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JACK UP HPHT DRILLING RISER DEVELOPMENT.

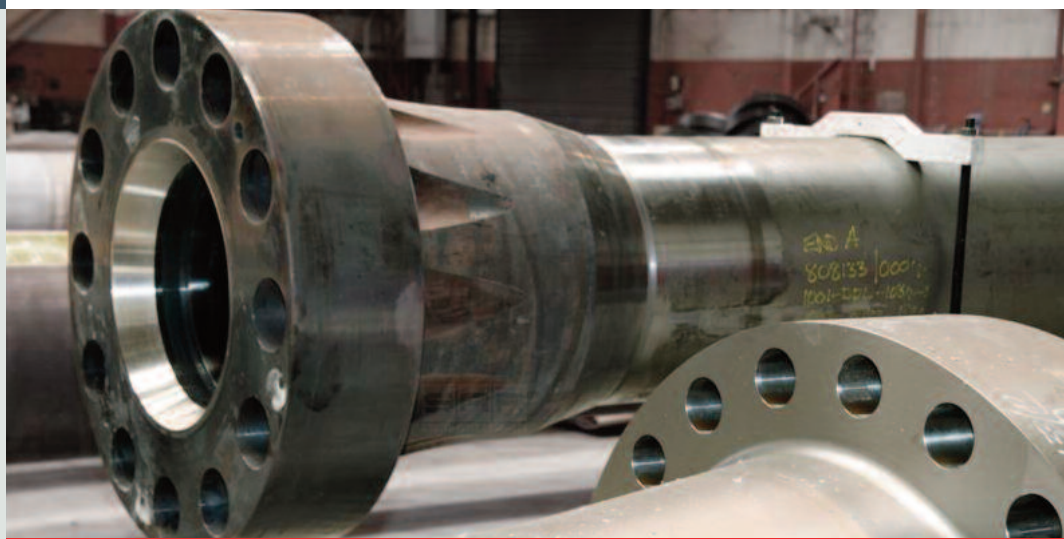
New technology, delivered through the combined strength of Claxton, 2H Offshore and SRP, enables HPHT drilling from jack up rigs.

Acteon companies Claxton, 2H Offshore (2H) and Subsea Riser Products (SRP) received an order from Centrica (formerly Venture Production) to provide an ultra-high-pressure riser for use during a high-pressure, high-temperature (HPHT) drilling campaign in the North Sea scheduled for the fourth quarter of 2009.

The riser has a unique design. It is the world's first full-bore access 18¾" riser capable of working at pressures in excess of 12,000 psi. Linked to this, the flanges used to connect the individual pipe sections were attached using a shrink-fit process; the first time this technology was used in this application.

The riser enabled Venture to drill and complete HPHT subsea wells from a jackup drilling rig employing a surface blowout preventer (BOP), which provided significant cost benefits and operational efficiencies. Venture contracted the Noble Scott Marks, then under construction in China, for the HPHT campaign.

Alistair Montgomery, senior drilling engineer, Venture Production, said, "With HPHT drilling on the increase across the industry and given the tight rig market, a solution that enabled us to use a jackup rig and have the full-bore access necessary to carry out subsea completions was highly significant. The contract award was the result of months of collaboration with the three Acteon



