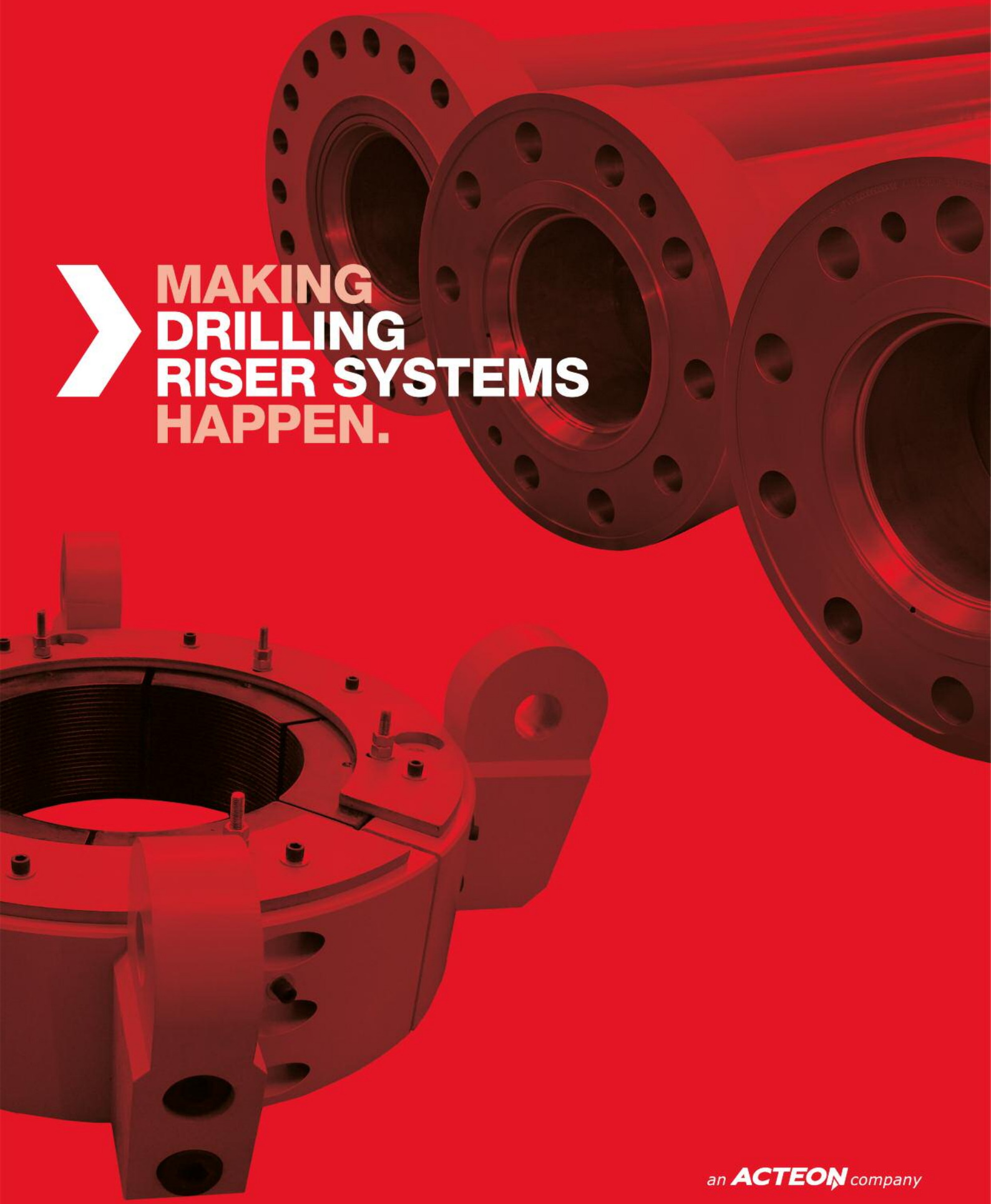
claxton®



MAKING DRILLING RISER SYSTEMS HAPPEN.

an ACTEON company

claxton®

"Claxton isn't constrained by only being able to offer one subsea riser technology – the range of system options we offer is in many ways unique"

Claxton has been supplying riser systems for over 20 years now, and the experience we have built up during that time is something that we believe sets us apart from the competition – that experience, built up over hundreds of mobilisations, is something that can't simply be replicated overnight.

