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SEPTEMBER 2013

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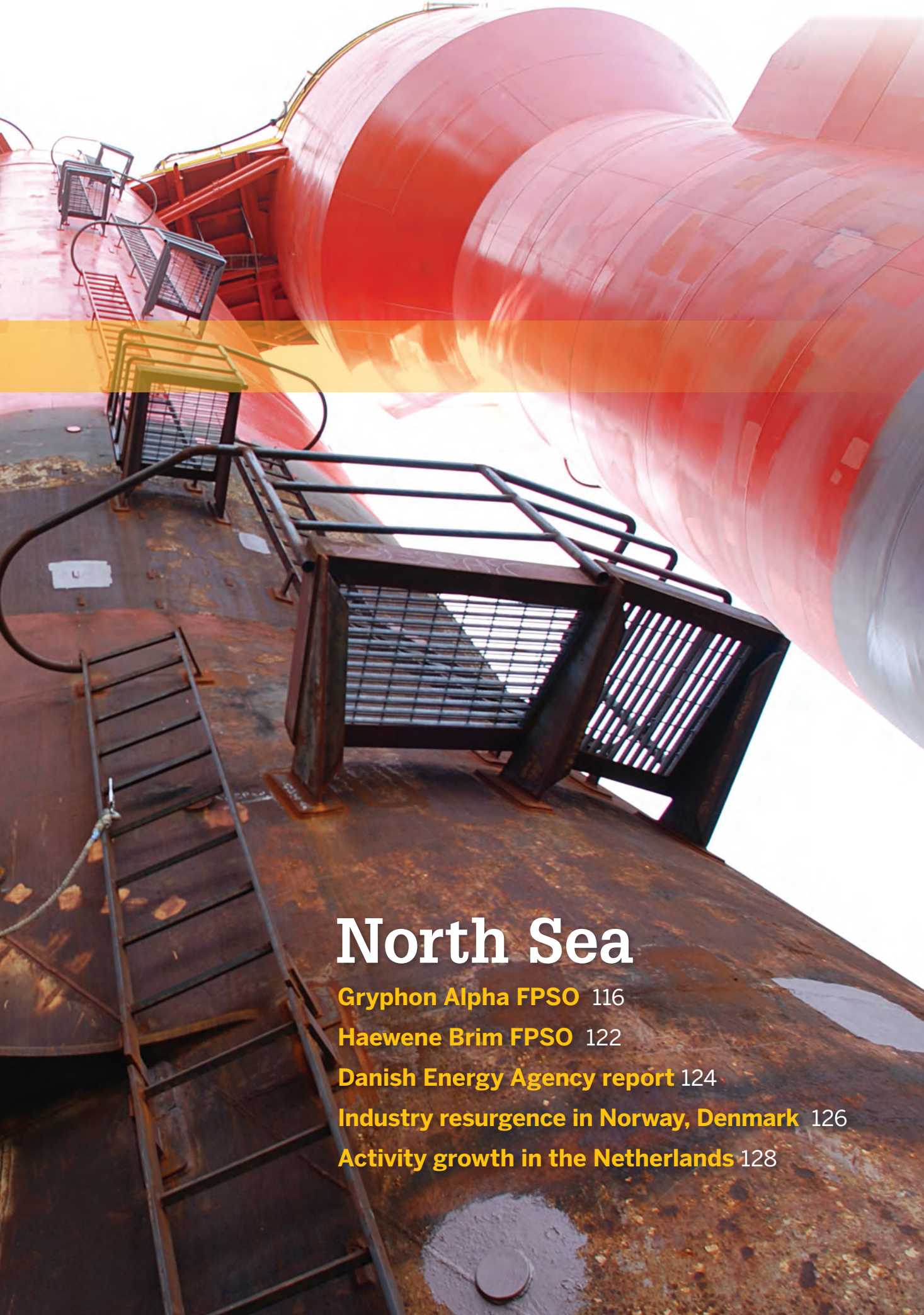
HSEQ • Myanmar pipelines • North Sea

## HSEQ



Offshore Engineer •September 2013
Vol. 38 • No.9



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## Cover Story

## HSEQ




ON THE COVER

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September 2013

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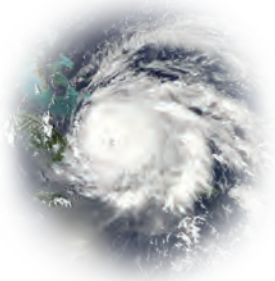
Volume 38, Number 9 September 2013

# Departments & Columns

**"How can the industry help foster an interest in engineering among children?"**





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## What's Trending

### Mexico unveils energy reforms

Mexican President Enrique Peña Nieto announced his plans to reform Mexico's energy industry in an effort to ease restrictions on foreign investment.

### NOAA: Atlantic hurricane season update

The US National Oceanic and Atmospheric Administration (NOAA) predicts a busy Atlantic hurricane season with 13 to 19 named storms, with up to five turning into major events.

**George P. Mitchell** passed away at the age of 94 on July 26th. He was a pioneer in hydraulic fracturing and transformed the natural gas industry. See more on Mitchell at OilOnline.com

## White Papers

### Critical asset performance standards (CAPS) development for offshore reliability

Life Cycle Engineering, Inc. discusses the process involved in developing CAPS for integration into a safety and environmental management system (SEMS).

### Hydrodynamic analysis of offshore structures

DNV Software's Torgeir Kirkhorn Vada describes the role of a linear frequency domain analysis for offshore structures.

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EXTRAORDINARY BEGINS HERE

# Voices

**Next Generation.** Faced with global staffing shortages, OE asked:

## "How can the industry help foster an interest in engineering among children?"

The industry needs to help children understand how you get from pre-college education to someone who is a successful engineer, and how this can become affordable. Yes, you have to take out college loans, but the opportunities at the end pay for themselves. The industry should also help our minority, female, under-represented groups, and students with disabilities. We've already damaged the field by allowing these students to think they can't achieve. That's one area I've been looking at in STEM outreach. 80% of all learning disabilities are students with dyslexia; dyslexia is highly correlated with giftedness. Children need to see that whatever appears to hold them back, someone has already pushed through and has made it in engineering.

**Barbara Moskal, Director of the Center for Assessment of Science, Technology, Engineering and Mathematics; Director of the Trefny Institute for Educational Innovation; Professor of Applied Mathematics and Statistics, Colorado School of Mines**

I would suggest we talk about the energy mix and the science involved, of which oil and gas is a huge part. Also, we should support teachers with volunteers from our organizations to work with schools on curriculum-focused initiatives. The SPE has developed www.energy4me.org and works with organizations like www.need.org, Satrosphere Science Center, Aberdeen, or Wiess Energy Hall, Houston, to educate and inspire teachers. We also need to work harder to create opportunities for young people to enter our industry as engineers, technicians or trainees so that children can see from their peers the potential there is.

**Colin Black, Vice President, Optima Solutions UK, and SPE Europe board member**

Math and science are a requirement for filling the pipeline of future engineers. These subjects can be viewed as difficult and static, bearing little resemblance to the interesting and dynamic careers they encompass. Industry must engage students in unexpected ways – through hands-on exploration, education, mentoring and internships – to show them the real-life relevance of their subject choices.

**Larraine Boorman, Managing Director of Skills, OPITO**

First and foremost, children need to see the fun and practicality associated with engineering. We, as a profession, need to be more visible with our work. Promoting real-world examples of challenges that engineering disciplines resolve should help with this translation. Additionally, engineering, unlike other professions like medicine or law, is not easily personified.

**John Bolton, Director of Marketing, Tensar International**

The Society of Hispanic Professional Engineers (SHPE) recognizes the need to engage Hispanics early on to foster interest in science, technology, engineering, and mathematics fields. This is why, through our corporate sponsors, we host Noches de Ciencias (Science Nights) across the nation to introduce students and their parents to STEM through hands-on activities and educational workshops. We also work with our chapters to mentor younger students and offer events such as pre-college symposia, introducing students to engineering prior to college. We encourage the industry to examine successful programs such as SHPE's and continue to support them as much as possible.

**Pilar Montoya, CEO**
**Society of Hispanic Professional Engineers**

The Society for Petroleum Engineers' Energy4me global energy education outreach program offers a wealth of unbiased, factual information that helps educate, inspire and motivate students to choose petroleum engineering or related field as a career. Developed for grades K-12, the program uses the energy4me.org website, teacher workshops and speaker programs to share the message about how important energy is to everyday life and what the industry is doing to improve the quality of life across the globe. We must proactively tell our story by communicating our commitment to take complex, challenging issues and find safe, responsible solutions.

**Sujata Bhatia, Chairperson, Energy Information Committee, Society of Petroleum Engineers**

**Go to OEDIGITAL.COM and give us your opinion on this month's topic!**

# Self-less

Brion Palmer

The oil & gas industry is about people. Every human being on the planet has benefited from the work this industry does.

People also represent one of the industry's biggest challenges. There is a global shortage of staff. There are not enough qualified people to fill the many open positions.

Companies are now trying to be very proactive in retaining their talent. It is one thing to find new talent but it is even more important to retain the talent you have.

Sometimes, unfortunately, circumstances are completely out of one's control. This just happened to us at AtComedia. Our colleague and friend, James Wallace Self, passed away on July 25th after a very courageous battle with cancer.

James was an integral part of the AtComedia team having served in a variety of capacities during his 23-year tenure. Everyone who interacted with *Offshore Engineer* over the past 23 years had, at minimum, an indirect relationship with James.

The fact you received *Offshore Engineer* in a timely manner, on a monthly basis, can be directly attributed to James. James served as production manager of *Offshore Engineer*. This position allowed James to interact and become both professional acquaintances and personal friends with many of our advertising customers. James just had a way with people.

James also served as the publisher of our two annual directories – Gulf Coast Oil Directory and Houston/Texas Oil Directory. These two directories now serve as the backbone of our new professional development website.

James also served a stint as web director for the company. He was responsible for bringing you OilOnline – one of the very first oil and gas websites, in 1995. James didn't know how to write code or design websites, but he learned – on his own with no formal classes or training.

James was used to taking on challenges like this. He had a can-do attitude. What you probably didn't know is James was a brilliant and truly gifted pianist. He could make a piano soar, and yes, he was self taught – which made his talent even more extraordinary.

In honor of James, AtComedia will offer an annual music scholarship in his name to a fine arts major at Sam Houston State University (his alma mater). This will insure James' legacy and memory will live on. James would have loved the idea of helping a young person pursue their musical aspirations. It is how he was.

**James W. Self**

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# How do you know the coating interface won't delay your offshore project?

## Here's a sign.

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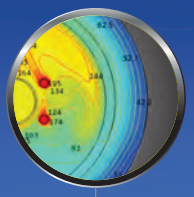

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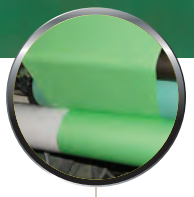
Pipe and Joint Coating Design

Coating System Validation

Logistics Management



Pipe Coating Application

Field Joint Coating

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# Colloquy

Nina Rach

# Ars longa, vita brevis

This adage was adapted from the first two lines of Aphorismi, written by the ancient Greek physician Hippocrates about 400 BCE. They translate: "life is short, arts (crafts, techniques) long," which can be taken to mean that it takes a long time to acquire skills and expertise, but one has only a short time in which to learn and use them.

Time limits our accomplishments in life. This summer was punctuated by the untimely death of our colleague at Offshore Engineer, James Self. A team player, James was talented, conscientious, kind, and generous. He is already missed.

These same qualities describe Texas oilman and philanthropist George P. Mitchell, who died July 26, the day after James. Mitchell's life is the quintessential American success story, as he was the son of Greek immigrants and became one of the wealthiest people in the state. He was diligent and hardworking, graduated first in his class from Texas A&M University with a degree in petroleum engineering in 1940—and later became the university's most-generous donor.

After Mitchell left Texas A&M, he worked for Amoco Production Co. in East Texas and Louisiana, then went to serve in the US Army Corps of Engineers during World War II. After the war, in 1945, Mitchell and his wife Cynthia moved to Houston, where he initially worked as an independent oil consultant, and they began a family that would grow to ten children.

In 1947, George and his brother Johnny became investors and owners of Oil Drilling Inc. with H. Merlyn Christie, and in 1952, bought into a substantial acreage position north of Fort Worth.

Then called the "Wildcatter's Graveyard," it became better known as the heart of the Barnett Shale play.

In 1962, the Mitchell brothers bought out smaller shareholders and reorganized the company as Mitchell & Mitchell Oil & Gas Corp. By 1964, Mitchell & Mitchell owned 1000 producing wells.

In 1972, Mitchell Energy and Development Corp.'s initial public offering was listed on the American Stock Exchange, and George Mitchell retained about 60% of the stock.

In 1991, the US Department of Energy subsidized Mitchell Energy's first horizontal drilling in the Barnett shale. Mitchell Energy later pioneered the use of hydraulic fracturing and found particular success with slick water fracturing by 1998. The rest, as they say, is history, and the shale boom has taken on astounding proportions.

George Mitchell completed the sale of Mitchell Energy to Devon Energy in January 2002 for about US$3.5 billion.

## Philanthropy

In 1978, the Mitchells founded the Cynthia and George Mitchell Foundation, "a mission-driven, grant-making foundation that seeks innovative, sustainable solutions for human and environmental problems." The projects and initiatives launched by this foundation are too numerous to list.

In 1982, George Mitchell funded and launched the Houston Advanced Research Center in The Woodlands, an institution dedicated to environmental issues and sustainable growth. HARC now has a staff of more than 40 research scientists and generates more than $20 million in annual revenue.

The Mitchells donated more than $100 million to Texas A&M, culminating in the George P. and Cynthia Mitchell Institute for Fundamental Physics and Astronomy in 2009.

Along the way, Mitchell donated the land for and supported the establishment of the Texas A&M campus at Galveston. TAMUG began in 1962 as the Texas Maritime Academy, and expanded in 1968, when Mitchell gifted 100 acres on Pelican Island. TAMUG offers undergraduate programs in marine (biology, fisheries, engineering technology, sciences, transportation) and maritime (administration, studies, systems engineering) disciplines, oceans and coastal resources, marine environmental law and policy. The graduate programs include marine resources management and marine biology.

In 2011, George Mitchell signed The Giving Pledge, committing the majority of his wealth to charity. The Giving Pledge is an effort to encourage the world's wealthiest to give most of their wealth to charity, promoted by Warren Buffet and Bill and Melinda Gates. As of July, 113 billionaires have signed this pledge.

Mitchell's values, behaviors, and work ethic were shaped by his upbringing in Galveston. His life, work, and legacy exemplify a quote from the classic Greek philosopher Aristotle: "We are what we repeatedly do. Excellence then, is not an act, but a habit." OE

# ThoughtStream

Chris Docherty, FQM Ltd.

# Putting the 'Q' into HSE

In order to utilize quality to bring about an effective HSE system, first it must be defined. This in itself is a challenge as quality is often about the perception of the individual. Joseph Juran, principally remembered as an evangelist for quality, gave the definition as "fitness for use" whereas Philip Crosby, author of "The Fourteen Steps to Quality Improvement," thought it was more a case of "right first time."

Perhaps the simplest definition is that of the Oxford English Dictionary which says "the degree of excellence of something." Whichever definition is used, a quality approach to achieving effective health, safety and environmental responsibilities is one that can bring immediate benefits to the organization.

Quality is easy to say, but is it a word that is overused as well as ill-defined? After all, what company believes it is not applying quality to everything it does?

The subject of quality has long been recognized, with quality control, quality assurance and quality improvement being the three main approaches to quality management. There are, however, well documented flaws and differing opinions on the effectiveness of these approaches when individually applied. Rather than focus on any one of the above, it is a holistic approach that will deliver quality in the successful management of HSE, from processes, procedures and people, through to suppliers of products and services, and the assurance and improvement in these elements.

There are five steps to successful health and safety management, all of which share similarities to a quality management system; policy, organizing, planning/implementing, measuring and improving.

**"Just as quality in practice has to be defined at the beginning of any process, quality in behavior should begin at board level, influencing the HSE culture within an organization to send a positive message to all stakeholders, importantly including the supply chain."**

Following these steps with a quality approach will help keep staff safe and injury free at work, while reducing the cost of injuries, illness, and damage. Not to mention, avoiding extremely damaging and costly legal actions that can sometimes follow as well as the incalculable human cost and suffering to those injured.

According to the Health & Safety Executive, you cannot be a "quality" organization unless these sound principles are applied to the management of health and safety.

Just as quality in practice has to be defined at the beginning of any process, quality in behavior should begin at board level, influencing the HSE culture within an organization to send a positive message to all stakeholders, importantly including the supply chain.

Although there are many companies that believe quality is a key factor in ensuring success - especially in an environment that is high risk, competitive and selective - there are equally many companies that are not committed to a quality approach. This is often due to a lack of understanding of the link between HSE and quality, which in this case is very much about providing consistency and assurance.

There has never been a better time to adopt a quality approach in the way you operate your business, especially when it comes to health, safety and environment. It is an exciting, and vibrant time for our industry as we look ahead to the next 50 years; so please consider putting "Q" into HSE and do not let your company make headline news for the wrong reasons.

***Chris Docherty** is a director of Aberdeen-based consultancy FQM Ltd, previously known as Facilitators Quality Management, with responsibility for FQM Training and sales and marketing. He has over 20 years experience in contracts, quality management and project management at a senior Level.*

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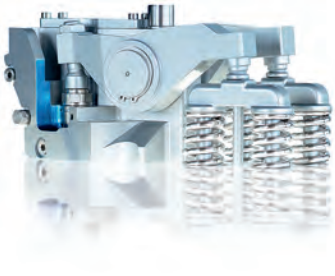

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# Global Briefs


### A Alaska states Arctic needs

Alaska's Lt. Governor Mead Treadwell stated the case for the state's needs at the Ice-Diminished Arctic Conference in Washington, D.C. He emphasized the need for safety, security, and economic development in the region, stating that valuable fisheries need to be considered and protected. Treadwell offered a safety checklist to guide policy.

### B CIGI urges increase in Arctic ops

The Center for International Governance Innovation (CIGI) issued a policy brief for the "New Arctic," encouraging Canada's federal government to devote greater policy attention and resources to Arctic maritime areas, including: better navigational aids, investment in ramps, breakwaters and windbreaks; infrastructure; Arctic deepwater ports; safety and security regulations; and a rigorous code of conduct for ships.

### C Rosneft studies Kara Sea

Rosneft, jointly with the RosHydroMet Arctic and Antarctic Research Institute, started a large-scale program of Kara Sea shelf studies as part of Kara Sea Summer 2013 Marine Expedition. During the expedition, meteorological stations will be installed at Novaya Zemlya archipelago, icebergs will be monitored, and buoys will be launched to monitor ice drift and settlement.

The data is required to assess potential environmental effects on future marine facilities, to be used for development of the Eastern Prinovozemelsky license areas.

### D TGS shots Canadian surveys

TGS announced two 2D surveys off Newfoundland and Labrador to define and delineate the Henley, Chidley, and Holton basins. The Labrador Sea Deep Basin 2D survey will cover 3000 line-km and the Labrador Sea 2D infill survey will cover 7100 line-km. The surveys will complement and infill the existing 22,167 line-km of 2D data acquired in 2011 and 2012. Data acquisition began in August and initial data will be available 2Q 2014.

### E Walter spuds relief well

Walter Oil & Gas Corp. began drilling on a relief well near its troubled A-3 natural gas well at South Timbalier 220, in the US Gulf of Mexico. The company, whose permit was recently approved by the US Bureau of Environmental Enforcement, is using the Rowan *EXL-3* jackup. Once the relief well intercepts the target, drilling mud, followed by cement, will be pumped into the well.

A fire aboard the *Hercules 265* jackup occurred in July, about 55mi (88km) off Louisiana. Operator Walter was completing a sidetracked well, when natural gas ignited. According to Hercules, the 44 people on board the rig were evacuated.

### F Santos basin discovery

Petrobras confirmed good quality oil (28°API) at Iara area, block BM-S-11, in the Santos basin presalt play, after drilling and testing well 3-RJS-706 (3-BRSA-1132-RJS). The well is 226km off Rio de Janeiro state and 6km west of the discovery well in 2197m water depth. It was the fourth exploratory well on the block.

The carbonate reservoirs, which start at a depth of 5260m, have excellent porosity and permeability, better than the discovery well (1-RJS-656). Petrobras is the operator (65%) in partnership with BG E&P Brasil (25%) and Petrogal Brasil (10%).

### G Norvarg gas confirmed

Total's appraisal drilling confirmed the "extensive" nature of the Norvarg gas discovery in the Barents Sea. Well 7225/3-2, in license PL 535 off Norway, was drilled in 377m water depth by using the *Leiv Eiriksson* semisubmersible. Norvarg was discovered in 2011, about 275 km north of the Hammerfest LNG plant on Melkøya Island, and was estimated to contain 10-50billion cu m of gas, equivalent to about 63-315MMboe.

Two production tests were done in the upper and lower parts of the Kobbe formation, with the well flowing at a maximum rate of 175,000cu m/d (about 6.2Mcf/d) on a 52/64in. choke. The well will be plugged and abandoned. Partners in the license are Total E&P Norge, operator (40%), North Energy (20%), Ithaca Petroleum Norge (13%), Statoil (10%), Det Norske (10%), and Rocksource Exploration Norway (7%).

### H TGS shoots West of Shetlands

TGS announced a 3D survey in UK West of Shetlands. Rona Ridge 2013 (RR13) is a 2420sq km 3D survey that will provide


3D data. Data processing will be performed by TGS, with initial data available to clients in 4Q 2013, ahead of the UK 28th Licensing Round.

### I Circle Oil buys Mahdia license

Irish independent Circle Oil announced that its subsidiary, Circle Oil Tunisia Ltd., has increased its stake in Mahdia license, offshore Tunisia to 100%, after acquiring the remaining 30% working interest from Tethys Oil & Mining Inc. for US$3 million. Circle Tunisia has identified multiple leads following a recent 3D seismic survey over the license area.

The company is highlighting two prospects: El Medouini and West El Medouini, containing an estimated 125MMbo and 75 MMbo unrisked, most-likely reserves, respectively. Circle will need to drill at Mahdia by July 19, 2014.

### J Yam Hadera estimate

Modiin Energy updated resource estimates for Yam Hadera field, off Israel. The best estimate of gross recoverable, prospective resources is 208MMbo (revised upwards from 133 MMbo) and 3.4Tcf of natural gas (revised upwards from 1.4 Tcf of natural gas). The estimates were prepared by Netherland Sewell & Associates Ltd., based on a 3D seismic survey of a 250sq km area around the prospect's northern closure.

Tel Aviv-based Modiin Energy wholly owns the rights to the 400sq km Yam Hadera license. The license is about 30km off the Israeli coast, between Hadera and Haifa, in 500-1000m water depths and is directly northwest of Adira Energy's Gabriella and Yitzhak license blocks.

### K ConocoPhillips acquires Senegal blocks

ConocoPhillips has agreed to acquire a 35% stake in three contiguous blocks off Senegal through two deals. The company is to acquire a 25% interest in all three blocks from Cairn Energy and a further 10% in the same blocks from FAR. The blocks are Rufisque, Sangomar, and Sangomar Deep, which cover about 7490sq km within the Mauritania-Senegal-Guinea Bissau basin.

Cairn has planned a two-well exploration program for 1H 2014, to target more than 1.5 billion bbls of undiscovered resource. Transocean's semisubmersible *Cajun Express* will drill the wells.

FAR said the exploration campaign will test a shelf play and a deepwater fan play, and estimates total prospective resources at 3.58 billion bo.

Cairn will retain operatorship and 40% interest in the blocks during the exploration phase. Petrosen, the Senegal National Oil Co., will retain its 10% interest in the exploration phase, and FAR will hold 15%.

If commercial, ConocoPhillips would have the option to become operator.

### L Eni discovery off Congo

Eni made an oil and gas discovery on the Nene Marine exploration prospect, in the Marine XII block, about 17km off Congo. Eni says two wells were drilled on Nene Marine and estimates it contains about 600 MMbo and 700Bcf of gas in place.

The first well, Nene Marine 1, was drilled in 24m water depth and encountered a wet gas and light oil accumulation in the Lower Cretaceous presalt clastic sequence. Nene Marine 2 was drilled 2km from the discovery well, confirming the hydrocarbons and reservoir continuity. Production tests on both wells flowed at a commercial rates with 37°API oil. Eni said it will continue the appraisal phase, while starting studies for commercial exploitation. Eni is operator of Marine XII block with 65% equity. Other partners are New Age, 25%, and Societé Nationale des Pétroles du Congo, with 10%.

### M Cobalt Energy wells

Cobalt International Energy is drilling the Mavinga #1 pre-salt exploratory well with Diamond Offshore's semisubmersible *Ocean Confidence* in block 21 and the Lontra #1 pre-salt exploratory well on block 20, using Petroserv's new-build *SSV Catarina* semi. Cobalt is operator (40% WI) in both the Mavinga #1 and the Lontra #1 wells, both offshore Angola.

Cobalt is also working on pre-development activities for its Cameia field in Angola block 21. Formal project sanction is expected during 2014, with first production from Cameia in 2017. Cobalt is operator with 40% WI.

The vessel will have one ROV and a complete survey spread.

### P Harkand launches ROV support vessel

Harkand launched the *Harkand Harmony*, an ROV support vessel, designed to service Asia Pacific's oil and gas industry. The vessel has secured on a three-year, hire-purchase contract that will see Harkand extend its inspection, repair, and maintenance (IRM) services in the growing Asia Pacific region.

ASL Marine Holdings built the vessel at Batam near Singapore. It will be fitted with one Comanche work ROV and a complete survey spread. It boasts a 580sq m main deck, a Kongsberg DP2 system, 20t man-riding knuckle boom crane, a 4.5m moonpool, and is able to accommodate 60 crew members.

### N BP, SOCAR, Total, and Fluxys join TAP

Trans Adriatic Pipeline AG (TAP) announced that BP, SOCAR, Total SA, and Belgian Fluxys have exercised their option to join TAP. They are members of the consortium developing Shah Deniz field off Azerbaijan. The BP-led group exercised a call option that gives it control of a 50% stake in the pipeline project. TAP's shareholding is now BP (20%), SOCAR (20%), Statoil (20%), Fluxys (16%), Total (10%), E.ON (9%) and Axpo (5%). TAP's shareholders remain open to further strategic partners joining the project in the future.

TAP will carry natural gas from Shah Deniz II field from Azerbaijan's Caspian to Italy, with the Trans Anatolian Pipeline, or TANAP, on the Turkish-Greek border, then taking it across Greece, Albania, and the Adriatic Sea, before coming ashore in southern Italy.

### O Ice-class LNG tanker delivered

Dynagas took delivery of two ice-class membrane LNG tankers, the *Yenisei River* and *Arctic Aurora* from Hyundai Heavy Industries' Ulsan shipyard, South Korea. The 155,000cu m vessels are fitted with GTT Mk III containment systems. Propulsion for the ships is provided by a dual-fuel diesel generator engine system. Four Wartsila-Hyundai diesel engines in each ship, fueled by gas or fuel oil, will power two propulsion motors driving a single, fixed-pitch propeller. Registered in the Marshall

Islands, the ships will operate on charter to Gazprom and Statoil.

### R Lundin swaps for CVII PSC

Lundin Sareba BV and Indonesia's SKKMigas entered into a PSC for 100% interest in the Cendrawasih VII (CVII) block off northeastern Indonesia. The block is a substitute for Lundin's existing Sareba acreage, since Sareba was declared a protected nature conservation area.

The CVII block covers 5545sq km and has been lightly explored. It contains the shallow water portion of the Mamberamo delta and an undeveloped gas discovery in Pliocene turbidite reservoirs. Large carbonate build-ups have also been identified with a 950sq km 3D seismic survey acquired in 2009.


**Hallin's modular saturation diving system on the *Carlisle* will be used to support dive teams.**

### Q Pipeline work off Java

Hallin Marine was awarded a project off northwest Java for installation of new control taps and a bypass for the island's main pipeline to the mainland. The pipeline supplies 60% of Jakarta's gas requirements. Hallin will provide full saturation-diving services using the *Ullswater* subsea operations vessel. Also on site will be Hallin's *Carlisle*, which was recently mobilized for duty as a diving support vessel.

Hallin teams will be performing concrete coating removal on existing pipelines, pipeline integrity checks, spools installation, precommissioning assistance, installation of hot-taps at multiple locations, and the fitting of underwater pipe-closure stopples.

### S Heavy-lift vessel for BigLift

BigLift Shipping's new vessel *Happy Sky*, started its maiden voyage from Shanghai to Cape Lambert, Australia. The vessel is transporting three large modules —935mt/818mt/777mt—to be installed as part of the Cape Lambert port expansion Phase B project. This voyage is the first of four consecutive shipments.

The vessel is the latest addition to BigLift Shipping's heavy-lift vessel fleet. It was built by Larsen & Toubro in India and features two 900mt, Huisman-built, heavy-lift mast cranes. The cranes have a lifting height of 40.9m above the main deck.

The vessel is 155m long, 18,680dwt, and has Finnish/Swedish 1A Ice Class notation. During sea trials it achieved 17kt service speed.

## Contract Briefs

### Höegh FLNG awarded pre-FEED

Höegh FLNG Ltd. has been awarded a pre-FEED study for a jetty-moored 2MMTA FLNG near-shore barge for a North American LNG export project. The study will be executed in 2H 2013.

### Meta wins Shell tiebacks

Meta Downhole Ltd. announced a contract with Shell for liner tiebacks in the Gulf of Mexico.

Meta will supply its V0 ISO14310-certified Meta liner tieback that connects the liner to a tieback string of casing. This is a metal-to-metal connection with no reduction in internal diameter (ID) and no reliance on elastomers.

### FMC wins subsea boosting

Petrobras awarded FMC Technologies a US$40 million contract to supply three subsea boosting stations for the Parque das Baleias development, off Brazil in the Campos basin.



### DOF Subsea awarded FPSO work

DOF Subsea Norway has been awarded a contract by Teekay Petrojarl Production for work on a newbuild FPSO, including mooring pre-installation, tow-out, and hook-up for Teekay's FPSO, to be installed on the Knarr field in the North Sea.

### Wood Group wins BP contract

Wood Group Kenny (WGK) will support BP's offshore Angola operations under a new engineering services contract worth US$18 million. The 12-month contract covers two subsea operations support scopes: one is for Greater Plutonio (block 18) operations group; the other is for PSVM (block 31: Plutao, Saturno, Venus, and Marte fields) operations group.

### Technip wins EPS contract

Total E&P Congo awarded Technip an engineering, procurement, and supply (EPS) contract for the Moho Phase 1bis development as part of the Moho Nord project, off Congo. The scope covers project management, detail engineering, procurement, and supply for the FPU modifications, with two new subsea tie-backs.

Located 75km from Pointe-Noire in 450-1200m water depths, Total operates (53.5%) the Moho Bilondo license with partners Chevron (31.5%) and Societe Nationale des Petroles du Congo (15%).

### Xodus awarded pipelines

Xodus Group secured two contracts from Abu Dhabi-based Valentine Maritime (Gulf) L.L.C. The first is for new subsea pipelines in the Arabian Gulf off Qatar's northeast coast. It involves design of a new 6.4km long, 24in. water injection pipeline, including risers and two J-tubes. The project is due for completion by the end of 2013. The second is for the pipeline installations in Fateh field, including: a 30in. by 6.7km subsea oil pipeline, a 30in. by 4km subsea oil pipeline, and a 16in. by 6km subsea water injection pipeline. All include new risers and tie-ins.

### Royal Boskalis awarded DCP contract

Shell Philippines awarded Royal Boskalis Westminster N.V. a contract to install a depletion compression platform (DCP) for the Malampaya Project off Palawan Island, Philippines. The contract is worth about US$60 million.

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# Can we agree on standards?

**Rune Mode Ramberg, chief engineer subsea technology and operations, Statoil (centre) and Dave Wilkinson, senior subsea systems consultant, Exxon Mobil (right).** Photo: Ole Kristian Olsen/ UTC2013

**Standardization sounds promising, but what exactly should be standardized and would it hinder innovation? The idea was a hot topic at UTC in Bergen, Elaine Maslin reports.**

On the opening day of Bergen's Underwater Technology Conference (UTC) 2013, Kristian Siem, made a striking remark. The chairman of Siem Holdings and subsidiary company Subsea 7 said: "The industry has a cost level that is astronomical and Norway is the high-cost leader."

While he may have been singling out his home nation, his comments were aimed at the global oil and gas industry, and the subsea industry in particular.

Increasing costs can damage the viability of subsea projects. According to Jannicke Nilsson, senior VP for technology excellence, Statoil, cost pressures can mean standard, "old-fashioned" facilities are the preferred option for developments, pushing out subsea alternatives that are often complex.

One solution to the increasing costs and increasing complexity of subsea production systems, is greater standardization—a topic which dominated this year's UTC.

"We need to do more standardization," says Nilsson. "If we can push that, we can make the subsea solution the better alternative."

Operators and suppliers agree on the concept, but not necessarily on what should be standardized.

## A need to standardize

Werner Menz, VP technology, subsea systems, Cameron (now part of OneSubsea) said problems arise because operators "too often" make general specifications for API and ISO standards, but then add unique specifications.

Remi Eriksen, CEO, DNV Maritime and Oil & Gas, calls the practice "preference engineering," where operators do not want to trust a standard product.

The effect is that suppliers must stock all the different tools required to meet multiple standards, each with their own spare parts and procedures, increasing risk.

In addition to multiple product and tooling specifications, there are also QHSE, documentation, and technology qualification requirements, says Dave Wilkinson, senior subsea systems consultant, Exxon Mobil.

"These are the things that really make it hard for the suppliers to deliver what operators want," he says. "It is the operators that keep changing the requirements and upping the bar."

Bill Cowan, subsea engineering advisor, ENI Petroleum, based in Houston, says: "It comes down to a matter of trust. The very large oil companies do not trust the manufacturers to do the right thing and to get it right. As a consequence, they have what amounts to parallel engineering staff that propose their way to manufacture. So you have duplicate engineering staff. Is the interest in standardization genuine and does it take into account this need for 'do it my way, or not at all'?"