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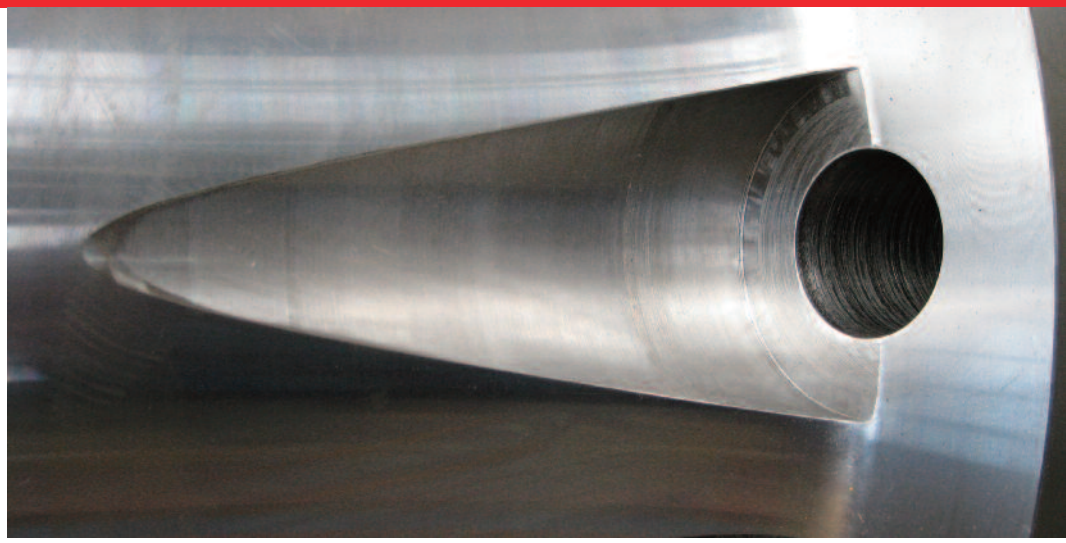
companies, as well as tree supplier FMC and drilling contractor Noble Drilling. During this process safety, operational efficiency and ensuring effective systems interfaces were among our top concerns. Designing a riser of this large diameter for use at such high pressures poses considerable challenges. Engineers are forced to use either high-wall-thickness or high-strength steel, both of which are very difficult to weld, especially in cases such as this where NACE sour service requirements are cited. The proposed solution, shrink fitting the flanges to the pipes, was the key to this entire project. Shrink fitting eliminated the need for welding; high-strength and fatigue-resistant connections were made in essentially non-weldable materials.

2H and SRP undertook an exhaustive development and testing programme to qualify this technology, which is likely to find broad application for both shallow and deepwater riser systems in the future.

Dannie Claxton, engineering director, Claxton Engineering, said, “We worked closely with our Acteon colleagues to offer Venture this very practical solution to the challenges of drilling high-pressure wells. The first of its type in the world, the riser is important because it gave Venture the opportunity to make a cost-effective step out in drilling practice: one we expect others to follow.”

As well as acting as the lead contractor, equipment integrator and offshore service supplier, Claxton provided a range of ancillary equipment, including an umbilical, wellhead and BOP connectors, a tensioning ring, and a hydraulic power and control system. A team from Claxton



was responsible for running and pulling the riser on the rig, and for its inspection and maintenance.

2H carried out the initial riser design and analysis work, and SRP led the development of the new shrink-fit technology. SRP was ultimately responsible for supplying the riser, which had 13 main sections plus fatigue-critical, tapered stress and tension joints.

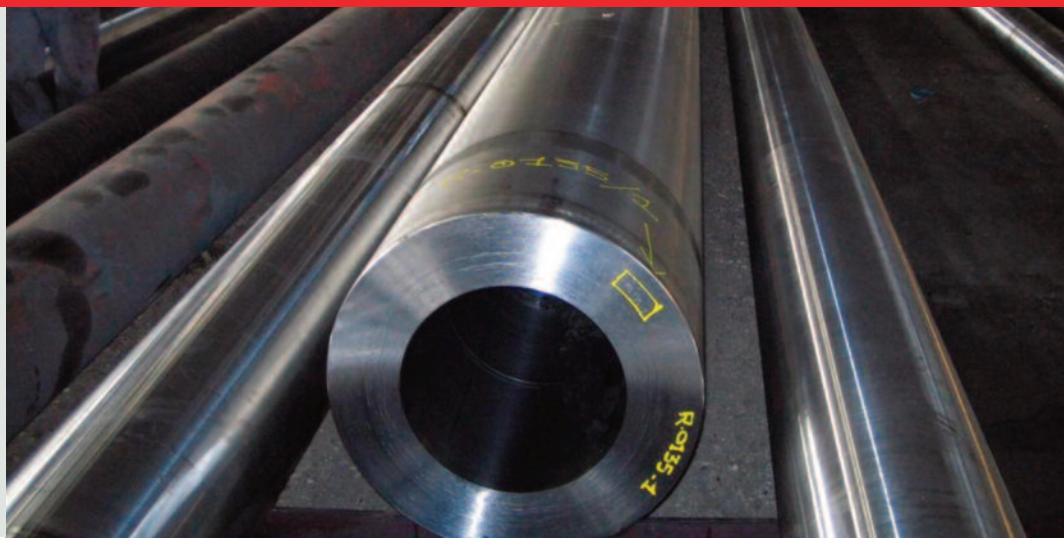
Forging the main pipe sections was completed at two plants in France and Italy. The flanges were forged once the main pipes were finished, and then extensive machining was required before the flanges were shrink fitted.