We have a riser and adaptor rental inventory that extends to over 470m of riser, 4,000 ancillary tooling items and a variety of different connection types, including fullbore API/NACE compliant systems up to 12,200psi. No other company in the market can offer this breadth of inventory when providing clients with the options best suited to their projects.

Claxton is not constrained by only being able to offer equipment from one manufacturer – we genuinely want to supply the most effective system for your project. This flexibility and depth of inventory, combined with our links to the other specialist riser businesses in the Acteon Group (2H Offshore and SRP), makes Claxton the subsea riser supplier to beat.

We look forward to assisting with your projects very soon,

Dannie Claxton
Technical Director

A genuine riser expert

Claxton has been supplying subsea riser systems since 1990 and has pioneered a number of technologies in that time – including the first positive grip tension rings and supplying the first-ever 12,200psi API/NACE compliant riser.

Full system supply

From individual riser joints, through to complete riser systems with tensioning equipment, VIV suppression and subsea connectors, Claxton riser systems will meet the needs of your drilling campaign.

Subsea connectors and adaptors

Our riser systems are complemented by our comprehensive inventory of subsea connectors, H4 connectors, crossover adaptors, DSA flanges, hubs, lifting adaptors and bolting/gasket stocks.

Rapid mobilisation

Our inventory is available for rapid mobilisation from stock and 100% back up can be supplied.

Multiple pressure configurations

We supply systems for pressures up to 12,200psi, with a variety of joint connection options, from flanges to quick-connect options, through to world-first shrink-fit technology.

A pioneer in tensioning

Claxton has long been a pioneer in riser tensioning equipment, supplying proprietary tension ring and system technology that has been much-emulated by our competitors.

Our riser project experience list extends to over 100 projects since 2005 alone. Email **info@claxtonengineering.com** for your copy and compare our record to other suppliers.

The support of a wider group

Being part of the Acteon Group's risers, conductors and flowlines division, Claxton has the support of other well-known riser specialists.

Our close relationship with 2H Offshore (riser analysis) and Subsea Riser Products (riser design and manufacturing) means we have access to riser knowledge no one else can offer – something well-proven by our close collaboration on a number of class-leading technologies and projects.

ACTEON

2H offshore

SRP SUBSEA RISER PRODUCTS

> "Claxton isn't constrained by having to supply either our own proprietary equipment or the equipment of any given manufacturer – meaning we have multiple options for your project, perhaps more than anyone else."

Claxton Riser System Overview

	 12,200psi - Flange	 5,000psi - Flange	 5,000psi - Quick Connect
Joint Connector Type	SRP Shrink-Fit high performance flange	API, custom or SRP high performance flange	OilStates Merlin
Joint Make-Up	Optimised make-up with 100% ring-type bolt tensioners	Optimised make-up with 100% ring-type bolt tensioners	OilStates make-up tool & crew
Outer Diameter	24"	24"	24"
Inner Diameter	18.¾"	21"	21"
Wall Thickness	2.17"	1.½"	1.½"
Operating Pressure	12,200psi	5,000psi	5,000psi
Test Pressure	13,500psi	7,500psi	7,500psi
Coating	TSA Coating Norsok M501-7	TSA Coating Norsok M501-7	TSA Coating Norsok M501-7
Material	ASTM A182 F22-80ksi	X65, X80	X65, X80
Subsea H4 Connector	Vetco DWHD	Vetco E, ExF & EWHD	Vetco E, ExF & EWHD
Quick Connects	Vetco NT-2 & Dril-Quip Radial Bolt package	Vetco NT-2	Vetco NT-2
Riser Tensioning	Full suite of tensioning equipment 'from stock'	Full suite of tensioning equipment 'from stock'	Full suite of tensioning equipment 'from stock'

Riser System Connectors & Handling Tools

Claxton holds a full inventory of riser system surface and subsea connectors – including high performance NT-2 quick connector nipple up packages and H4 connectors.