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# Quick stats

*OE*'s at-a-glance guide to offshore hydrocarbon reserves and key offshore infrastructure globally is updated monthly using data from leading energy analysts Infield Systems (www.infield.com).

## New discoveries announced

| Depth range | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|
| Shallow (<500m) | 93 | 105 | 75 | 23 |
| Deep (500-1500m) | 28 | 25 | 23 | 8 |
| Ultradeep (>1500m) | 36 | 20 | 34 | 13 |
| **Total** | **157** | **150** | **132** | **44** |

*Note: Operators do not announce discovery dates at the time of discovery, so totals for previous years continue to change.*

## Reserves in the Golden Triangle

by water depth 2013-17

| Water depth | Field numbers | Liquid reserves (mmbbl) | Gas reserves (bcf) |
|---|---|---|---|
| **Brazil** | | | |
| Shallow | 22 | 1,721.75 | 980.00 |
| Deep | 16 | 3,257.00 | 2,255.00 |
| Ultradeep | 40 | 12,428.45 | 17,340.00 |
| **United States** | | | |
| Shallow | 24 | 106.95 | 1,146.50 |
| Deep | 23 | 1,378.71 | 1,624.87 |
| Ultradeep | 24 | 2,989.00 | 3,340.00 |
| **West Africa** | | | |
| Shallow | 147 | 3,416.55 | 18,047.59 |
| Deep | 46 | 5,454.00 | 6,320.00 |
| Ultradeep | 14 | 1,900.00 | 2,650.00 |
| **Total** | **356** | **32,562.41** | **53,703.96** |
| (last month) | (360) | (33,444.96) | (54,451.18) |

## Greenfield reserves

2013-17

| Water depth | Field numbers | Liquid reserves (mmbbl) | Gas reserves (bcf) |
|---|---|---|---|
| Shallow | 1,284 | 75,600.19 | 824,193.58 |
| (last month) | (1,315) | (77,066.36) | (832,926.99) |
| Deep | 160 | 13,654.58 | 80,326.57 |
| (last month) | (165) | (13,879.58) | (83,871.57) |
| Ultradeep | 97 | 17,746.45 | 66,847.00 |
| (last month) | (99) | (18,392.45) | (67,197.00) |
| **Total** | **1,541** | **107,001.22** | **971,367.15** |

## Pipelines

(operational and 2013 onwards)

| | (km) | (last month) |
|---|---|---|
| **<8in** | | |
| Operational/ installed | 41,860 | (41,793) |
| Planned/ possible | 23,721 | (23,645) |
| | **65,581** | (65,438) |
| **8-16in** | | |
| Operational/ installed | 77,688 | (77,457) |
| Planned/ possible | 47,837 | (47,149) |
| | **125,525** | (124,606) |
| **>16in** | | |
| Operational/ installed | 89,110 | (88,414) |
| Planned/ possible | 50,241 | (48,333) |
| | **139,351** | (136,747) |

## Production systems worldwide

(operational and 2013 onwards)

| **Floaters** | | (last month) |
|---|---|---|
| Operational | 277 | (277) |
| Under development | 48 | (48) |
| Planned/possible | 313 | (313) |
| | **638** | (638) |
| **Fixed platforms** | | |
| Operational | 9,655 | (9,655) |
| Under development | 145 | (145) |
| Planned/possible | 1,467 | (1,467) |
| | **11,267** | (11,267) |
| **Subsea wells** | | |
| Operational | 4,416 | (4,416) |
| Under development | 411 | (411) |
| Planned/possible | 6,007 | (6,007) |
| | **10,834** | (10,834) |

## Global offshore reserves (mmboe) onstream by water depth

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Shallow | 10,471.06 | 6,006.89 | 65,246.75 | 30,610.38 | 36,880.04 | 34,931.09 | 53,788.13 |
| (last month) | (10,421.19) | (6,132.60) | (65,316.14) | (31,247.39) | (38,700.72) | (35,037.35) | (54,172.29) |
| Deep | 1,312.21 | 1,735.15 | 3,528.61 | 5,788.99 | 4,144.84 | 5,282.95 | 9,070.98 |
| (last month) | (1,312.21) | (1,768.96) | (3,528.61) | (5,788.99) | (4,320.26) | (5,353.47) | (9,675.04) |
| Ultradeep | 199.94 | 737.15 | 3,243.07 | 2,922.43 | 1,907.54 | 5,669.67 | 15,789.23 |
| (last month) | (199.94) | (737.15) | (3,090.44) | (3,075.06) | (1,789.91) | (6,060.93) | (16,231.98) |
| **Total** | **11,983.22** | **8,479.18** | **72,018.43** | **39,321.42** | **42,932.42** | **45,883.71** | **78,648.34** |

8 August 2013

Patrick O'Brien, CEO, the Industry Technology Facilitator, says: "The reality is you have a standard against which you design, but you have things that go wrong and you have to fix it.

"So then the operator adds a specification to cover that problem not happening again. That is when you get the build-up in company-detailed specifications."

### A quick win, perhaps

A quick win could be to standardize interface connections and tools, which are the interface to connect systems, but are sometimes used only once or twice, suggests Rune Mode Ramberg, chief engineer subsea technology and operations, Statoil.

"This [the standardization of interfaces] is something the supply chain and operators need to do together," he says, "because it is not really the interfaces we should spend much time on, they do not add any value. We should look in to what type of interfaces we should have in the future.

"We should agree on how to connect the product to the system and then [the supply chain can] compete on the best product."

Helge Sverre Eide, business manager, Blue Logic, agrees, especially for intervention on subsea processing systems. "Interface standardization is a simple way of moving quickly forward," he says. "If you look at the electronics industry and the USB, it was produced as an interface and has created an explosion of products."

Standardizing core components would also create repeat orders, enabling suppliers to invest in stock, which would improve lead times, create a buffer during execution, and therefore improve schedules.

### Involve the supply chain

For standardization to be a success, Jarand Rystad, managing partner of Rystad Energy, says the supply chain needs to be involved

**Hot stabs: a range of Blue Logic's off-the-shelf standard hot stabs. Most are standardized (ISO or API) hydraulic connector systems, the production of which Blue Logic has industrialized.**

in setting the standards. A basic component could be standardized to 90mm, but unless the supply chain is consulted, those involved might not realize the existing mills able to make the component are only set up to work at 80mm, he says.

Tim Crome, sales and business development manager, Technip, says this already happens. "Current standardized [subsea] tie-in systems are so big that they don't go down the ramps on the back of the pipeline installation vessels," he says.

"That is a complete lack of interface between the developers on the subsea processing systems side, the client and ourselves as the installation contractor."

Standardization does not just apply to the product, system, component or interface, however.

Jerome Lesgant, from FMC Technologies, says documentation, technical requirements and quality requirements should be standardized before anything else.

Werner Menz, VP technology, subsea systems, Cameron (now part of OneSubsea) and Wilkinson, of Exxon Mobil, also say standardization should be applied to materials and welding and qualification requirements, respectively. Eriksen, from DNV, says there are opportunities to standardize work processes too.

Most important, is that the operators who set standards cooperate on those standards, says Rystad. They should also make sure the standards do not go so far as to lock-in technology—locking out new innovation, he adds.

Nilsson, from Statoil, agrees: "We need to have more focus on standardization than we have today," she says. "But we cannot make everything into a worldwide standard. We probably can, but it take a long time and I think we have to realize we have different regulations in different countries and that we still want suppliers to be competitors.

"And we cannot just have standardization, we also need new technology and new ways of doing working. It has to be a balance." OE

### What do you think?

**Should the industry focus more on standardization and if so, where should that focus be first? Tell us what you think—join the debate on our Linkedin group, OE (Offshore Engineer).**

# Enhanced control for improved safety offshore

**A new offshore safety directive, issued by the European Union, has been adopted across the continent. Remi Eriksen, CEO DNV Maritime Oil & Gas, and Graham Bennett, VP DNV, business development director, division Europe and North Africa, take a look at the consequences.**

The Macondo incident in 2010 shook the offshore industry to its core, not just across every oil and gas company, but also in government and regulatory circles.

The 25th anniversary of the Piper Alpha disaster in July 2013, the continued fallout from Macondo and the continued occurrence of other offshore incidents, have heightened media and public interest in offshore safety.

This put pressure on the European Union (EU) to exercise stronger governance over offshore oil and gas operations.

Consequently, on June 10, 2013, after nearly two years of industry and stakeholder consultations, the EU for the first time adopted a directive on safety for offshore oil and gas activities.

DNV has been monitoring the development of the directive over the last two years. It has also provided input on the directive, both to the European Commission directly and also indirectly via consultations with industry bodies.

## Defining clearer responsibilities for safety and environmental protection

The directive will apply to existing and future installations and operations of both production and non-production installations. Clear rules are set for the whole lifecycle of all exploration and production activities from design, drilling, development, and production to the final removal of offshore installations.

DNV's evaluation of the new regulatory framework concludes it has many of the elements necessary to reduce the

probability of major accidents offshore and to limit their consequences should they occur. However, the realization of the directive into national legislation by the member states will dictate its real effectiveness.

In the event of offshore pollution events, the directive aims to minimize possible damage to the marine environment, and to protect the livelihoods of coastal communities and economies from consequential damage.

EU Member States are required to establish that operators provide adequate evidence that they have sufficient financial and technical provisions to cover liabilities from their operations. It establishes minimum conditions for safe offshore exploration and development and requires improvements to the response mechanisms in the event of a major accident.

The creation of a single empowered competent authority (CA) by each of the member states will ensure that offshore safety and environmental protection is made a priority.

Each CA's main roles are to assess and accept or reject major hazard reports, including internal emergency response plans, and notifications prepared by offshore operators, to perform inspections and investigations, and to establish systems for the anonymous reporting of safety concerns.

The CA will be legally empowered for taking effective, proportionate and transparent enforcement action, including, where appropriate, temporary cessation of operations. To avoid potential conflicts of interest, the CA will be independent, especially from licensing and revenue collection activities.

A new element required by the directive is the creation of the major accident prevention policy (MAPP), which is a governing statement produced by every oil and gas company with a head office in Europe, or who wishes to operate in European waters.

As a corporate statement of intent, it also identifies who is responsible for realizing safety and environmental protection, and closely aligns with the safety and environmental management system (SEMS), which is also required by the directive.

The directive recommends that EU-based companies apply the directive on a voluntary basis to their operations overseas, but operators should note that whatever they commit to in their MAPP, must also be applied outside EU waters.

## Leveraging North Sea offshore experience across the EU

Although the directive observes that no member state currently incorporates all relevant best practices in legislation, some of the offshore regulatory regimes governing the North Sea are more closely aligned with the directive's approach than others.

The North Sea countries have obtained significant experience from their well-established offshore industry. Norway, although not an EU Member State, provided input to the EU institutions during the drafting of the directive, but has at the same time reached the conclusion that the directive falls outside the scope of the European Economic Area agreement and that it will therefore not be applicable to offshore activities on the Norwegian Continental Shelf.

Norway and the UK implemented different legislative regimes after the catastrophic *Aleksander Kielland* event in 1980 and the Piper Alpha disaster in 1988, respectively. However, what their offshore safety regimes have in common is that both legislations are performance-based.

In these regimes, performance requirements and acceptance criteria are specified and industry must document that their specific solutions meet such requirements, for example in terms of acceptable risk levels. Significant emphasis is placed on risk assessment and focus on the verification of critical barriers.

Following the Cullen Inquiry on the Piper Alpha accident, the UK implemented the Offshore Safety Case regulations. One of the key changes by the new directive is that the safety cases will now become the major hazards report, and these will be required to cover both safety and environmental impacts and will define both safety and environmental critical elements, and the associated independent verification scheme.

The definition of an environmental critical element is not clarified in the directive, though this could encompass anything from spill containment to remediation.

Further work will need to be completed in this area by the CAs in each of the member states. Although the impact from the directive on current North Sea practices should be relatively low, operators can expect incremental changes in the environmental sphere, while further work will also be required on developing and implementing the MAPP.

## Directive implementation challenges

Substantial effort could be required to implement the directive across other EU member states with oil and gas operations.

In particular, countries such as Cyprus, Malta and Greece are quickly developing a significant offshore activity and these countries can benefit from the safety experience obtained from North Sea operations. These member states will need to develop an implementation plan for the new directive, in conjunction with increased levels of offshore activities over the

next two years.

By the very nature of its closed maritime environment, a substantial spill in the Mediterranean could possibly have a catastrophic impact on a number of coastlines with large environmental, social and financial consequences. The directive addresses cross-border safety and environmental events to ensure that these are dealt with in an effective and efficient manner.

However, the directive allows different implementation legislation across EU states and this could cause inefficiencies, for example in moving a drilling rig from the UK sector to the East Mediterranean to conduct drilling operations.

The necessity to gain repeated approval for an operator's major hazard report, verification scheme, etc., from country to country, may mean a lack of consistency that could result in lengthy and costly delays without benefit to offshore safety.

Both industry and regulators will have to consider developing an acceptable "template" that can be used across the EU for the owners and operators of such installations.

EU member states will have 24 months from the date of transposition, in July 2013, to implement the directive; including the establishment of a CA. The directive includes an additional 12 months translational provision for non-production installations, such as mobile offshore units.

For operators with an existing fixed installation offshore, the directive must be introduced at the point of the next routine submission of the safety case or 60 months, whichever is the soonest.

## Alignment with improved safety management approach

The major hazard report is one of the CA's most practical tools to exert regulatory control over offshore operations. The success of its safety case predecessor is anchored in root cause analyses of historic accidents.

Investigations into major accidents concluded that these accidents were caused by known risks for which a number of safety measures had been planned and implemented.

However, the accidents occurred as a result of multiple barrier failures, often in combination with a lack of, or inadequate barriers in certain areas.

The safety barriers' performances must be defined, their status continuously monitored, and acted upon when deviating from the set targets. Although preventive barriers are preferred, mitigating barriers are also important. Therefore, improved emergency response solutions are part of the portfolio of instruments to limit harm to people, the environment and assets.

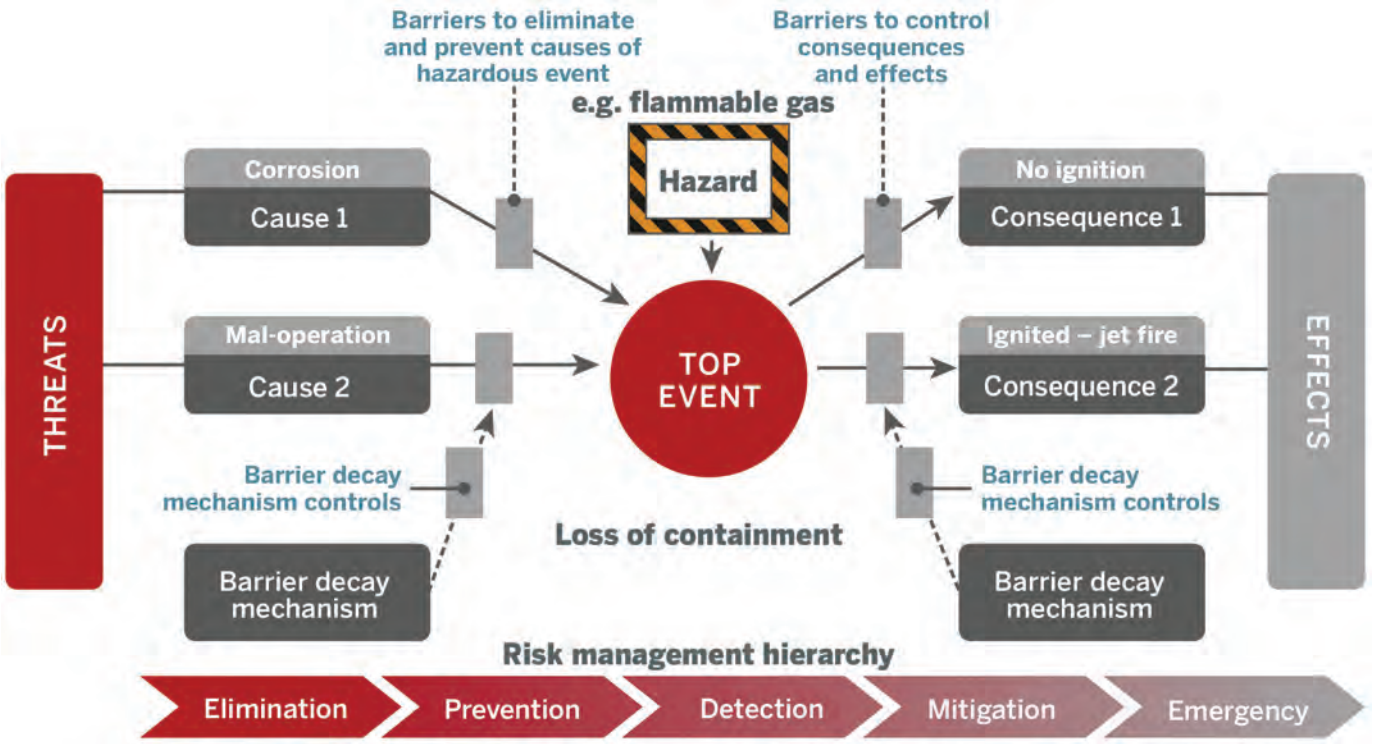
The barrier approach, increasingly adopted by oil and gas companies today, uses the bow-tie risk model as it's under-pinning. Bow tie diagrams can greatly assist with the identification of critical barriers and the development of the necessary verification schemes required by the new directive.

This sets out in a simple figure the scenarios that may occur; the top event (i.e. the undesired loss of control or undesired event), the threats that cause this (left) and the consequences that might arise (right).

In between the threats and the top event are the prevention barriers which stop a threat from propagating through to the top event. Similarly, between the top event and the effects are the mitigation barriers which reduce the magnitude of the potential consequences.

The scheme is further extended by depicting the barrier decay mechanisms, which also show what specific controls are put in place to prevent degradation, e.g. training, competence, inspection, preventive maintenance (See illustration).

It is critical that an offshore safety regime properly accounts for




**Example of a simplified bow tie diagram**

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technological, organizational and human factor defenses—or barriers—in the prevention and mitigation of accidents throughout the installation's lifetime.

Actively involving the offshore workforce in major hazards management, and explaining their role in effective barrier management is a key benefit of this approach.

Ideally, companies should have near real-time status on each barrier to manage their activities safely. A problem is to know what barriers have been degraded over time, due to various failure mechanisms.

Surveys, inspections, independent verification, preventive maintenance and audits are all good techniques to assess status of barriers but these occur at a low frequency (once a year).

DNV has developed the BSCAT methodology that provides much more frequent updates on the barrier status. BSCAT is the barrier-based extension to the organization's SCAT (Systematic Cause Analysis Technique) method.

Every incident or near miss means that some barriers have failed, and since many facilities experience a high frequency (e.g. over 100 a year) actual or near-miss events, analyzing these for barrier failures can provide the most frequent and up-to-date barrier status.

The effort required is not much more than routine investigations and it reinforces the role of risk assessment supervisors and staff for every incident. The status of barriers is identified as amongst the most useful leading indicators for major hazard accident risks. The combined BSCAT approach and bow tie risk management integrate well into existing standards such as API 754 and OGP 456.

The traditional approach for systematic cause analysis is complex as several failures need to be mapped simultaneously. This method can be both error-prone and hard to comprehend.

The BSCAT approach makes analysis easier by looking at one barrier failure at a time. A single barrier fails for less complex reasons than all barriers failing. The focus on individual barrier performance promotes data collection and analysis at barrier level, with frequent updates on barrier status.

## Towards a safer offshore future

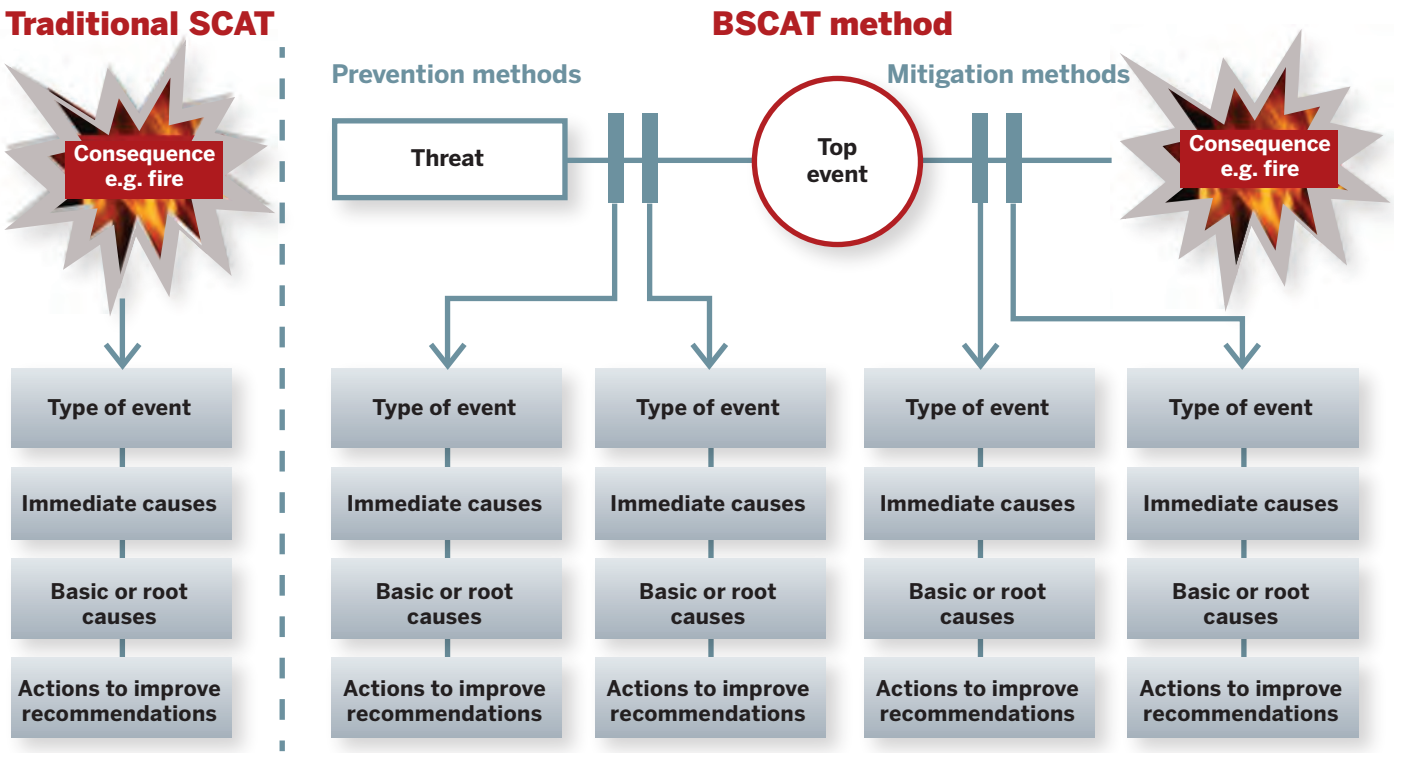
With the implementation of the EU directive, Europe's offshore industry can look forward to a more harmonized safety and environment regulation across EU member states. Countries with emerging offshore developments will benefit from regulatory and operational experience obtained in more mature areas such as the North Sea.

The new directive and the high public expectations and zero tolerance for major hazard accidents, require companies to put particular emphasis on advanced barrier management in their offshore operations.

Modern techniques such as the bow-tie risk management in combination with frequent updates on barrier status, such as DNV's BSCAT approach, support the directive's implementation and will lead to a safer offshore future. OE

***Remi Eriksen*** *is CEO of DNV Maritime and Oil & Gas and a member of the DNV executive committee. His technical expertise lies within maritime and offshore technology as well as gas value chains.*

***Graham Bennett*** *is a VP of DNV, with specific responsibility for Business Development for DNV's Europe & North Africa Division. A qualified mechanical engineer, Graham has led several incident investigations in the major hazard industries, and subsequently assisted the companies concerned with recovery programs.*




**BSCAT diagram illustrating assessment of barrier status from actual or near-miss events.**

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## NEW THIS YEAR!

A half day interactive special session on Tuesday, September 24th:
"Mooring Systems-Issues, Concerns and Solutions"
Speakers include Subir Bhattacharjee, Exxon; Kai-Tung Ma, Chevron; Hongbo Shu, Shell, Arun Dugal, Sofec; Kent Longridge, Intermoor; Andrew KIlner, AMOG; and more!

Forum keynotes include Bernard Van Leggel, Managing Director, SBM and Blake Moore, Project Engineer / Manager - Stones FPSO, Shell!

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**SUPPORTED BY:** KBR, BW Offshore, SBM Offshore, ABS

# Preliminary Agenda

## DAY 1 Tuesday, September 24th

| | | |
|---|---|---|
| 1:00 - 5:00pm | **Special Session: Mooring Systems**<br>• Issues, Concerns and Solutions | **Session Chairs:** Arjan Voogt, Marin USA/ David Cobb, Intermoor/ Christy Lan, BSEE |
| 1:30 - 2:30pm | **Session Breakdown:**<br>• The Most Important Mooring Issue | - Subir Bhattacharjee, Exxon/ Kai-Tung Ma, Chevron/ HongBo Shu, Shell/ Arun Dugal, Sofec |
| 2:30 - 3:30pm | **Mooring Intergrity**<br>• A Practical Approach to Mooring Integrity Management<br>• An Update on the API 4F Guidelines on Chains and Connectors<br>• Overview of Findings within the SCORCH JIP | - Kent Longridge, Intermoor<br>- TBD<br>- Andrew Kilner, AMOG |
| 3:30 - 5:00pm | **Design and Specifications**<br>• Installation Procedures<br>• Design Specifications including new API RP2SK<br>• Design Challenges, Larger Disconnectable Buoys Require New Assessments | - Jennifer Tule, Anadarko<br>- Hongbo Shu, Shell<br>- MARIN or SBM (to be confirmed) |
| 5:00 - 7:00pm | **Opening Night Reception on the Exhibit Floor** | |

## DAY 2 Wednesday, September 25th

| | | |
|---|---|---|
| 7:45 - 8:00am | **Introduction and Opening Remarks** | - Joe Lovett, Senior Industry Consultant |
| 8:00 - 8:30am | **Keynote:**<br>• The World of FPSOs: Trends Today and Outlook for Tomorrow | - Bernard Van Leggelo, SBM |
| 8:30 - 9:50am | **Session I: The State of the Business**<br>• Is it Healthier this Year than Last Year?<br>• Own or Lease in Today's Business World<br>• Redeployment Realities | **Moderator:** Peter Lovie, Peter M. Lovie PE, LLC.<br>- Stuart Bannerman, BW Offshore<br>- Boyd Howell, Modec<br>- Cobie Loper, SBM Offshore |
| 9:50 - 10:20am | **Morning Coffee Break in the Exhibit Hall** | |
| 10:20 - 11:40am | **Session II: Financing & Planning Risky Business**<br>• Industry Outlook: Active Projects in the Decision Making Process<br>• Shipping and Offshore Market Trends in Stormy Weather<br>• FPSO Industry Finance Outlook | **Moderator:** Barry Donovan, Raymond James<br>- Jim McCaul, International Maritime Associates<br>- Barbara Gronquist, Det Norske Bank<br>- TBD |
| 11:40 - 1:10pm | **Lunch in the Exhibit Hall** | |
| 1:10 - 2:55pm | **Session III: Execute or Die**<br>• Growing Recognition of Project Management as Critica Discipline<br>• Keeping Score on FPSO Projects<br>• FEED, Definition, Operator Objectives and Practical Realities<br>• Contracting It-Strategies that have worked for FPSOs<br>• Panel Discussion | **Moderator:** Dick Westney, Westney Consulting<br>- Dick Westney, Westney Consulting<br>- Jonathon Walker, IPA<br>- Lawnie Sturdevant, Modec<br>- Mike English, Senior Industry Consultant |
| 2:55 - 3:25pm | **Afternoon Break in the Exhibit Hall** | |
| 3:25 - 5:00pm | **Session IV: Pioneers Overcome their Challenges**<br>• **Round is Good:** The Contractor's Journey<br>• Dealing with Gas Pains in Offshore Oilfield Developments<br>• Concept into Practical GTL Plant for FPSOs | **Moderator:** Jim Wodehouse, Water Standard<br>- Fredrik Major, Sevan<br>- Ian Baxter, Compact GTL<br>- Jeff McDaniel, Velocys |
| 5:00 - 7:00pm | **Reception on the Exhibit Floor** | |

## DAY 3 Thursday, September 26th

| | | |
|---|---|---|
| 8:00 - 8:30am | **Keynote: Shell's Choice for an FPSOs at Stones** | - Blake Moore, Shell |
| 8:30 - 9:50am | **Session V: FPSO Operations in the GoM**<br>• FPSO Operating History on First FPSO in GoM<br>• Working with the Regulators on Operations – 2013 Realities<br>• Contrast with FPSO Operations in Mexican GoM<br>• Panel Discussion | **Moderator:** Kirk Barlass, BW Offshore<br>- Harry Leonard, Petrobras<br>- Partha Ganguly, Petrobras<br>- Kirk Barlass, BW Offshore |
| 9:50 - 10:20am | **Coffee Break in the Exhibit Hall** | |
| 10:20 - 11:40am | **Session VI: Rules and Regulations**<br>• Update of FPSO application process and an overview of any revised standards and regulations<br>• Overview of the statutory compliance process for floating structures in US GoM<br>• DNV Approach to Deepwater FPSOs and Conversions<br>• **Panel Discussion:** What's ahead in the GoM with Regulators/Classification Societies | **Moderator:** Peter Noble<br>- Christy Lan, BSEE & CDR James Rocco, USCG<br>- Ken Richardson, ABS<br>- Kenneth Vareide, DNV North America Maritime |
| 11:40 -1:00pm | **Lunch in the Exhibit Hall** | |
| 1:00 - 2:20pm | **Session VII: FPSO Offloading in GoM**<br>• Living in the Jones Act World and experiences at Cascade/Chinook<br>• Economics, Performance - Four Options for US GoM Offloading<br>• Contrast - 14 Years of High Volume Offloading in Mexican GoM | **Moderator:** Jeremiah Daniel, Petrobras<br>- Eric Smith, OSG<br>- Peter Lovie, Peter M. Lovie PE, LLC.<br>- Lawnie Sturvedant, MODEC |
| 2:20 - 3:30pm | **Session VIII: Closing Session**<br>• **Operator Panel:** What's Ahead<br>• **Tying it all Together:** Wrap Up and Closing Remarks | **Moderator:** Blake Moore, Shell<br>- Shell, Petrobras, Conoco, Chevron |

**Hercules 265 on fire.** Photo: BSEE

# Shallow water safety concerns

**Recent Gulf of Mexico well control incidents have US regulators calling for better safety in shallow water. By Audrey Leon**

Representatives from the US Bureau of Safety and Environmental Enforcement (BSEE), US Bureau of Lands and Minerals Management, and oil and gas industry representatives gathered in Houston last month to discuss the need for improved offshore safety operations. The meeting follows three recent well control incidents since February that occurred in shallow water since February. An earlier event, in November 2012, led to the death of three workers during maintenance operations.

Acting Assistant Secretary for Lands and Minerals Management Tommy Beaudreau, who was in attendance at the meeting, mentioned that there are a few things companies can do to increase safety offshore.

"There are practices relating to the drilling operations, well control and contingency plans that companies must share with each other to protect workers and the environment."

BSEE Director James A. Watson urged the industry to avoid complacency with regards to safety in shallow water environments.

"While many consider shallow water operations to be less technically challenging than those occurring in deep water, they are not without risk," Watson said. "Offshore workers need to be empowered to take actions to save lives when they see a leading indicator that something is wrong."

Newly appointed US Secretary of the Interior Sally Jewell, who also attended the meeting, characterized new regulatory reforms put in place by the department as "aggressive" and "comprehensive."

"These recent incidents underscore the inherent risk in offshore operations and the need for everyone – from the chief executive officer to the roustabout – to make safety his or her number one priority," Jewell said.

Following the meeting, National Oceans Industries Association (NOIA) President Randall Luthi called this a good start in determining how to minimize the risks of future incidents. "It's clear, he said, "that when it comes to offshore operations, safety is safety, whether on the shelf or in deepwater."

## Causes for concern

The latest loss of well control incident to ratchet up safety worries occurred at Walter Oil and Gas Corp.'s natural gas well A-3 at South Timbalier Block 220 on July 23, 2013.

Completion work had been underway on a sidetrack well when the blowout happened. All 44 people on board were evacuated. Later that evening, natural gas from the well ignited a fire onboard Hercules Offshore's Hercules 265 jackup rig. According to a BSEE incident report, the source of ignition is unknown. No injuries were reported.

The Hercules 265 sustained considerable damage with the beams that supported the derrick and rig floor folded and collapsed over the rig structure.

On August 4, drilling began on a relief well using the Rowan EXL-3 jackup rig. Drilling is expected to continue for approximately 35 days.

## A kicking feeling

On February 5, 2013, Apache evacuated 15 workers after experiencing a kick from an abnormally pressured gas zone during drilling operations at Main Pass Block 295, 50 miles off the coast of Venice, Louisiana.

The incident occurred while the


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Ensco 87 rig was operating in 218ft of water. Workers were able to activate the blowout preventer to stop gas from flowing to the surface.

Although no bubbling was seen that would have indicated a seafloor breach, gas had intermittently been detected on the surface at the well-head indicating slight seepage through surface connections, according to an incident report from BSEE.

Image: Courtesy of the US Coast Guard.

**Commercial vessels extinguish a platform fire on board Black Elk Energy's West Delta 32 platform approximately 20 miles offshore Louisiana.**

### A deadly day

On November 16, 2012, an accident at the shallow water West Delta Block 32, located 18 miles southeast of Grand Isle, Louisiana, left three contract workers dead and 11 injured when the oil production platform caught fire.

