BAKER HUGHES
a GE company

North Sea Well Abandonment

Differentiating technology saving time and cost

bhge.com

TURNKEY WELL ABANDONMENT SOLUTIONS

Baker Hughes, a GE Company (BHGE), is your best source for fit-for-purpose well abandonment solutions. We offer proven technologies and expertise backed by competent job planning and execution that enables you to maximise efficiency while also ensuring safe, reliable, and cost-effective operations.

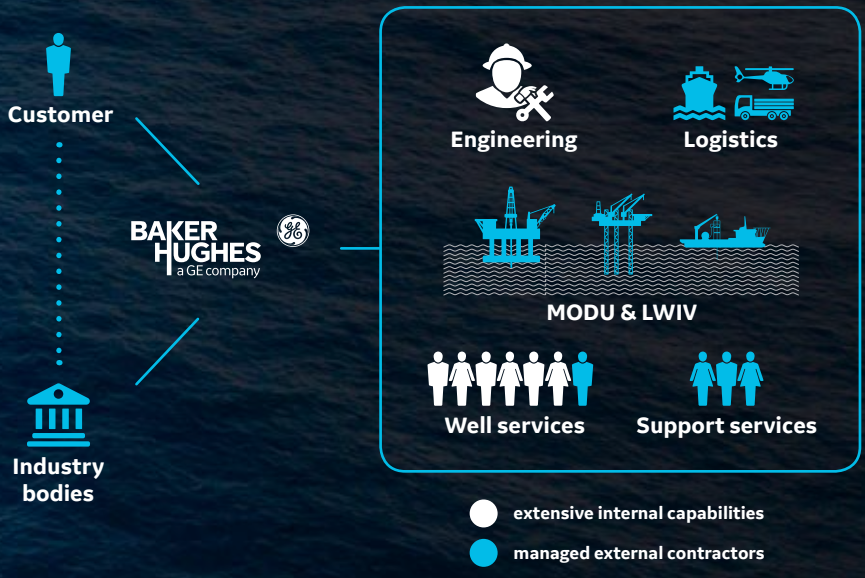
Whatever the challenge, our experts, technologies, and solutions—rig-based and rigless—can transform your plug and abandonment campaign into a seamless final step in your well's lifecycle.

Integrated execution models

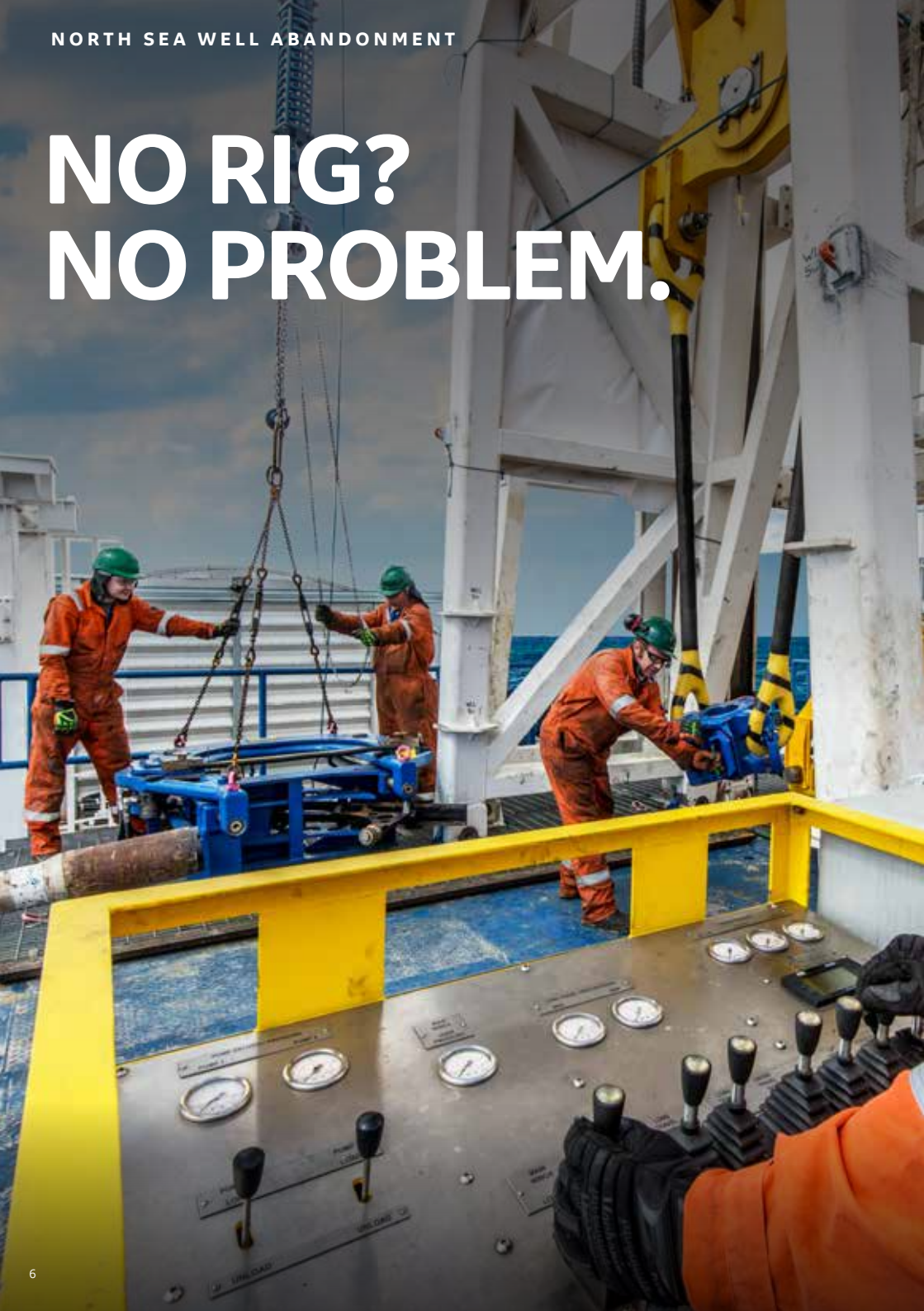
We can manage the entire project—planning, coordination, and execution. The level of support is flexible and scalable, and can be tailored to your needs—from single services to fully managed turnkey projects. Let our experts focus on the details of your well abandonment project so you can focus your resources on revenue-generating activities.