Quick Connectors

BOP Adaptor (NT-2 Box down)

An 18.¾" 15k NT-2 Box down and a standard 18.¾" 15k studded top to permit attachment to the 18.¾" 15k BOP.

BOP Adaptor (NT-2 Pin up)

An 18.¾" 15k NT-2 Pin up and a standard 18.¾" 15k studded bottom to permit crossover between the high pressure riser joints and BOP.

Test stump

Our test stumps have an 18.¾" 15k NT-2 pin up to permit testing of the adapter when fitted to the 18.¾" BOP.

Subsea H4 Connectors

DWHD

The 18.¾" 15k DWHD H4 Connector is a high strength hydraulic connector designed to rigidly attach the BOP or subsea production tree to the subsea wellhead. The connector is operated by hydraulically actuated pistons that drive a cam ring and subsequently a segmented ring of locking dogs into a grooved profile on the wellhead housing. This provides a large axial locking force that energises the ring gasket and preloads the connector to the wellhead. Indicator rod(s) provide visual confirmation of the locked/unlocked status of the connector. (62" OD, 49" Height).

ExF

The 18.¾" 15k ExF H4 Connector is a very similar specification connector but is smaller. (51" OD, 41" Height).

NT-2 Box down Connector

DWHD H4 Connector

We've continually strived to improve the efficiency and safety of riser running processes – this page shows just a couple of examples of how our suite of proprietary running tools does just that.

Riser Handling Tools

Recently we developed a new Hydraulic Riser Handling Tool which provides a solution for running, handling and remote pressure testing of a 18.¾"-15m NT-2 Tension Joint to 7,000psi.

The tool was developed for a Norwegian client and saved 4.5 hours of rig time with each run – equating to a project saving of an estimated £1.8 million.

In addition to cost savings the tool provides a suite of safety and operational benefits – removing scaffolding requirements and offering protection to the associated riser connector.

The tool is supplied as a package including dedicated HPU, which is ATEX approved.

Riser Spider

Claxton provides a fully hydraulic riser spider designed and manufactured by our sister company Subsea Riser Products. The riser spider's compact footprint allows compatibility with standard drillfloor layouts, and the design is suitable for hang-off in all sea states. Using a twin plate design the tool takes just 12 seconds to engage. No electronic systems exist within the spider - improving field life - and the tool offers a fail safe positive lock.

Additionally Claxton supplies our own non-hydraulic riser spiders, if required.

Riser Handling Tool

Riser Tension Rings

Claxton has long been the global market leader for tension rings. Here's why…

Positive Grip Tension Rings

Claxton has unparalleled experience in tension rings and systems. We pioneered the original Positive Grip tension ring – which, using interchangeable machined slips, is installed on slick pipe of all sizes, weights and grades – saving rig time, eliminating 'space out' issues and removing the need for welding.

> "Claxton invented the Positive Grip tension ring – a design that has been much-copied around the industry. However the original design can only be supplied by us."

Tension Ring Toolkit

Our tension rings are supplied with a robust toolkit, including bolt tensioning equipment – the modular nature of the toolkit enables rapid installation and ensures everything is to hand when required.

Slimline Tension Rings

The patented Claxton Slimline tension ring can be taken from a container directly onto the drill floor, installed offline and the riser and tension ring can be run through the rotary table together, saving rig time. Designed in-house by Claxton, the slimline tension ring maintains the rugged performance we expect of more traditional designs despite being significantly smaller.

Many operators, rigs and drilling contractors already call Claxton thanks to our…

Unique Experience

Our designs are in successful use by numerous operators and have been much-copied by the competition. However, the technical expertise that created our tension rings can only be found within Claxton.

Flexible Supply

We have a well-earned reputation for flexibility, so if you have a project specific application remember our tension rings can be dressed with slips for non-standard pipe sizes.

Proven Quality

Our tension rings have been proven on rigs working all around the world… meaning you can trust them to perform on your project.