The platform was not producing at the time, and had been shut-in due to maintenance. Louisiana-based Grand Isle Shipyard had been contracted for maintenance work on the platform owned and operated by Houston-based Black Elk Energy.

Three workers, all from the Philippines, employed by Grand Isles Shipyard were killed. Two died during the incident and were later found near the accident site. A third worker, a welder, passed away due to complications from major burn injuries on November 23.

In November, John Hoffman, CEO of Black Elk Energy, told Houston TV station KTRK that workers had used a cutting torch to cut a line that required cold-cutting. However, Grand Isle Shipyard's CEO Mark Pregeant disputed that version of events."Those gentlemen did not cut that piece of pipe with a torch," Pregeant said in a statement released by the US-Philippine Consulate in November.

BSEE's investigation into the incident is ongoing. OE

# Safeguarding the Human Element

By Kevin McSweeney, ABS Safety and Human Factors Group Manager

As the offshore industry expands into more exacting environments where extreme temperatures and higher pressures increase operational risk, safety processes and appropriate worker behavior are essential to reducing hazards. Offshore personnel are being called on to manage multiple industrial safety factors on board facilities and rigs to lessen the probability of an incident or "close call" (near-miss) event.

If an event does occur, international organizations, government, and non-governmental organizations conduct incident investigations to help identify causes so corrective actions can be developed and implemented to improve safety. ABS uses this information and additional resources to work with industry and regulatory bodies to create publications that can help minimize incidents. One example is the Guidance Notes, which describe how to perform incident investigation activities, gather and analyze data, determine root cause, and generate corrective action recommendations.

Class guidance also includes such topics as crew habitability, applying ergonomics in equipment/machinery spaces, noise and vibration control, assessing safety culture, performing job safety analyses, change management, and the appropriate design of technical procedures and manuals. In both industrial and process safety, these tools provide guidance that can be used to verify that the design and arrangement of ships and offshore structures are habitable and provide safe work environments.

When ergonomics, human factors, and safety practices and principles are applied during the earliest stages of design, many hazards can be eliminated or controlled. For example, providing appropriate access for equipment maintenance and operation can help eliminate posture and strain-related injuries, and using an appropriate angle of inclination for stairs can help eliminate slips and fall injuries.

Admittedly, some hazards cannot be completely "engineered out" of the workplace. In these instances, owners and operators must rely on substituting a less-hazardous process or piece of equipment, use administrative controls such as training and additional procedures, or introduce personal protective equipment (PPE) to help protect the worker or the process. It is important to recognize that using substitution, administrative controls, and PPE require that workers modify their behavior, including following the new procedures, retaining new training information, and using the new PPE.

### Data drives improvement

In 2009, ABS and Lamar University in Beaumont, Texas, initiated the Mariner Safety Project, collocating more than 20,000 safety incident and near miss reports contributed by industry partners.

This project has evolved into the Mariner Safety Research Center, an online resource database that acts as a 'safety clearinghouse,' with more than 50,000 records. Data includes benchmarking and trending statistics, safety spotlights that focus on unique hazards, and ergonomics and safety discussion papers about hazards such as hearing loss, human performance in extreme environments, and slips, trips, and falls. The result of having the data available in one place is that the information can be used to improve decisions.

While the oil and gas industry is adopting technologies to improve efficiency and decrease the number of manual operations vulnerable to human error, informed decision-making remains a critical component in offshore operations. Class is committed to verifying that the human element is safeguarded as the industry, equipped with advanced technologies, moves into more remote and challenging frontiers. ■


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# Beating an Advanced Persistent Threat

## Make no mistake, APTs are watching, learning, and poised to attack

By Richard Sale

Globally-interconnected digital information and communications infrastructure—better known as "cyberspace"—underpins almost every facet of modern society and provides critical support for the US economy, its civil infrastructure, public safety, and national security.

Security in cyberspace relies on interdependent networks of information technology, national infrastructure, the internet, telecommunications networks, computer systems and embedded processors and controllers. Each of these plays a critical part in maintaining intellectual property, the efficient function of the banking and energy industries, and protection of key corporate and national assets.

Yet, it is abundantly clear the activities of hackers or malware can severely impair industrial or government systems and their assets. There is a trend in the oil industry that aims at integrated management of control and safety systems resulting in improved use, efficiency, reduction in personnel, training costs and cost savings. But industrial systems for the oil industry and offshore platforms remain extremely vulnerable to attacks by hackers.

Such breaches, often called advanced persistent threats (APT), can have a devastating effect on national economic security and public safety, and sophisticated hacker attacks can result in huge thefts of intellectual property, financial data, damaged integrity, as well as system disruption or even physical damage. The blunt fact is these APTs live and learn, while remaining undetected on systems, sometimes for years. If they get an coded command to attack, they can cause hardware malfunctions that could prove catastrophic to the asset and onboard personnel.

A congressional source with intimate knowledge of the subject, says of APTs:"What used to be called an "unlikely" event should now probably be thought of as a persistent threat with potential systematic implications." The increasing menace of hacker attacks "leapt to prominence as networks moved to the center of business operations," says James Lewis, cyber expert at the Center for Strategic and International Studies (CSIS). A persistent threat facing the offshore oil industry is the continued plundering of value from systems and government agencies by hackers and other hostile actors, including state-proxies. Lewis added such breaches "have become big business." Such attacks have resulted in "a very risky environment…cyberspace is the wild west."

### Hacking the easy way

According to serving U.S. intelligence officials, the newest oil rigs, some of which approach US$1 billion in cost, employ cutting-edge robotics technology, but the software that controls a rig's basic functions is often antique.

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Most rely on decades-old supervisory control and data acquisition (SCADA) software, written in an era before security was even thought of, says Jeff Vail, a former counterterrorism and intelligence analyst with the US Interior Department, in a news report. "It's underappreciated how vulnerable some of these systems are," he says. "It is possible, if you really understood them, to cause catastrophic damage by causing safety systems to fail."

A study of threats to oil and gas companies by Rice University noted: "Clearly by any means, the operator will be prepared to consent to any demands, however bizarre, in order to avoid a catastrophic failure of the offshore asset which is usually a multi-billion dollar investment. If the cyber criminal wishes to impose disastrous damage to the platform, this is a very elaborate task requiring specialized coding intended to fool the automatic shut-down mechanisms."

Another congressional source says, "Security is not simply a matter of funding or planning," pointing out "the security systems for offshore oil platforms were not designed with security in mind. They simply had a layer of IP thrown over them like a blanket. They are legacy systems and are all over the place, and they remain extremely vulnerable."

The cost of making improvements argues against industry making them. "Ultimately, it is the wallet that pushes the move to integration," says Steve Elliott, director of Triconex product management for Invensys Operations Management. "If integration is cheaper, people will buy it."

Ingenious attacks on offshore oil installations can lead one to believe hackers are evil geniuses operating with deft, breathtaking skill in outwitting company security procedures. The truth is extremely deflating. In 2011 and 2012, surveys showed more than 90% of successful penetrations of company networks required only the most basic techniques.

More worrying is the fact breaches went undetected for weeks, sometimes even years, according to the Verizon 2012 Data Breach Investigations Report. The report states, "Most victims fell prey because they were found to possess an (often easily) exploitable weakness," and 96% of the successful breaches could have been avoided if the victim had put in place simple or intermediate controls. In addition, 85% of the penetrations took five months to discover; the discovery in most cases made by a third party.

IP makes up most of a company's value, but its accurate value is not known until it is put on the market. It usually takes time for a hacker to turn intellectual property thefts into a commercial product, but not always. China severely penetrated the design and the avionics of the new US F-35 fighter, says Vince Cannistraro, former head of CIA Counterterrorism. He says it is abundantly clear some of the stolen US data is already seeing the light of day on the latest Chinese fighter designs.

The sad fact is that losses from cyber intrusions can cost companies big money. When Saudi Aramco, Saudi Arabia's national oil and gas company,

suffered an attack last August, by Iran, at least 30,000 computers were infected (not damaged) and had data permanently erased, while hackers stole IP, military and commercial technology, marketing plans, plans for new products, plus confidential business information, according to US intelligence officials who say "other companies were affected." These sources say the dollar loss "was extremely significant."

Yet, the ability to inflict such losses actually doesn't require much talent.

"Hacking shouldn't be as easy as it is," Lewis says; 75% of the breaches of oil platforms exploited publicly known vulnerabilities found in commercial software, congressional sources say. Surveys, in 2011 and 2012, show only basic techniques are required to cause breaches and one of the easiest paths to invade an offshore energy facility is using default settings on computer and network devices.

A default setting is when a system provider presets the password and the username. After the system is installed, users sometimes forget to reset the default setting. Cyber criminals can use default settings to gain entrance. The use of the ordinary password is completely useless as a defense against hacking. The hackers lock in on known or publicly unknown (Zero Day) software vulnerabilities, misconfigurations, weak passwords and systems that leak information. Lewis says a clever 12-year-old can cause a serious breach.

Professional hackers also rely on the black market for automated malware

## Whitelisting a solid defense partner

**While there are quite a few elements to a solid defense in depth program, application whitelisting is becoming one of the shining stars in the security professional's ever-growing bag of tools.**

**Whitelisting, while not the silver bullet that cures all security ills, is a list of email addresses or domain names from which an email blocking program will allow messages to be received. Email blocking programs, also called spam filters, should prevent most unsolicited e-mail messages from appearing in subscriber inboxes.**

**Whitelisting means only approved programs can run. Any unapproved programs will be prohibited from starting up.**

**One challenge when using application whitelisting in business networks is managing the constantly changing list of allowed applications. That burden is significantly reduced in control systems environments, because the set of applications that run in those systems is essentially static.**

**–Gregory Hale, Industrial Safety and Security Source.**

kits that can be used to steal personal data, credit card information, and passwords. Some hacker devices can even download via the Internet.

"Cyber attack and terrorism have now moved into the automation and process safety stage," Elliott says. Digital technologies are being deployed from the ground up in the form of smart field devices that send plant health diagnostics data into the plant-wide network. He pointed out because digital communication technology is at the heart of these advances, the threat will only get greater, especially as digital communication "extends into the field."

## Open systems

The offshore oil world has been severely shaken by the development of internet connectivity and terrorism, Elliott says. He pointed out these two entities "draw attention to a frightening reality: there are bad people across the water who would love to do great damage to the upstream asset and its surrounding environment."

Oil companies warn that the worst case scenario would be one in which valves were accessed, which could set offshore rigs on fire, kill personnel and halt production. The average cost of down time on an offshore rig is $6.3 million/day, experts say. The financial loss could be huge. Stuxnet, which crippled Iran's nuclear centrifuges, shows the potential devastation of a worm created to cause damage. Experts believe this kind of attack could be replicated on oil producing offshore rigs, and many think it has already.

The list of oil company cyber victims is growing all the time. In August 2011, a McAfee white paper exposed "Operation Shady Rat," a five-year operation that targeted natural gas distribution, oil platforms, federal, state and county governments, plus defense and construction industries.

Then in October 2011, the US Department of Homeland Security warned of attacks on gas, oil, waste and sewage systems.

In November 2011, hackers attacked Norway's oil, gas, and defense businesses, thanks to targeted emails that appeared to come from legitimate sources. The attackers pilfered drawings, contracts, current negotiation documents and others.

In April 2012, DHS said attacks on oil and natural gas facilities had begun five months earlier, the attackers using tightly focused "spear-phishing" email attacks.

The recent discovery of malware such as Flame (2012) and Stuxnet (2010), that targeted, for the first time, industrial control systems, have highlighted the susceptibility of critical infrastructure to cyber threats. In other words, offshore oil rigs and facilities, like any major organization or company, require defensive programs that employ strategies like whitelisting, effective patch management, and intrusion detection, that can ward off or isolate attacks that could injure the network._

US congressional officials said any industrial component is liable to be an attack target. While oil companies try to keep it quiet, malware infections have occurred at several offshore rigs and platforms, knocking some offline.

A congressional source says a tailored attack, directed to target a facility through widely distributed malware, could have dangerous repercussions. When infected devices have been connected to isolated networks, malware can spread like wildfire and create serious problems. In one instance, malware on a facility in the Gulf of Mexico caused a system to lock up, says Misha Govshteyn, co-founder of Alert Logic, a network security company. "They literally had a worm that was flooding their network, and they're out in the middle of the ocean."

A congressional source says if companies understood how Stuxnet propagated throughout the industrial control system at the Natanz nuclear enrichment facility in Iran, then it would be very easy to understand how an attacker could get into a system to control an offshore platform. With enough knowledge of a facility like an oil platform, refinery, or pipeline network, a cyber attack that used distributed malware, could lead to real physical damage.

## SCADA attacks

In the past, infrastructure networks were locally isolated and disconnected from the outside world. It was "security via obscurity." However, the Stuxnet virus was the trigger that laid bare the weaknesses and vulnerabilities of the industrial control systems. Elliott says a major trend in process safety and prevention continues to be integration of control and safety systems. He added there is also a trend toward open standards and networked solutions, not just at the automation level but also at the business and IT levels. Yet, he says, more and more digital communication technology remains at the heart of these advances, the threats will only get greater, "especially considering that digital communication extends into the field."

"Stuxnet is an interesting weapons design," Lewis says. "You need to introduce the virus and then you need to trigger it. It only works against a specific configuration." The first stage of the virus uses a "beacon" that performs surveillance of the target, mapping an electrical blueprint of Iran's centrifuges, with the data sent back to the National Security Agency in Maryland. The second stage, a trigger, added "Zero Day exploits" that can cause physical damage. The virus was only configured for Iranian nuclear facilities. It wasn't designed to spread, US officials say. But it did.

> "Cyber attack and terrorism have now moved into the automation and process safety stage."
>
> Steve Elliott
> director of Triconex product management
> Invensys Operations Management

It provides scant comfort to know that in spite of the fact "thousands of places around the world were infected but only one was damaged," the Iranian facility at Natanz, Lewis says. While past attacks focused on swiping terabytes of sensitive corporate data to gain

a competitive edge for nation state corporations, the latest attacks—representing a serious escalation have tried to gain the ability to manipulate America's critical infrastructure: power grids and other utilities. This all leads back to the digitally-weaponized world of Stuxnet, SCADA infiltration, destroyed machinery and networks—in other words, literal warfare, Cannistraro says.

The nightmare that many fear is that a critical piece of infrastructure on an offshore installation like the master control station (MSC), which acts as the interface between the operator and the subsea equipment, could become infected by a virus brought on board by unsuspecting platform workers that simply just downloaded some music or video. The virus would then attack the electronic messages from a human/machine interface to the subsea unit, sending false readings to the subsea control model, the main brain of the system.

Another case feared by many would involve hackers, state-sponsored agents, or terrorists using a malicious code that could send false on-screen readings to operators of subsea wells. This could be similar to the Stuxnet attack, where the virus seized control of Iran's centrifuges at Natanz and yet continued to give Iranian operators false readings that masked the fact the machines were running wildly out of control.

Offshore oil and gas systems are not immune to malicious cyber attacks. Another congressional source says oil companies have to take all the steps necessary to remove malware from offshore facilities and protect them from any future attacks. Users could prevent quite a few of these malware attacks with anti-virus systems and updated system software, the source says.



## Fighting back

Oil rig operators and strategists have done good analyses of the breaching techniques used by hackers, and they are learning steps to counter or forestall them. Yet, company owners have not used that information to prevent attacks. Lewis says oil companies consistently make the grave mistake of underestimating the risks of hacking they face, especially as dependence on computer systems continues to grow.

The *New York Times* reported only one of 45 types of malware ended up detected by companies' anti-virus defense. Lewis says while companies are spending more money on cyber defense, it is used in many cases on measures and activities that are ineffective.

Shawn Henry agrees addressing vulnerabilities just does not work."Instead of addressing vulnerabilities, you have to know who your adversaries are," says the former head of the FBI Counterintelligence Division and president of CrowdStrike Services. "Our digital DNA is all stored or transmitted electronically and it is riding on an inherently insecure network," Henry said during his keynote address at the ABB Automation and Power World conference in Orlando, Florida, this past March.

One bright spot rests on devising an effective strategy and tactics to block cyber attacks. Keeping a close account of hacking incidents is a start. Instead of seeing cyber security as central to a company's welfare and growth, company leadership too often sees it as an IT problem best left to specialists, techies, and information officers. Persistent threats are not a "board room" problem but on the margins of company operations. But as Lewis pointed such an attitude is dreadfully obsolete. A PricewaterhouseCoopers survey, entitled "*Global State of Information Security Survey 2013*," made clear while companies believed they were securing their networks, most were not. The old strategy centered on identifying a pattern of code and then blocking it. But if the malware has not been identified, then blocking can't occur.

"Instead of addressing vulnerabilities, you have to know who your adversaries are."

Shawn Henry, President
CrowdStrike Services

## Mitigation strategies

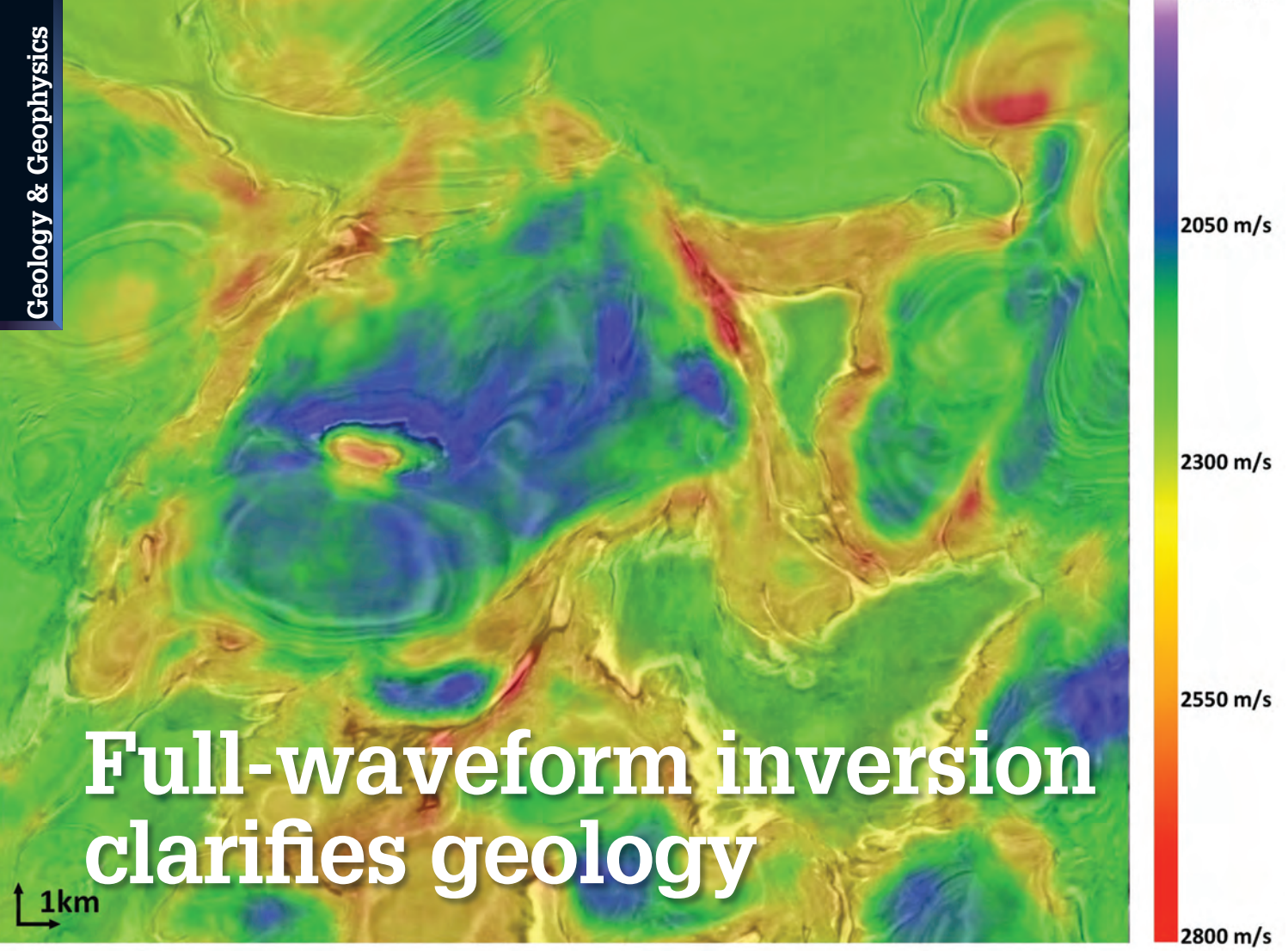
Meeting cyber threats requires much more corporate energy than is apparent today. The combination of weak defense and easy hacking is an extremely dangerous one to a company's future. Perhaps the most promising program is a joint effort between Australia's Defense Signals Directorate and the US National Security Agency (NSA) of Ft. Meade, Maryland, which worked with private companies and government agencies like the FBI to analyze cyber breaches on the basis of their frequency and effectiveness. The study was based on measurable, repeatable data.

The result was a list of 35 mitigation steps, with four of them viewed as especially successful. Since most dangerous cyber attacks are carried out using steps that allow an attacker to infiltrate a system and steal data, the new approach allows companies to attack those steps one at a time. Using four mitigation strategies was effective in stopping 85% of the intrusions, according to the five-year study.

Perhaps the most attractive aspect of this approach is that it saves companies money by not having to mitigate a cyber incident and recover from the unplanned downtime. If users carry out the steps with vigilance, cyber attacks can be successfully managed.

Cyber security is a business decision about profit and risk, and underestimating the threat can be fatal to a company's future. Cyber risks can be drastically reduced if they combine computer networks and computer power. OE

***Richard T. Sale*** *was United Press International's intelligence correspondent for 10 years, and at the Middle East Times, a publication of UPI. He is the author of Clinton's Secret Wars (2009) and Traitors (2003).*




# Full-waveform inversion clarifies geology

Map 1. Full waveform inversion defines high-resolution geologic structures including shale bodies, carbonate, and carapace.

**In Keathley Canyon, GOM, a 3D seismic data set was sharply focused using transmitted energies to update velocities using long and full azimuth streamer data. Authors S. Mothi, K. Schwarz, and H. Zhu of CGG share how it was done.**

Because of recent advances in imaging technology, geophysical processors now look to resolution improvment of the underlying seismic velocity model to enhance overall subsurface image quality. In the last decade, almost all approaches were based on picking events from migrated offset/angle gathers and reducing gather curvature by ray tracing. Wave-equation-based full waveform inversion (FWI) is designed to minimize mismatch in the data space and can theoretically achieve a resolution of half the seismic data's recorded wavelength (Tarantola, 1984). In the last few years, several successful applications of FWI have resulted in high-quality velocity models in various settings, like ocean bottom cable, towed streamer data in deep water, and land data.

Most applications of FWI rely on transmitted energy for determining velocities. The major shortcoming of this method is that velocity updating is limited by the offset range in the acquired data. Using towed-streamer acquisition, penetration depths of transmitted energy are limited to a couple of kilometers below the water bottom in deepwater regions of the Gulf of Mexico (GOM). To overcome this, FWI may be used with the seismic reflections as proposed in Tarantola's pioneering work that requires knowledge of the densities. Migration-based waveform inversion that uses reflected energy appears promising. However, these methods have not yet been widely adopted for real data.

In this project, transmitted energies updated the velocities in Keathley Canyon, GOM using long offsets (up to 18km) and full azimuth (up to 10km) streamer data with variable depth

tow. The staged methodology presented uses the wide range of offsets to investigate the impact of long offsets and full azimuth data on velocity inversion.

## Study area

The study area is in the deepwater GOM, and is characterized by sedimentary basins with faults, carapaces, and complex salt structures. The staggered configuration of two streamer boats allows ultra-long offsets of over 18km in the inline direction, Figure 1a. The study uses east-west and north-south sail lines, Figure 1b, yielding full azimuth coverage, Figure 1c. Acquisition with variable-depth towed streamers results in diversity of the receiver ghost notch, creating significant low-frequency content at far offsets that can aid initial FWI iterations.

## FWI components

Acquired shot gathers are minimally processed with a mild denoise flow to remove low frequency swell noise and spikes. The shot records are muted to prevent any reflection energy and surface-related reflection multiples from interfering with the velocity updates. The far-field source signature is deghosted for the source ghost to obtain the source wavelet for the inversion. Then, a TTI acoustic model is applied and the FWI updates velocity along the tilt axis $V_0$ using transmitted energy. The anisotropic parameters $\delta$ and $\varepsilon$ are derived using well logs and 1D inversion, and the tilt axis is assumed to be perpendicular to the plane of the bedding. The starting velocity model is obtained using two iterations of ray-based tomography with beam migration to obtain a good starting velocity trend and prevent FWI from converging to a local minimum.

## Offset stripping inversion

Starting with the lowest usable frequency content in the data, i.e. from 2-3Hz, the data is split into three offset classes: middle offsets (less than 8km), long offsets (8–12km) and ultra-long offsets (plus 12km). Structural horizons determined by the diving wave's maximum penetration depth for the starting model and available offset ranges are used to constrain the velocity update regions. Shallow velocity updates are then done using several iterations of FWI on the middle-offset data at 3Hz. Following this, the long offsets are included in the inversion, and the updates cover the shallow and deeper sections. This process is repeated for the ultra-long offsets. At this stage, there is 3Hz inversion for the shallow overburden, using all the offsets and 3Hz data. Next a multi-scale approach is used to invert up to 7Hz in increments of 1Hz, using all the offsets.

## Long offsets

Next, processing performs two inversion tests. Test #1 imitates a traditional wide azimuth acquisition (WAZ) receiver spread with maximum inline and crossline offsets, 7.5km and 4km respectively. Test #2 uses no offset restrictions. Test #1 produces velocity updates in deeper sections that are highly oscillatory in nature, and the carbonate section is incorrectly inverted as a slow-velocity section; this is attributed to insufficient diving ray penetration. From Test #2, the updates are more characteristic of the geology and do not have the same artificial oscillation. Furthermore, offset gathers from beam migrations also suggest that the perturbation from Test #1 results in over-corrected gathers in the area immediately above the carbonate section. Test #2 produces flatter gathers.

## Full azimuth

Orthogonal acquisition provides data with a variety of azimuth information. With increased crossline offset, the transverse direction produces better illumination and transmission energy penetration, as well. To understand the benefits of this acquisition configuration, the above inversion scheme was applied to middle-offset data using 1) only N-S shotlines and 2) both N-S and E-W shotlines (full azimuth). From the 3Hz FWI results (after 1 iteration), the inversion suffers from a vertical striping pattern, i.e. an acquisition footprint, when using limited azimuth information. Sparse sampling of the acquisition in the crossline direction compared to the inline may cause these artifacts. This effect tends to be cumulative. In contrast, inversion using the full azimuth data does not suffer from these issues.

## Inversion results

With the offset stripping and multi-scale approach, processors perform the inversion using full azimuth and long-offset data for frequencies up to 7 Hz. The velocity models, Figures 2 and 3, clearly show that the inversion produces geological models, and tracks the faults and high-velocity condensed sections directly above the top of salt. The carbonates and the shale bodies are detected by the inversion. The

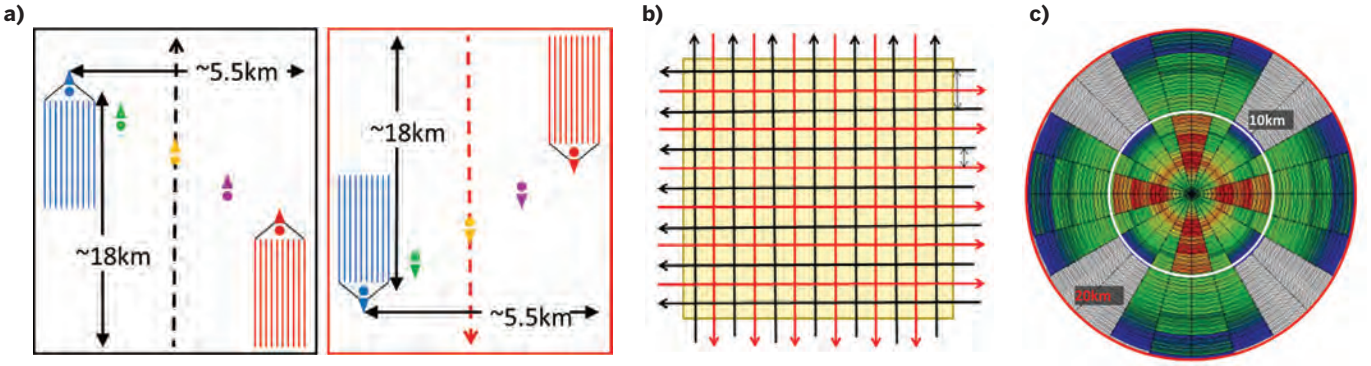



**Figure 1 a) Staggered acquisition configuration b) Sail lines c) Rose diagram with reciprocity. The white circle denotes 10km offset, and the red circle represents 20km offset.**

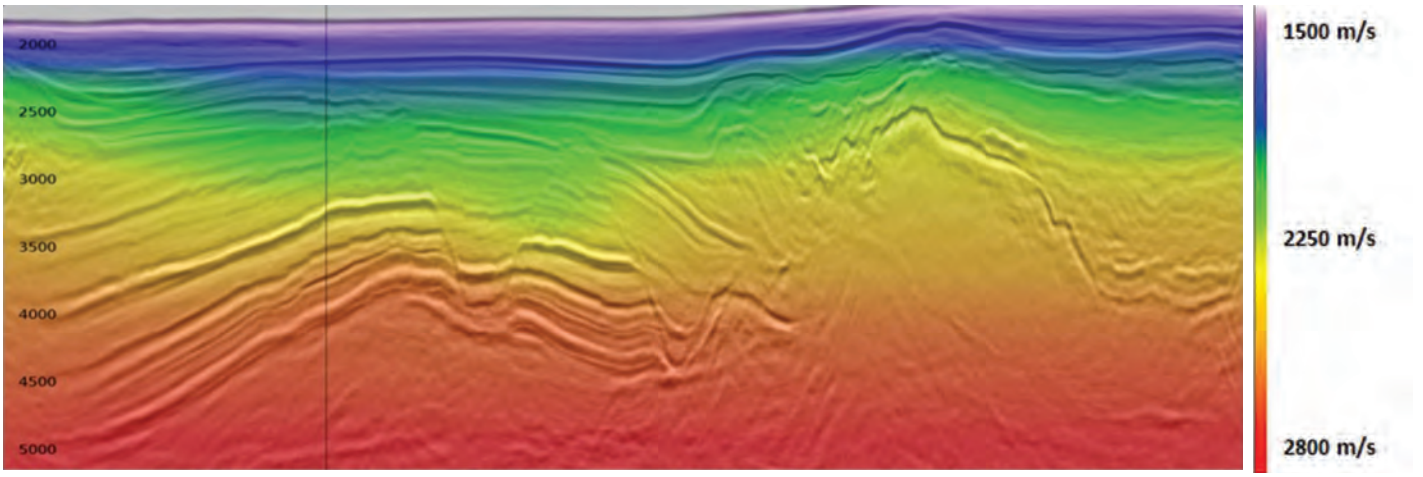



**Figure 2. The initial velocity model is smooth and does not show geologic detail.**

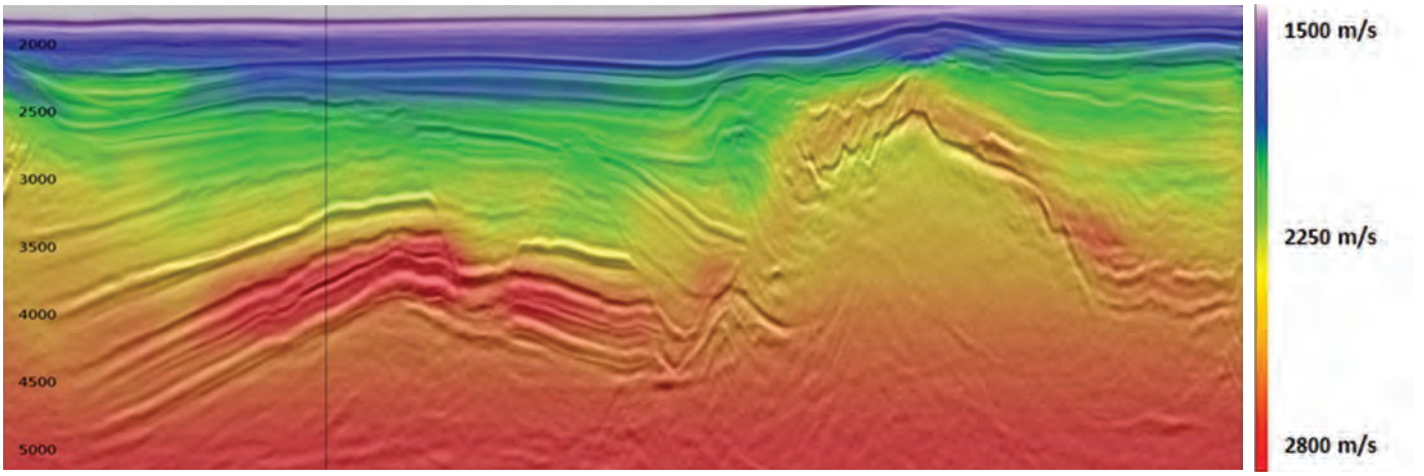



**Figure 3. After FWI update, the velocity model shows high-resolution features and conforms to structures, with velocity contrast across faults.**

pre-stack depth migration (PSDM) stack response is also improved after the inversion, see main image Map 1. Further, beam migrations show that the gather flatness is mostly improved and the detailed velocities result in more consistent curvature across the orthogonal azimuths. The improvement from the gathers is subtle because the starting velocity model had two iterations of reflection tomography.

