

# Lift IQ Service and Engineered Systems Dramatically Extend ESP Run Life in Mature Field, North Sea

Holistic approach overcomes sand and temperature challenges to reduce total cost of ESP ownership

## CHALLENGE

Improve North Sea field economics by increasing the mean time between failures (MTBF) for electric submersible pumps (ESPs).

## SOLUTION

- Monitor and optimize well and ESP performance using the Lift IQ\* production life cycle management service.
- Design and deploy fit-for-purpose REDA\* Maximus\* ESP systems in most wells and MaxFORTE\* high-reliability ESP systems in new, highly productive wells.

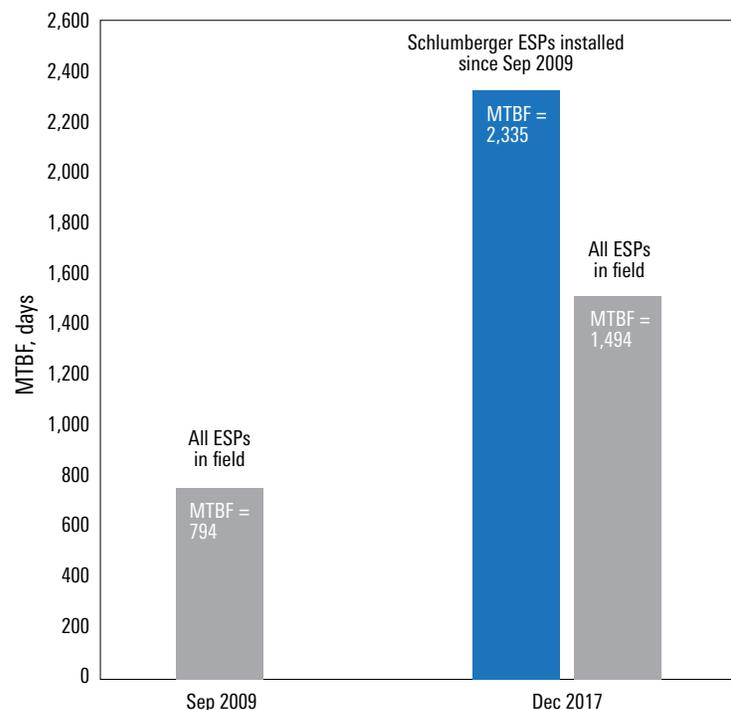
## RESULTS

- Improved MTBF by nearly 200%, from 794 to 2,335 days, significantly reducing total cost of ownership of the ESPs.
- Reduced frequency of critical events by 64%.



## Sand and temperature effects reduce ESP run life

ESPs from various providers have been deployed in about 50 wells in a North Sea field since the early 1980s. As the field matured, water cut, scale deposition, and sand production increased. At one point, abrasion damage accounted for 78% of all ESP failures. The technical challenges were compounded by the need for high-horsepower tandem motors with the ability to withstand sustained downhole temperatures of 95 degC [203 degF].



*Engineered ESP system improvements combined with 24/7 surveillance through the Lift IQ service almost tripled MTBF in a mature North Sea field from 2009 through 2017.*

By September 2009, MTBF (defined as cumulative number of run days/number of failures) was 794 days. While more than satisfactory for some applications, in this case the combination of some ESPs below this level, high workover costs in the offshore environment, and declining production from the mature field made the total cost of ownership (TCO) for ESPs uneconomical. To reduce lifting costs, the operator tendered the entire work scope and mandated a minimum guaranteed run life (GRL) of 2 years (730 days). Schlumberger was awarded the work and in 2014, the GRL for Maximus and MaxFORTE systems was further increased to 2.5 and 4 years (913 and 1,460 days), respectively.

## Surveillance and engineered ESP systems enhance performance

To meet the challenge Schlumberger adopted a holistic approach, combining root cause failure analysis, advanced hardware engineering, and 24/7 real-time surveillance with the Lift IQ production life cycle management service.

Level 2 Lift IQ service uses experienced surveillance engineers to monitor artificial lift performance with real-time data delivered from each well to a Schlumberger Artificial Lift Surveillance Center (ALSC). The data includes alarms for critical events—conditions that require immediate action to avert an ESP failure—including deadhead events, blockages, pumpoff conditions, and subminimal speeds.

When ESPs did fail, the combination of historical remediation data and dismantle inspection failure analysis (DIFA) enabled development of customized operating procedures and hardware designs specific to that well or section of the field. ESPs were replaced with more robust Maximus and MaxFORTE systems designed specifically to survive the failure mechanism for that well, whether corrosion, abrasion, scale, or something else.

Improvements incorporated into the new systems included

- 5530 alloy stage material to improve corrosion and erosion resistance
- silicon carbide sleeves and bushings to increase hardness and resist abrasive wear
- full-bearing housing configuration to increase shaft stability
- sand shedders and retainers to mitigate sand fallback damage
- advanced protector technology to improve and protect the shaft seal and drain abrasives
- improved motor bearing design to maintain operation even under poor lubrication

- mine-duty motors with increased insulation thickness and low-stress winding design to handle high-horsepower applications at 95 degC and operating motor winding temperatures of up to 140 degC [284 degF]
- high-viscosity oil, thicker wiring insulation, fully varnished motor stator, high-temperature stator laminations, and a low-stress winding process to improve motor reliability.

### Holistic approach surpasses minimum GRL mandate

From 2009 through 2017, ALSC engineers responded to 400 critical ESP events, making immediate recommendations for remedial actions to prevent damage or failure. Not only were critical events rapidly resolved, but the lessons learned helped the operator's field staff avoid recurrence. As a result, the frequency of these events decreased from 1.4 per well year in 2012 to less than 0.5 in 2017, an improvement of 64%.

MTBF for Schlumberger ESPs installed since 2009 was 2,335 days (>6 years) at the end of 2017, nearly three times the 2009 MTBF for all ESPs in this field. In addition, MaxFORTE systems in the field have more than 12 years of cumulative installed days with zero failures to date. Proactive monitoring and the changes in ESP system designs have significantly improved the lifting performance of the entire field.