Rapid Mobilisation

Claxton has a large fleet of tensioning equipment, much of which is ready for 'from stock' call-off. Contact us today to discuss your requirements.

Riser Tension Systems

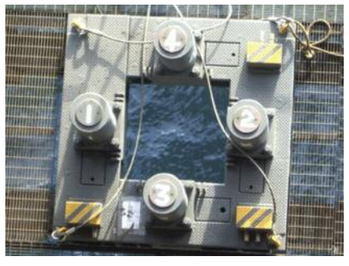
Claxton has supplied many major rig operators with riser tension systems that mitigate riser stress and enhance fatigue performance.

Riser Tension Systems

We can supply complete systems or modular packages that will interface with your existing equipment.

Features:

- **Passive or fully active systems available**
- **Flexible solutions – we're able to provide either a pushed or pulled load facility**
- **Supplied with shackles, heavy duty connecting slings and all hydraulic hoses for interface and system connections**
- **Fast-track and cost-effective build service or 'from stock' rental supply**
- **Compact design to ease handling and positioning issues**
- **Comprehensive site surveys can be undertaken to determine the interface requirements**
- **Experienced engineers provided for system installation, commissioning and training.**



Rental Tools

Our riser system inventory extends to over 4,000 items of supporting tools and equipment. We can service full riser systems 'from stock' – often with 100% back up.

Rental Tools

A riser is more than just the joints themselves – and whether you choose a flanged or quick-connect system we've got everything you need to run the riser successfully.

Additionally our large inventory means we can supply equipment to suit non-standard applications, or support you if you encounter an unexpected interface issue.

Our large inventory means many rental items are readily available:

- **Pup and tension joints**
- **C-plates**
- **Clamps**
- **Spools**
- **Nipple up packages (NT-2)**
- **H4 connectors**
- **Handling and running tools**
- **Umbilicals and reels**
- **Bolt tension/torque systems**
- **Overshot connectors**
- **Hubs**
- **Inspection camera systems**
- **Hydraulic power units**
- **DSAs, crossovers and flanges.**

Quality assured

Claxton employs a dedicated quality team to keep our rental equipment in first class condition, certified and ready for mobilization at a moments notice.

World first HPHT Riser

Case study

Claxton, in conjunction with 2H Offshore (2H) and Subsea Riser Products (SRP) recently supplied an ultra-high-pressure riser for use during a high-pressure, high-temperature (HPHT) drilling campaign in the North Sea.

This riser is unique: the world's first full-bore access (18.¾") riser capable of working at pressures in excess of 12,000psi. Linked to this, the flanges used to connect the individual pipe sections will be attached using a shrink-fit process – the first time this technology has been used in this application.

The riser will enable the client to drill and complete HPHT subsea wells from a jackup drilling rig employing a surface blowout preventer (BOP), which will provide significant cost benefits and operational efficiencies.

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 the current one, where NACE sour service requirements are cited. The proposed solution, shrink fitting the flanges to the pipes, is the key to this entire project. Shrink fitting eliminates the need for welding; high strength and fatigue-resistant connections can be made in essentially non-weldable materials.

2H and SRP have undertaken 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. (For an explanation of this aspect of the project, see the attached technical note).

Dannie Claxton, Engineering Director, Claxton Engineering, said, **"We have worked closely with our Acteon colleagues to offer 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 creates an opportunity to make a cost-effective step-out in drilling practice – one we expect others to follow."**

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

Shrink fit technology

The riser was designed with key requirements: a full-bore (18.¾") riser with a pressure rating to 12,200psi. Individually, these are not uncommon requirements. However, when taken together they pose a considerable manufacturing challenge.

If a weldable grade, say 65ksi, of steel were to be used for the riser, a wall thickness of up to 75mm 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 110ksi 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 has been resolved by using a shrink-fit process to attach the flange connectors to the pipe sections. It was Steve Hatton, founder of 2H Offshore, 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 has been seeking a solution to the problem of welding high-strength riser joints for years, and with the current increase in HPHT applications, the problem has become critical. 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 are still several issues that have to 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 has been conducted 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, has been conducted on a series of joints made using the 80ksi steel chosen for this project. (There is no reason, however, why the same process cannot be used for steels in excess of 110ksi.)

