Baker Hughes

Case study: North Sea

xSight service improved efficiency, performance of 7-in. single-run casing exit, saved $520,000 USD

A major customer in the North Sea faced a challenging casing exit. The objective was to successfully run and set a whipstock, and to mill a window out of a 7-in liner at 21,800 ft (6644 m) with 68° inclination, in a single run. In addition, the challenge was to improve milling performance from historical jobs by incorporating predictive and prescriptive analytics.

Baker Hughes recommended an exclusive combination: the **WindowMaster G2™ whipstock system** with the **xSight™ smart intervention service**. The WindowMaster system combines a one-trip capability with a full-drift outside diameter (OD) window mill. This state-of-the-art system saves substantial rig time by eliminating at least two round trips with drillpipe, which are required by conventional window-cutting systems. The xSight service improves window milling efficiency by observing downhole data such as weight, torque, equivalent circulating density (ECD), vibration, and differential pressure in real time.

The well consisted of a $9^{5}/_{8}$-in. casing and a 7-in. liner set from 14,850 ft (4526 m). When the bottomhole assembly (BHA) reached the top of the liner, Baker Hughes field personnel initiated circulation to observe downhole set-down weights. Only 1 to 2 tonnes (2,204 to 4,408 lb) was observed at the surface, but a 5-tonne (11,020-lb) measurement was observed downhole. As a result, the string was properly adjusted and the BHA was able to enter the liner without set-down weight. Real-time downhole data, provided by the xSight service, helped avoid a pre-set or shearing of the whipstock assembly bolt. At the setting depth of 21,800 ft (6644 m), the xSight service enabled successful orientation and setting of the whipstock.

In collaboration with the customer, the xSight service collected a rich data set of downhole measurements in multiple casing exit operations. Baker Hughes engineers collected data sets from five historical operations from the same field to optimize milling parameters through analytics modeling. A predictive and prescriptive analytics workflow was developed and applied to the customer's offset well. This workflow involved three major steps:

- Preprocessing data to cleanse, transform, and aggregate data from past casing exits
- Building accurate machine learning models to predict milling performance
- Optimizing objective functions to recommend best-case operational parameters

Drawing on the analytics modeling, a recommended milling schedule was provided to the completions and well intervention (CWI) team. This milling schedule prescribed rotational speed (RPM) and downhole weight on bit (WOB) at incremental positions along the length of the whipstock.

The WindowMaster G2 whipstock system included a BHA consisting of an upper and lower mills dressed with **Glyphaloy™ advanced milling technology (AMT) cutters**, **SilverBack™ window mill with G-3 cutters**, and a **PathMAKER™ formation mill** which enables a one-trip casing exit and rathole.

Challenges

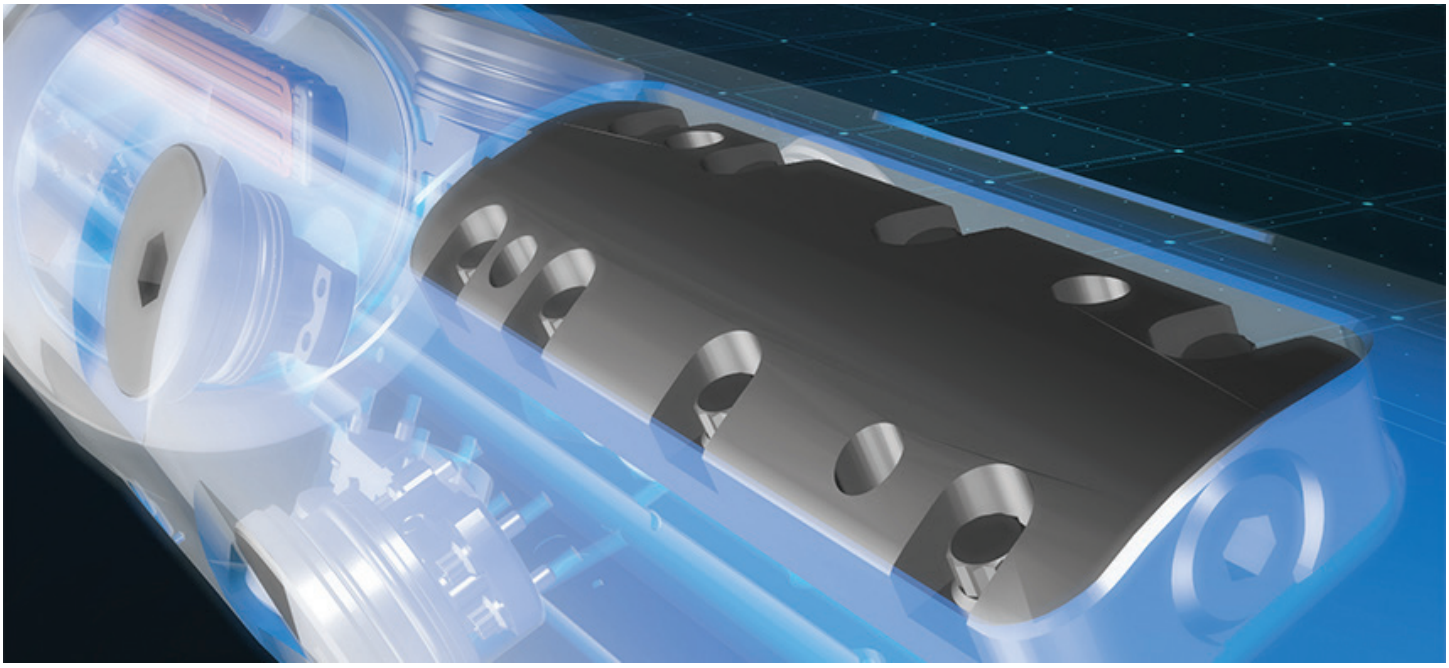
- Set whipstock at 21,800 ft (6644 m) with 68° inclination and mill window in a single run
- Recommend operating parameters from data analytics models
- Improve milling performance compared to historical jobs

Results

- Prevented premature anchor setting and bolt-shearing of milling assembly using real-time data
- Corrected inability to enter 7-in. liner at 14,850 ft (4526 m) by verifying set-down weight with real-time data
- Set whipstock and milled window in a single run using recommended operating parameters from prescriptive analytics models (i.e., RPM, WOB)
- Improved milling performance compared to historical jobs
  - 14% increased ROP
  - 23% reduced mill time
  - 30% reduced vibration
  - 70% reduced drag
- Experienced no health, safety and environmental (HSE) issues or nonproductive time (NPT)

The BHA milled the window with a 14% increase in ROP, a 23% reduction in milling time, a 30% reduction in vibration, and a 70% reduction in window drag. During the window milling operation, the xSight system delivered real-time feedback, allowing the CWI team to monitor and adjust milling parameters. When the mills were examined after the operation, the mills were fully in-gauge, indicating a successful casing exit and a significant improvement in milling performance.

The customer was extremely satisfied with the results delivered by the expertise of the Baker Hughes team and the combination of the WindowMaster system and the real-time results provided by the xSight service. The solution saved the customer approximately 42 hours of rig time, at a cost of $520,000 USD. The Baker Hughes team conducted the operations flawlessly, experiencing no health, safety and environmental (HSE) issues, and incurring no nonproductive time.



xSight services offer live downhole sensing and fluid-driven power generation, bi-directional communication between the bottomhole assembly and the surface to optimize operations at the rig, and cloud-based services like remote monitoring, real-time operational advice, and broad-spectrum digital insight.

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