These results clearly show the image improvement that additional offsets and azimuths bring to the inversion by illuminating more subsurface angles and deeper sections. This approach produces interpretive models that better characterize the different geological sections. OE

***Acknowledgements***

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***Huifeng Zhu*** *has worked for CGG for three years and is currently an imaging project coordinator. He has performed velocity model building work with both ray-based tomography and full waveform inversion. Zhu holds a B.Sc. in physics from the University of Science and Technology of China and a Ph.D. in physics from the University of Houston.*

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# BLISS-fully solving seismic processing problems

By Mirko van der Baan, University of Alberta and Colin Sanderson, ITF

During the last 10 years, the oil and gas industry has seen significant developments in seismic acquisition strategies, pushing the boundaries imposed by the technical limits of conventional 3D marine acquisition using narrow-azimuth towed streamers.

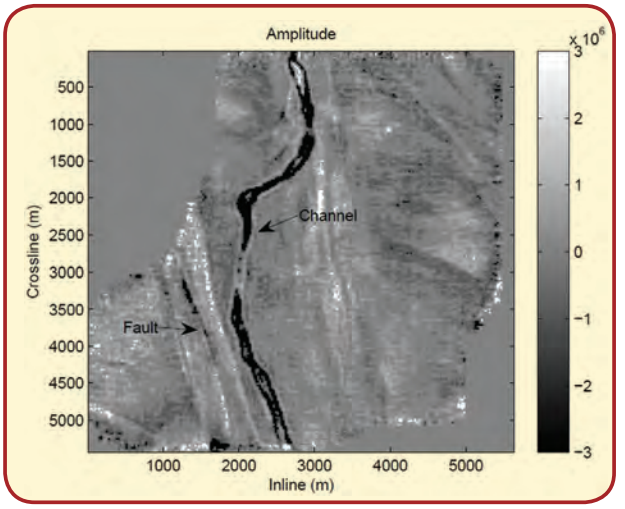
New acquisition geometries, including ocean-bottom nodes, coil, wide- and multi-azimuth shooting, can provide considerable improvements in data quality, but acquisition costs can be higher. There is therefore a need to develop new strategies that reduce costs, without imposing a noticeable deterioration in data quality.

A joint industry project (JIP) to ease the detection of by-passed hydrocarbons and help identify satellite fields has recently been concluded. The project, titled BLISS (Blind Identification of Seismic Signals), began in 2010 and is focusing on the identification of advanced signal processing techniques that can be applied to seismic processing problems.

The latest phase of the project received support from two operating companies, with assistance from ITF, the UK-based technology facilitator for the global oil and gas industry.

An interdisciplinary collaboration between the Department of Physics at the University of Alberta, and the Jean Kuntzmann Laboratory in Grenoble, France, united geophysicists and experts in statistics and signal processing. The goal was to identify techniques in advanced signal processing that have been largely ignored by the geophysical community, but carry promise for a step-change in seismic processing algorithms.

The BLISS consortium investigated how the detection of by-passed hydrocarbons and new satellite fields can make an impact on field life extension in mature areas, such as the North Sea and the Gulf of Mexico, particularly with respect to increasing the signal-to-noise ratio of seismic data, and extracting geologic features of interest.




**Time slice through a seismic volume revealing a channel and fault.**

The ease with which these additional reserves can be detected depends predominantly on the quality and resolution of the seismic data available for interpretation.

The two main approaches within the BLISS project relate to: local signal enhancement and robust wavelet estimation for blind deconvolution, in order to achieve the highest quality and resolution feasible.

Blind deconvolution is a technique that can be used to separate the seismic source signature, i.e. the explosion or air gun signature, from the true geology, without having any knowledge of either signal.

This technique is of interest to the communication industry, as it enables more effective use of bandwidth by separating voice patterns from the spoken words prior to compressing both. In exploration seismology, the voice patterns would be equivalent to the source signature and the spoken words—the geology.

Phase 1 of the project led to new statistical methods for random and coherent noise attenuation, in both pre-stack and stacked sections, blind PP/PS wavefield separation, and non-minimum phase wavelet estimation from surface seismic.

The aim of Phase 2 was to evaluate and adapt these techniques for advanced data processing and noise reduction, to render them suitable for increasing the quality and resolution of conventional seismic data, as well as developing novel strategies to reduce acquisition times.

Defined projects for Phase 2 include: simultaneous shot acquisition and post acquisition separation, and nonlinear sparse deconvolution.

## Simultaneous shot acquisition and post-acquisition separation

One possibility to reduce total acquisition times is to fire several shots simultaneously at different locations. This is particularly interesting for wide-angle, towed-streamer acquisition geometries, since they involve multiple ships.

The challenge then becomes how to then separate simultaneous shots to recover the individual shot gathers.

Independent component analysis (ICA) is an emerging technology in the field of advanced signal processing. It separates a set of observed signals into the statistically, most independent components by appealing to higher-order statistics.

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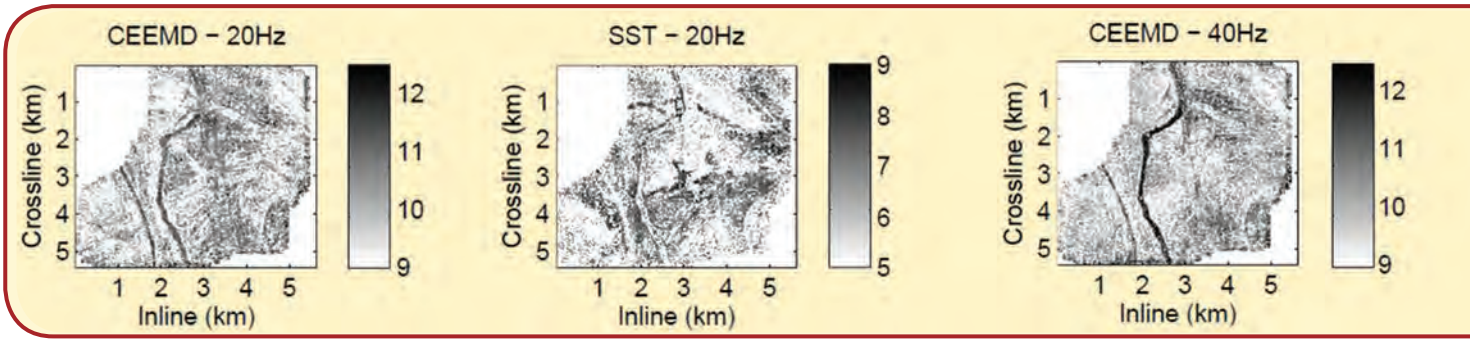



**Different frequency slices of the same time slice to analyze channel thickness.** Images by Jiajun Han and Henry Herrera.

ICA retrieves the original source signals blindly if they are statistically independent, without the need of further information. Blindly, in this context, means that no information is available about waveforms or polarizations of the desired source signals.

Independent component analysis holds promise for post-acquisition separation of simultaneously acquired shot records. Successful applications could have a far-reaching impact on future seismic acquisition strategies by all major operators.

## Nonlinear sparse deconvolution

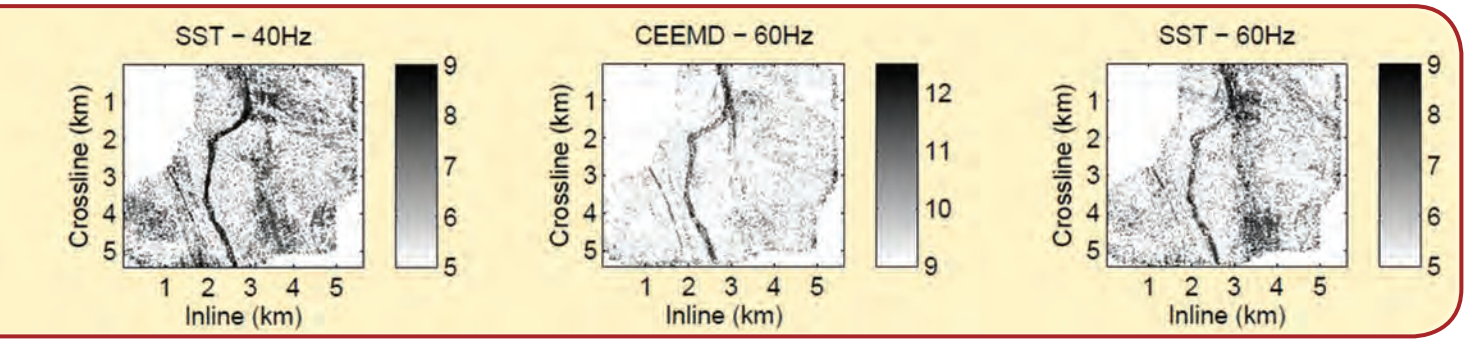
Predictive deconvolution is possibly the most commonly applied, statistical, signal-processing technique for any commercially acquired, seismic reflection survey. This determines a linear combination of observations that yields the optimal trade-off between recovery of the underlying signal structure and noise amplification.

Any linear deconvolution filter (such as Wiener filtering) has to find a compromise between recovery of the reflectivity series and noise amplification. It cannot solely recover the reflectivity series, given a linear combination of noisy past observations.

Predictive deconvolution also makes a minimum phase assumption for the wavelet, which is not generally valid. Nonlinear deconvolution is significantly more computation intensive than its linear counterparts; yet it offers the opportunity to create a step change in current processing strategies for seismic data by providing impedance sections with limited to no well control. The resulting deconvolved seismic sections are always sparse by construction and therefore ideal for creating blocky seismic impedance sections. The latter are routinely used in seismic interpretation.

## Statistical wavelet estimation

Recent developments in advanced signal processing may make it possible to estimate accurate enough wavelets




in exploration settings from surface seismic alone, with limited to no well control to produce meaningful interval attenuation maps.

Robust wavelet estimation is also crucial for other important applications, such as seismic inversion, guided interpolation of well-tie misfits, analysis of amplitude variations with offset, and for quality assessment of amplitude and phase-controlled processing.

Deterministic wavelet estimation is often done by means of seismic-to-well ties, that is, by finding the digital filter that matches best synthetic seismograms created from well logs to observed data.

In these cases, the well logs act as ground truth. Unfortunately, this procedure only works at well locations and different wells can give different wavelet estimates, thus raising the question how to predict best wavelet variations away from the well.

In addition, no wells are available in virgin exploration areas. Statistical methods developed in the BLISS project enable accurate wavelet estimation directly from the observed seismic data, and have been shown to be robust even for relatively low-quality recordings.

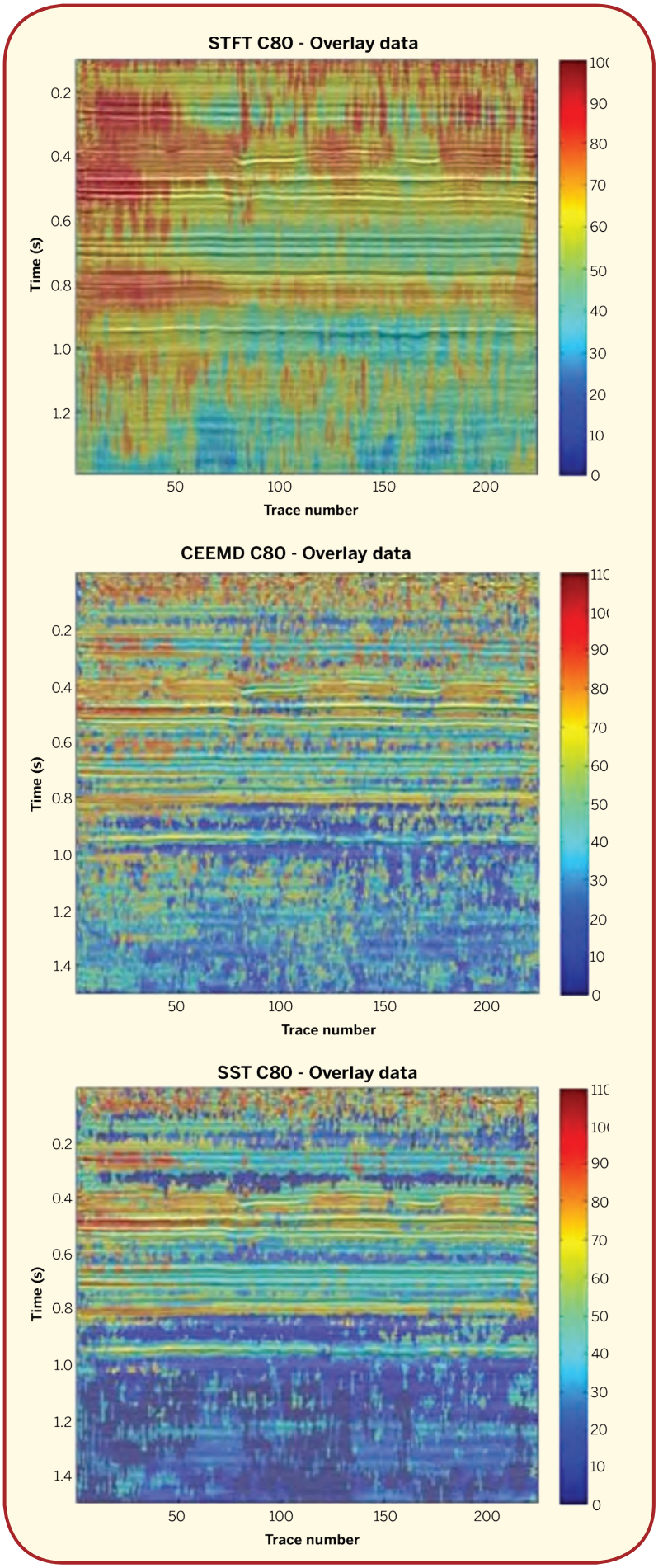
Finally, the developed wavelet-estimation methods provide the information needed by the sparse deconvolution methods to enhance the resolution of seismic data.

## Attribute analysis

Seismic attributes are commonly used by the oil and gas industry to facilitate interpretation of large 3D datasets and to effectively communicate subtle structural and stratigraphic features. Attributes can lead to simplified images of the subsurface and can detect many features at or below the resolution of seismic data.

The BLISS project set out to develop robust interpretation attributes, based on spectral analysis by empirical mode decomposition.

This decomposition was developed by researchers at NASA to facilitate analysis of complicated nonlinear signals. Methologies developed led to high-resolution seismic attributes.




**Three time-frequency transforms of vertical cross-sections through the same volume to analyze reflector characteristics, river channel at about 0.4 seconds.** Images by Jiajun Han and Henry Herrera.

This is not only relevant for the detection of structural and stratigraphic features in controlled-source seismic data, but developed applications also have implications for data analysis in fields such as earthquake seismology, biomedicine, telecommunications, and remote sensing.

These combined projects should produce novel statistical signal processing tools for high-resolution imaging of small-scale structures, leading to an increased confidence in the interpretation of current and new exploration prospects.

As the oil and gas industry has developed, so have its requirements on information quality and detail that can be extracted from the vast data collected by seismic surveys.

The output from this project, some of which is already being used by the sponsors, will result in processing software that can be applied on a range of datasets, including legacy data, new 3D seismic and repeat 4D surveys for exploration, appraisal and exploitation purposes.

As such, it may contribute to the discovery of new satellite fields, as well as enabling the progress of oil recovery from mature fields to be tracked. **OE**

***Mirko van der Baan*** *is the principal investigator of the Blind Identification of Seismic Signals JIP, and the Microseismic Industry Consortium, a collaborative venture with the University of Calgary, dedicated to research in microseismicity. He is also a co-founder of the Centre of Integrated Petroleum Engineering and Geosciences, a joint initiative of several departments at the University of Leeds, UK, to foster and promote multidisciplinary petroleum-related research and teaching.*

***Colin Sanderson*** *has been with ITF since its formation in 1999. During this time, as a senior technology analyst, he has collaborated with researchers, technology developers, and industry domain specialists across a wide range of technology areas within the oil and gas industry. Recently, he has concentrated on subsurface activities.*

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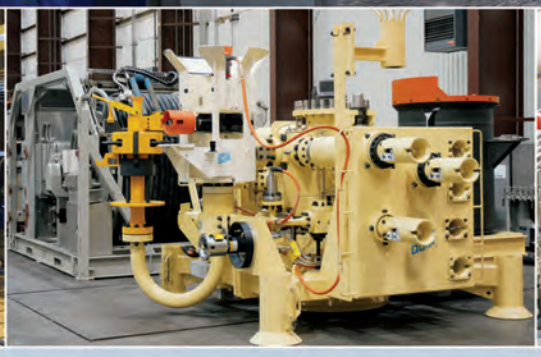

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# Speedy, accurate assessment of deepwater reservoirs

**Standard coring methods often yield incomplete reservoir fluid information. Doug Kinsella, managing director of Corpro, describes a new coring system that provides better information while saving rig time.**

Deepwater finds are now playing a crucial role in replacing global reserves, but they also come with new challenges to ensure the reserves are accurately discovered, appraised, and developed safely and efficiently.

Today's coring operations require superior functionality, performance, and reliability because they are exploring in deeper water, which means higher pressures and higher temperatures.

Drilling in ultra-depwater means higher costs for exploration. Therefore, large reservoirs have to be targeted to have the biggest impact on global reserves. To maximize their efforts, operators are looking to revolutionary technologies to optimize their drilling campaigns.

Accurately assessing the vast reserves available and plotting the best route forward can be a complex process, where the risks, economics, and potential success of an exploration program have to be carefully weighed to fully evaluate the potential performance and deliverability of any exploration program.

Poor reliability and safety risks have often resulted in infrequent use of some traditional coring technologies and methods to analyze pore fluids. Inconsistent analysis has led to reserves estimates that are wide and varied, the results of which are constantly debated.

## Deepwater coring

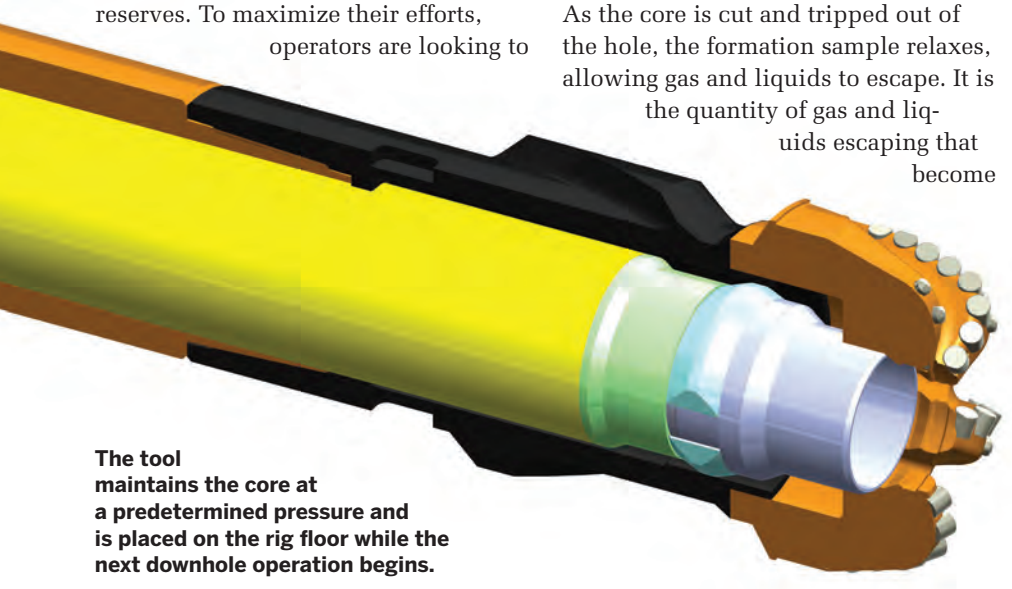
Samples that are recovered from deepwater are under extreme stress and pressure. Using current technology, as operators trip out of the hole with a regular conventional static core, the core arrives at surface under atmospheric pressure. During the trip out of the wellbore, there is a release of the tons per square inch of pressure that is on the rock in its natural state. As the core is cut and tripped out of the hole, the formation sample relaxes, allowing gas and liquids to escape. It is the quantity of gas and liquids escaping that become the unknown, resulting in large variations when calculating total reserves.

Rapid depressurizing of the core and gasses forcing their way through the formation can cause fractures that do not exist under reservoir conditions. These fractures can create artificial pathways for gas or liquids to travel that will not be there when the well is produced, exaggerating the well's potential flow rate. The more pressure on the core in the reservoirs, the greater the problem, which intensifies the situation for deepwater offshore reservoirs. Cores may be pulled to surface with altered permeability equivalent to the core being subjected to a mini frac.

When this occurs and the core arrives at surface, it appears to have many natural pathways for the fluids to migrate out of the reservoir into the wellbore. But when operators go to treat that scenario down hole and emulate those same results, production can be limited. The current belief is these fractures are not actually there. Instead, these fractures are damage that is created during the trip out of the hole. Conventional pressure coring technology can often cause a total loss of pressure, making it impossible to get an accurate picture of the reservoir.

When assessing conventional reservoirs today, operators of offshore conventional wellbores also use a Modular Formation Dynamics Tester (MDT). The MDT latches onto the wellbore in the reservoir sweet spot. The tool creates a draw, or suction, to pull-in fluids and gases from the formation, and brings them to surface at the same pressure as the reservoir. Currently, in a conventional offshore reservoir, firms can only estimate formation reserves with this technology.

Today, operators cut a core and know the volume of that core, but there are empty pore spaces in the core, and it is



**The tool maintains the core at a predetermined pressure and is placed on the rig floor while the next downhole operation begins.**

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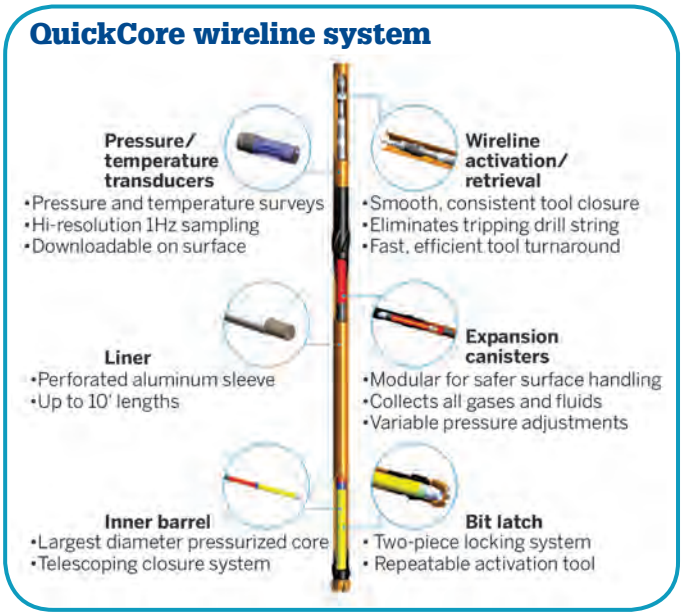
difficult to determine, with accuracy, if those spaces were filled with hydrocarbons or water. Operators then use the MDT test, but there's no true way to correlate how much reservoir volume that ssample came from, because it was drawn out of the reservoir near the wellbore wall. From that, operators are forced to estimate how much came out of that known volume of core. They know that the liquids and the gases are from their sample, then they do backwards math in an attempt to understand how much gas and liquid came out.




**Fluids are captured in cylinders and stacked above the core barrel.**

## New technology

Operators often define their coring program not by what they want, but rather by what they can afford. They are constantly seeking to secure more core samples at a lower cost, allowing them a better reservoir assessment.

The QuickCapture coring platform allows operators to better understand exactly what they have in their deepwater reservoirs before making critical, fact-based, completion and production decisions, because it reflects the exact amount of hydrocarbons that came out of an exact amount of core volume.

One hundred percent of gas and liquids are captured in storage cylinders by proprietary valves and are stacked above the core barrel. The core is only allowed to depressurize to a certain level during the trip out. The confining pressure is predetermined with the client and that decision is based on a compromise between rig safety and core integrity preservation. Although the core is allowedto depressurize to some degree, all of the subsequent liquids and gases are retained and temperatures and pressures are monitored for the entire trip out of the hole.

Currently, clients are trying to minimize the damage due to the decompression of the core by extending trip time to as much as 48 hours from the bottom of the well bore to surface. While this does not solve the problem of lost hydrocarbons, it is believed that it reduces the mini-frac effect. This

can drastically increase the cost of obtaining a core. The tool offers slow depressurization without any associated rig time cost.The tool maintains the core at a predetermined pressure and is placed on the rig floor while the next downhole operation begins. The tool is capable of depressurizing the core over days not hours, while still collecting all gas and liquids migrating from the core. Depressurizing the core becomes an offline procedure, dramatically decreasing the costs, to obtain the added benefit.

This coring technology cuts larger samples (76mm-diameter by 3m-long) and catches fluids that would normally be lost during regular coring operations. These fluids provide data about the reservoir conditions, allowing operators to make quicker decisions and avoid rig downtime.

While the technology is offered for the conventional coring platform, it has proven to be the most cost effective on the QuickCore wireline coring platform, which was specifically designed to enhance the overall speed of the coring process. The tool secures the core in a steel inner tube that holds a thin aluminum sleeve, protecting the core from fluid invasion, while still enabling gases to slowly vent. The aluminum sleeve also serves as a container in which the core can be left in an undisturbed state until the samples are taken to the lab for analysis.

When taking four or five cores in conventional coring, you have to be ready to trip four or five times. Using this system, the assembly is tripped into the hole, cores are cut, never tripping any pipe, just using a wireline, and then tripped back in the hole again. On an average well with four to five cores, this tool can cut the number of trips from ten to two.

In addition to significant time and related cost savings, these tools produce a safer work environment. It is well known the majority of injuries on a rig are from tripping drill pipe—due to the number of activities happening simultaneously and number of personnel involved. Because the tool reduces both the number of wireline trips and drillstring trips required, it minimizes injury potential.

## Exploration

More carbonate formations are being drilled offshore in a presalt environment, like those off Brazil and Africa. These formations are naturally fractured, and are difficult to core. For instance, while cutting a 30m core, an operator may cut 8-10m of core before jamming-off. The core then must make a long trip back out of the hole, frustrating operators because of the costs. In this situation, the tool can remove significant time and expense. Instead of taking 24-36 hours to trip out, it takes only 90 minutes on wireline. Using the wireline platform, as soon as a jam occurs, the wireline is dispatched down the hole to pick up the core and bring it out.

## A first for the industry

The tool recently completed the first ever 125ft wireline run in a shale gas reservoir, for a major operator in the US. Cutting this core length amounts to a 35% increase in core previously cut over the same recovery time. The operator has used the 90ft assembly on a number of other wells, achieving an average 99.25% recovery across these wells, producing consistent results. Prior to this well, the longest wireline core cut was 60ft with a 3in. diameter. The larger diameter core and 125ft wireline run presents operators with excellent analytical options. The larger diameter core aids in the recovery process while improving core quality. OE

***Doug Kinsella*** *is managing director of Corpro. He began his career in 1995 with Baker Hughes, where he focused on coring. He joined Corion in 2000, which was ultimately acquired by NOV. In 2009 Kinsella establish Quest Coring, in Edmonton, Alberta, and under his direction as CEO, the company developed QuickCore and QuickCapture.*

*Quest Coring was acquired by Reservoir Group in May 2012, where Kinsella continues to expand Corpro's technologies and services. Kinsella earned a mechanical engineering degree from Northern Alberta Institute of Technology.*

# Achieving total isolation to optimize wellbore cleaning

**The combined application of the ISO-MAX security packer and selective rotation and circulation tool (SRCT) helped a North Sea operator prevent losses during well displacement, thus ensuring well integrity and improving the chances of a successful completion.**

By Michael Ronson, Weatherford

The ISO-MAX security packer

Drilling mud displacement is a critical step in the well construction process to ensure completions operations are conducted in a clean, solids-free wellbore environment. However, displacement operations also introduce the risk of fluid losses that, if left unchecked, can lead to a poor completion and subsequent well control problems. While even minor losses have the potential to damage the formation and reduce production rates, more serious losses may lead to runaway well control problems in the form of a blowout.

Weatherford has worked closely with several operators to advance packers and wellbore cleaning tools that limit losses and validate well integrity during displacement operations, thus ensuring a successful completion operation. One such advancement, the ISO-MAX security packer, is a drillpipe-conveyed downhole liner-top test packer that enables the negative testing of a liner overlap and shoe track while used in conjunction with other wellbore cleanup activities such as mechanical scraping, debris removal and mud displacement to a completion fluid. Combining pressure testing and wellbore cleaning operations in a single trip avoids the need for a separate retrievable-packer run or wellbore displacement to a lower-density fluid through the choke, thus saving cost and risk.

The packer can be run in hole (RIH) or pulled out of hole (POOH) without speed restrictions, and is set hydraulically, which avoids the need to apply excessive weight to the liner top to set the tool after drilling cement and before inflow testing. This setting feature also allows multiple sizes to be run simultaneously to test more than one liner on the same run—another cost-saving benefit over conventional systems. Once set, the packer seals the well below it up to a differential pressure of 5,000 psi; thus, any pressure loss in the annulus up to this pressure will have no effect on the formation. Bypass valves incorporated into the packer body enable test fluid to be pumped with the annulus sealed, and allow the packer to be set only once. The unique setting and unsetting features of the ISO-MAX security packer, also allows for drilling of shoetrack to be performed after the inflow test.

The packer can be run with several wellbore cleaning tools, such as the selective rotation and circulation tool (SRCT), a repeat-cycle, shear-activated flow tool primarily designed for wellbore cleaning in deviated wells with liners. The tool has a disengaging spline drive, which allows the operator to rotate the upper part of the drillstring while the lower part remains stationary, avoiding the risk of twisting off the lower (weaker) string while displacing to completion fluid and losing lubricity from the drilling fluid.

Rotation of drillstrings in wellbores containing small-diameter liners has historically proven difficult due to excessive torque, which hinders wellbore cleaning by preventing effective agitation of cutting beds and other debris. The SRCT contains flow ports that are closed during normal operations, which allows flow to be directed to the lower part of the string. Once the tool reaches a predetermined point such as a liner top, weight is set down on the string to activate / shear a shear ring that allows the disengaging of the spline from the lower portion of the string. The upper part of the string is then free to rotate, while the lower portion sees no torque and remains stationary. With the spline disengaged the flow ports are open, which divert flow to the annulus to increase fluid velocity. It should be noted that the SRCT can be opened or closed at any point in the displacement operation.

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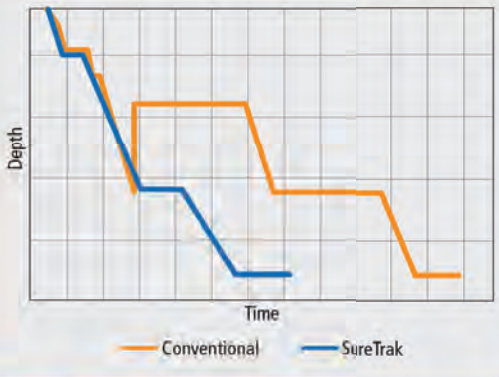


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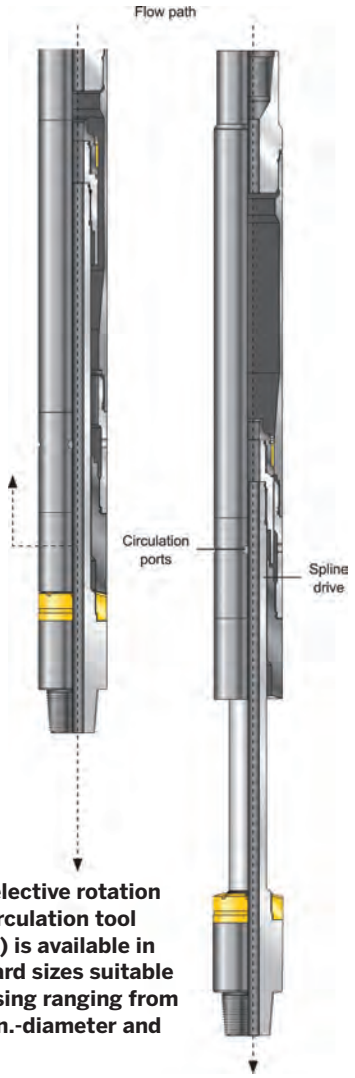
Typically the SRCT will be opened when clean completion fluid is displaced to above the tool and friction in the liner is at its peak and there is a requirement for increased AV's in the larger casing sections.

## Preventing losses in North Sea wells

A North Sea operator had a history of fluid losses during circulating in several wells. As a result, the operator could not achieve the desired circulation rates to fully displace the well, resulting in a buildup of a water-in-oil emulsion created from the mixing of water with the oil-base mud, which contained an emulsifier package. The addition of more water into the emulsified fluid increased its viscosity, causing further displacement challenges. If this emulsified fluid is not fully displaced out of the wellbore, it may cause problems for the completion, such as plugging up valves and inflow control devices or preventing efficient setting of completion packers. The emulsified fluids then need to be shipped to shore for treatment or disposal, which can impact operations due to rig space and shipping.




**The selective rotation and circulation tool (SRCT) is available in standard sizes suitable for casing ranging from 9-5/8in.-diameter and up.**

Weatherford was called upon to help the operator to develop a cost-effective well cleaning solution that would avoid these possibilities. This began with a preplanning meeting in which the operator provided all relevant information for the next well to be drilled and completed using the new well cleaning strategy. Located at a water depth of 103m, the well was to be drilled to a measured depth of 4,550m and total vertical depth of 2,889m. The plug back total depth for the well was 3,846m and the bottomhole temperature was 114 °F. Both the mud provider and Weatherford engineers prepared a hydraulic simulation for the well, which estimated that the maximum allowable ECD (equivalent circulating density) would be exceeded when pumping at the required rate to effectively circulate and condition the mud system, resulting in the well going on losses.

Based on the simulation, Weatherford recommended the combined deployment of the security packer and SRCT to isolate above perforations in the 9-5/8-in. casing section of the well to prevent losses when circulating and subsequent formation damage. A full schematic of the drillstring configuration with the tools was developed and agreed to by the operator, and the deployment was planned.

After perforating the casing in the planned locations, cleanup runs with scrapers and magnets were performed to remove debris and prepare the wellbore to accept the packer and SRCT, and subsequent completion.

The configuration of the wellbore cleaning assembly consisted of a ported bullnose placed at the bottom of the drillstring, followed by the ISO-MAX packer and SRCT, and finally, more drillstring to surface.