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

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 has incorporated into the design. The resulting connection capacity is demonstrated to be as strong as the pipe.

Unique Combination

The equipment inventory and offshore experience of Claxton, combined with the analysis expertise of 2H and riser hardware from SRP has produced something unique and powerful – a riser that can, at a stroke, extend the operating envelope of jackup drilling. This combination of experience and technology simply can't be found anywhere else.

> "This riser represents a step change in drilling practice – it enables HPHT wells to be drilled from a standard jackup rig and is the only 12,200psi API/ NACE compliant system available today."

Deep Panuke Riser

The Deep Panuke drilling riser project is a perfect example of something that Claxton is equipped to do probably better than any other company.

Claxton was successful in its bid to rent out a 5,000psi drilling riser system for the development of the Deep Panuke gas field, 250km off the coast of Nova Scotia, Canada. The development plan called for one new well to be drilled and four suspended wells to be re-entered and completed in 44m of water using the Rowan Gorilla III jackup rig.

Claxton's first step was to involve fellow Acteon company 2H Offshore to carry out the detailed riser analysis necessary to determine the riser configuration and support system best suited to the rig and the fatigue conditions in the field.

Armed with this information, Claxton set about withdrawing and testing all the necessary components for the riser-and-connector package from its inventory of over 4,000 riser-related items in Great Yarmouth, UK. In addition to 24" diameter riser joints fitted with Merlin connectors, Claxton assembled proprietary positive-grip tension rings, C-plates, an H4 wellhead connector, umbilicals and power units for the primary and secondary tension system hydraulic cylinders.

These were then promptly shipped via Liverpool to Halifax, Nova Scotia, where they were united with the jackup. Also joining up with the project at that time was a four-man team from Claxton, which would be responsible for all aspects of the running and retrieval of the riser system throughout the drilling campaign.

Drilling started in January 2010 and was dogged by consistently poor weather. Nevertheless, the various parties on the rig combined in an impressive fashion to ensure the successful completion of the five-well campaign by November 2010. The level of cooperation, teamwork and willingness to pool ideas and experience on the rig was cited as one of the main reasons for the smooth progress of the project. From the Claxton team's viewpoint, the project undoubtedly had the feel-good factor.

Technical director Dannie Claxton believes the ability to contribute so positively to projects like this is down to the company's 20 years' experience of the riser rental business and the quality of the people it has to support the use of the systems in the field. But, even after all this time and numerous riser rental projects, he admits that **"there is still a great sense of satisfaction when everything comes together to ensure the sort of success enjoyed by the Deep Panuke drilling campaign. The project was a credit to the whole team. We are delighted to have played a part."**

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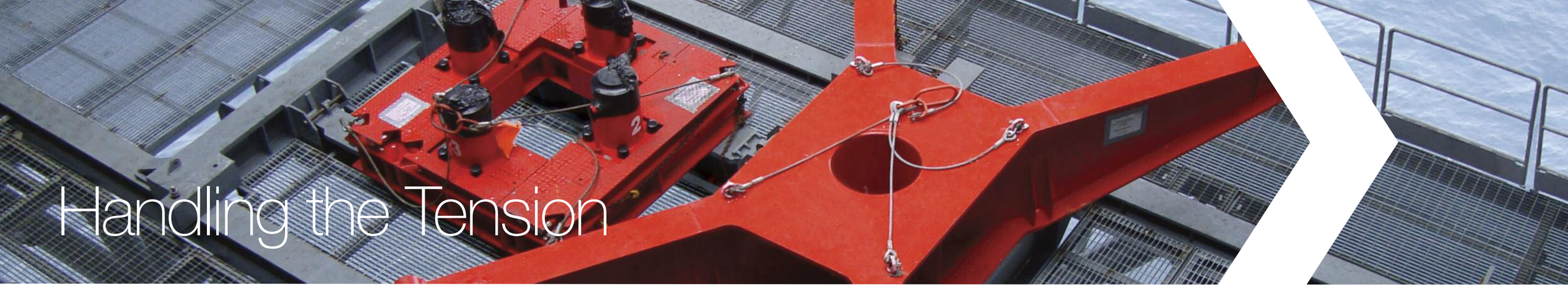
Case study