Flexible commercial models

Our flexible commercial models offer a true partnership with risk-sharing and deferred-payment that give you the opportunity to reduce your project risk and financial exposure.



NO RIG? NO PROBLEM.



BHGE offers a number of rigless and portable solutions for your offshore well abandonment operation. Lightweight, modular, compliant, and cost-effective—with all the muscle you require, and then some. As the leader in offshore well abandonment solutions, we have the knowledgeable people and innovative technology that can handle anything your well can throw at us.

Our **Mastiff™ rigless intervention system (RIS)** is a superior alternative to conventional intervention systems. It significantly improves efficiency offshore without the need for a rig—whether for multiwell abandonments, conductor pre-installations, or workovers. Regardless of the application, the Mastiff RIS provides easier setup, quicker transport, and more reliable operations to boost efficiency. Its 352-ton pulling capacity enables it to safely lift 15.2-m (50-ft) sections of 0.91-m (36-in.) conductor with inner casing and cement. It can then safely lay the sections out using the deck crane, saving time and further reducing risk during platform abandonment.

The **Retriever™ jacking unit system** occupies a small platform footprint that nullifies the need to mobilise a full-size rig. Its lightweight fit-for-purpose smart design includes its own independent power supply, too. Together, the Retriever and Mastiff systems can ensure that every job removing casing and conductors can be done cost effectively, with new equipment that is certified and tested. This lowers nonproductive time and fosters safer working conditions.

Offshore, space on deck is at a premium. Our **Micro CT**™ service's smaller footprint leverages a modular, lightweight design to provide an effective, efficient alternative to conventional coiled tubing units that require additional support vessels, time-consuming modifications, and complicated logistics and planning. The Micro CT breaks down into nine major components that are easily and quickly rigged up. There is no need to compromise coiled tubing performance. You can apply the right solution to well abandonment challenges such as cleanouts, fishing operations, remedial and intervention procedures, and cementing.

BHGE also offers the very portable, patented **Liquid Stone™ cement system** to simplify the primary cementing of major casing strings, coiled tubing squeezes, abandonment plugs, and slimhole applications, among other offshore cementing applications. Ideal for rigless intervention, this storable, premixed cement slurry can be kept onsite in the liquid state for days or weeks before use.

WELL ABANDONMENT PHASES

PHASE 1

LOWER WELL ABANDONMENT

- Reservoir access
- Well kill
- Reservoir isolation/suspension
- Production tree removal and BOP installation
- Completion removal

PHASE 2

UPPER WELL ABANDONMENT

- Well integrity evaluation
- Set mechanical and cement barriers
- Casing removal (if needed)
- Casing removal alternatives (if needed)
- Surface (environmental) cement plug (including annuli)

PHASE 3

CONDUCTOR OR WELLHEAD REMOVAL

PHASE 1

LOWER WELL ABANDONMENT

Permanent isolation of the reservoir requires placement of permanent barrier material to fully isolate all reservoir producing or injecting zones from the wellbore. Comprehensive annular integrity evaluation and fit-for-purpose through-tubing barrier placement methods deliver cost-effective solutions.

Abandonment strategy support

BHGE will support you to enhance and develop your well abandonment philosophy. With early geoscience support, and a collaborative interpretation of regulations and guidelines, this analysis can help identify the correct location for hydraulic barriers to permanently abandon the well and provide insight into the best approach to well abandonment in a given field. Evaluating utilisation of salt caps, shales, and combined plugs can often minimise the final plugging design regime.

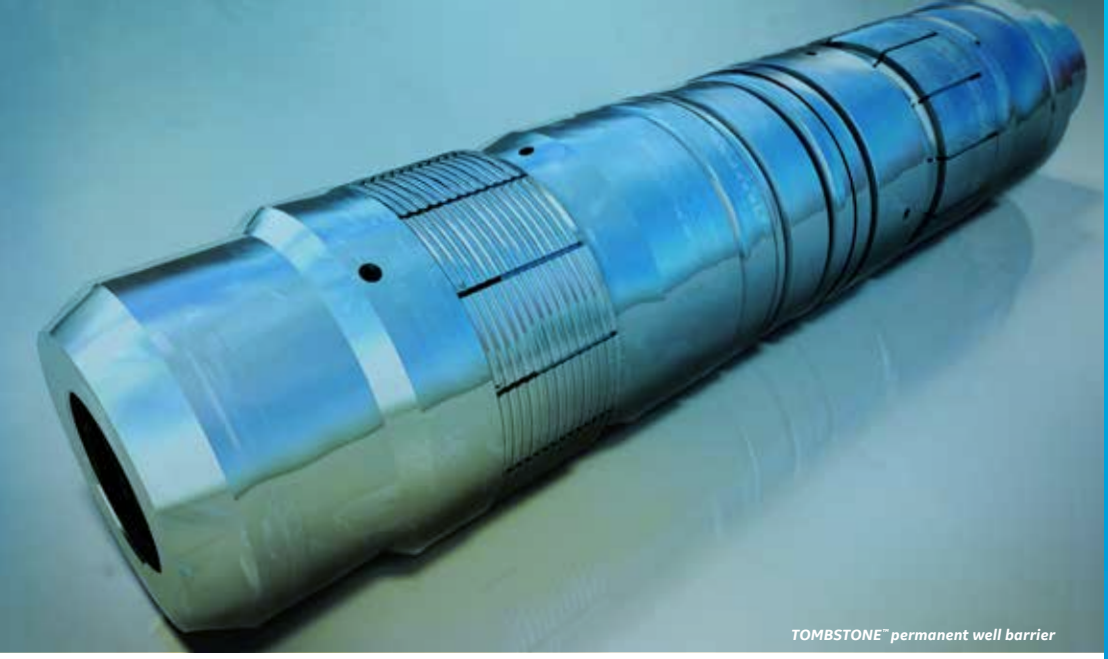
Integrity eXplorer
Cement evaluation service