The wellbore cleaning string was then RIH to the desired setting depth. The ball was then dropped and pressure applied to set the packer, once the ball had landed on seat. The ball was left in place throughout the operation to provide complete isolation for the perforated sections below.

The annular BOP was then closed and 1,500psi applied to confirm successful setting of the packer and SRCT. The test demonstrated that the wellbore below the packer was isolated up to the required pressure of 1,500psi. The annulus was then bled off and the annular BOP opened. The Weatherford operator then set down weight on the SRCT, which sheared the activation ring to collapse the tool, disengage an integral clutch and open the circulating ports, allowing the mud conditioning and displacement to commence by circulating out of the SRCT and rotating the string, without placing any torque through the packer.

The displacement stage consisted of pumping base oil as a lead spacer, followed by a viscous pill, then a wash pill, and finally, clean brine. Once clean brine was observed returning to the surface to signal complete displacement, the drillstring was picked up to close the SRCT ports, The ball seat on the ISO-MAX security packer was then sheared to allow communication from drill string to annulus in the event that any well control situations arose. The packer was released with overpull, and the entire assembly was then POOH without incident.

The operator was pleased with the packer and SRCT's performance in fully isolating the lower wellbore and efficiently cleaning the well ahead of subsequent completion operations, and recorded a savings of one day in rig time, roughly US$500,000. This job validated the potential of using this combination of tools in any openhole application where losses are likely, and conditioning of mud or displacements are required. OE

***Michael Ronson*** *is a project manager for Weatherford in Norway, situated in the Well Construction group. He came to Weatherford in February 2011, and has 10 years' experience in the oil and gas industry. He has served in numerous rolls, working in completion fluids, displacement chemicals, and mechanical downhole tools disciplines.*

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# Bucket foundation
## may cut wind turbine costs

**Suction piles have anchored offshore oil and gas production for years, but a new type - called a bucket foundation - is being promoted for offshore wind turbines in an effort to reduce costs.**

By Bruce Nichols

In February, Forewind, a consortium planning a huge turbine farm in the North Sea, started testing the bucket foundation system, using it for a meteorological station at Dogger Bank site where the farm is to be built. Universal Foundation, a Danish affiliate of Fred. Olsen of Norway, originated, designed and patented the new foundation type. Harland & Wolff of Belfast is the manufacturer.

Universal's bucket is one of four innovative foundations being pushed by the UK Carbon Trust's Offshore Wind Accelerator research and development program, which aims to cut offshore turbine construction costs and make wind power more competitive.

The other three OWA-endorsed designs are a tri-bucket system from SPT Offshore, a twisted jacket from Keystone Engineering, and a gravity base from GBF. All four, including Universal's bucket foundation, aim to cut costs by simplifying installation.

The Universal design is the closest of the three in appearance to a monopile, although it has a much wider base. It amounts to a giant upside-down bucket with a shaft rising from the center of its upturned bottom.

The shaft extends above the water and is topped by a distinctive integrated transition piece onto which a wind turbine or other topside structure can be installed. Usually, adding the transition structure is a separate step, Universal says.

Universal says the bucket foundation can work in waters out to 50m deep, the relative shallow water depth at which most of the world's wind turbines are installed.

Like traditional suction piles used in the oil and gas industry, the bucket foundation fills with water when placed into the sea at the start of installation. Pumps then suck out the water, creating a pressure gradient that, along with the structure's weight, pushes it into the seabed, like a cookie cutter slicing into dough.

Unlike suction piles, the bucket foundation's skirt has controllable, water-emitting jets or nozzles lining the lip where the skirt cuts into the seabed. Varying the force of water shooting from the jets into the seabed helps ease the bucket into place in a level orientation.

"The rim of the skirt is equipped with a unique system for distribution of water pressure," says Soren Nielsen, Universal's technology director. "The bucket structure will, by these means, be steered vertically, allowing precise location within the inclination tolerances."

Using this approach, the monopile-like structure extending above the water ends up almost perfectly vertical, without grouting or other subsea work. The typical wind turbine inclination limit is 0.25°. Universal can achieve installation within 0.1 degree of vertical, promoters say.

As for stability and strength after installation, the bucket foundation can resist the large forces exerted on it by wind and waves and remains in place because it combines the benefits of a gravity structure and a monopile, Nielsen says. The design also prevents scour, avoiding the need for anti-scouring measures.


**Fred. Olsen Windcarrier's jackup Brave Tern was used to install Universal's bucket foundation. Engineers are studying additional installation options.** Photo: Maersk

"The stability of the foundation is ensured by a combination of earth pressures on the skirt and the vertical capacity of the foundation," he says.

There have been questions about the bucket foundation: Installation in seabed that is too rocky presents challenges; manufacture requires a lot of welding; delivery and installation methods remain to be perfected.

Universal has answers for all of the questions: If installers encounter unexpected rocks, the bucket foundation is easy to shift slightly; the relative shallowness of its penetration into the seabed, compared with traditional suction piles, also helps when installing in potentially problematic seabed.

As for the welding in manufacturing, promoters say it is a benefit because it enables the cost savings associated with unitization.

As for hauling and installation, existing jackup vessels have the capability needed for delivery, and other hauling options are being studied for larger projects; installation has been proven at Dogger Bank and will be optimized in future projects, Universal says.

But the bucket foundation has to do more than work effectively to be competitive. It has to cost less.

The Carbon Trust's head of offshore wind, Phil de Villiers, warned a recent UK conference that offshore wind power development could stall without more powerful turbines, lower-cost foundations and full-scale demonstrations that the technology can be cost effective.

Cost is clearly an issue; especially with offshore turbines costing as much as four times onshore turbines, in the range of £3-4 million per MW of capacity.

Universal is happy to talk about cost. They estimate the design can shave 30% off the cost of traditional subsea foundations (the old-style monopoles, jackets and gravity bases).

First, the bucket foundation is much lighter. It uses less steel. "Compared to monopiles, we expect to demonstrate a 25-30% reduction in weight," says Universal spokeswoman Michelle Maria Langkilde.

With the transition piece already attached, installation requires fewer steps. Importantly, the design avoids the grouted connection that can lead to future problems.

**Several bucket foundations are shown during manufacture at the Harland & Wolff shipyard in Belfast, Northern Ireland. The worker walking underneath gives a perspective on the dimensions of the upturned bucket design.** Photo: Fred. Olsen United

"The traditional foundation relies on a grouted connection, and in recent years, failing grout connections have gained the attention of industry experts and could result in huge upgrade investments for already operational wind farms," Langkilde says.

Universal points to the bucket's comparative ease of decommissioning and removal, which allows it to be reused or recycled, cutting costs even more.

Complete removability also is an environmental benefit. When a site is decommissioned, pulling the bucket completely out returns the seabed to its prior condition. Traditional monopoles often are cut off at the seabed with their bottoms left embedded.

Promoters also tout the lower environmental impact of installation. Unlike conventional foundations, Universal's requires neither pile drivers nor vibration machines that disturb marine life.

Two other Universal bucket foundations have been installed; one in 2002 to support a 3-MW demonstrator turbine at Frederickshavn (harbor), Denmark, and a second in 2009, to carry a meteorological station at the Horns Rev 2 wind turbine site, also in Danish waters.

Two other bucket foundations are under contract for met stations; one at Dogger Bank, and for the Seagreen turbine site in Scotland's Firth of Forth, Langkilde says.

It is too early to say which foundations will be used for the wind turbines at Dogger Bank as that decision will be made by the lead operators of the various parts of the sprawling development, a Forewind spokeswoman says.

But Forewind General Manager Lee Clarke notes the bucket's advantages, saying that it was chosen for two met masts because it uses less steel than conventional piled foundations and its design removes the need for pile driving, seabed preparations, scour protection and a transition piece.

"We have taken our requirements for met masts to look beyond the standard approach and instead use the opportunity to demonstrate a new, and potentially very exciting, technology with possible benefits well beyond just the Dogger Bank development," he says. OE

**Two bucket foundations loaded aboard the Fred. Olsen Windcarrier jackup, prepared for installation of a meteorological station at Dogger Bank, in the North Sea.** Photo: Fred. Olsen United


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A worker installs a leg pin after jacking to raise the platform's deck.

# Air gap restoration: a platform-based solution

By John Greeves, Versabar

Reservoir compaction and seafloor subsidence continue to be a significant concern for the oil and gas industry. Subsidence near oil and gas reservoirs is usually caused by a high production rates from multiple wells over many years. Production from hydrocarbon reservoirs decreases fluid pressure in the pore space and increases the stress on the rock formation. Depending on the rock strength, the increased stress could induce significant compaction of the reservoir. Typical deepwater Gulf of Mexico reservoirs consist of loose turbidite sands that carry the potential for considerable compaction, especially if significant depletion occurs during the productive life of the reservoir. Compaction can then produce seafloor subsidence, with significant displacements occurring over time.

Direct results of seafloor subsidence are the increase in water depth and the corresponding reduction in the air gap between the average sea level and the base of a platform structure. This resulting loss of air gap and the potential impacts on platform safety are a major concern for operators. The wave force generated from hurricane winds presents one of the greatest risks for physical damage to offshore platforms; therefore, deck height is one of the most important characteristics in determining platform safety. All offshore platforms are built with the assumption that the deck is high enough to avoid being struck by waves. As subsidence causes a platform to sink over time, it increases the potential for inundation of the deck in extreme storm conditions, putting the platform at greater risk for structural failure and premature shut-in of production.

## Gulf of Mexico

Versabar has developed a solution to prolong the life of platforms affected by seafloor subsidence and threatened by potential storm conditions. Raising a platform' height is performed by using hydraulic arms to jack (lift) the structure up, increasing the air gap between the cellar deck and the expected maximum wave height. This deck-raising technology was developed in 2006, after two Devon Energy platforms experienced considerable storm damage during two major hurricanes in 2005: Katrina (August) and Rita (September). Each platform was successfully raised 14ft using 32 synchronously controlled hydraulic cylinders, each with 260 ton capacity.

A key design element of this deck-raising technology is the inclusion of split sleeves placed around the platform's existing legs. The sleeves contain the deck legs during cutting, provide lateral stability for the topsides during jacking, and become permanent leg extension sections to support the topside at the new elevation. Another crucial element is the use of a pin connection to keep the platforms storm safe during the cutting and welding process.

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Custom-engineered hydraulic power units (HPUs) were built to operate the rams. They were designed with redundancy (two engines, two fuel tanks), so that they would still be able to safely operate in the event of one total engine failure.

The deck-raising system was designed with two different control modes, synchronous and manual. Synchronous is the primary mode and uses a computer system to send signals to the flow-control valves for all of the rams. Operators use computer monitors to observe all aspects of the raising procedure including leg displacements, cylinder pressures, and hydraulic oil temperatures. When in manual mode, operators adjust the flow control valves for each leg.

The deck raising technology can be used on multi-platform complexes in a simultaneous and synchronized process.


## Southeast Asia project

Versabar has provided engineering and equipment for the raising of a multi-platform bridge-linked complex in Southeast Asia to counteract the subsidence that has occurred at the field. Synchronized rams will raise three platforms and their connecting bridges about 4m to restore a safe air gap. Because the current air gap does not provide enough clearance for installation of rams long enough to perform the entire lift, the process needed to be broken down into multiple stages. Two types of rams were custom-engineered for the job. The first set of rams will raise the platforms 38.5in. After the legs are pinned off, a second set of rams will be installed that will raise the platforms to 106in. After pinning off once again, the dual-rod rams will continue to raise the platforms to 159.5in.

Project experience verifies the deck raising system is scalable to over 20,000 metric ton platform weights. In addition, use of multiple, split-sleeve extensions and dual-rod rams allows the raising of these large platforms with a high level of operational efficiency and safety.

As the probability of extreme waves entering the deck increases with further subsidence, modifications to facilities should be considered to minimize future adverse effects of compaction and subsidence. OE

***John Greeves** is the technical director of the Versabar Group of companies. He has worked in the oil and gas industry for more than 20 years, including 10 years for Shell international. He holds a PhD in civil/structural engineering and is a UK-registered chartered engineer.*

**This GOM platform became unsafe due to subsidence (left). The jacking system (above) raised the deck 14ft to create a safe air gap (right).** All photos: Versabar.

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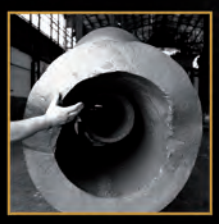

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# Keeping things moving:

## Tips on finding a rapid response service

By Thomas Dunn, CSI Aviation

In the oil and gas industry, one broken piece of equipment in the field or on a rig can be a big problem. With equipment down in the field, an entire operation can be jeopardized, and the financial cost to the company grows with every hour and day that passes. Broken equipment needs to be fixed immediately.

But what happens when a replacement part isn't within arm's reach or even within the same state or country? The clock still ticks and the afflicted company bleeds money until somebody figures out how to fix the problem.

In this business, equipment failure is expected, so having a contingency plan in place to minimize downtime is essential. That's why it's absolutely critical for oil and gas companies to find an aviation management company that offers rapid response services to ensure that replacement equipment can be shipped quickly, handled properly once it reaches its destination, and then moved from the hangar to the worksite in good order, (See Figure 1).

While a company can try to manage its own rapid response services, it's best to seek professional help because of the many risks involved. This is especially true for a company that needs to transport equipment across international lines.

Stringent airport restrictions, customs requirements, and over-flight permits are just some of the logistical challenges that, if not handled appropriately, can cause a major problem, (See Figure 2). Lack of aircraft knowledge and of services specific to moving cargo could also cost the company significant money that it could have otherwise saved.

And those are just a few reasons to seek professional help.

Most rapid response services are offered through aviation support and logistics companies, but what each company can provide to its clients varies. Navigating the aviation transport arena can be challenging on a good day and treacherous on a bad one, so contracting with a company that has a proven track record for success and excellent service is optimum.

When looking for an aviation management company to provide a rapid response service, there are three critical components to look for: experience, capabilities, and availability.

**Figure 1. A contingency plan can minimize downtime, ensuring that replacement equipment is shipped quickly.**

### Experience

When looking for aviation management companies for rapid response purposes, first and foremost, determine if they have ever serviced oil and gas companies. Ask for case studies. Those case studies will shed light on real missions — the emergencies, what was done to solve the challenges and the outcomes. Be specific when asking questions because, even within the oil and gas industry, there are many different needs and types of logistical emergencies.

Experience is also demonstrated through longevity. How long has your provider been in business and how long have they been providing aviation management support?

They should be able to provide a long list of successfully implemented rapid response operations for their clients whether they be large corporations, government entities or non-profits.

Longevity is also key because it means that an aviation company has built lasting relationships with air carriers. Because of those important relationships, they are able to provide a quicker response. Furthermore, a company with longevity will be knowledgeable about aircraft and know what to ask of the carrier when it comes to pricing and services, (See Figure 3).

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By building a large air carrier network, an established provider has better buying power and can receive preferential pricing from cargo providers. It also will have established lines of credit with many suppliers, which allows it to expedite flights for customers.

In looking at a company's experience, ask the company whether it has experience transporting people and cargo over international territory. This is important because it can be very difficult to deal with customs. For example, Canadian customs is very professional and easy to work with. Many of the required, pre-flight forms can be submitted electronically to speed up the process.

But not every country's customs work the same. Each country has its own set of rules and, if there is any issue with compliance, it will cause long delays. Additional issues — temporary import bonds, customs warehousing, and customs brokers — present challenges that can cause a company to lose a lot of money, if it is not careful.

An oil and gas company in crisis-mode doesn't have time for delays. That is why it's so important to get a list of countries that the company has had experience working with.

If you know you'll need to import parts from a particular country and it isn't on the aviation management company's list of customs it has experience with, reconsider. Keep shopping around until you find the right company. Always get the details.

## Capabilities

Your aviation management provider must prove that they have the ability to do the job from start to finish. Not every job requires the same type of aircraft. For example, an operation requiring a very large piece of equipment might require a 747, while an operation that requires multiple smaller parts might require a King Air turboprop aircraft, (See Figure 4).

Why does this matter? Cost. The larger the airplane, the more the customer pays. A good aviation management company will understand this and work not only toward completing the mission as rapidly as possible, but completing it at the lowest cost possible.

Don't forget about the need for companies to provide the right kind of aircraft anywhere in the world. Most oil and gas companies operate in many countries. They need to be able to count on their aviation management company to provide rapid response services regardless of where it occurs.

**Figure 2. Logistical challenges include airport restrictions, over-flight permits, import bonds, customs warehousing, and customs brokers.**

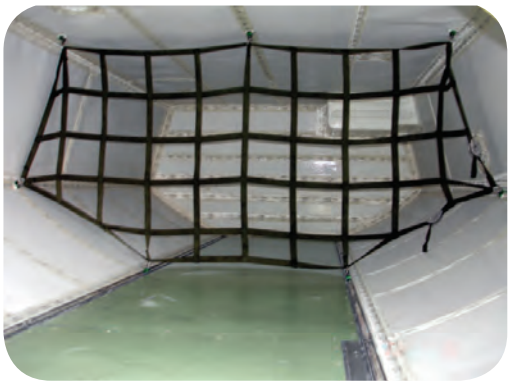

**Figure 3. Knowledge of aircraft (space and weight limits) and cargo moving services can reduce transport costs.**

**Figure 4. Each transport requires the appropriate aircraft and very large equipment might need a 747.**

Furthermore, a good aviation management company should be able to provide comprehensive solutions unique to the situation. They may have to arrange ground transportation, hire security guards, and find storage for its clients — all in the same mission.

Every step is important to ensure that the cargo is transported. Every project should revolve around a strict timeline with open communication between all parties involved: giving feedback and making adjustments as required.

## Availability

Another critical factor when choosing an aviation management company is availability. The provider should have no geographical or time restrictions. The company should be international in scope and its representatives must be available 24 hours a day, seven days a week.

Logistical emergencies don't usually occur when it is convenient to deal with them, so your provider should offer solid examples of their around-the-clock capabilities. For example, not all rapid response emergencies revolve around broken equipment. Sometimes, lives could be at stake.

In 2007, four contractors for a global oil and gas company were taken hostage by gunmen off the coast of Nigeria. As soon as it happened, CSI put planes on standby in a neighboring country and was ready to take the hostages home, once they were released. After three weeks, the hostages were released. Because of prior planning, the hostages were transported back to their homes safely and securely.

If your company does not have an aviation management company with a rapid response program in place, now would be a good time to shop around and find a provider that meets your needs. OE

---

***Thomas J. Dunn*** *is the Vice President of Marketing and Business Development at CSI Aviation, a global aviation support and logistics company.*

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Dry cuttings coming off the MudCube.

# Cutting through mud

**Cubility's MudCube shale shaker made a name for itself on its first commercial installation on Maersk Drilling's *Maersk Giant* in the North Sea.**

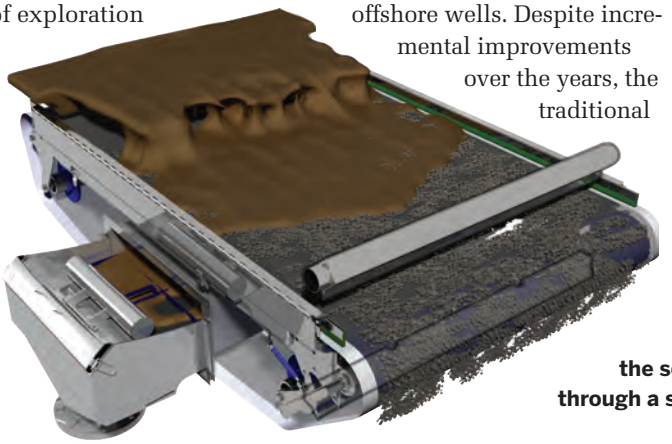
By Asbjørn Kroken, VP, Cubility

The North Sea has long been a critical area of exploration and production within the oil and gas industry. Advances in technology mean many fields once thought to be fully tapped are still producing at great volumes. The region is also known for its stringent HSE (health, safety and environment) standards, particularly related to waste and employee conditions. One area of concern is the waste produced and environments created during the solids-control process, where fluids and cuttings are separated via a shaker.

Traditional shale shakers, which rely on technologies created in the 1930s, have remained the primary method for solids control for both on- and offshore wells. Despite incremental improvements over the years, the traditional shale shaker still poses a number of HSE concerns, including noise, vibration, emissions, and inefficient solids control.

Maersk Drilling recently decided to tackle the HSE and inefficiency issues, created by traditional shale shakers, by using Cubility's MudCube on its *Maersk Giant* jackup rig. Its use aboard the jackup was the first commercial installation and was operational from 3Q 2012.

A vacuum conveyor system (VCS) integrates cuttings transport and cleaning, real-time monitoring systems, and automation components. It operates cleanly and safely, without high-g-forces, cuttings degradation, or fluid mist and vapor pollution, thereby improving the working environment. To date, the shaker has been introduced to drilling sites in the North Sea and in the US Marcellus shale play.



**Drilling fluid with cuttings enter and are distributed over the filterbelt (screen). The vacuum conveyor system pulls fluid through the screen, leaving cuttings. The fluid then pssses through a second filter and back into the active system.**

# Third-party HIL testing

Modern ships and rigs have advanced computer systems for dynamic positioning, power generation & distribution and drilling operations. Software errors in these systems lead to delay, non-productive time and compromise safety. Marine Cybernetics performs third party testing and verification of control system software. We detect and eliminate such errors and weaknesses using Hardware-In-the-Loop (HIL) testing technology.

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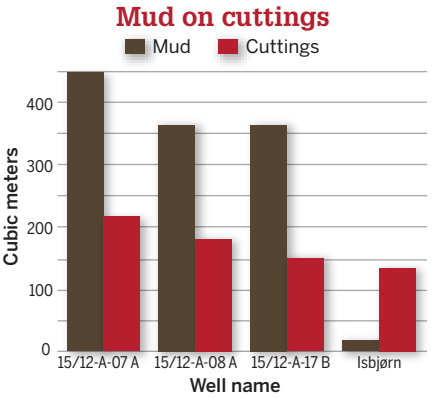
## Drilling waste minimation

**16/10-5 Isbjørn**

- Total meters drilled (OBM): 1,976m
- Total drilling waste sent to shore: 438mt
- Total OBM added for priming of screw-conveyor: 62 mt (40cu m)
- Mud on cuttings: 27 mt (17cu m)
- Mud on cuttings by stage:
- 12 ¼" section : 5.4 wt%
- 8 ½" section : 12.6 wt%
- 16/10-5 Isbjørn well: 6.1 wt%
- For each cubic meter drilled, 0.13 cu m
- OBM to cuttings ratio: 1:0.13




**Comparing mud volume versus cuttings volume for four wells shows how the mudpump change reduced mud loss from cuttings.**

### Key goals

Previously, the *Maersk Giant* used four traditional shale shakers for primary solids control. Following discussions between Cubility, Maersk Drilling, Talisman Energy Norway, and DONG Energy, these were replaced with three MudCubes.

Cubility and Maersk set three key goals to determine the success of the project: improving the shaker room's working environment, reducing the mud volume typically lost over standard solids control equipment, and minimizing the corresponding waste volume, while improving overall drilling fluid performance. Throughout the drilling process, these and other parameters were monitored to assess the new shakers' impact.

### Shaker differences

The new shakers receive fluid and cuttings conventionally through a distribution box. From here, the integrated VCS processing technique takes effect. First, fluid is distributed evenly via adjustable gates across a replaceable, non-tensioned, woven wire, stainless-steel screen (filterbelt), secured to a drivebelt, and vacuumed through the entire area of the filterbelt via a vacuum tray. Then, an air-knife blows on the wet cuttings and returns the fluid to the active system. While the unit does not shake, micro-vibration devices are employed to increase maximum flow capacity.

As available screen openings are covered by mud flow, air travels more quickly through the remaining openings. This increased air velocity, coupled with a continuously rotating screen, offers high resistance to screen blinding, minimizing the potential for fluid to cascade off the unit and into the drilling waste. Additionally, a secondary air-knife removes residual solids from the screen and deposits them in the discharge line.

After passing through a secondary filtration system, clean fluid is separated from air and gas, through a negative-pressure generating unit. The unit's cyclone filter captures moisture and returns it to the active system. This recovery feature minimizes losses to evaporation and benefits the environment. Finally, the collected, filtered, drilling fluid is deposited back into the active system via gravity flow.

### Results

Maersk and Cubility had high expectations for improvements in HSE conditions and waste volume reductions. The ratios between solids and fluid in the drilling waste on the *Maersk Giant*, when using traditional shakers, ranged from 1:2.20 to 1:2.72, while 1:1 is commonly accepted by the industry as a very good ratio. However, the ratio between solids and fluid was reduced to 1:0.13, following the shaker replacement.

Waste and costs were reduced, due to a reduction in the waste transported ashore and reuse of drilling fluid. The lifespan of the system's filterbelt is 40 times longer than that of a traditional screen, from less wear on the surface system, pump liners, etc.

Improvements in HSE conditions were seen, particularly in noise, emissions, and vibration. Noise-levels were reduced to 68dBA from about 95dBA, well below the recommended 83dBA NORSOK standard for a 12-hour working day. Oil vapor and oil mist issues were completely eliminated in the shaker room. Finally, there was no need for structural reinforcement on the platform, due to the system's comparatively light weight and low-frequency vibration.

A result of the project, workers on the *Maersk Giant* have start calling the shaker room the "cube lounge," due to its emission-, noise- and vibration-free environment. The *Maersk Giant* is currently on contract to DONG Energy, working on the Trym field in the Norwegian sector of the North Sea. OE

***Asbjørn Kroken,*** *vice president of engineering marketing and sales, Cubility, has nearly 25 years of global experience in oilfield services, focusing on new product and technology portfolio management.*

**The *Maersk Guardian* jackup's mudpumps were replaced with MudCubes.**

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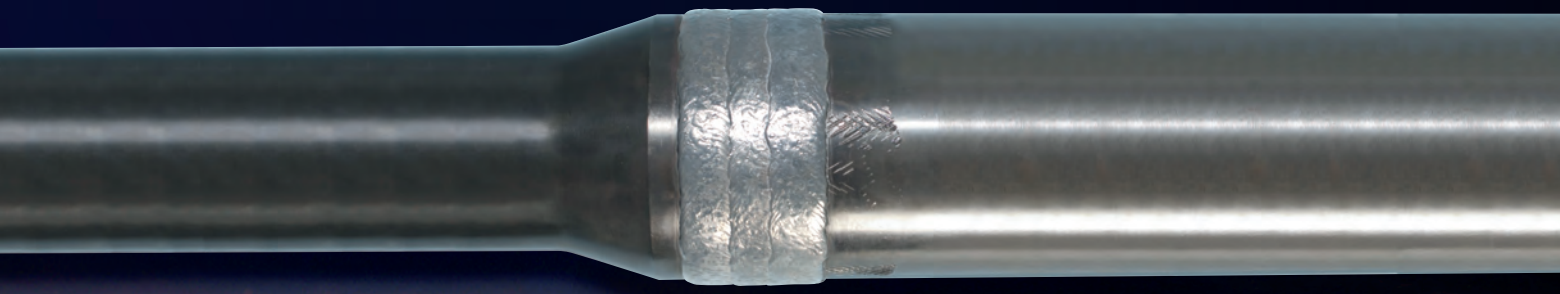

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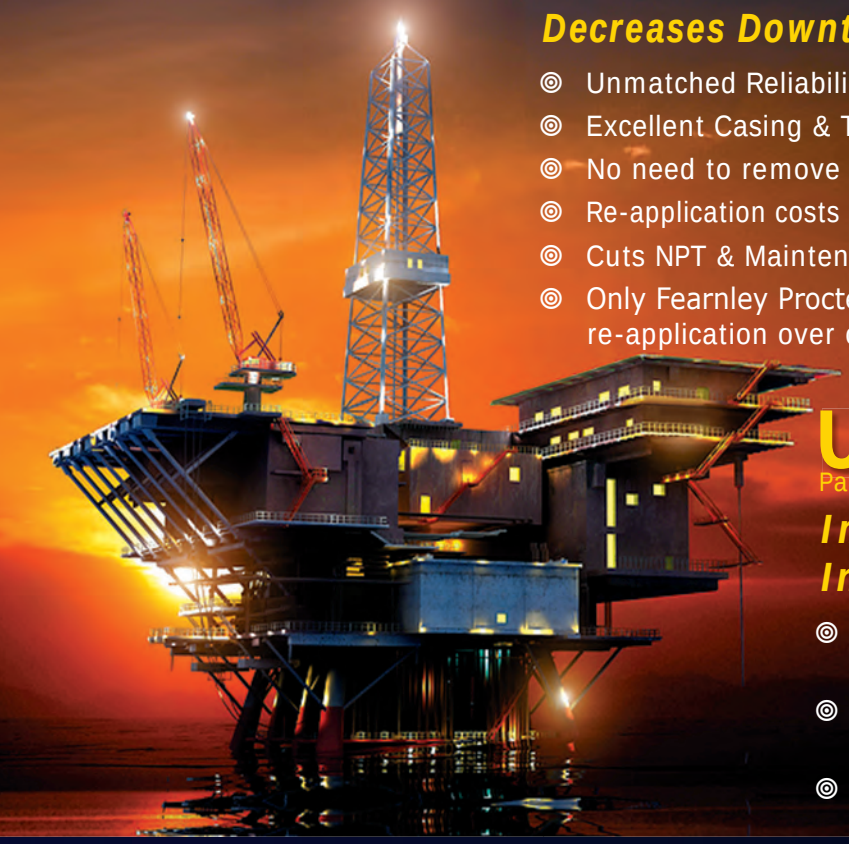

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A coil tubing reel in action.

# Depth control: in real time

**Issues can develop in a producing well that can negatively affect operations, production, and ultimately, revenue generated. Oilfield services provider Aker Solutions has recently completed trials of a new well intervention system designed to track coiled tubing operations in real time. Donald Kellock explains.**

Although technology has advanced in recent years, the main method of determining depth during coiled tubing (CT) operations still relies on a mechanical wheel in contact with the pipe, which effectively measures the length of pipe that has passed.

The main discrepancy in this system comes from slippage of the wheel against the surface of the pipe, due to a build-up of rust, wax, oil or other substances. In addition, it cannot take into account downhole stretch of the CT itself, which can vary on each job due to temperature, pressure, or deviation.

Depth control is more critical during complex well intervention operations, so it is important that accurate measurements can be taken to determine the position of the bottom-hole assembly (BHA) in the well.

Logging a well or correlating depth on CT in real time is not a new innovation. It has traditionally been carried out using a standard e-line cable (5/16-in. or 7/16-in.) inside the CT. This system of "stiff wire" logging has several drawbacks: it limits the fluid rates and types of fluids that can be pumped, it does not allow balls to be pumped to activate ball drop tools and adds a significant amount of weight to the coiled tubing reel when installed.

Aker Solutions designed and developed a real time coil (RTC) system with a view to overcoming the problems associated with the traditional method. It captures all of the necessary downhole data and transmits it in real time back to the coiled tubing cabin. This is all achieved by using a 1/8-in.-diameter wire inside the CT.

## System overview

The RTC system consists of three main components: the downhole BHA/

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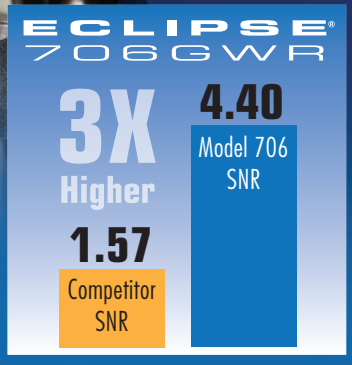


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sensor tools, tubewire conductor and the data acquisition system (DAS).

The first component in the BHA is a cablehead assembly, where the electrical wire terminates into the downhole tools and is sealed-off from any fluid or pressure. The cablehead also includes check valves and a ball-activated disconnect function, which releases the tool and the cable in the event of being stuck downhole.

The cablehead is a simpler design than previous "stiff wire" cableheads and can be installed in the field in about 45 minutes.

Attached below the cablehead is a gauge carrier to house the logging tools. The cablehead is connected to the gauge carrier by a castellated quick-connect sub, which means there are no additional electrical connections to make up.

We chose to run the logging tools in a gauge carrier to offer protection to the tools and make it simpler to swap out tools during operations.

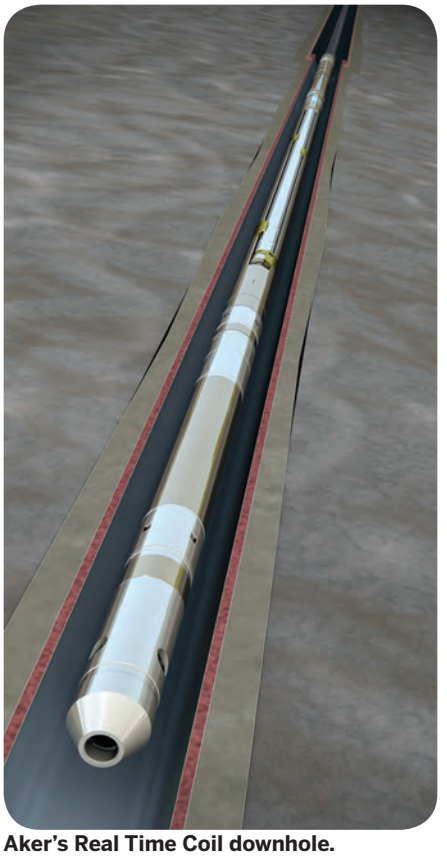
An optional lower disconnect sub can be installed, should the need arise to run additional logging tools or perforating guns below the gauge carrier. This allows electrical connection through the entire BHA but provides a disconnect function so the whole BHA is not left downhole in the event of getting stuck.

The entire BHA has a 20mm thru-bore, which allows for pumping of fluid and also allows pumping of balls to activate any ball drop tools. It was developed as a modular system to allow flexibility to run various combinations of tools depending on the needs of the customer.