Handling the Tension

Case study

Claxton's new tilting tensioning system pushes the boundaries of what can be done to help drillers in the North Sea

Although from a production perspective the North Sea's best days may now be in the past, the province still generates great examples of offshore engineering innovation, as this drilling riser project for BG Group plc illustrates.

About two years ago, BG Group plc approached Claxton to provide a conductor tensioning system to meet some unusually demanding requirements. The company wanted to drill in water depths of 78m in the Jackdaw field using the Rowan Gorilla VI jackup drilling rig – nothing too out of the ordinary so far. However, as Chris Kyson, project engineering team leader, explains: **"A combination of the way the rig was configured, the environmental conditions in the area and the fact that BG Group wanted the system to be capable of withstanding the sort of seas normally associated with a 50-year storm resulted in the need for a conductor tensioning system that could generate up to 400 tonnes of load."**

A more common rating for conductor tensioning systems in the North Sea is 300 tonnes, which can easily be achieved using Claxton's positive-grip tension-ring systems. Presented with this challenge, Claxton went back to the drawing board and came up with a new tensioning system: one that would not only provide the required tensile loads but also tilt to reduce the bending stresses and wave-shock loading affecting the conductor.

"We were reluctant to resort to a welded tension ring in place of our positive-grip system because this would have meant having to set a precise space-out distance between the ring and the tension deck," says Kyson. "It is easy to get this wrong and create knock-on effects that compromise the integrity of the other elements of the conductor system. Instead, we opted to insert a machined rack, 37.¾" long, into the conductor tension joint, which, with its outside diameter of 34", can pass through the rig's rotary table. In place of the ring, we have a two-piece adjustable nut that engages on the teeth of the rack and enables the space-out distance to be readily altered during the conductor installation process."

Perhaps more unusual than the tension rack was the tilting mechanism that was also incorporated into the conductor tensioning system to alleviate the wave- and current-induced stresses experienced by the conductor. To understand how this works, it is necessary to know that the tension in the system is generated by a series of four hydraulic cylinders acting against the floor of the tension deck upwards onto a tension plate. The four cylinders are connected between the deck and the tension plate via either concave or convex bearing plates: the four on the deck floor are convex and the four on the underside of the loading plate are concave. During operation, the wave and current forces acting on the conductor are sensed and transmitted to the power unit that governs the movement of the individual hydraulic cylinders. By this means, the angle between the deck and the tension plate adjusts (tilts, gimbals and squats) to reduce the effective localised bending moment seen at surface by the riser. This reduces stress and therefore increases fatigue life.

Before the tensioning system was installed on the rig, it underwent tests in Claxton's workshops in Great Yarmouth, UK. The tilting mechanism was thoroughly checked, and the system was subjected to a 750 tonnes test load. In October 2007, two Claxton engineers and a rig crew went out to the Rowan Gorilla VI, where they ran the conductor and installed the tensioning system. First, the hydraulic cylinders were fitted to the tension deck. These were then connected to their power pack and extended by 4-6". before the tension plate was added on top. The conductor, with its pre-installed rack section, was run through the centre of the tension plate via the rotary table; then, once the correct space-out had been achieved, the two-piece adjustable nut was attached to the rack.

"The system was installed within budget and on time, and subsequently performed exactly as we expected," says Kyson. "BG Group must have been impressed because it has recommended the system to Canadian Natural Resources (CNR), which is down to use the rig next."