Once the riser was complete, a detailed testing programme was carried out before delivery to Venture in September 2009. Venture used the riser immediately thereafter to drill HPHT development and appraisal wells in several of its Central North Sea assets in water depths to 120m.

SHRINK FIT TECHNOLOGY

As far as the riser was concerned, Venture had two key requirements for its 2009 HPHT drilling campaign. The company needed a full-bore 18¾" riser with a pressure rating to 12,200 psi. Individually, these are not uncommon requirements. However, when taken together they posed a considerable manufacturing challenge.

If a weldable grade, say 65 ksi, of steel were to be used for the riser, a wall thickness of up to 75 mm would be required. Apart from the problems of manufacturing pipes of this type, the weight of the riser string would be enormous. Moreover, welding connectors of any type to pipe of this thickness is not straightforward and would probably result in a poor weld-fatigue performance classification. Selecting a high-strength steel would reduce the wall thickness needed (using 110-ksi steel would mean a wall thickness of about 30mm), but such steels cannot be welded successfully; it is difficult to achieve the required physical properties in the weld.



This problem was resolved by using a shrink-fit process to attach the flange connectors to the pipe sections. It was Steve Hatton, founder of 2H Offshore and a vice-president of parent company Acteon, who had the idea of shrink fitting to avoid the problems typically encountered with high-integrity riser fabrication. Shrink fitting is not an unusual process in other industries but it had never been proposed for an application such as this.

Hatton said, “The industry had sought a solution to the problem of welding high-strength riser joints for years, and with the increase in HPHT applications, the problem became critical. Shrink fitting is an excellent solution, we believe, and this was well understood by Venture; the company supported the technology and fast-tracked our qualification process. There is significant potential in this technology to enable the manufacture of higher-strength, lighter-weight risers with improved fatigue performance.”

DEVELOPMENT AND TESTING

Shrink fitting is a simple process in principle. However, there were several issues that had be understood in order to guarantee repeatable performance to the level demanded by the offshore industry, particularly for critical HPHT riser applications. In view of this, a thorough testing programme was conducted in Sheffield, UK, to prove the process and confirm the earlier, extensive finite element analysis work.

When making the joints, the machining of component profiles and finishes is tightly controlled, as is the heating of the flange body during the assembly process. Mating the two components is a further practical challenge requiring precise alignment at the instant the two are stabbed together. Simply allowing the mated assembly to cool generates a high-quality structural connection and a gas-tight seal to complete the assembly process.

Rigorous load and pressure testing, witnessed by Bureau Veritas, was conducted on a series of joints made using the 80-ksi steel chosen for this project. (There is no reason, however, why the same process could not be used for steels in excess of 110 ksi.)

The joints successfully completed hydrostatic pressure testing up to 13,500 psi (equal to 90% of pipe body yield strength) under various external tension and bending loads. In addition, gas testing was conducted to 12,200 psi.

The integrity of a shrink-fit joint relies primarily on the radial contact force generated as the connection cools and shrinks onto the pipe end. The friction generated at the interface is further enhanced by geometrical and mechanical features that 2H incorporated into the design. The resulting connection capacity was demonstrated to be as strong as the pipe.