Barrier verification

Integrity eXplorer™ (INTeX™) provides a unique sensor technology that allows for verification of well barriers in all well conditions. The specific capabilities, which have already been deployed in the North Sea, will allow logging in all fluid types—including gas—allowing pre-plug and abandonment surveys in currently producing wells. From lightweight cements to standard Class “G,”the high-speed logging INTeX provides the answer.

Our **Segmented Bond Tool (SBT™) well integrity evaluation service** quantitatively measures the cement bond integrity in six angular segments around the casing. The pad deployment solution allows verification of well barriers even when run through a milled window.

The **SBT™ seal service** provides cement bond seal intervals based on your isolation criteria as well as any pre-defined local cumulative zonal isolation regulations. This new service is the first in the industry that takes into account formation properties when evaluating the cement seal.



TOMBSTONE™ permanent well barrier

Barrier placement

The most critical part of any well abandonment operation is the installation of permanent barriers across the well. BHGE better addresses various well-integrity challenges by deploying the optimal combination of integrity evaluation, perforating technology, mechanical barriers and cementing, or alternative barrier materials.

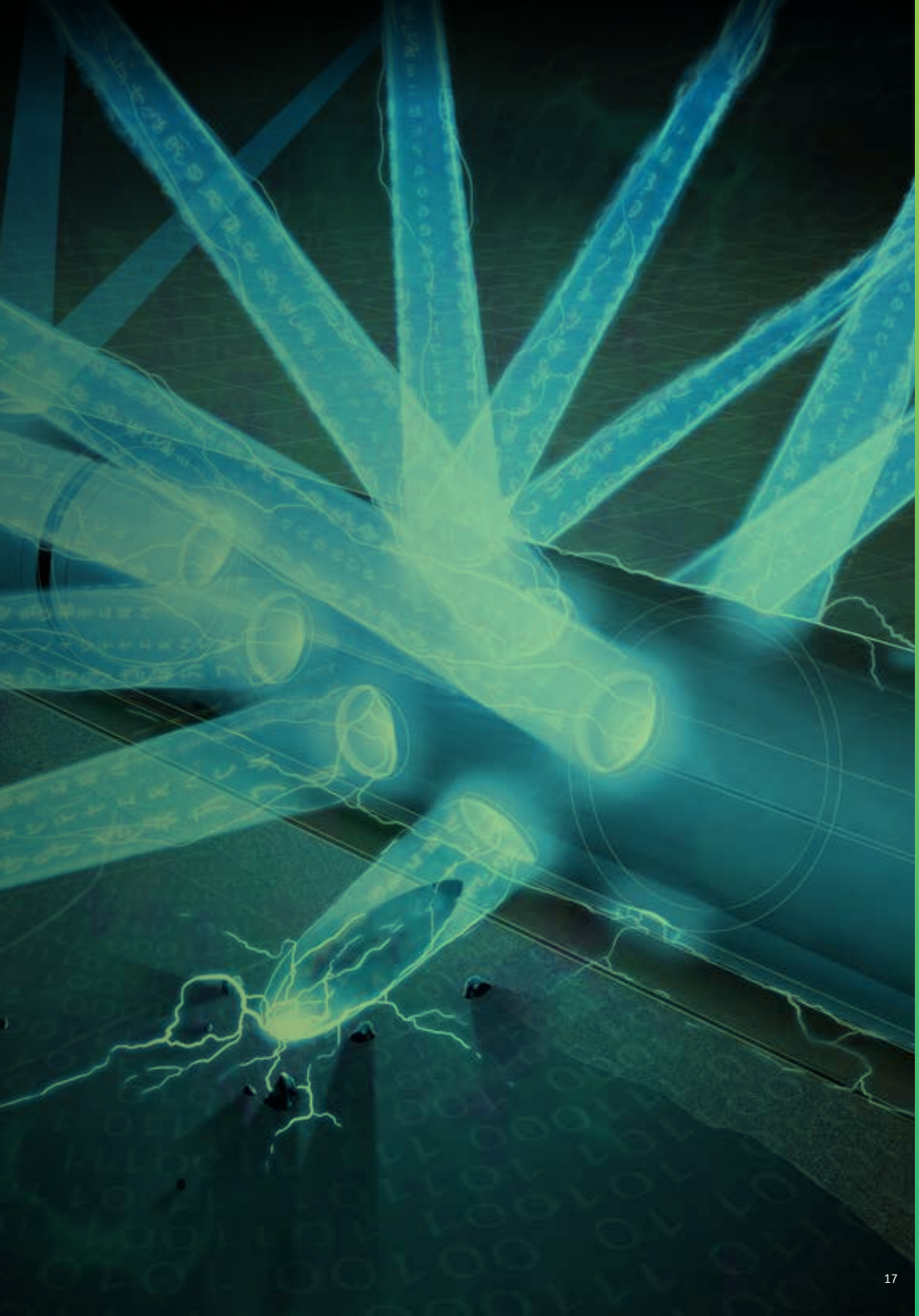
Selecting the right mechanical barrier is a critical step in any successful well P&A operation. BHGE offers the industry's most comprehensive range of bridge plugs and cement retainers, including gas-tight inflatable solutions for through-tubing applications and the **STONE WALL™ V0-rated well barrier portfolio**, helping to ensure total well control, enabling safe operations, and protecting the environment.