Lockart Campbell, senior subsea engineer with BG Group, confirmed satisfaction with the system: **"Our partnership with Claxton has worked well. I am confident in their ability, both to provide well-executed engineering solutions and to react to arising needs in a helpful and professional manner."**

The tilting tensioning system is now back in Claxton's workshops being serviced before being reinstalled on the rig for CNR. Beyond this contract, Maersk has also expressed an interest in using it. Kyson concedes that this is not the first tilting tensioning system on the market, although he is not aware of another system that can also generate a tension of 400 tonnes. Furthermore, he is proud of the fact that Claxton was able to provide the ideas, the engineering expertise and the people to devise and then quickly deliver a highly practical and reliable solution to its latest challenge.

A Claxton tension system, similar to the one supplied for Jackdaw

Concentrated Power

Case study

Claxton designers have used their ingenuity to supply a small but perfectly formed hydraulic power unit to upgrade the tensioning system on the Ensco 102 jackup drilling rig and significantly extend its operating envelope.

Upgrading the riser tensioning system on the Ensco 102 jackup drilling rig has meant installing a new hydraulic power unit, the specification for which posed some interesting challenges for engineers at Claxton, the company chosen to design and build it, as project engineer Will Robinson explains.

“Claxton was contracted by the Ensco 102 to drill an exploration well in the North Sea and stipulated that drilling operations at the given location had to be possible under 100-yr storm conditions. A riser analysis determined that to drill the required well safely the rig would have to be capable of pulling 400 tonnes of tension on the riser. Additionally, the hydraulic cylinders within the tensioning system would have to be able to cope with a cyclic displacement (sometimes termed a ‘squat’) of 8" within a four second time period.”

In order to accommodate this degree of rapid movement the Claxton project team had to incorporate an unusual amount of hydraulic energy storage into the system. They calculated the unit would require 12 accumulator bottles, each with a volume of 37 litres. Although this was not considered to be such a problem in itself, it did create a headache for the designers who knew the entire unit had to be small enough to fit into a space on the rig no bigger than 1.8m wide by 2.0m long and 2.0m high.

In fact, packed into the frame of the unit are the 12 accumulator bottles, a 450 litre fluid reservoir, four 40:1 hydropneumatic pumps (which provide the basic power for the system) plus all the requisite hoses and valves, which are all roughly twice the usual bore to handle the necessarily higher fluid flow rates through the unit.

“It took quite some ingenuity to get all the equipment into the frame,” says Robinson. “One of features of the design that helped significantly was the use of a flat, stainless steel control plate for the unit in place of a normal console. This saved space and made it easier for the hydraulic fitter, as he was able to fit the valves and pipework to the control plate while it was on the bench and then offer it up to the unit afterwards.”

The unit is also designed to last. As painting was never going to be possible after the unit was assembled, the unit was built and tested and then stripped down for the application of a high-performance paint system before being rebuilt, an exercise that added three weeks to the production schedule.

The unit was recently fitted to the rig on location by Claxton engineers. As there are now four Ensco jackups that benefit from Claxton riser tensioning systems, the last word really ought to go to the client. Speaking on its behalf, James Foreman, the Ensco 102’s barge engineer, said, **“The new hydraulic power unit fits well and the crew are finding it easy to operate. The upgrade to the tensioning system is allowing us to use the jackup to drill a well that would normally have required a semi-submersible rig.”**

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Systems available now

“Claxton’s riser experience extends across multiple projects stretching over two decades – including over 100 riser projects since 2005. The images on this page represent a tiny fraction of the equipment we have waiting for call off on your project, right now.”











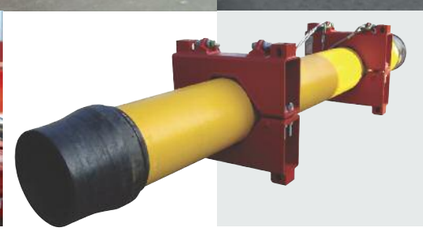

claxton®

Great Yarmouth - Main Base

Claxton
Bureside House
North River Road
Great Yarmouth
Norfolk, NR30 1TE
UK

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

Aberdeen

Claxton
Tern Place House, Tern Place
Bridge of Don
Aberdeen
Scotland
AB23 8JX

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

Dubai

Claxton
PO Box 262490
Jebel Ali Free Zone
Gate 5, South Side
FZS1 ALO5
Dubai

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