The tubewire conductor is a 1/8-in. incoloy alloy-encapsulated wire, which is installed in the bore of the CT. This allows power and signals to be transmitted between the BHA and the DAS on surface. The incoloy outer tube protects the wire from abrasive or corrosive fluids being pumped through the CT and, due to its small diameter, it has no effect on pump rates and still allows the capability to pump balls for activating downhole tools.

The surface logging DAS allows the CT operator to easily see all of the downhole parameters in the control cabin, and the data can be downloaded to a memory stick to be viewed on a laptop.

The logging graph can be printed off in API format, so that checks can be made on exact locations for perforating or setting plugs, etc. The DAS is a small, portable, Zone-1-rated enclosure, with push button controls, which can easily be moved between CT units.



**Aker's Real Time Coil downhole.**

## Capabilities

The downhole logging tools in the RTC system consist of a casing collar locator (CCL), scintillation crystal gamma ray sub, dual-pressure sensor (inside CT and in wellbore), and a fast-response fluid temperature sensor. The system is rated to 175°C and 10,000psi.

The logging tools also have a built-in memory, with a 26-hr lithium battery back-up.

When the cablehead and gauge carrier are installed on the CT, it results in a BHA length of about 14.5ft. With a standard 18,500ft CT string, the additional weight of having the tubewire installed is about 250kg, which can be up to 10 times heavier in a conventional e-line cable.

The system is also capable of running a downhole camera and is compatible with different types of firing heads and firing panels.

## Development

The biggest challenges during design and manufacturing centered on the logging tools and gauge carrier. We required as large a through-bore as possible in the tools, while keeping the tools to a maximum OD of 2-7/8in., ensuring length was kept to a minimum and still meeting the 10,000psi pressure rating requirement.

In conjunction with Probe (a measurement tools and systems manufacturer), Welltools Ltd., and Wellvention Ltd., we were able to design a tool to meet all of these requirements.

Aker recently completed testing the system in a test well, which involved running different downhole tools, including motors, burning shoes, Venturi junk baskets, and fishing tools.

This was done with the logging tools installed and allowed Aker to correlate against known tubing connections in the well. It also provided downhole pressure and temperature data.

The results proved that the sensors downhole do provide different data trends from those traditionally observed at surface and allowed Aker to operate the tools in a different manner than it would normally.

Several tests have also been carried out to prove the capability to pump balls through the CT string and applicable tools. The emergency downhole disconnect systems were also tested.

The system has been designed to run in conjunction with a wide range of standard CT tools with a view to making it a standard deployment on all CT operations in the future.

The RTC system will allow us to more accurately place tools in the wellbore and gives us downhole data to make the correct decisions during operations. OE

***Donald Kellock*** *joined Aker Solutions in 2011 and has been involved in developing the Real Time Coil (RtC) system. He has a Masters degree in mechanical engineering from Strathclyde University.*

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Dive-support vessel, *Joanne Morrison*, deploys the SHARC tool during plug and abandonment operations.

# P&A costs slashed by new cutting tool

By Victor Schmidt

Decommissioning is on the rise and the cost to industry will be about US$80 billion over the next 25 years to plug and abandon more than 5,000 wells, clear flowlines, and remove related structures. Is there a way to improve the decommissioning process, increase effectiveness, and improve worker safety? There are many steps in the decommissioning process and each one will be scrutinized and improved as decommissioning becomes routine.

Chet Morrison Contractors (CMC) has developed a piece of equipment that accomplishes part of the process: removing surface casing and embedded jacket legs. Once wells are plugged, the casings cut and pulled, and platform topsides and related in-water structures removed, then the remaining support leg stubs are cut below the mudline and extracted to leave an unobstructed seabed.

Fixed platforms are limited to continental shelf water depths with most structures in water depths less than 600ft. Standard operations to remove tubulars requires divers, breathing special air mixes under saturation conditions and working for extended periods at depth. They jet soils from around the legs until the required depth is reached, cut the stubs, and then backfill the excavation after stub removal. All this activity is done under the constant danger of potential burial from sloughing slopes. A standard operation can take four to five days to completely remove the stubs.

**During a cutting test onshore, the SHARC tool was able to cut through three cemented casing segments.**

To make better use of divers, avoid slip-slope hazards, and reduce operational cost, CMC developed a subsea hydraulic abrasive rotating cutter (SHARC) that can remove well strings and stubs without the need for major soil removal. According to CMC, the tool can be positioned over the well or stub by divers or remotely by ROV. The tool is inserted into the hollow tube. It is then lowered to

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## DSV *Joanne Morrison*

The *Joanne Morrison* has four-point mooring system for stability, a saturation-diving system that can support four divers to 1000ft water depth (deployed through the moon-pool), and can do subsea inspection with a work-class ROV.

| | |
|---|---|
| Length | 240ft |
| Width | 48ft |
| Molded depth | 14ft |
| Main deck area | 46 x 125ft |
| Open deck space | 5750sq ft |
| Main deck cargo capacity | 225tons |
| Fuel | 60,000gal |
| Water | 90,000gal |
| Flag | USA |
| Classification | USCG/ABS |
| Crane | Mantis Model 14010, 70-ton hydraulic |
| Engines | 2 x 645 EMDs C Model |
| Horsepower | 1,500 |
| Main generators | 2x 300 kW |
| Emergency generator | 375 kW |
| Saturation generator | 275 kW |
| Winches | 2 x SMATCO double-drum |
| Wire | 4 x 6,000ft x 1-1/4in. |
| Dynamic positioning | White Gill thrusters |
| Anchors | 2 x 17,000lbs; 2 x 15,000lbs |
| Diving system | 4-man, saturation diving system (1000ft), moon-pool deployed |
| Hyperbaric rescue chamber | 4-man |
| Diving station | deep air/gas surface |

the required subsurface cutoff depth (15-25ft in the Gulf of Mexico), and then it executes the cut using high pressure water with entrained abrasive, a finely-ground coal slag.

Cutting efficiency is limited by the hydrostatic head that the jetting tool must overcome. The tool is designed to compensate for pressures down to 1000ft water depth and CMC says it can cut through 3in.-thick material as well as multiple pipe strings.

The tool and resulting cut is controlled from the surface vessel. Once the stub is cut, the tool is removed and the freed stub can be extracted from the seabed and the open hole filled.

Energy Resource Technology GOM, Inc. (ERT), former oil and gas subsidiary of Helix ERG, tested the tool at three fields in the Gulf of Mexico. According to Rod Hebert, ERT consultant, "The [crew] did outstanding work. Using this new cutting tool, they completed four wells for us at about half of the expected cost. Chet Morrison saved ERT and partners many millions of dollars."

Bobby Lott, VP Well Services for CMC, noted that they had recently completed a P&A operation for a McMoran well in the Gulf of Mexico where three strings were cut and pulled: 9 5/8in., 13 3/8in., and 16in.-diameter. The deepest cut was 25ft below the mud line. With that length of cut tubular, he says that it usually requires pulling 40,000-50,000lb more than the pipe weight to extract the tubular.

Lott noted that the tool will not work for every well, especially those with a longer reach or with multiple groutings. But, most subsea wells are completed with mudline hanger systems set 100ft below the mudline, so most casing strings are not grouted together. This makes the cutting task simpler. For caissons that are driven over surface casing (usually 30in.-diameter) to support a single well platform, CMC has added a feature to the tool that can extend the cutting head out from well center to cut 2.5in.-thick x 60in.-diameter caissons.

Most P&A operations can be completed in one day, according to Lott, saving significant time and expense using the *Joanne Morrison*, CMC's diving support vessel. OE

## FURTHER READING

Further reading on decommissioning: ***OE***, August 2013, pg. 26.


**The SHARC cutting head is secured in a frame that attaches to the exposed tubular.**

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Subsea

The Halden facility includes a high-voltage, test laboratory.

# Nexans updates its Halden cable facility

**Nexans has fine tuned its specialized facility at Halden in Norway, after a cable failed to meet the final acceptance test a couple of years ago and had to be remade. Meg Chesshyre visited the plant, which has a full order book and a more than two-year backlog.**

"One of the first topics on which we worked significantly was to simplify the plant organization," explains Vincent Dessale, chief operating officer submarine high voltage, with Nexans. The importance of the qualification process in terms of risk management and assessment of the company's capabilities is such that this is now a standalone department, instead of being inside the manufacturing area below the plant manager organization.

The addition of a fixed cable way, which can take up to four cables, has increased efficiency, and there is a new building for raw material storage. Process engineering has been examined to improve process control and to maximize asset use. There has also been a focus on the supply chain, reinforcing planning management, to better anticipate planning adjustments and optimize slack.

"We are investing on a regular basis," adds Frédéric Michelland, senior executive VP high voltage and underwater cables. "The last three years, we have invested in the submarine business the equivalent of about €40 million a year." It is a constant process and compares with an annual capex for the Nexans organization of €150 million.

"The capital is being directed to strengthen [relieve] some of our bottlenecks into the plant." The doubling of the capacity of the extrusion tower in 2011, with the addition of a second extrusion line, and increasing the height of the tower to 121m (making it Norway's tallest building), involved a capital outlay of around €30 million.

## Market overview

"The submarine, high-voltage market currently stands at about €3 billion and is growing fast," says Michelland. "It is expected to stay a buoyant market at least for the next five years," he adds.

There are three main elements to the market: grid interconnectors, offshore wind, and the oil and gas business. The grid business represents close to 60% of the overall market, the wind segment slightly less than a third, and the oil and gas portion only 10 to 15%. "Today 80% of the market is in Europe. Tomorrow we expect that percentage to remain more or less the same. The good news is that Europe is our backyard." Nexans is well placed with a manufacturing facility in Norway.

## Grid interconnectors

A major €300 million contract underway at Halden is for one of two subsea cables for Terna's new high-voltage, direct-current (HVDC) power


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interconnection between Italy and Montenegro. This is Nexans largest ever subsea cable contract. The HVDC interconnection will be about 415km in length, comprising 393km of subsea cable and 22km of underground cable for the onshore connections. It will be laid to 1200m water depth and will feature two, 500kV, HVDC cables in a bipolar configuration (2 x 500 MW), with one cable supplied by Nexans. Over the last 20 years, Nexans has supplied more than 3000km of HVDC submarine cables manufactured and installed.

Nexans is also carrying out a €200 million turnkey contract to build a 200MW, 101km interconnector between Malta and Sicily with completion expected in 2014. The *C/S Skagerrak* is laying cable in two campaigns, while the Nexans Capjet (an ROV system) will be cable trenching. Dirk Steinbrink, executive VP high voltage and underwater cables, explains that the project's workscope is being expanded to offer comprehensive interconnection solutions. The work for the Malta-Sicily interconnector includes: submarine cable supply from Halden, laying and protection, land cables supply and installation, and power station supply and commissioning in Malta. This work is being done by Alsthom under a sub-contract.

A major interconnector in the planning stage is the Statnett, TenneT and KfW NORD.LINK project, which will run between Tonstad (Norway) and Wilster (Germany), a distance of 514km, plus a 55km underground cable route in Germany. The final investment decision is due next year with the goal of having the 1400MW, twin-cable interconnector operational by 2018.

**Nexans owns and operates three complete Capjet trenching machines with dedicated launch and recovery systems.**

**The *C/S Skagerrak* is Nexans' specialized cable-lay vessel for high-voltage subsea cable, shown at the Halden plant. The vessel has a 7000 tonne turntable and 52 tonnes of laying tension. It was built for the first crossing of the Skagerrak Strait between Norway and Denmark in 1976, and is now working on the fourth crossing.**

## Offshore wind

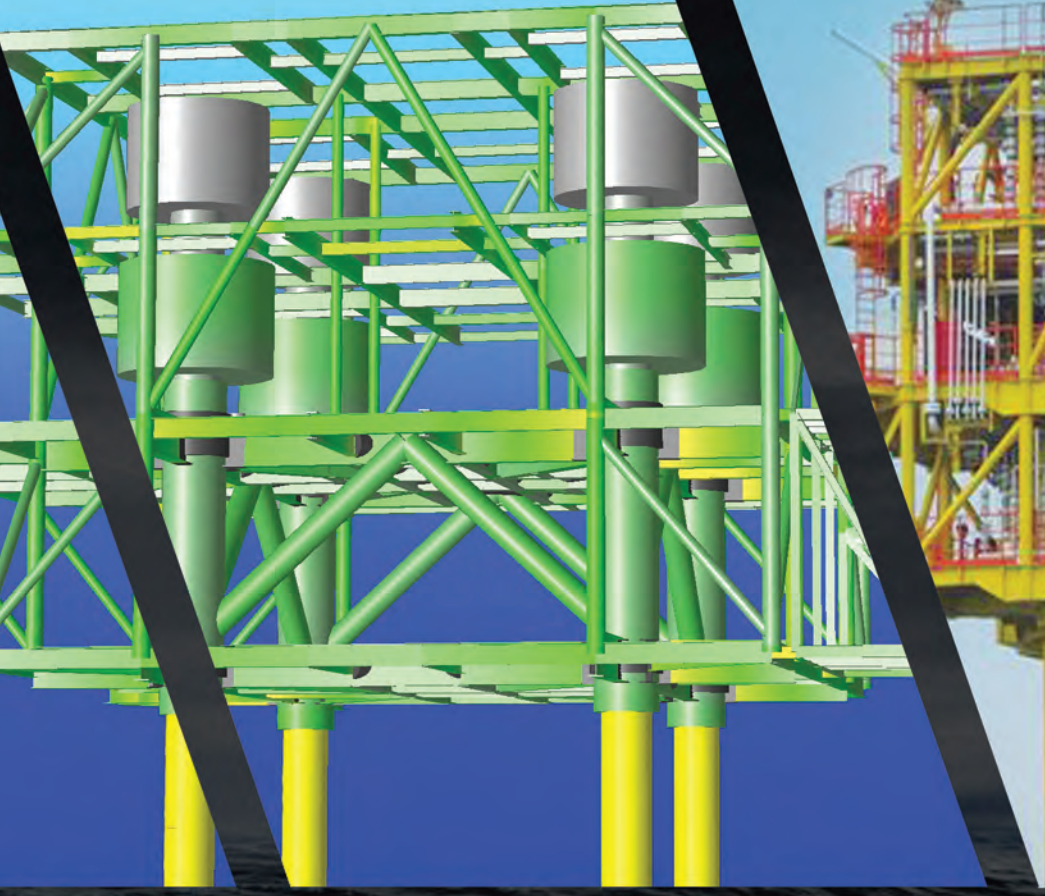
In the renewables sector, Nexans signed an agreement earlier this year for delivery of 53km of medium-voltage, submarine cables for the Westermost Rough wind farm, off the Holderness coast of Yorkshire. A further two kilometers of cable will be delivered for the internal platform cabling. Delivery is scheduled to begin in spring 2014. The wind farm will be constructed and subsequently operated by Westermost Rough, a subsidiary of DONG Energy.

This new agreement is the third call-up from a framework agreement concluded with DONG in August 2011 for the delivery of up to 900km of medium-voltage, submarine cables. Previous call-ups were for the West of Duddon Sands wind farm and the Borkum Riffgrund 1 wind farm.

## Oil and gas

On the umbilicals side, Nexans has made a breakthrough in the Malaysian offshore sector this year with an order from Persada Engineering for an electro-hydraulic umbilical for Sarawak Shell's F29 field development project. The 22km umbilical will be installed in 100 m water depth. Nexans is responsible for the supply and transportation of the umbilical, together with accessories as required, in a fast-track 72-week contract. The F29 umbilical will be manufactured at Halden, the only facility within the group capable of such manufacture.

Nexans has a €45 million contract with Statoil to supply static and dynamic umbilicals for three, fast-track projects on the Norwegian Continental Shelf - Oseberg Delta, Snøhvit (gas), and Smørbukk Sør fields. The Halden plant will manufacture around 42km of static and dynamic umbilicals to Statoil's new, standardized, umbilical design. The umbilicals will provide hydraulic, data, and fiber optic services for subsea equipment at a 100m water depth for Oseberg, 345m for Snøhvit, and



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300m for Smørbukk. Manufacturing is expected to start at Halden next year, with delivery anticipated during 2015.

Nexans also won a €16 million contract with Statoil last year to engineer and supply a 16.5 km subsea power umbilical that will be used to connect the Gullfaks C platform to the new compression facility. Additionally, Nexans has a 10-year global frame agreement in place with BP to supply umbilicals, direct heating systems, accessories and services for various oil and gas projects worldwide. The agreement runs from 2012 to 2022.

**The Halden plant includes a 121m-high extrusion tower.**

A niche offshore market for Nexans is direct electrical heating (DEH). Alternating current transmitted from the DEH cable runs through the steel in the pipe, which heats due to its own electrical resistance. By controlling the current, the pipeline's inner wall can at all times be maintained above the critical temperature for wax and hydrate formation. Over the past 15-20 years, Nexans has supplied 19 out of the 20 pipelines operating with DEH systems.

A new €25 million offshore order for Halden has come from Subsea 7 for the design and manufacture of a DEH system for the subsea pipelines serving Chevron's Lianzi oil field development, located in a unitized offshore zone between Congo and Angola, off western Africa. The Lianzi fields tie back to the Benguela Belize Lobito Tomboco (BBLT) platform in Angola Block 14. With a water depth between 390-1,070m, this will be the world's deepest DEH system. The cables are due for delivery during the summer of 2014.

The contract with Subsea 7 covers the delivery of a complete DEH system, including DEH riser cable, armored feeder cable, a 43km-long piggyback cable, and all associated accessories for connection to the pipeline that will join the Lianzi development project subsea facilities with the BBLT platform. OE

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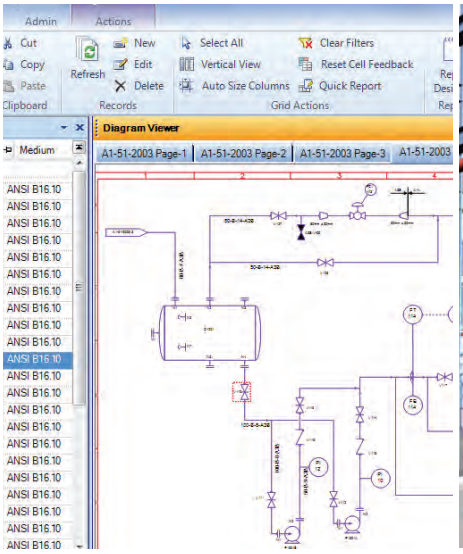


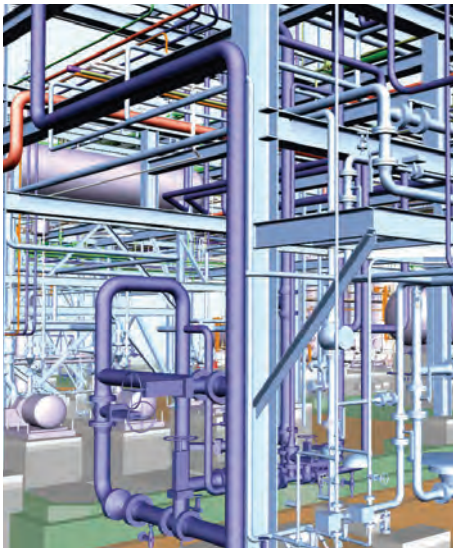

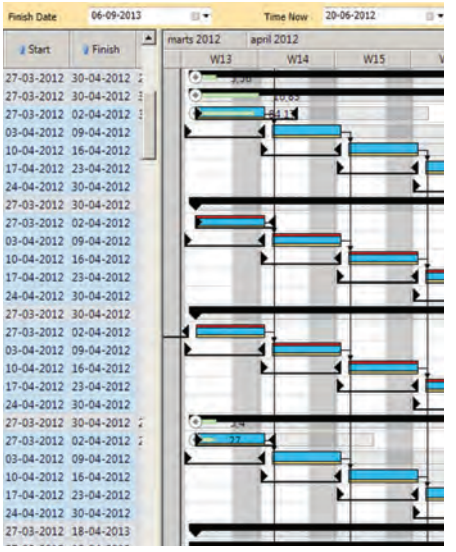


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# Subsea UK calls for national program

Neil Gordon, energy minister Michael Fallon, and Sir Robert Smith, MP for West Aberdeenshire and Kincardine.

By Meg Chesshyre

Subsea UK is calling on the UK government to back plans for a national program that will support and fund subsea research, and a UK-wide skills program that will help the sector find the 10,000 people it needs to capitalize on current and future demand, nationally and internationally. Subsea UK was formed by the UK government and industry in 2004 as a focal point for stakeholders to promote and develop the sector at home and abroad, maximizing its international and diversification opportunities. Subsea UK now represents a major part of the subsea industry with over 250 members throughout the UK.

Subsea UK CEO, Neil Gordon, said at a parliamentary reception in London this summer "Extracting the UK's remaining reserves is now heavily dependent on subsea innovation and skills. Already, almost 45% of UKCS production comes from subsea wells and new developments will take this up to 70%. Getting the remaining oil out of the ground, in the North Sea and in other deeper water provinces around the world, will largely rely on the next wave of subsea innovation. But, we are not investing in R&D to the same extent as competing countries in Brazil, the US, and Norway."

Brazil's oil and gas R&D fund, managed by ANP, is projected to raise almost £6billion by 2020. Norway's Demo 2000 program has attracted around £7million/yr and in the US, the DeepStar joint industry technology development project receives annual funding of £2.4million. In comparison, there has been zero investment from UK industry and government in any similar programs in the last 15 years. The UK's current success in subsea is due to industry and government investment in the early years of the North Sea when it was a test-bed for subsea equipment and processes.

Gordon added: "Our blueprint reveals that for our industry to continue to create jobs, generate wealth and export revenues, we need significant funding for R&D, a national skills program that will create a sustainable pipeline of new talent into the sector, an effective government-led and funded technology development program and a stable fiscal regime that encourages investment in game-changing technology."

"A national subsea R&D program would help extend the life of ageing North Sea assets, ensuring maximum recovery of remaining reserves in a commercially viable way, it would underpin the long-term future of a major UK manufacturing and service industry and have a positive impact on the emerging marine renewables sector," he added.

Subsea UK has just launched a UK-wide initiative to attract people into the subsea sector, but believes that more needs to be done to raise the profile of the industry and ensure that subsea companies have access to a pool of engineers, technicians, and project managers now and in the future. The challenges in finding suitably qualified people, particularly in engineering disciplines, have come about as a result of the decline in the number of school children taking up math and science subjects, the ageing workforce in the oil and gas industry, the industry's perceived negative reputation, and increasing global competition.

Gordon said: "We are already working with schools and universities, as well as rolling out conversion training programs for engineers coming into subsea and for former military personnel but we need a much more concerted effort between the industry, education and government to make sure we have a sustainable pipeline of talent."

Subsea UK estimates that the UK's subsea industry is now worth £8.9 billion, about 45% of the £20 billion global market. A new survey of more than 750 companies throughout the entire supply chain shows that 16,000

## Government supported research and development projects

### Brazil

**The R & D agreement clause - Brazilian National Agency of Petroleum (ANP), www.anp.gov.br (Portuguese only)**

- Companies pay 1% of their gross oil & gas production revenue to the government to create an R&D fund for invested in R&D schemes within Brazil.
- As part of the R&D scheme, ANP stipulates that at least 50% of the fund must be used within universities or research institutions approved by ANP.
- In 2012, the R&D fund is expected to accumulate R$1.21 billion (£362 million).
- The fund is projected to raise almost R$20 billion (Almost £6 billion) by 2020.

### Norway

**Demo2000 - Ministry of Petroleum and Energy (MPE) www.demo2000.no**

- It has funded 219 projects since 1999, with a Norwegian focus. With 20 member companies, it averaged NOK84.2 million ($14.6 million) in investment from 2006-2008.
- It is driven by a national technical strategy: Oil and Gas in the 21st Century (OG21).

### USA

**DeepStar - http://www.deepstar.org**

- 132 projects since 2002, with focus on subsea systems.
- Received an average annual funding award of £2.4 million (US$3.7 million).
- Gulf of Mexico key market area.
- 11 member companies.

**RPSEA (Research Program for the Security of Energy for America) – US Dept of Energy – www.rpsea.org**

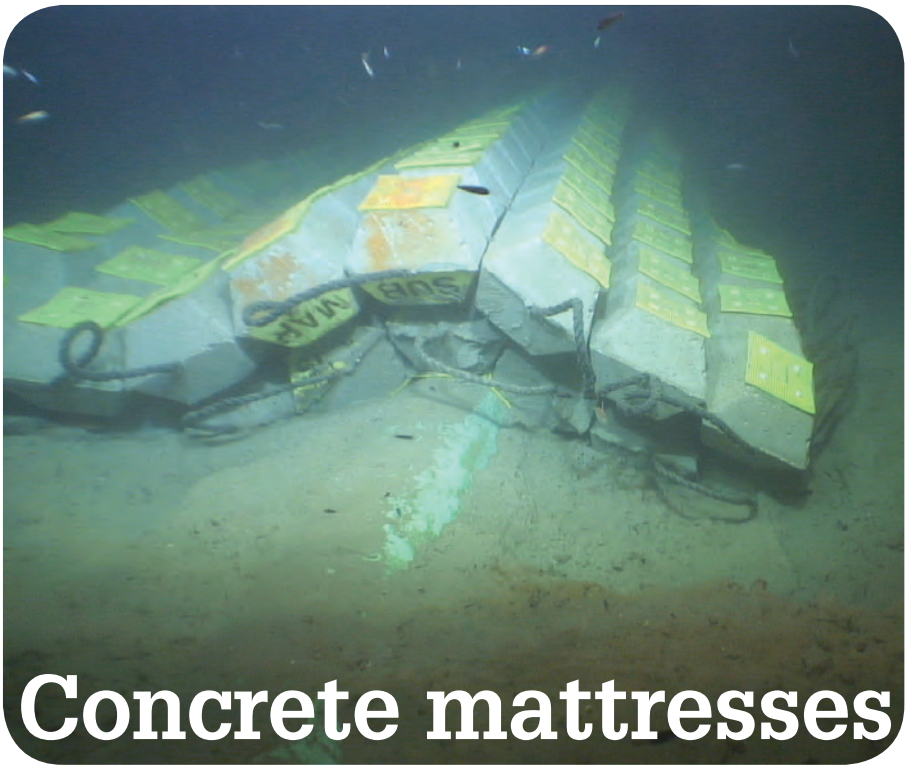
- Established in 2005, the program ends September 2014. From 2007-2010 it funded 109 projects with annual funding of US23.5million/yr (£14.7 million). It is funded at US$30million/yr to the end of the program. RPSEA as 165 members strategically focused on:
  - Ultra Deep Water Program (UDW),
  - Unconventional Resources Program (UCR), and
  - Small Producer Program (SP).

**NETL (The National Energy Technology Laboratory) – www.netl.doe.gov/index.html**

- Established in 1999, NETL has completed more than 1800 projects with total funding of US$9 billion ($5 billion from private sector). It has 11 site support contracts with several areas of strategic focus including:
  - Oil and natural gas supply,
  - Coal and power systems,
  - Industrial capture & storage,
  - Carbon sequestration,
  - Hydrogen and clean fuels, and
  - Technology transfer.

new jobs have been created in the sector since 2010, bringing the total number of jobs supported by the industry to 66,000. This figure takes account of the 53,000 directly employed in the subsea industry as well as the 13,000 in jobs which indirectly support the sector.

Of the direct subsea workforce, 48% work in services which include engineering, construction and diving. Manufacturing accounts for 19% of the 53,000 jobs. Almost half the respondents are anticipating growth in excess of 20% in the next three years, with 28% predicting to grow by 10-20%, only 1% predicting less than 10% growth, and a further 28% forecasting no growth. If these forecasts are achieved, the sector could grow to £11.1 billion by 2016. The increase in activity in the North Sea has played a major factor in this continued growth but exports remain high, accounting for 43% of total revenues. OE



**Articulated concrete mat protecting subsea pipeline.** Photo: Submar.

# Concrete mattresses offer more than just pipeline protection

By Sarah Parker Musarra

There are many methods used to protect offshore pipelines: sand, grout or cement bags, burying, concrete or cathode coating, and trenching, to name a few. Most methods address ancillary issues like separation, support, erosion, expansion of infrastructure, pipeline corrosion, and ensuring that the pipeline infrastructure itself is not detrimental to the environment surrounding it.

Only one form of pipeline protection technology however, found itself in the midst of a battle between the seafood industry of southeastern Louisiana, the oil and gas industry, and environmental agencies: concrete mattresses, also commonly referred to as concrete mats.

While the mats were effective at protecting and stabilizing pipelines in the navigable waters off southeastern Louisiana, some fishermen were reporting that the mats were ensnaring the shrimp trawlers' nets, greatly reducing their harvest.

"It took a long time and a lot of resources to convince everyone that mats were a better solution than leaving pipelines exposed," said Monique Roberts, offshore division manager of Submar, a company that has produced approximately 80,000 mats for the Gulf of Mexico over the last 20 years. "The situation was affecting two of Louisiana's top industries [oil and gas; seafood]."

Following four years of intense battles, lobbying and at least two case studies, the Louisiana Department of Wildlife and Fisheries enacted General Permit 24 (GP24), in 2010, and concrete mattresses continued their industry reputation as one of the most reliable and cost-effective ways to protect existing or expanding pipeline infrastructure.

## History

According to the 'Concrete Mat Subsea Deployment Procedures' published by the International Marine Contractors Association (IMCA) in September 2011, mattresses first emerged as a method of subsea pipeline support and stabilization during the 1970s. Rather than concrete, they were made of canvas bags filled with bituminous material and aggregates. This was not a formidable solution, as they would often split when submerged or would fail to take the pipeline shape due to their stiffness.

European companies were the first to widely develop the technology for concrete mats after environmental regulatory agencies began cracking down on the use of sand or cement bags that were then-prevalent in stabilization, capping, and abandonment.

Mats produced in the early 1980s marked the first usage of concrete to increase flexibility and versatility. Initially made from concrete cured in pre-made plastic pots that were interconnected with rope, this iteration was known as the link-lok mattress. Bituminous materials were prohibited by environmental regulatory agencies in the 1990s. Both the manufacturing technique and materials used needed further refinement to become the cost-effective, environmentally friendly solution that the concrete mattress presents today.

Today, polypropylene rope is laid into a form, with concrete poured over it–no more plastic pots. The result? The wet-cast, 8-ft by 20-ft by 9-in-thickarticulated concrete block mat that the pipeline industry knows today, with 4000psi compressive strength. Concrete density can range 1800-4800 kg/cu m, depending on the amount of applied weight needed. To protect the pipeline, the concrete is usually coated with a non-abrasive substance or pad that varies by manufacturer and product.

In the early 1990s, European companies began to license the technology behind their mats. Submar, headquartered in Houma, La., was one of the original companies to receive this licensing in 1990 and they were the first to bring the mats to the Gulf of Mexico.

The only major change made to today's industry-standard size is that, at times, a 12-in. mat rather than the industry-standard 9-in. thickness can

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be approved for permit on a project-by-project basis by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). Water depth, install cost and diver efficiency are typically some of the major factors in determining if a 9-in. or 12-in. mat would be the most effective.

Concrete mats can also be tagged with information such as pipeline number, mat number, contact details, and location, so that in the event a mat is moved, the finder is alerted to return the mat to its proper owner or location as quickly as possible, so that the pipeline affected can be checked and tested if needed.

Premier Concrete regional engineer Patrick Bonorden explained that these concrete mats offer a low-cost, permanent solution to several of the issues greatest affecting the industry: permanent pipeline protection and environmental stability.

"The predominant technology is the mats; they're generally used across the board," he said.

### Alternate protection

Depending on the project or pipeline, the protection these mats provide pipelines are among the industry's best. The technology can be employed for a host of situations, including rig pads, capping, abandonment and separation.

Concrete or sand bags – also referred to as sling bags - are the closest offshore competitor to the concrete mat. Bonorden described the standard sling bag as a burlap bag that contains a 3:1 mixture of concrete and cement that hardens under water. Multiple bags are typically arranged in pallet-sized form for deployment.

While the usage of sand or concrete bags somewhat overlap with that of concrete mats – they, too, count abandonment, trenching, capping and spanning among their uses – some projects present obstacles that exclude sling bags as a viable option. David Flannery, in business development – Americas at Deepwater Corrosion Services, explains that while sand bags are very cost-effective, depending on the project or pipeline placement, it is the deployment that can sometimes present issues. There can be more guesswork involved in their placement over the pipeline than with concrete mats, leaving more room for error.

"With sand bags, it's kind of an art form; with mats, it's more obvious how they're applied," he continued. "They're very stable, both dimensionally and against the environment."

Then, should the need for removal arise, as in the case of a pipeline inspection, sling bags must be removed – and replaced – one by one. The bags are not always permanent solutions, either, as they are not as stable as mats and run the risk of not maintaining their shape.

In direct contrast, concrete mats are recognized throughout the industry as stable, versatile, and easy to apply. After risk assessments have been performed and any necessary type of permits obtained, in most cases, the mats are transported to the pipeline, where teams of divers and/or remotely operated vehicles (ROVs) are ready to assist. The crane operator negotiates the mats into final position with guidance from the diver or ROV supervisor. Once settled, quick-release frames are commonly implemented to allow the divers to detach the load from the crane.