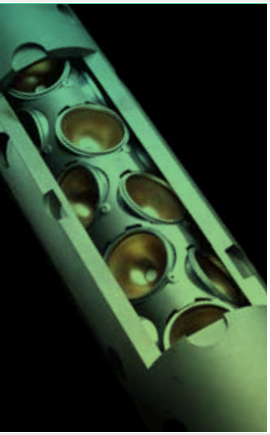
BHGE's pressure pumping experts help minimise risk and ensure long-term well integrity by designing and implementing bespoke cement programs that meet your well's abandonment requirements. Each cement slurry is tested in the laboratory before the job to ensure the cement will provide a seal without shrinkage. Run by well-trained personnel, this equipment includes fully automated slurry density control and a robust process that allows high-rate, heavyweight, and ultra-lightweight mixing. Some of our top cement technologies include our **CemFACTS™**, **Plug Cement Wizard™**, **LiquidStone™**, **DuraSet™**, and **PermaSet™** products.

PHASE 2

UPPER WELL ABANDONMENT

Permanent isolation of all intermediate zones with flow potential involves major steps in the well plug and abandonment process. The application of industry-leading well intervention technology and collaborative engagement drives down the time to abandon a well and enables rapid adaptation to unforeseen circumstances.





Perforating services

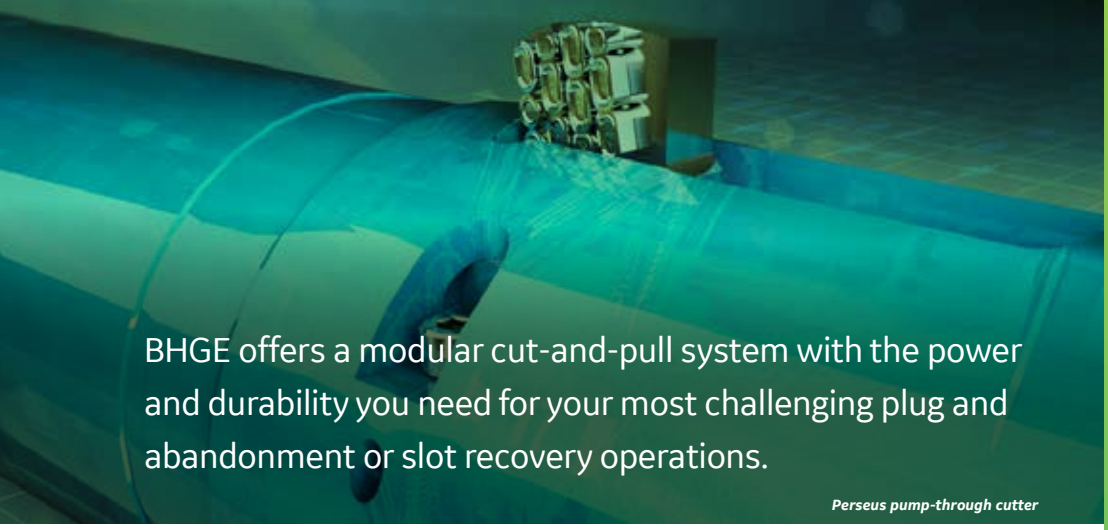
Backed by a 30-year track record of plug and abandonment successes, BHGE offers a full portfolio of gun and charge offerings, including our abandonment gun system—ideal for maximum casing removal in larger casing applications. Our perforating technology is deployable on wireline, coiled tubing, or drillpipe. Partner with BHGE and gain access to our database of plug-and-abandonment-specific shot testing, which allows you to evaluate the best strategy to successfully and safely achieve your goals.

Shoot and squeeze one-trip abandonment system

This system offers a simple and effective solution to perforate and cement with a single assembly when block squeezing for zone or well abandonment. The tubing-conveyed perforating (TCP) guns are selected for the proper cementing program requirements.

Wellhead Abandonment Straddle Packer (WASP)

Isolate multiple subsea annuli for permanent well abandonment in one trip. The WASP enables operators to abandon suspended subsea wells by perforating, circulating out mud from behind the casing strings, and placing a lateral cement plug across casing annuli and the main bore. Providing significant cost savings, the unit can be deployed from a dynamically positioned vessel eliminating the need for a rig.



BHGE offers a modular cut-and-pull system with the power and durability you need for your most challenging plug and abandonment or slot recovery operations.

Perseus pump-through cutter

The **MASTODON™ hydraulic pulling-tool system** can deliver the pulling capacity of a big rig and heavy work strings without the high cost or significant HSE exposure. Exerting 1.8 million pounds of pulling capacity, the MASTODON can effortlessly pull tubulars by using hydraulic pumping pressure.

The tool anchors in the casing before it exerts a pulling force on the fish below and transmits the force to the casing, rather than the surface equipment. This reduces the need for rigs with heavy lifting capacity and associated work strings. Keeping pulling forces downhole eliminates high-jarring loads at surface, should a fish fail during pulling. Having the ability to pull longer sections of casings reduces the number of trips required to complete the operation, thereby reducing handling exposure.

The **Perseus™ pump-through cutter** is a hydraulically operated downhole tool designed to cut a single string of casing on command. Ideal for plug and abandonment or slot recovery operations, its knives are dressed with our **METAL MUNCHER™ advanced milling technology (AMT)** that provides the industry's most durable, effective cutting and swarf control carbide to mill even the toughest steels. The knives can be easily changed at the rig floor and include an integral retraction feature that allows for easy downhole manipulation.