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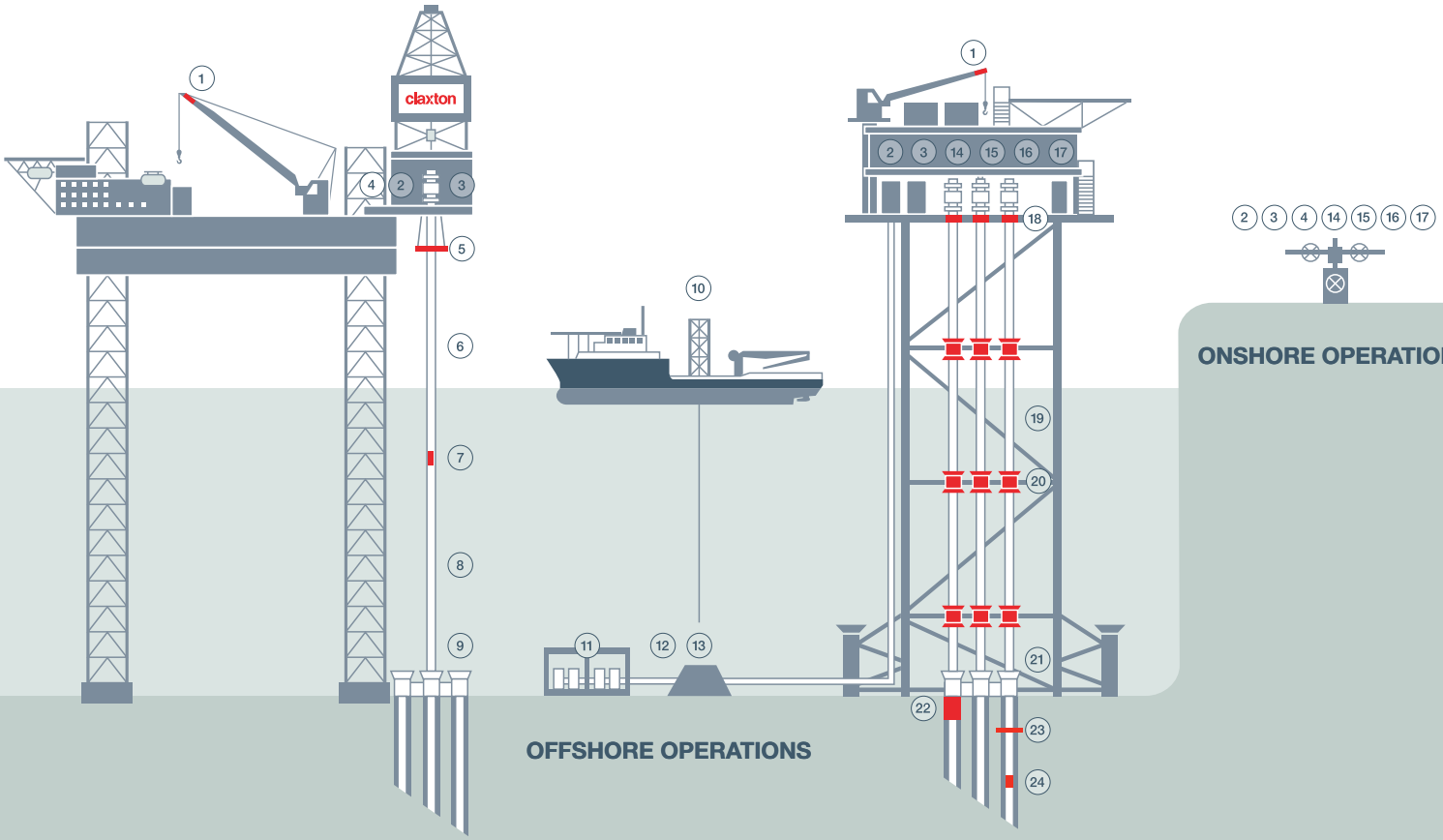
MAKE IT HAPPEN.

Trust Claxton to make your project happen.

CLAXTON CAPABILITIES



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UK HEAD OFFICE
T: +44 (0) 1493 744500
E: info@claxtonengineering.com

ABERDEEN
T: +44 (0) 1224 452371
E: aberdeen@claxtonengineering.com

DUBAI
T: +971 4 8863540
E: dubai@claxtonengineering.com

NORWAY
E: norway@claxtonengineering.com
W: www.claxtonengineering.no

SINGAPORE
E: singapore@claxtonengineering.com
W: www.claxtonengineering.sg

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