bits</b></p> <p>Halliburton used its SPARTA™ rock mechanics analysis model to optimize bit selections. The analysis pinpointed what the main challenges of the formations were and enabled Halliburton to customize two drill bits to successfully drill through the formations.</p>
<p><b>Reduce number of trips downhole</b></p> <p>Petrobras wanted to reduce the number of downhole trips during drilling. In previous wells in the region, drill bits needed to be changed out two to three times just to drill 200 meters downhole. This increased production costs and rigtime by causing extra trips to the surface.</p>	<p><b>Customized drill bits successful in one trip</b></p> <p>Halliburton optimized the FXD74D and the FM3653Z bits to drill these harder formations. The structural designs increased the amount of diamond available to drill. The designs also reduced vibration and tool failure. Petrobras drilled through both sections in just one trip downhole.</p>
<p><b>Increase rate of penetration in section</b></p> <p>Petrobras needed drill bits capable of drilling into both pre-salt reservoirs with higher rates of penetration. Based on the history of the fields, the average rates of penetration were 4.3 and 6.3 meters per hour, respectively.</p>	<p><b>Halliburton achieved record runs for bits</b></p> <p>The FXD74D bit successfully drilled the 8 1/2 inch section with an ROP of 7.2 meters per hour, saving \$1.5 million USD. The FM3653Z bit drilled a 1,594-meter section at 10.4 meters per hour. This run set a new record and saved Petrobras over two weeks in rigtime and more than \$8 million USD.</p>

# ZERO TOOL FAILURES

## DESPITE THE HARD, VARIABLE FORMATION

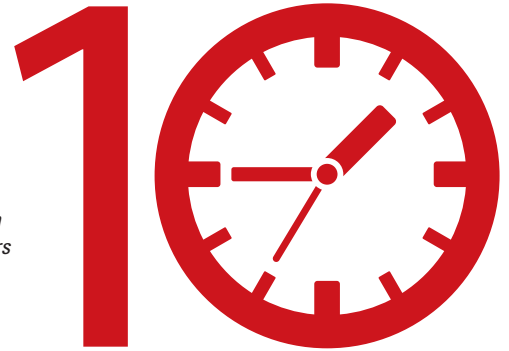
With the use of SPARTA™ analysis software, Halliburton customized the FXD74D and FM3653Z bits to drill hard carbonates of pre-salt reservoirs and hard and interbedded post-salt formations of two different offshore wells. These customized bits and real-time monitoring lowered vibrations, increased rate of penetration and caused no tool failure during drilling in both wells.



The customized FXD74D and FM3653Z bits drilled through the extremely hard and interbedded formations in just one trip downhole.

# ONE TRIP DOWNHOLE

## RECORD RUN



The FM3653Z bit successfully drilled a 1,594-meter section in one well at 10.4 meters per hour, a record for the bit in the area.

# METERS PER HOUR



AND

# \$8M SAVED

Halliburton drilled a record run with the FM3653Z bit in just 8.5 days, saving Petrobras 16.5 days of drilling time and over \$8 million USD.

## Custom bit designs key to new benchmark performances in hard rock



### Hard pre-salt section in deepwater wells caused drilling challenges

Petrobras, a multinational energy company, met several challenges while drilling offshore wells in southern Brazil. Petrobras wanted to save money and rigtime while drilling through very hard formations into the pre-salt reservoirs. Previous attempts to drill through these formations only achieved a penetration rate of four to six meters per hour. The formation also prematurely wore out drill bits and caused tool failure, requiring multiple trips downhole. Petrobras wanted to increase the rate of penetration and drill through these sections in just one run downhole. Petrobras chose Halliburton to help overcome these challenges in two different wells. Halliburton recommended using two customized bits to power through this hard rock in each well and optimized the bit design to help solve Petrobras' challenges.



### Halliburton analyzed formation to optimize bit

Halliburton used its SPARTA™ rock mechanics analysis model, part of its on-site DatCI<sup>SM</sup> process, to optimize bit selections for this particular formation. Halliburton analysis found the main challenge was in the carbonate section, which was very complex due to different layers with varying degrees of hardness. The top section consisted of very hard shale, marl, and sandstone, while the bottom section consisted of carbonates and volcanic rock. Halliburton used the SPARTA models to optimize the FM3653Z and the FXD74D bits to deal with these challenges.



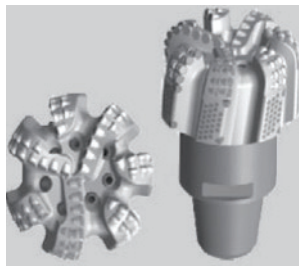
### Petrobras wanted to decrease the number of trips downhole

Petrobras wanted drill bits that could drill through these hard formations with fewer trips downhole. In the past, drilling just 200 meters downhole required two to three trips to change out bits. This increased production costs, rigtime and could delay drilling. With the use of SPARTA analysis software, Halliburton made modifications to both bits, enabling Petrobras to drill through both formations, – 248 meters in one well and 1,594 meters in another well – in just one trip downhole for each well.

### Petrobras needed increased rates of penetration

In this deepwater application, where offset costs reached more than \$26,000 USD per meter, Halliburton needed to provide bits capable of drilling into pre-salt reservoirs with higher rates of penetration. The average rates of penetration in these wells ranged from just 4.3 to 6.3 meters per hour. Petrobras wanted to increase ROP and reduce vibration levels to help logging tools function properly.

## Custom bit designs key to new benchmark performances in hard rock



### Halliburton technologies led to record runs downhole

Halliburton optimized the FXD74D and the FM3653Z bits to power through the hard rock at higher rates of penetration. The modified designs featured new blade geometry designed to increase stability, mitigating vibration problems. The blades combined abrasion and impact resistance with greater thermal stability, enabling the bit to withstand friction heat while limiting heat build-up.

Halliburton designed a dual row cutting structure on the FXD74D bit and a single row structure with high cutting density on the FM3653Z bit. These designs increased the amount of diamond available to drill the harder formations. Advanced computational fluid dynamics analysis provided hydraulic optimization that maintained cleaning and cooling of the structure. Halliburton also used its Geo-Pilot<sup>®</sup> XL rotary steerable system, which is more robust and better supports the extreme drilling conditions. Halliburton optimized the bottomhole assembly with its MaxBHA<sup>™</sup> software.

These combined efforts resulted in faster, more durable bits. The FM3653Z bit successfully drilled a 1,594-meter section in one well at 10.4 meters per hour, a record for the bit. In another well, the FXD74D bit drilled the entire 8 1/2 inch section in just one run downhole, reaching an ROP of 7.2 meters per hour.

### Petrobras saved days of rigtime and millions of dollars

Halliburton drilled a record run with the FM3653Z bit in just 8.5 days, saving Petrobras 16.5 days of drilling time and over \$8 million USD. Halliburton also saved 75 hours of rigtime in the other well, and dropped the cost per meter to just \$2,486, saving Petrobras more than \$1.5 million USD. Halliburton technologies helped establish new benchmark performances for this region with faster ROPs and reduced number of trips downhole.

### Petrobras plans to use DatCI<sup>SM</sup> process in other wells

Petrobras was so impressed with the customization and optimization of the drill bits used by Halliburton that it now plans to implement the entire DatCI process for other wells in the region. The DatCI process is a custom process that helps customers plan, design, optimize and manufacture application-specific solutions. It is unique solutions such as these that make Halliburton one of the market leaders in drill bits and services.