The Perseus will remain dormant and maintain pressure integrity while a plug is set either mechanically or hydraulically. A ball can then be dropped to activate the knives for the cutting of the casing. Alternatively, the cutter can be run above a mill/bit to dress a cement plug, then activated to cut the casing after the isolation of the well has been confirmed. A pressure indicator that signals a successful cutout with a pressure drop ensures there will be no doubt when a completed cut to surface has occurred.

The cutter can make multiple cuts during the same run, too, making it ideal to be run with a spear for cutting and pulling casing in one trip.

PHASE 3

CONDUCTOR OR WELLHEAD REMOVAL

The final phase may include installing the near-surface cement barrier and removal of the wellhead and conductor. Rigless and riserless solutions can provide significant cost savings for this part of the operation.

Offshore platform conductor removal

During plug and abandonment operations, the removal of tubing, casing, and conductors are often the final steps in the well abandonment program. Recovery services can be deployed using existing platform rig infrastructure, or utilising the Mastiff™ Rigless Intervention System (RIS). For smaller platforms, customized fit-for-purpose solutions are developed to suit. Our units are designed to be lightweight and easily integrated into your fishing and milling operations.

Conductor boring, pinning and cutting service

Our tubular experts provide a wide variety of equipment and services for removing well tubing and conductors. Some examples include power tongs, double drilling units for the boring and pinning of multiple casing strings at surface, and guillotine saws for cold cutting applications.

Topside and pipeline decommissioning services

Decommissioning topside process facilities and pipelines involves multiple specialised techniques to safely and efficiently prepare pipelines for removal and ultimately progress them to a hydrocarbon-free state. A complete portfolio of solutions is available from BHGE.

Subsea well applications

Partner with BHGE to isolate multiple subsea annuli for permanent well abandonment in a single trip. Our **Wellhead Abandonment Straddle Packer (WASP**) enables operators to abandon suspended subsea wells by perforating, circulating out mud from behind the casing strings, and placing a lateral cement plug across casing annuli and the main bore. This system can be deployed from a dynamically positioned vessel, too, saving the requirement for a rig and providing significant cost savings.

Our **Universal Wellhead Retrieving System (UWRS**), when run with a **Hercules™ multistring cutter**, provides a one-trip method for removal of subsea wellheads from the sea floor. The system works with wellheads from any manufacturer. It also allows for the cutting of multiple strings in tension, which reduces drillpipe wear, increases stabilisation, and reduces rig time. Abrasive water jet cutting solutions are offered through industry partners.

CASE STUDY

Game changing P&A approach changed days per well to wells per day

CHALLENGES

- Inadequate well information
- Highly corroded, leaking, and parted surface casing
- Cemented nested casing strings and twin well conductor removals
- Plugged tubing IDs and stuck barrier plugs

SOLUTION

- Completed 343* well plug and abandonment operations on 19 different platforms within one year–**ONE RIG**
- Combined cement retainer setting and pressure testing in 1 trip