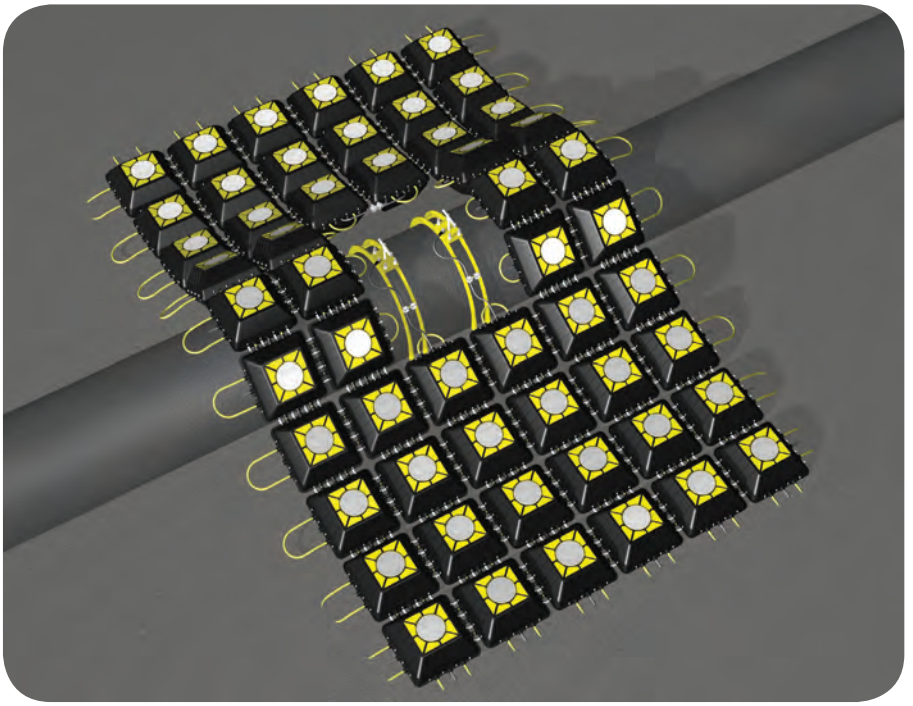
"You use the mat because it's one piece, and it's articulated to do what it needs to do," Premier's Bonorden said.

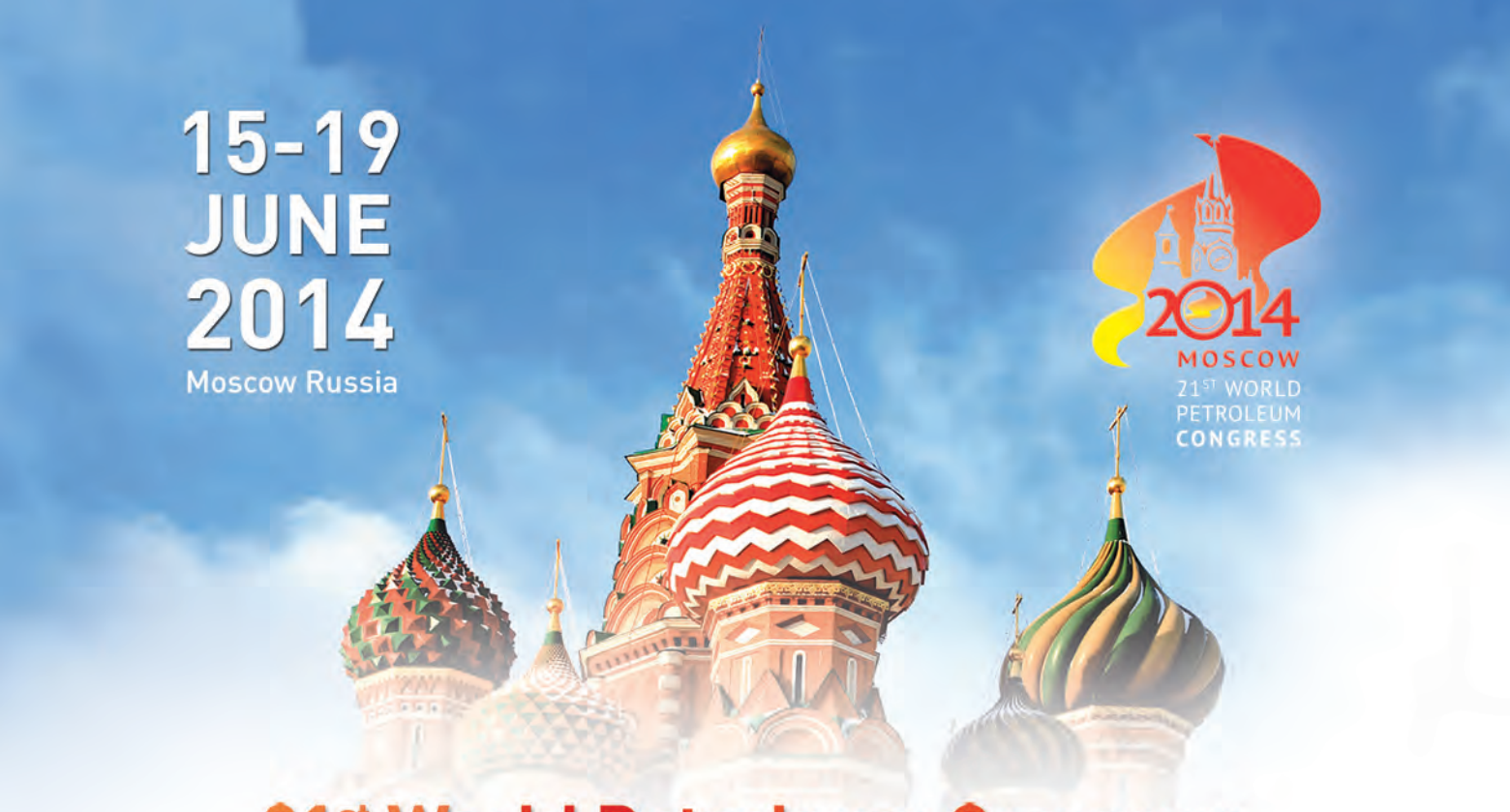
Perhaps the most famous example of how critical concrete mats can be to the industry was immediately following the Deepwater Horizon oil spill in 2010. BP used ROVs to build a subsea staging area with Submar's mats. Roberts explained that BP needed to be able to immediately deploy equipment to assess and address the situation. This concrete mat platform was a holding ground for the underwater tools and equipment necessary for quick access and dispatch to different areas. More than 4,800 sq ft of concrete mats were deployed to the area, creating a large, stable platform. This allowed the ROVs to survey the area, access tools and equipment, and respond– without being affected by the dips, dives, and obstructions of the uneven ocean floor. It was a watershed moment in demonstrating the usefulness of concrete mats. Sling bags would have been incapable of smoothing the bottom of the ocean floor.

"We're directly affected and have a vested interest: It's a way we could help," Roberts was quoted as saying to Houmatoday.com following this project with BP. "Our projects are meant to be more of a long-term solution. We don't want to have to deal with this again."

This use of concrete mats is perhaps the biggest example as to how this technology can be creatively utilized

**Deepwater mat with hole allowing for clamp.** Image: Deepwater Corrosion Services.



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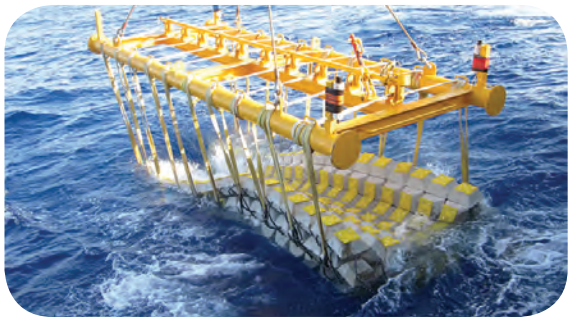
to serve a particular need, but many companies are working to innovate the concrete mat even further.

Flannery explained how, in order to provide cathodic protection (CP) to pipelines in unstable conditions, Deepwater Corrosion's offshore concrete mat design includes casting small, interconnected aluminum anodes directly into the concrete.

A recently completed project off the coast of California required a tailor-made solution for an older pipeline needing protection for another 20-30 years. In California, a permanent CP monitoring system replaced the usual anodes in the concrete to protect and extend the life of the pipeline. The CP monitoring system was connected to the pipeline by a clamp, and in order to protect the clamp from trawling, a four-six block hole was created in the mat. While this particular project was completed in more shallow water – around 300 ft deep – Flannery contends that because concrete mats can be used in nearly any water depth, this technology could be employed much further offshore.

There are a few instances in which products are still in danger of moving under concrete mats, primarily in water less than 300 ft deep or where pipelines are located at the mouth of a river. Of course, without any protection at all, the unthinkable could happen: pipelines could jump or break. Furthermore, the environment around the pipeline could be harmed indefinitely from exposure. Clearly, pipeline protection is critical to a pipeline's long-term integrity and success.



**Twenty-ft single-release, ROV-friendly frame with concrete mat load.** Photo: Submar.

## Deep water

Industry leaders are finding that water depth does not negatively impact the concrete mats, so they regularly stretch the depths into which the mats are installed.

More concrete mats have been used "around 5,000 ft," Bonorden said "That's now starting to get to 7,000 and even down to 10,000 ft. They can also be used all the way up to the shoreline."

Both Premier and Submar have current mat installation projects at 7,000 ft in the Gulf of Mexico. Submar will be shipping mats this month to the Keathley Canyon, about 250nm southwest of New Orleans.

## Environmental impact

In addition to being used for pipeline separation and pipeline crossing, another notable advantage to using concrete mats – and one that extends beyond the industry—is the product's inherent environmental friendliness. Concrete was cited as environmentally sound by the IMCA, and the mats are used to combat erosion beneath and surrounding pipelines. In cases where the soil under the pipeline is eroding, the mat can be used to span that area, thereby halting erosion underneath. It is generally regarded as the technology that is the least obtrusive to operations and, equally importantly, the environment and vegetation below and around the mat.

In New Orleans, the banks of the Mississippi River have been lined with a form of concrete mats since at least the 1930s for flood control. Premier's Bonorden pointed to last year's report that the New Orleans branch of the U.S. Corp of Engineers were once again lining the river with concrete mats to maintain stabilization and to keep the river from diverting, estimating that the group had been doing so since around the 1970s.

"Although there are no pipelines involved, it is still erosion control," Bonorden said. "Once they realized they could do it in inter coastal waterways, it was used up and down the coast for the same purpose."

"In all reality, you're not just protecting the pipeline," Submar's Roberts said. "You are also protecting nature from the pipeline." OE

# Field system design needs crude knowledge

**Heavy oil characterization identifies flow assurance risks that drive system designs**

By Colin Smith, production chemistry consultant, Maxoil Solutions

The necessity for accurate characterization of heavy oil separation properties and emulsion formation tendency is critical for any design team, as it has a major impact on the field development concept selection.

This includes, for example, the fluid lifting mechanism for production wells, on the system detailed design and, finally, on the selection of fit-for-purpose operational solutions, especially for offshore new field developments.

Heavy and extra heavy oil are crude oils which are so viscous that they will not flow easily. In this article, heavy oil is referred to as oil with an API gravity of less than 23°, noting that classification schemes exist that organize such oils into medium heavy, heavy, extra heavy and bitumen oils, based on density and dynamic viscosity.

As oil and gas resources in current basins of the world continue to decline, heavy oil provides a significant solution to the world's thirst for energy.

There are enormous reserves of heavy oil, potentially up to 1Gbbl (1x10^9) bbl, depending on the recovery factor. However, with current technologies the recovery rate is currently low and so far less than 1% has been produced or is under development.

If the recovery rate could be increased to 50% of the available deposits, 50% of North American demand would be met for more than 50 years, according to Francois Cupcic, heavy oil research leader at Total.

There are numerous flow assurance challenges associated with the production and processing of heavy and extra heavy oils in both onshore and offshore environments that directly impact the ability of any process system design to successfully handle such fluids.

Many of these challenges are centered on the production separation system and are generally addressed in the early stage of the field development. These challenges include:

Artificial lift options (gas lift, electrical submersible pumps, hydraulic submersible pumps, etc.)

Space and weight restrictions on platforms and floating production systems that govern separation vessel sizes and residence times:

- Accuracy of the fluid characterization data
- Heating and power requirements
- Separation vessels' Internal design
- Process vessels' configuration
- Oil, water, emulsion, foam, microbiology, and solids handling
- Optimal treatment chemicals application.

A critical aspect of the heavy oil production separation system design is the accuracy of the fluid characterization data upon which the design is based.

During the appraisal phase of a new heavy oil field development, when appraisal well tests occur and fluid samples are being collected for other issues such as PVT (pressure, volume, and temperature) studies, it is paramount that good, quality, representative samples of oil, and indeed formation water, are collected.

This is so some samples can be allocated for the accurate determination of fluid physical properties and production chemistry characteristics, as this is crucial information for the

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basis of design of any production and separation system. The degree of drilling mud contamination, especially if it is oil-based mud, is very important to know.

Both live downhole and stabilized oil samples need to be collected and analyzed. The dynamic viscosity of the oil and its water-in-oil emulsion is one of the more important parameters required. It defines the factor between dry oil and emulsion viscosity for a system and is a key flow assurance parameter input for any system design.

It crucial that representative fluid samples are collected, and that the laboratory test methods selected to define the rheological properties and to characterize the production chemistry issues are fit for purpose for each system.

An example of this would be the measurement of fluid dynamic viscosity, where the test shear conditions must directly relate to the passage of live fluids through the points of significant shearing, i.e. shearing due to passage through electric submersible pumps, hydraulic submersible pumps, gas lift, and wellhead choke valves.

Calculation of representative flow regime and shear conditions for an emulsion creation in the laboratory is recommended. Otherwise, the measured properties used for design purposes will be misleading, resulting in unnecessary production equipment redesign and upgrades at a later date.

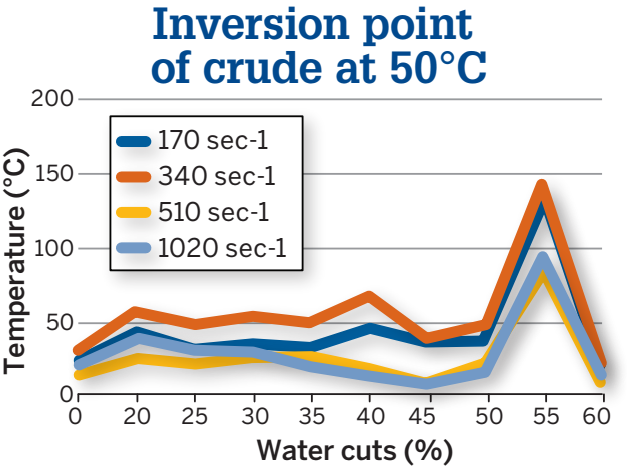



**Figure1. An example of emulsion inversion point, emulsion viscosity (cP) versus water cut at 50°C.**

Following laboratory measurement of rheological properties, it is then possible to model live fluid viscosities using PVT software and viscosity correlations, including algorithms, to calculate relative viscosity and the ratio of emulsion viscosity to stabilized crude oil viscosity.

Heavy and extra heavy oils can exhibit unusual rheological properties and variable flow assurance characteristics during production and processing, which must be properly defined. These include, but are not limited to, the following, all of which must be considered in any new facility design:

- Variable, multiphase flow and

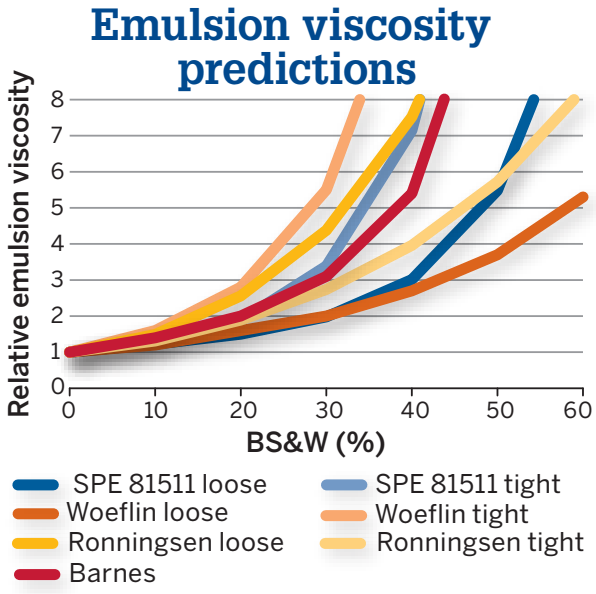



**Figure 2. Prediction of emulsion viscosity.**

slugging characteristics in surface and subsea pipelines (need to be modelled)

- High, dynamic, oil viscosities causing lifting issues in production wells, which influences lifting-mechanism selection, especially in remote, offshore locations with subsea wells
- Subsea systems with long, tieback flowlines, because of problems with high viscosity fluids that require relatively high restart pressures, following lengthy unplanned shutdowns
- Variable tendencies of oil types to form stable emulsions, including differing amounts of emulsifying agents
- High emulsion viscosities, especially up to a critical maximum prior to the emulsion inversion point, Fig.1.
- Onerously slow oil-water separation rates linked to typically low oil-water density contrasts and high, continuous, oil-phase viscosities, unless the fluids are heated to 120°C or more to lower the fluid viscosities
- Swelling of the continuous oil phase by flashed gas, causing gas undercarry downstream
- Stable foam formation in separators and slug catchers that causes liquid carryover to the gas treatment system
- Heavy oils with associated formation-derived sand and fines solids production can further stabilize emulsions and drop out subsea and in topsides vessels to plug and erode internals and to reduce vessel residence times.
- Varying propensity to form precipitated solids from the production fluids during production and depressurization while flowing to the surface, which can generate various unwanted solids that form flow restrictions and even plug lines.

## Case studies

### Offshore Western Australia

The facility involved offshore production of heavy oils of between 17°API and 20°API gravity to a floating production, storage and offloading vessel with common production facilities in

an environmentally sensitive area. This facility required good performance of the primary separation vessels as being vital in ensuring standards were met for produced water discharge quality in addition to export oil quality.

A series of studies were carried out to review the post-FEED (front end engineering and design) proposed designs of production vessels (separators and an electrostatic coalescer) in the system, covering all aspects of vessel designs that would affect separation performance, and later a review study took place after operation of the system to help optimize performance further.

Discoveries were made at the design stage and later after operation of the field on-site with recommendations implemented by the operator that led to an optimized separation system design including:

- Key emulsion stabilisers in the production fluids were found to be carboxylate soaps, so demulsifiers could be reformulated to directly handle such components and improve separation vessel performance leading to in specification separated water and export oil.
- Separator vessel internals (including inlet pipes, inlet device tubes, vane packs, and gas outlet demisting devices) were critiqued and redesigned to improve performance.
- An optimal emulsion treating temperature range of 55-60°C was identified and set in the design.
- Hot water recycling to the first-stage separator inlet from the second-stage separator and coalescer was incorporated in the design to aid separation performance and help keep the fluid from being too near its emulsion-inversion-point zone of peak emulsion viscosity, which can hinder good separation performance.
- A revised subsea and topsides chemical application strategy was implemented.
- Later trials of a subsea-injected demulsifier indicated that it could decrease the fluid viscosity significantly, while achieving some moderate increases in oil flow rate and reduction in flowline pressures. The effect was very dose-rate sensitive and care must be taken to not add too much chemical, due to the risk of water dropping out too rapidly, which would result in water accumulation promoting slug formation and subsequent pressure fluctuations in the flow lines.
- New operational practices were put in place to handle fluids from newly drilled flowback to host production wells, including optimized use of the slops tank.

## UK North Sea

A new oilfield development in the UK North Sea comprised of a 14°API gravity heavy oil produced from subsea wells to a FPSO required a full review of the critical fluid-sampling and production-chemistry characterisation data, to ensure that potential issues were identified and incorporated into the production facilities design and development planning process, so as to generate a fit for purpose design. One area of focus

was on forward emulsions rheological properties.

A variety of laboratory-based production fluid rheology studies with stabilized crude oil were undertaken on dry oil and its forward emulsions. It was found that the measured dry oil and forward emulsion viscosity was very sensitive to the mixing method used (including the type of blender or stirrer used, plus shearing duration) as indeed was the measured emulsion inversion point and the emulsion stability of the samples.

It was also necessary to control the shear rate for viscosity measurement to closely mimic the conditions on fluid passage through production equipment, like submersible pumps and wellhead choke valves, to get representative data for design purposes.

In this case and for analog fields, it was found that the emulsion viscosity multiplier (to dry oil) was between 3 and 5, though if too excessive shearing was employed, unrepresentative results of >6 could be achieved and, if too gentle mixing was employed, the multiplier would be below 2, and again unrepresentative.

This was the most representative result for this particular oil (and close analogs) that was used for design purposes. For other heavy-oil fields, it is recommended that such detailed test work be repeated for each case, or the design premise will be incorrect.

Laboratory experimental data was then compared to theoretical relative emulsion viscosity data versus water cut using various published algorithms to determine the validity of the data, noting that the algorithms do tend to give a spread of predicted emulsion viscosities. Correct interpretation of the data comparison gives confidence in the data used for design purposes, Figure 2.

In this particular heavy oil case, the generated fluid rheological data was used in making a number of decisions including the following:

- Help decide upon the lifting-mechanism concept for the subsea wells.
- Determine the risk of flow assurance issues, like the restart pressures required of subsea wells with cold fluids.
- Help decide upon the use of recycled, produced water to aid surface production separation characteristics.
- Decide on the requirement for downhole chemical injection, e.g. demulsifier, wrt protection of submersible pumps, and maintenance of production rates.
- Decide upon the number of subsea chemical umbilicals required. OE

***Colin Smith*** *is a process chemistry consultant at Maxoil Solutions with 25 years experience in the oil industry. He initially worked in the wax, hydrates, and asphaltene laboratories of the BP Research Centre, Sunbury, followed by global on-site troubleshooting work at various oilfield consultancies. Smith earned a graduate chemistry degree from University College Dublin.*

# Pipelines off Myanmar carry Shwe gas, imported oil

By Nina Rach

The Myanmar-China natural gas pipeline is now delivering hydrocarbons produced from the Bay of Bengal, offshore Myanmar, to China. The soon-to-be complete, parallel oil pipeline will transport Middle East and African oil. The pipeline projects have five investors from four countries: China, Myanmar, South Korea, and India.

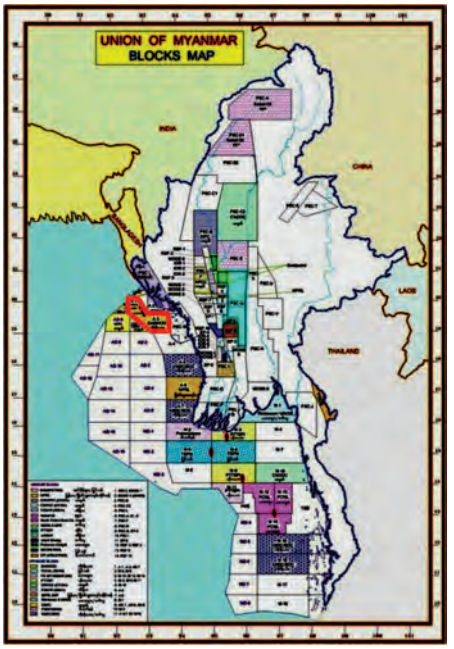
The Shwe project is about 43.5mi (70km) off Myanmar's Rakhine-Arakan coast and is operated by a consortium led by South Korea's Daewoo International Corp. Daewoo said that it will invest US$3.2billion in developing the Myanmar gas fields, and has a 30-year contract with China National Petroleum Corp. (CNPC) to provide up to 500 Mcf/d. The gas pipeline will help meet rapidly expanding demand in southern China and the oil pipeline will reduce dependence on oil imports through the Strait of Malacca.

Daewoo has a majority stake of 51% in the consortium with the remaining shares are held by Korea Gas Corp. (KOGAS; 8.5%), India's GAIL (8.5%), Myanmar Oil & Gas Enterprise (MOGE; 15%), and India's Oil and Natural Gas Corp. (ONGC; 17%).

## Gas pipeline

In February 2010, Daewoo finalized a US$1.4 billion EPCIC contract with Hyundai Heavy Industries to build the Shwe platform, subsea production system, subsea pipelines, onshore gas terminal, jetty, and supply base. French company Doris Engineering designed the systems and HHU carried out fabrication and installation.

The offshore gas pipeline is 32-in. diameter and about 110km long, connecting to a 5.7km-long, 32-in.-diameter segment that leads to the onshore gas terminal at Kyauk Phyu, at the northern end of Ramree Island. From the terminal, the gas flows through a 40-in.-diameter onshore gas pipeline that stretches 793km east across Myanmar to Ruili, just across the Chinese border, and 1727km further into China, ending at Naning. The project has an annual throughput capacity of 12 billion cu. m.




**Myanmar license blocks; Shwe area shown in red outline.** Map: MOGE, February 2013.

In June 2010, MOGE and CNPC created the joint-venture Southeast Asia Gas Pipeline Co. (SEAGP) to direct the gas pipeline project.

After three years of construction, the Myanmar-China natural gas pipeline began flowing on 29 July 2013, carrying gas from the Shwe field complex in the Rakhine Offshore Area, Bay of Bengal, to Yunnan province, southwest China. The natural gas is being produced from the Shwe and Shwe Phyu fields in Block A-1 and Mya field in Block A-3.

In February 2013, MOGE estimated the gas pipeline cost at US$2.15 billion.

## Gas facilities

The Shwe project includes a production and processing platform with 11 wells and the Mya-North subsea wellhead/manifold with 4 wells.

Dockwise Ltd. installed the 22,000-ton jacket in March 2012, in about 110m water depth.

The 30,000-ton topsides for the Shwe production platform were built at the HHI fabrication yard in Ulsan, Korea. Dockwise used the same barge to install the topsides in a floatover on 8 Dec 2012.

The new platform accommodates 200 people, along with drilling and production equipment.

## Oil pipeline

The 32-in.-diameter crude oil pipeline is still under construction, and will be 2402km long, traversing 771km in Myanmar and a further 1631km in China. CNPC and MOGE created the Southeast Asia Oil Pipeline Co. (SEAOP) to develop the oil pipeline project.

CNPC began building the wharf for the crude oil pipeline on Ma Day Island, Myanmar, in October 2009. The commencement of the wharf construction was the formal start of the oil pipeline, which will be able to carry up to 12 million tons/yr of crude oil into China. Nearly 80% of China's oil is currently shipped through the Malacca Strait, and this new pipeline will bypass that sea route.

In February 2013, MOGE estimated the cost of the crude oil pipeline at US$2.45 billion. OE

## Shwe development chronology

| | |
|---|---|
| **August 2001** | South Korea's Daewoo International Corp. signs production-sharing contract with Myanmar Oil & Gas Enterprise (MOGE) to explore, produce, and sell offshore natural gas. |
| **January 2004** | Daewoo-led Myanmar A group spuds Shwe-1 well in offshore Block A-1. |
| **February 2004** | Daewoo acquires adjacent offshore Block A-3. |
| **September 2006** | Daewoo completes 12-well drilling program on Block A-1; hires UK-based Gaffney Cline & Associates to certify reserves (4.8 tcf most likely, 8.6 tcf max. recoverable). Continues to drill exploratory wells at A-3. |
| **October 2006** | Myanmar junta agrees on preliminary deal with China National Petroleum Corp. (CNPC) for trans-border crude oil pipeline. |
| **January 2007** | Myanmar reaches agreement with India and Bangladesh for Shwe natural gas pipeline, then delays until offshore reserves in Block A-3 are certified. |
| **June 2008** | CNPC signs MoU with Shwe consortium to purchase and transport natural gas from Blocks A-1 and A-3. |
| **March 2009** | Myanmar and CNPC sign formal agreement on crude oil pipeline construction. |
| **3 April 2009** | Daewoo buys out consortium partners in licenses for offshore Block AD-7 along Myanmar-Bangladesh maritime border, adjacent to A-1. |
| **June 2009** | Myanmar and CNPC sign an additional MoU over joint development, operation, and management of crude oil pipeline. |
| **31 October 2009** | Oil pipeline inauguration; CNPC begins building wharf for oil import terminal at Ma Day Island, east of Ramree Island, Kyauk Phyu township, Arakan state, Myanmar. |
| **November 2009** | Daewoo sets US$1.4 billion, turnkey EPCIC contract with Hyundai Heavy Industries to build Shwe offshore natural gas platform, subsea production system, subsea pipelines, onshore gas terminal, a jetty and a supply base. |
| **February 2010** | Daewoo finalizes contract with HHI. |
| **3 June 2010** | CNPC announced two joint-venture companies created—Southeast Asia Gas Pipeline Co. Ltd. (SEAGP) and Southeast Asia Crude Oil Pipeline Ltd. (SEAOP)—and began pipeline construction. |
| **Mid-2010** | Onshore gas pipeline route preparation begins (June – Myanmar; Sept – Yunnan Province, China). |
| **August 2011** | First pipes welded. |
| **2012** | Daewoo drills four wells at Mya North natural gas field. |
| **March 2012** | Dockwise Engineering Services installed the 22,000-ton Shwe jacket in 110m water depth, using the world's second-largest installation launch barge, the HYSY229. |
| **15 November 2012** | Shwe topsides leave HHI dock, South Korea – largest offshore facility made by HHI. |
| **8 December 2012** | Dockwise installs 30,000-ton Shwe production platform topsides, in floatover, using HYSY229 barge, setting a new company record. |
| **30 May 2013** | Shwe natural gas pipeline tested. |
| **28 July 2013** | Gas pipeline commissioned at Namkham metering station; first gas shipped. |
| **Yearend 2014** | Daewoo estimates it will finish drilling production wells at Shwe complex. |

# The *Gryphon Alpha* rises

**Twenty years after it came online, the UK's longest serving permanently-moored FPSO has been given a new lease on life. Elaine Maslin reports on the extent the UK's largest offshore project in 2012.**

When production from the central North Sea Gryphon field came online in October 1993, it was seen as a success.

In a tough economic climate, operator Kerr McGee cut 35% of the capital cost and achieved first oil almost three years faster than planned, by choosing a floating production, storage, and offloading (FPSO) vessel, the *Gryphon Alpha*, instead of a fixed platform (*OE*: October 1994).

The *Gryphon Alpha*, stationed 282km north-east of Aberdeen in 112m water, in Block 9/18b, was the North Sea's first permanently moored FPSO. Of the first 12 wells—7 were for horizontal production.

Kerr McGee had expected the 90,000-tonne vessel to remain on station for its estimated 15-year field life By 2011, the vessel had been producing for 17 years. Maersk Oil North Sea UK took ownership, after it had bought Kerr McGee's UK assets in 2005.

The *Gryphon Alpha* was upgraded in 2003, primarily to enable it to process fluids from the Maclure and Tullich reservoirs. However, obsolescence was becoming an issue. Equipment was getting harder to support and plans were underway to replace multiple systems.

Then, on February 4, 2011, disaster struck. The vessel broke four of its 10 anchor chains and drifted off station in a storm. Extensive subsea infrastructure was damaged, including subsea risers and riser bases, several of the 18 mid-water arches, and flowlines to two well centers. The *Gryphon Alpha* itself also sustained damage, requiring it to be drydocked.

It was a blow. But the result was the Gryphon Area Reinstatement Project (GARP)—an intensive, 2½-year campaign, involving simultaneous design, procurement, rebuilding, and installation, to reinstate the now heavily overhauled FPSO and subsea infrastructure. It was the largest offshore project in the UK North Sea during 2012, with first production in May this year.

## Subsea equipment

The first major piece of work was the removal of the damaged subsea infrastructure, carried out over six campaigns between July 2011 and March 2013. First, about 34 tonnes of oil was recovered through flushing to 34ppm (parts per million) of oil topside, using the temporarily-reconnected FPSO and support vessels.

Next, 36.6km of pipeline was removed, comprising 3600m of risers, 1920m of umbilical risers, 21,640m of seabed pipelines, and 9520m of seabed umbilicals. In addition, six riser bases and seven mid-water arches were removed.

Onshore contractor, TWMA, handled, cleaned and recycled 95.3% of a the 2.5million tonne of recovered materials.

## Reinstatement

The removal of the subsea infrastructure gave Maersk an opportunity to re-engineer and simplify its subsea facilities.

Instead of replacing the seven mid-water arches, Maersk designed a new subsea layout using three, 98-tonne, tethered midwater arches, built at the Nigg Yard, and three risers with buoyancy modules. This reduced manufacturing and offshore lifting scopes.

The number of gas lift risers was reduced from eleven to two, with distribution via new subsea control modules, which replaced the complex, direct control arrangement with a simpler multiplex system. The layout of flowlines and umbilicals was also consolidated.

In normal circumstances, the work involved would have taken 4-5 years, says Maersk's Shona Campbell, project manager, subsea. On GARP, conceptual engineering, front-end engineering and design, procurement, and construction, involving more than 70 vendors and multiple contractors, was all carried out at the same time.

Technip used the 15 dynamic risers, two

dynamic and two static umbilicals (manufactured by DUCO Dynamic Umbilicals, Newcastle), 11 flexible flowlines (from NOV Flexibles) and other subsea equipment,using *Skandi Arctic* and *Wellservicer* vessels to install. Fugro provided survey and ROV services from the *Fugro Symphony*, as well as ROV services for four Technip DSVs (dive support vessels).

Maersk used 22 diverless hull connectors, supplied by FES International, to install the risers, which was trialed onshore before the offshore campaign.

In total, about 39km of flexible flowlines, umbilicals and risers were installed, as well as 3000tonne of structures, the mid-water arches and 21 wells hooked up, utilizing 703 vessel days.

### FPSP *Gryphon Alpha*

The *Gryphon Alpha* arrived in dry dock at Damen Shiprepair Rotterdam (Schiedam) on June 27, 2011.

Superficial cracks, not identified offshore were found, enabling a more thorough overhaul than could have been achieved offshore, with 550-tonne of steel replaced.

Neil Smith, offshore health, safety, security, environment, and quality (HSSEQ) specialist, Maersk, says: "Any vessel, through natural vessel movements, is subject to stresses, fatigue, and corrosion. You can deal with most of this offshore, but it is very challenging, time consuming, and costly. When we had the opportunity to have the *Gryphon Alpha* in the yard we were able to do a lot of that work."

The vessel's three Hydralift hydraulic cranes were removed and refurbished with upgrades addressing obsolescence issues. New loading alarms and boom-tip cameras were also fitted. In addition, new bumper bars were installed to protect high-risk areas during lifting operations.

A new, taller, inert gas tower, including high velocity vent valves, was installed, standing 24m above the production deck, to increase its distance from the vessel. Lay down areas were expanded and improved, by replacing a metering skid with a new, smaller, multi-phase system, and removing an old dehydration unit and produced water systems.

A new high-pressure flare-knockout drum was also installed, replacing two vessels used previously, also improving the footprint.