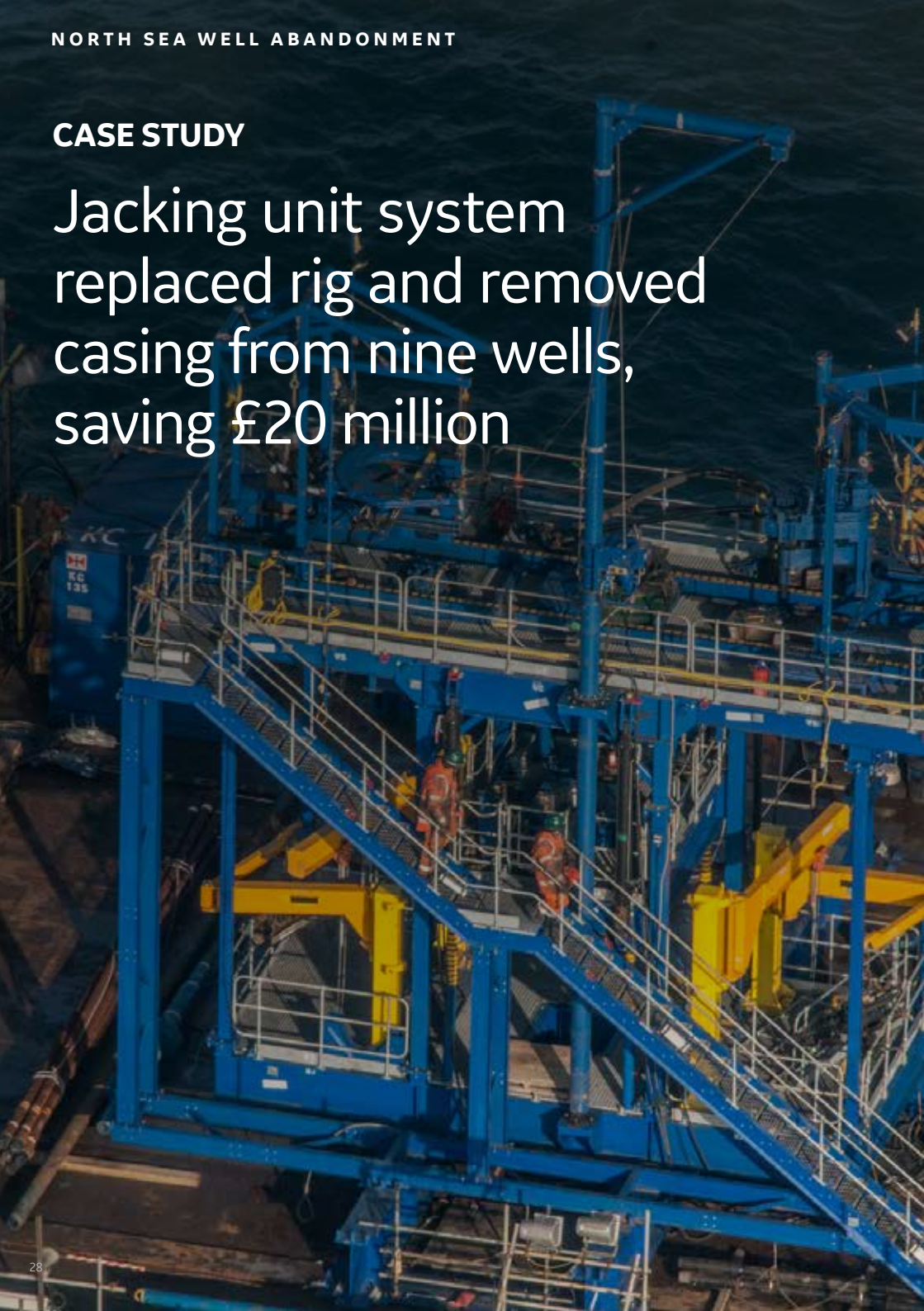
RESULTS

- Completed 280* well P&As on 16 different platforms within nine months on a single rig
- Reduced on-well time from average 1.1 days to 0.4 day
- Successfully ran more than 300 cement retainers and bridge plugs
- Saved trips by combining cement retainer setting and pressure testing with a packer in a single trip
- Executed another 94 well P&As on 14 platforms from different rigs to fill-in the drilling schedule; successfully ran more than 100 bridge plugs and cement retainers

* *More than 450 wells were successfully abandoned in this operator's Thailand P&A project in 2017, with 550 more P&A operations scheduled/in progress in 2018.*

CASE STUDY

Jacking unit system replaced rig and removed casing from nine wells, saving £20 million



CHALLENGES

- Small platform with restricted deck space
- Restricted crane capacity
- Entry to casing and conductor cut 8 m (26 ft) below mean sea level
- Drill out of conductor fill

SOLUTION

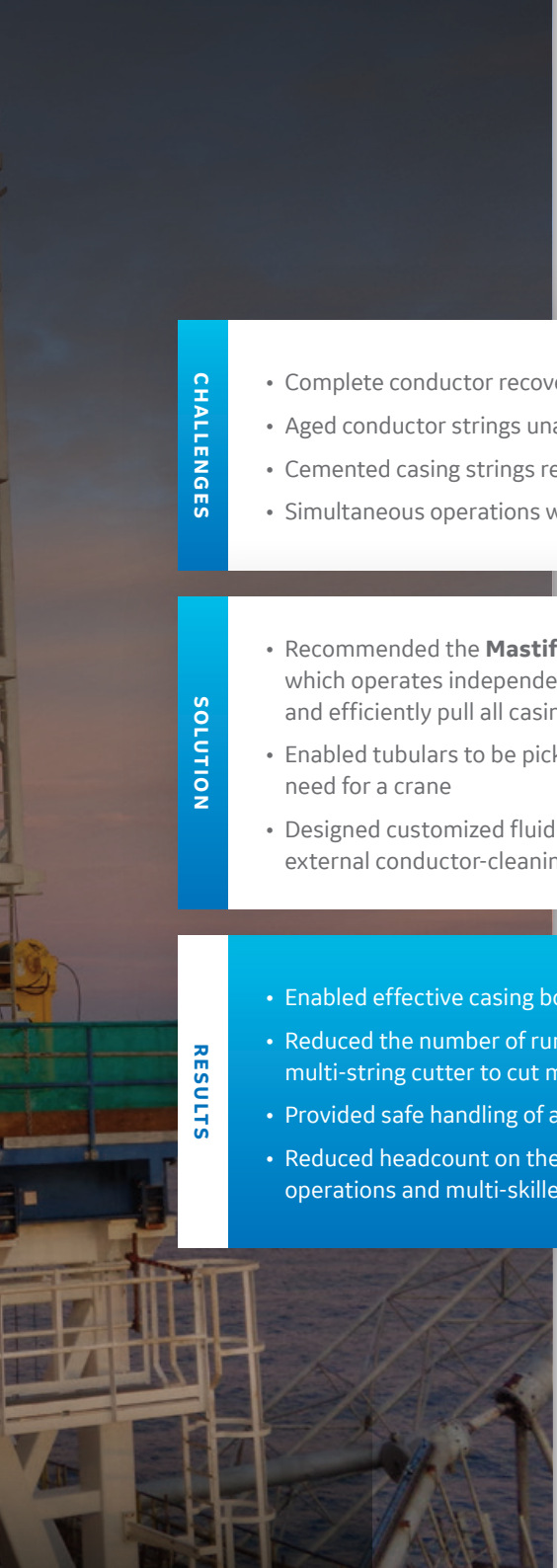
Purpose-built, lightweight, and modular **Retriever™ jacking unit** system incorporating required ancillary equipment

RESULTS

- Successfully removed casing and conductor from nine wells
- Completed operations with less than 2% NPT
- Completed operations within 1.5% of planned project duration
- Successfully accessed wells with casing and conductor cut 8 m (26 ft) below mean sea level
- Eliminated the cost of a rig and removal of subsurface pipe work to allow the rig to position itself close to the platform, representing cost savings to operator of approximately £20 million

CASE STUDY

Mastiff RIS completed casing recovery during simultaneous operations



CHALLENGES

- Complete conductor recovery on over 30 wells in the North Sea
- Aged conductor strings unable to support self-weight
- Cemented casing strings required to be cut and pulled together
- Simultaneous operations with platform drilling derrick

SOLUTION

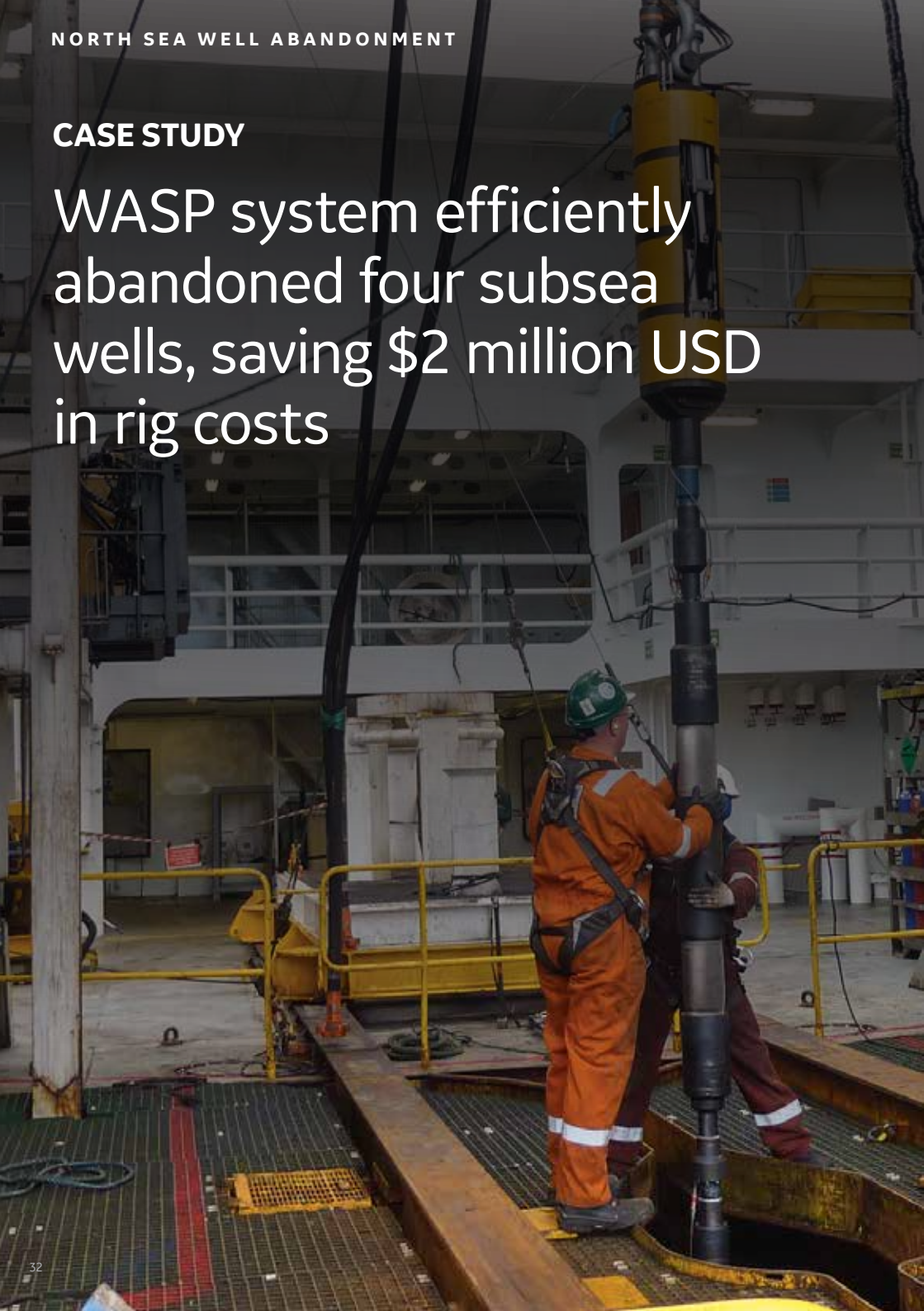
- Recommended the **Mastiff™ rigless intervention system (RIS)**, which operates independently of a rig, and has the ability to quickly and efficiently pull all casing strings and skid between well slots
- Enabled tubulars to be picked up and laid down without the need for a crane
- Designed customized fluid-handling system, and lightweight external conductor-cleaning unit

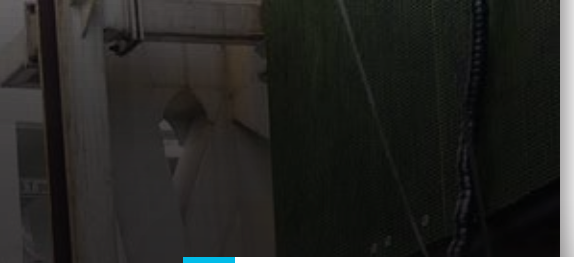
RESULTS

- Enabled effective casing boring, pinning, and cold-cutting operations
- Reduced the number of runs by using a downhole motor and multi-string cutter to cut multiple casing strings in a single trip
- Provided safe handling of all contaminated fluid returns
- Reduced headcount on the platform with integrated operations and multi-skilled personnel

CASE STUDY

WASP system efficiently abandoned four subsea wells, saving $2 million USD in rig costs





CHALLENGES

- Environmental plugs were needed to complete the full abandonment of four suspended subsea wells
- Required the placement of a shallow cement plug across annuli, followed by severance and removal of wellheads 3.1 m (10 ft) below mud level

SOLUTION

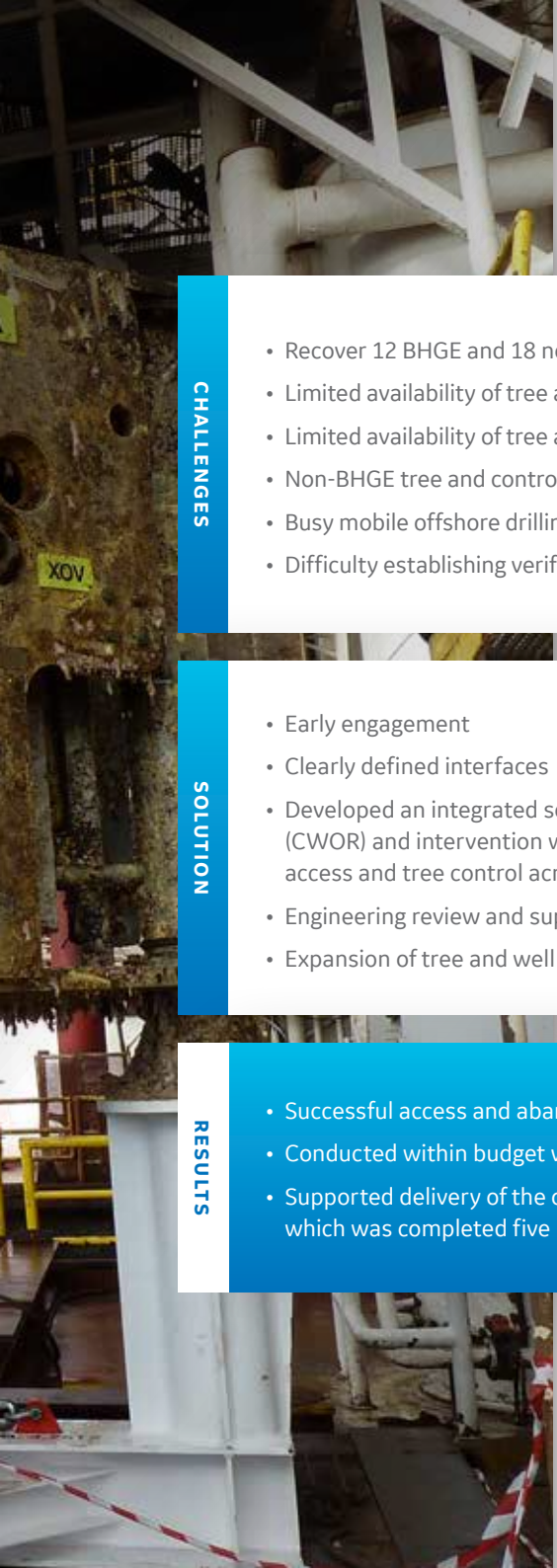
- Deployed a wellhead-abandonment straddle packer (WASP) system to place an environmental plug in each well
- Offered an integrated approach, including multiple services with experienced personnel in each discipline: wellbore intervention, tubing-conveyed perforating, cementing, and project management
- Coordinated operations with vessel operator, and wellhead severance company
- Removed water-based and oil-based mud from annuli with specifically designed spacers and flushes before placing the required cement plugs for long-term environmental isolation

RESULTS

- Successfully abandoned all four wells in less than 23 days
- Avoided an estimated $2 million USD in rig costs, and completed project faster than if it had been with a rig
- Improved efficiency and job execution through integrated project management and coordination of third-party vendors
- Reduced costs and surface footprint by omitting the need for semisubmersible vessel and riser

CASE STUDY

Integrated well access solution delivers 30-well P&A campaign



CHALLENGES

- Recover 12 BHGE and 18 non-BHGE tree and tubing hanger systems
- Limited availability of tree and wellhead equipment records
- Limited availability of tree and wellhead tooling assets
- Non-BHGE tree and controls interfaces
- Busy mobile offshore drilling unit (MODU) decks
- Difficulty establishing verified communication with tree and wellhead

SOLUTION

- Early engagement
- Clearly defined interfaces
- Developed an integrated solution with our completion and workover riser (CWOR) and intervention workover control system (IWOCS) to deliver well access and tree control across BHGE and non-BHGE systems
- Engineering review and support
- Expansion of tree and well tooling availability

RESULTS

- Successful access and abandonment of 30 subsea wells
- Conducted within budget with zero lost-time incidents
- Supported delivery of the overall P&A campaign, which was completed five months ahead of schedule

WELL ABANDONMENT SERVICES

• Project management

• Plug and abandonment engineering

• Deployment systems

- Slickline/digital slickline/wireline
- Coiled tubing/microcoil/telecoil
- Jacking and rigless intervention systems
- Pumping services

• Well abandonment services listing

- Tubing/casing inspection
- Cement/annular barrier evaluation
- Pipe recovery
- Perforating
- Mechanical services
- Plug setting
- Through-tubing fishing
- Through-tubing inflatables
- Wellbore cleanup
- Fishing services
- Cutting and pulling
- Casing/section milling
- Conductor removal
- Boring, pinning, cutting
- Wellhead abandonment straddle packer
- Subsea wellhead removal
- Cementing services

• Topside (T) and pipeline (P) decommissioning

- Hydrocarbon freeing of process systems (T&P)
- Foam inerting (T)
- Vapour phase and liquid phase chemical cleaning (T)
- Steaming (T)
- Carrier gels and enzyme breakers (T)
- Water flushing (T)
- High pressure and ultra-high pressure water jetting (T)
- Fluid filtration (T)
- Temporary flaring (T)
- Gas recompression (T)
- Hydraulic torque and tensioning services for unbolting of mechanical joints (T)
- Onsite machining—pipe cutting/flange facing (T&P)
- Pipeline cleaning and gauging (P)
- Chemical treatments (P)
- Mechanical pigging (P)
- Gel pigging—carrier gels and enzyme breakers (P)
- High-velocity flushing (P)
- Filtration (P) duplicate
- In-line inspection—**VECTRA**™ magnetic flux leakage/ultrasonic thickness (P)

Together, we can improve your outcomes

- **Simplify operations**
- **Increase efficiency**
- **Reduce time**
- **Reduce cost**
- **Improve reliability**
- **Deliver industry-leading solutions**

For more information:
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