A strong theme of the replacement equipment was a greater ability to capture, access and use data from the process and marine systems.

The Solar Turbines gas turbine control systems were replaced with a Turbotronic 4 system, including new programmable logic controllers (PLCs), enabling more information about performance to be accessed, including analyzing alarms and ability to access data from a remote terminal at the bridge.

The Provox process control system (PCS), which was becoming harder to maintain due to obsolescence, was replaced with an Emerson Delta-V system. This meant increased access to data for onshore teams, for monitoring and reviewing trends. Due to a change from switches to transmitters, the application of plant inhibits will also be reduced through improved monitoring.

One of the biggest pieces of work was the installation of a new second-stage separator, says Marc McAndrew, Gryphon asset process engineer.

The existing second-stage separator had a design pressure of 3.1 Bar(g) but the upstream first stage and test separator systems wererated to 12.9 Bar(g) and were operating in the 9-10 Bar(g) range. A fully rated replacement vessel, including new pressure safety valves, was installed at 12.9 Bar(g) design pressure.

This was supplemented by a new HIPPS (high-integrity pressure protection system), with two, 16in. Mokveld valves on the production header, two 6in. Mokveld valves on the test header, and an intelligent logic solver from Yokogawa. This was the result of analysis, which highlighted a potential to overpressure the first stage and test separator, due to de-packing of flow lines potentially at gas lift pressure.

In addition, a nucleonic density profiler was added to the second-stage separator, allowing increased visibility


***Gryphon Alpha* out of the drydock at Damen Shiprepair Rotterdam (Schiedam).** Photo: Maersk Oil North Sea UK

of the separation performance, on- and offshore, specifically around the build-up of emulsions, so early proactive action can be taken, says Alan Simmonds, controls engineer.

The new second-stage separator and the HIPPS, were the result of a high level of design work, says Neal Gray, head of technical assurance, Maersk.

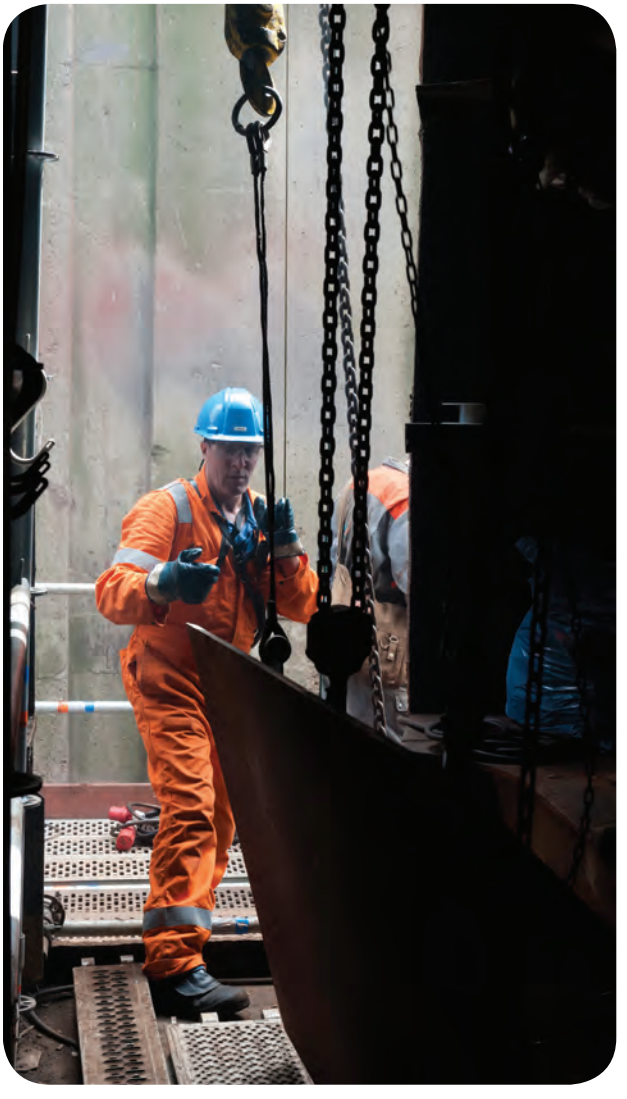
"The whole system is the way we control the risk of overpressure in the first vessel in the process train," he says. "With the HIPPS system we can monitor it and, if it happens, shut it down quickly and then control how fast it starts up."

The *Gryphon Alpha's* Lintott direct hydraulic well head control panel, which consisted of a manually operated panel inside the turret and had become obsolete, was removed. Its functionality was absorbed into the existing electric-hydraulic system, feeding into a master control station, that has greater flexibility to be reconfigured.

Obsolescence also resulted in a new cargo system, Kongsberg's K-Gauge. The cargo pumps, valves and chemical inject skid were fully refurbished and a new fiscally-rated offload metering system introduced.

All at-risk areas, including the forward blast wall, that protected a temporary refuge area, were brought up to a 90-minute jet fire (J90), standard, when previously only the risers and the emergency shutdown valve were covered. All vessels were reclad in Foamglas and a Terostat outer cover. Insulation around pipelines was also upgraded to hard foam, instead of fiberglass wool.

The vessel's flare tower was going to be replaced, but it was refurbished, and additional lights installed. New life boats, adhering to recently increased personnel size specifications, were also installed.



**More than 550-tonne of steel was was replaced on the *Gryphon Alpha*, while it was in drydock.**
Photo: Maersk Oil North Sea UK

## Marine systems

Work had already started on replacing the *Gryphon Alpha's* dynamic positioning (DP) systems, with an upgrade to the Kongsberg thruster control and vessel automation system. The vessel had a Kongsberg Simrad vessel control and Simrad dynamic positioning system, which has been upgraded to K-Pos thruster control system, K-Chief vessel automation system and K-Safe safety module, or emergency shut down and fire and gas system. The upgrade to K-Safe included replacing the vessel fire detection system with a new Autronica fire panel and detectors. Maersk also upgraded the position reference systems, giving *Gryphon Alpha* triple redundancy.

The thruster control system now has full redundancy, so that if there is any single failure, no matter how significant, the vessel will have sufficient thruster capacity to remain on station.

In a situation such as a Force 8 gale, the power systems can be split, separating process power (two Solar Mars gas turbines) from marine systems (five marine 3MW diesel generators). The marine systems can also be split, so that at least two thrusters are always available. The system went through a full failure mode analysis and sea trials, prior to deployment.

Rolls Royce at Ålesund, Norway, also overhauled, recertified, and refitted *Gryphon Alpha's* thrusters.

## Tanks

The FPSO has a storage capacity of 525,000 bbl in 12 inert, gas-blanketed cargo tanks, with offloading via a 20in. hose to shuttle tanker. These, and the ballast tanks and anodes, were corroded and were due to be refurbished offshore. Instead, they underwent a more thorough inspection in drydock, and were blasted, cleaned, had welds repaired, and recoated in drydock.

## Mooring system

When the vessel was first installed, the mooring system was rated to the latest 1989 standards. The rating has now been increased to 2010 standards, increasing the minimum break load (MBL) of the chain to 858-tonne—a 17% improvement on the old R4 chain.

To meet new codes, including DNV-OS-E301, the damaged 10-point mooring system was replaced, upgraded, with new mooring chain forged by Spain's Vicinay Cadenas. Fair leads were also increased to an MBL of 858-tonne.

The Vryhof Stevpris anchors were overhauled and new Smit towing brackets and chocks fitted fore and aft, for vessel positioning during hook-up.

The 134 cylinder bearings (67 sets of two) on the 4000-tonne, 20m-diameter, hydraulically operated turret amidships, were overhauled, and the carousel steelwork and drag chain overhauled. The turret turning and locking system was

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# Our activities

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also replaced, due to obsolescence, with a new programmable logic controller system with human-machine interface, to enable the operator to see more data.

The reality is that much of the work carried out between February 2011 and April 2013 in drydock—not all of it outlined here—was planned before the incident. But, it would have been carried out offshore, during a time which has seen multiple periods of bad weather and the grounding of part of the North Sea's helicopter fleet, due to two ditchings in 2012, making logistics particularly difficult.

The extent of the repairs meant the vessel was able to achieve class renewal, which had been scheduled for 2016.

Scott Taylor, installation support engineer, Maersk, says: "It would have been challenging to see *Gryphon Alpha* out of commission much further than that. Now, as long as wells are producing, we should see *Gryphon Alpha* through in to the future. It was all about doing work now that was going to future-proof us."

## Tow-out

On May 27, 2012, the drydock was flooded and *Gryphon Alpha* floated out. Sea trials were in the southern North Sea during August, and mooring hook-up and riser pulling during September and October 2012.

Commissioning and hook up of marine systems started October 2012, including failure mode and effects analysis, a process limited by the allowable number of persons on board (130), and not helped by poor weather and the limited helicopter service. Topsides commissioning then led up to May 2013, for first production.

"We checked everything in triplicate—flanges, nuts, lines, piping and instrumentation diagrams (P&IDs)," says Stuart Oswald, offshore installation manager, Maersk.

The P&IDs had all been updated to "as built" and line walked, the process integrity register updated, as was the alarm and trip register, the safety and integrity level register—in fact all documentation—in addition to DNV verification.

"From Martin Rune Pedersen [managing director, Maersk Oil North Sea] to Pers Skrumsager, the operations manager, the mind set was that we were not going to start until we were ready," says Oswald.

Before first oil the entire team took "24 hours out for safety." All staff, both those who had been with the vessel before February 4, and after, undertook training on the new and retained systems.

A vessel was hired with the same DP system as *Gryphon Alpha* for the crew to train on. Emergency situation scenarios were also introduced, with every potential emergency scenario worked through, training carried out, for staff, vendors and contractors, and procedures recorded in the Environmental Health and Safety Plan.

Production of *Gryphon Alpha*, targeted at 20M bbl/d restarted in May, without any leaks, and is currently "exceeding expectations," says Oswald, with additional wells due online by the end of the year.

The third gas compressors is scheduled to come online this month [Sept] and water injection systems were due to be commissioned as we go to print.

## The future

While the short term aims are to make the *Gryphon Alpha* work optimally and stably, Maersk has a long term plan for *Gryphon Alpha*.

New 4D seismic was shot over Block 9 in 2011, while the vessel was off station—work that had already been planned in cooperation with other operators in the area.

The Gryphon reservoir is in shallow Eocene sands and has heavy crude oil, at 22°API gravity. Maersk has developed expertise in injectile sands, which it has been working on in the Gryphon area since 2003.

During the reinstatement project, Maersk also carried out a drilling campaign at the Tullich field, and, in July, it started drilling a new well at Gryphon, using the *Sedco 704* semisubmersible. Another well is planned on Maclure, using the *WilPhoenix* semisubmersible. Maersk is still working up its 2014-15 drilling program.

**One of *Gryphon Alpha's* three Hydralift hydraulic cranes being refitted.**
Photo: Maersk Oil North Sea UK

Doug MacLeod, development manager, Quad 9, Maersk, says: "There are certainly a lot more opportunities in the area. It's very exciting. There is a lot of potential—Gryphon is going to need more subsea infrastructure."

## Gryphon ownership

Maersk Oil operates the Gryphon field and the Gryphon South field (discovered 1987) in partnership with Sojitz. Gryphon field equity share: Maersk 86.5%, Sojitz 13.54%, South Gryphon field equity share Maersk 89.875, Sojitz 10.125%.

Maersk also operates the Tullich and Maclure fields (both discovered in 1991, with first oil in 2002), which tie in to Gryphon.

Maersk has a 38.2% equity share in Maclure, with partners TAQA Bratani (37%), Apache (17.2%), and Enterprise Oil (7.6%).

Tullich is 100% Maersk-owned and operated.

With thanks to, alongside those quoted, Rob Waugh, senior piping engineer, Paul Baker, environment manager, and Fred Toal, naval architect. OE

# Bluewater's *Haewene Brim* in Cromarty

**Bluewater's *Haewene Brim* undergoing an upgrade at the Nigg fabrication yard, Cromarty, Scotland.**

By Elaine Maslin

Bluewater's *Haewene Brim* floating production and offloading vessel (FPSO) has been in dry dock for an upgrade at the Nigg fabrication yard in the Cromarty Firth, north-east Scotland.

It is the first time the yard, operated by Global Energy Group, has accomodated an FPSO. It is also a rare sight on the Scottish coastline, with very few FPSOs having docked in Scotland yards in the history of the North Sea.

The work, led by engineering group AMEC, is to extend the life of the *Haewene Brim* and to enable it to take production from Lundin Petroleum's Brynhild subsea development, about 210 km off the Norwegian coast (PL148).

The Brynhild project is a four-well subsea development on Block 7 on the Norwegian continental shelf. Two are slated to be production wells and a third will be used as a production well to enhance early production rates. Brynhild will be tied back to the *Haewene Brim*, which handles production from the Shell-operated Pierce field. Pierce is 38km from Brynhild on UK North Sea Blocks 23/22a and 23/27.

As operator, Lundin began drilling the first Brynhild well from a subsea template in June, using the self-elevating cantilever jackup rig *Mærsk Guardian*.

Gross reserves at Brynhild, according to Lundin, are 23MM boe. Plateau production is estimated at 12M boe/d, with first oil expected at the end of 2013.

The Brynhild field will operate using a subsea production system (SPS) tied back via a 38km-long, 6in.-daimeter pipe-in-pipe flowline, with a control system on the *Haewene Brim*.

A riser base manifold, containing isolation valves and a multiphase flow meter module, adjacent to Pierce, will be the commingling point between Brynhild and Pierce.

The common Brynhild-Pierce well flow will then be transported to the FPSO via a renewed 10-in.-diameter dynamic flexible riser for well fluid processing on the *Haewene Brim*.

Produced gas will be re-injected into the Pierce field. A water injection system will inject treated seawater into both the Pierce and Brynhild fields.

The *Hæwene Brim* was converted from a shuttle tanker to an FPSO at the Aker McNulty yard in Newcastle in late 1997-1998, and started operating at the Pierce field early in 1999.

The *Haewene Brim* last drydocked at A&P Tyne's number 5 dock on Tyneside, England, in 2004, for the addition of a water injection stopides module and hull maintenance, led by a partnership between A&P Tyne and McNulty Offshore Contractors. OE

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# Danish Energy Agency releases annual report

By Meg Chesshyre

The Danish offshore is a mature oil and gas province with 40 years of production, but the Danish Energy Agency's latest annual report,* says that the country is expected to remain a net exporter of oil through 2020, while gas production is estimated to exceed domestic gas consumption through 2025. This is three years longer than estimated one year ago, due to an expected decline in future domestic gas consumption.

The Danish sector of the North Sea is a mature area and the Danes' primary focus is on optimizing current production and maintaining existing installations. Exploration continues, and investments are still being made in new production installations. In 2012, investments in exploration activity totaled about DKK 1.2 billion (US$214 million), of which investments in new installations accounted for about DKK 5.7 billion, an increase over 2011.

## Dan, Tyra, Dagmar fields

July 4, 2012 marked the 40th anniversary of Danish oil and gas production, which began at the Dan field, still producing today. Since 1972, close to 28% of total Danish oil production has been extracted from the Dan field, and current projections are that the field will keep producing well into the future.

A comprehensive plan for the further development of Maersk's Tyra Southeast field was approved on 20 November 2012. Start-up is targeted for spring 2015. The plan includes a new four-leg platform to accommodate 16 wells. The new platform will be connected to the existing TSEA platform by a bridge. A new pipeline will run from the Tyra East platform to the new platform to supply lift gas to both new and old wells. Power supply and control signal cables will be laid parallel to the pipeline. Based on the 12 production wells planned initially, total production from the field is expected to increase by around 3.3 million cu.m of oil and around 4.6 billion cu.m of gas. Total investments in connection with the development are estimated at DKK 5 billion. Bladt Industries, in Aalborg is building the new 1100-tonne platform and bridge. Delivery is scheduled for May 1, 2014.

A clarification of the future of the Dagmar field, which has been closed since 2005 due to poor or non-existent hydrocarbon production, is expected in 2013

## State revenue

In 2012, the Danish state generated revenue of about DKK 25.2 billion from oil and gas production, a decline of about 15% from 2011, when state revenue totaled DKK 30.3 billion. The fall in state revenue is partly attributable to decline in production as Danish fields age. Thus, oil production decreased to 11.7 MMcm last year, a 9% drop from 2011, while sales gas production fell by about 14% to 4.9 Bcm in 2012. Oil production has halved since

**The Dan field – 40-years on from the start of Danish offshore oil and gas production on July 4, 1972.**

production peaked in 2004.

Amounting to about $110/bbl in 2012, the average oil price remained at the 2011 level. However, in terms of Danish kroner, the oil price rose by slightly more than 11% due to the higher US dollar exchange rate. Based on an oil price of $125/bbl, total state revenue from North Sea production is estimated at DKK 24-30 billion/yr for the next five years.

### New licensing round

The DEA is preparing a new licensing round, covering the area in the Danish sector of the North Sea west of the 6° 15' east longitude. The aim is to officially open the seventh round at the end of this year. The most recent licensing round (sixth) was held in 2006. The rest of the Danish licensing area is offered for licensing according to the Open Door procedure introduced in 1997.

The success rate for wells drilled under the sixth round license remains high, at 80%.

Wintershall Noordzee, operator for license 5/06, drilled the Hibonite-1 (5504/1-3) exploration well in the western part of the Danish North Sea in 2012. Bayerngas and EWE, and as the Danish North Sea Fund, were also partners in the well, which discovered oil in Upper Jurassic sandstone. Hibonite-1 was drilled as a deviated well and terminated in Jurassic clay at a vertical depth of 4,431m below mean sea level. Wintershall took cores and logged the well. Oil and gas were produced during testing. In order to assess the extent of the oil discovery, two sidetracks were drilled, Hibonite-1A and Hibonite-1B. Both sidetracks confirmed the presence of oil-bearing sandstone of Late Jurassic age.

In April 2012, Denmark's minister for climate, energy and building agreed on a new action plan for 2012-2014 with Danish operators, aimed at reducing energy consumption offshore. The new action plan is based on valuable experience gained from the previous action plan for 2006-2011, which successfully reduced energy consumption by 18%. A preliminary estimate shows that energy consumption was reduced by about 20% in 2012, thus achieving the target for the year. The targeted efforts to reduce energy consumption on the North Sea installations brought the total CO2 emissions down to about 1.7 million tons in 2012, the lowest level in the past 10 years.

In 2012, the DEA carried out a total of 40 inspections of installations in the North Sea and onshore, safeguarding health and safety standards for the almost 3,000 people who work on North Sea installations. In 2012, the DEA registered 12 reports concerning work-related accidents on offshore installations and mobile accommodation units. The accident frequency—defined as the number of accidents per million working hours—has dropped by 70% since 2004, and is far lower than the average accident frequency for all onshore industries.

### State participation

On 9 July 2012, the state-owned company 'Nordsøfonden' (the Danish North Sea Fund) joined Dansk Undergrunds Consortium (DUC) as a partner with a 20% interest. The Danish North Sea Fund has, therefore, taken over a substantial share of production activity in the North Sea and has become a co-owner of the relevant platforms, processing facilities and pipelines. State participation was one of the main requirements set out in the North Sea Agreement of 2003, regarding the extension of DUC's sole concession until 2042. Maersk Oil and Gas is the operator of the concession, the other partners being Shell and Chevron, and now the Danish North Sea Fund. **OE**

## FURTHER **READING**

*The report 'Oil and Gas Production in Denmark for 2012' is only published electronically. It is available on the Danish Energy Agency website at www.ens.dk.

# Scandinavia: investing to grow

**Scandinavia's oil and gas industry, focused on Norway and Denmark, is expecting a resurgence. Espen Erlingsen looks at trends in the sector.**

The North Sea is characterized by large, producing platforms with declining production. To stop the falling production in the North Sea, countries are now developing and investing in new projects, which are expected to come online before the end of this decade.

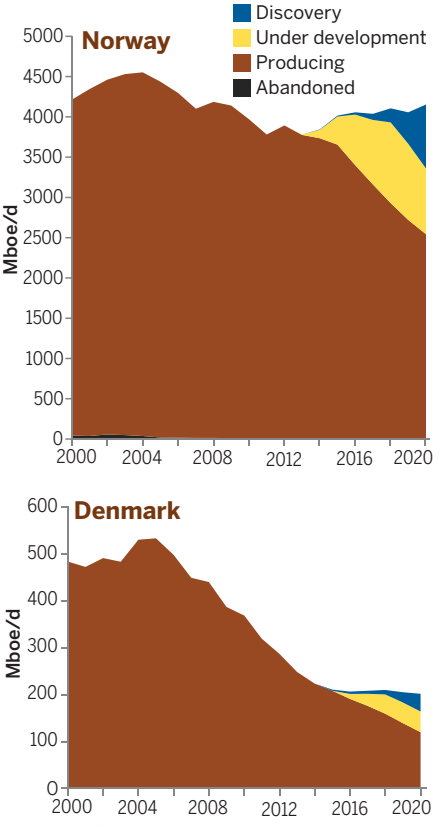
This counts also for countries like Norway and Denmark.

Both Norway and Denmark experienced declining oil and gas production over recent years. Since the peak in the middle of the last decade, Norwegian and Danish production has fallen by 15% and 45%, respectively.

However, Rystad Energy estimates that in future there will be an upward trend. Norway will be able to increase production and Denmark will stay around current levels. This is illustrated in Figure 1, which shows total oil and gas production for these countries split by the lifecycle of the underlying fields.

Since 2003, production in Norway has declined almost every year. Exceptions include 2007, which saw the start-up of the Snøhvit and Ormen Lange developments, and 2012, due to high demand for Norwegian gas.

## Predictions for petroleum activity




*Source: UCube, Rystad Energy.*

Historically, new projects were not able to compensate for declining production from old assets. The period from 2000 to 2012 also saw a change in the production mix. In 2000, gas contributed to about 20% of total production; by 2012 this amount had increased to approximately 50%.

Although current Norwegian producing fields are predicted to continue to decline in future, total production is expected to move from a declining to a growing trend over coming years, as fields currently under construction come online. The biggest contributor, in the short run, will be the development of the Valemon, Gudrun, and Martin Linge fields.

Between 2013 and 2015, around 27 new fields are expected to start up, compared to 10 fields between 2010 and 2012. Toward 2020, total production has the potential to peak at more than 4MMboe/d.

This growth is a combination of three elements: new discoveries, such as Johan Sverdrup; new platforms on already producing fields, including Ekofisk and Eldfisk; and old stranded discoveries being developed, such as Gina Krog.

At the same time, due to more liquids production, the gas content is estimated to make up around 45% of the total production for the remaining decade.

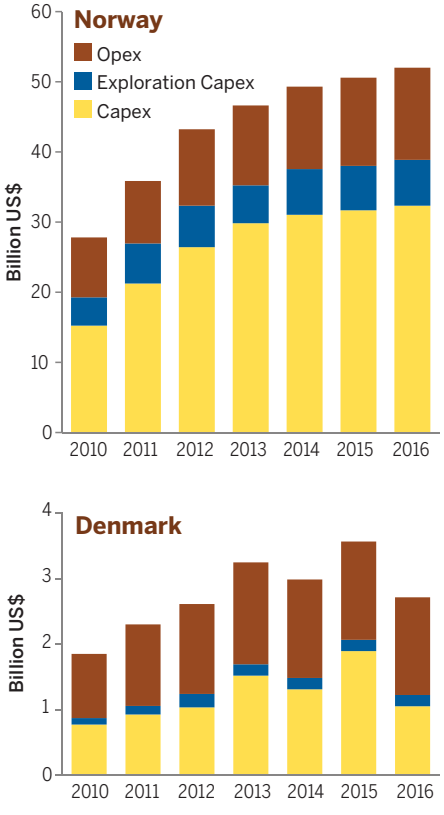
Looking at Denmark, it is estimated that Danish production will continue to decline in the short term, due to the lack of new development projects currently in place.

Today, only the DONG-operated Hejre field is under development, with estimated start up in 2016. Among the current discoveries not yet developed, Rystad Energy estimates that about five fields would be able to start first production by 2020. Hibonite is the main discovery in this area.

With potential production from these fields, the total oil and gas production for Denmark is estimated to stabilize at just above 200,000boe/d, compared to about 250,000boe/d today.

Figure 2 shows total spending related to the upstream activities for Norway and Denmark, split by exploration, operation, and capital expenditure. Rystad Energy estimates that total

## Total E&P spending




*Source: UCube, Rystad Energy.*

2013 exploration and production (E&P) spending for Norway and Denmark is US$46.3 billion and US$3.2 billion, respectively.

From 2010 to 2013, the total Norwegian E&P spending increased by about 20% annually. This growth was caused by both higher activity and cost inflation. As illustrated in the production graph, a large part of the Norwegian production in 2020 will come from not yet producing fields.

This indicates that significant investments are needed for new infrastructure. This is also reflected in the Norwegian spending chart, by growth in the capex (capital spending) segment. In addition to new infrastructure, existing fields are expected to have high activity levels related to new drilling campaigns, modifications and maintenance going forward.

The Danish oil field service market is considerably smaller than the Norwegian market, as illustrated in the spending graph. Over recent years, total spending has increased, due to both higher investments and operational costs. In the short term, the main driver for increased spending is the development of the Hejre field.

With activity and investments picking up in the North Sea, the foundation for a new oil and gas supply has been set. The second half of this decade could see the decline production profiles reversed, creating highly valuable resources. OE

***Espen Erlingsen*** *is the lead Norwegian Continental Shelf analyst at Rystad Energy. His expertise includes company and acreage valuation, breakeven price analysis and international petroleum fiscal regimes. He has an MSc in industrial economics from the Norwegian University of Science and Technology.*

*UCube is an online, complete, and integrated field-by-field database, including reserves, production profiles, financial figures, ownership, and other key parameters for all oil and gas fields, discoveries, and exploration licenses globally.*

# Government policy aids Norwegian success

Norway's offshore region covers 2.04 million sq km and is split into five areas: the northern, southern and central parts of the North Sea, the Norwegian Sea and the Barents Sea. Over the five regions, there have been 1400 exploration wells drilled since 1966.

There are 76 fields in production—Ekofisk, in the southern part of the North Sea, is the largest. In addition, there are 16 fields currently being developed.

Out of the five regions, the Norwegian Sea is the least mature province: the Draugen field was the first on stream in 1993.

There has been a decline in activity outside the Norwegian Sea in recent years, but this has been made up for by recent discoveries in the northern North Sea and Barents Sea, leading to predictions that production will remain at a steady rate for the next 30 to 40 years.

Drilling activity has seen a sharp rise since 2005. The Norwegian Petroleum Directorate says 40 exploration wells are spudded every year, and there have been three of the largest ever finds in the area since 2008. Although discovery rates are high, proven volumes in these discoveries generally remain small.

The recent success of the Norwegian continental shelf is partially due to changes in government policy on exploration, including tax rebates. This has encouraged new entrants, with the number of companies operating in the basin having almost doubled to 50 since 1990.

However, rig rates remain higher in Norway than in other petroleum provinces, such as the neighboring UK continental shelf. According to the 2012 Reiten Commission, this is because of high operating costs in Norway.

The Norwegian Petroleum Directorate predicts that a total 85 billion boe will be produced, an increase of 267 million boe from last year's estimate. This target can be reached if managers, project leaders, and engineers focus attention on increasing overall production, and developing new discoveries. OE

***Kristin Færøvik*** *is CEO of Rosenberg WorleyParsons, and served on the Reiten Commission. She joined Bergen Group, bought by WorleyParsons this year, after serving as managing director for Marathon Oil in Norway. She previously held roles within BP. Færøvik holds degree in petroleum engineering from the Norwegian University of Science and Technology.*

# Dutch firms eye growing markets

**New vessels, acquisitions, and expertise are driving Dutch growth. Elaine Maslin reports.**

The Dutch offshore sector is leveraging its engineering and seafaring traditions to grow its presence in the global oil and gas industry.

The sector—including some newer entrants—is eying work in areas from subsea, including deepwater, to LNG; and from transport and installation to operations in Arctic waters.

A strong theme is diversification, through acquisition and fleet growth, as Dutch firms look to grow their expertise and portfolios to offer full package services.

Jumbo, for example, has two Finnish-Swedish, Ice Class 1A, K-Class, heavylift vessels on order—one, the *Jumbo Kinetic*, being built at Brodosplit shipyard in Split, Croatia, and scheduled for delivery last month (August).

With this, and the rest of its fleet, the firm is aiming to become a go-to contractor for combined transport and installation projects, covering mooring spreads and subsea installation, including deepwater and arctic projects, by combining its capabilities, says Michael Kahn, managing director of Jumbo.

"We want to be doing more mooring spreads and large subsea structures like templates and compression modules at 2000-3000m water depth and in new frontier areas like the Arctic," Kahn says.

"What we see in the market are more floating production units being used, instead of platforms, and field developments in more remote locations, including the Arctic. Also, decommissioning is coming. These markets will grow."

Jumbo completed its first contract as a full installation contractor earlier last month. This was for the mooring installation, tow-out and hook-up of EnQuest's *EnQuest Producer* FPSO, which is due to bring the central North Sea Alma and Galia fields on stream in 4Q this year. The contract included fabrication and installation of anchor piles, as well as pre-tensioning the anchors and bottom chains, and installing the mooring wires and top chains, using Jumbo's heavylift vessel *Fairplayer*.

Boskalis Offshore, part of Boskalis and traditionally a dredging business, has also been growing its capabilities, following the integration of fellow-Dutch firm Smit's salvage business into the business last year, and the purchase of marine-transport firm Dockwise Ltd., earlier this year.

Boskalis Director Bas van Bemmelen says, "In my ideal world, we will come to a point where, if you take a new export LNG terminal, we can do everything from dredging the port to building quay walls and relevant infrastructure, as well as the modular transport, logistics, and integration of the LNG facilities."

Boskalis Offshore would also be involved in offshore and or nearshore work to bring upstream products and infrastructure, such as pipelines, into the terminal.

Boskalis is due to combine its current capabilities on a project for Shell, the Malampaya Phase 3 project, in the Philippines next year. This will see a jackup, depletion-compression platform linked to an existing platform on the Malampaya gas field. A new vessel, the *Ndeavor*, is one of two new, multipurpose DP2


**Heavylift vessel *Fairplayer* completed Jumbo's first contract as a full installation contractor.**

Offshore Europe 2013

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construction vessels being built for Boskalis. These vessels will be purposely outfitted for the project. This will allow Boskalis to use just one vessel for the majority of the project, from seabed excavation to platform and bridge installation.

The *Ndeavor*, and its sister vessel, *Ndurance*, are due to be completed in 2H 2013, with the *Ndurance* going to Europe for cable laying work.

IHC Merwede, which also has its roots in dedging, dating back to the 17th century, is also combining its capabilities to grow its services and offer integrated projects.

Next year, it will deliver the first of two new, 550-tonne, pipelay vessels, being built at its Krimpen aan den IJssel yard, The Netherlands, for TL Offshore, a subsidiary of SapuraKencana.

A third is also being built for Subsea 7 and all three are due to work offshore Brazil installing flexible pipelines. IHC emphasizess that these are the world's first pipelaying vessels fully integrated by one supplier, with its IHC Engineering Business Ltd. and IHC Drives & Automation BV also supplying vessel components.

Others are introducing new vessels to increase their own fleet and market share. Allseas is planning to make a global splash with its twin-hull, heavy-lift vessel *Piewter Schelte* (*OE,* May 2013), targeting entire topsides decommissioning, for up to 48,000 tonnes, and pipelay services.

Heerema Marine Contractors' new deepwater-construction vessel, *Aegir*, based on an Ulstein Sea of Solutions SOC 5000 design (*OE,* April 2012), is due to start operations in 2H 2013. It will be able to carry out installation and pipeline projects in ultra-deep water, with sufficient lifting capacity to install fixed platforms in shallower water.

Damen Shipyards is also growing its oil and gas offshore offering, through the introduction of a new fleet, (see sidebar).

Activity in the region is attracting investment. A division of COSCO, COSCO Shipping Europe, opened its new offices in Rotterdam in May.

Trading as COSCO Heavy Transport,

## Damen looks offshore

High activity levels in the North Sea are making an attractive market for Damen Shipyards. Last year, its biggest newbuild market was in tugs and work boats, with 80 delivered. Now, the firm has turned its attention to oil and gas industry support vessels with its new Damen Offshore Series. Arnaut Damen, chief operating officer, says there is demand in the platform supply vessel (PSV), anchor handling (AHTS), ROV/diving support, and subsea construction vessel markets.

Nor-Ocean Offshore highlighted demand for PSVs in a June report. It posted 17 additions to the North Sea PSV fleet in 1H 2013, with the total market

**Damen's PSV 3300 *World Diamond* was launched in June.**

Damen's new AHTS 200 vessel design is capable of working in 3000m deep water.

it markets and provides technical support worldwide to COSCO Shipping Co.'s fleet of semisubmersible heavylift vessels.

With the Arctic in their sights, subsea installation (and transportation) firmly on the radar and global operations from Europe to the Phillippines, expect to see more of the Dutch in the offshore oil and gas sector. **OE**

standing at 232 vessels (an 8% rise year-on-year). Term fleet stands at 195 vessels (up 8%), while the spot fleet added two, taking it to 37 vessels (up 6%).

For the week ending June 14, average rates for cargo runs were more than £20,800, above rates seen in 2011 and 2012. Operators chartered AHTS for cargo runs, due to limited PSV availability. Utilization rates for large PSVs were 93% for June.

Damen recently introduced its PSV 3300, one of the Damen Offshore Series, to the market. The first of six new PSV 3300s on order, *World Diamond* was delivered from Damen Shipyards Galati, Romania, in June.

The vessel is now on the spot North Sea market, and is operated by Remøy Management for owner World Wide Shipping. A second vessel will also go on the spot market. The remaining four, also under construction at the Galati yard, have been contracted for charter off Brazil.

The PSV 3300 has a slim bow, based on computational fluid dynamics studies and tests at the Maritime Research Institute Netherlands, with diesel electric propulsion and (DP2) azimuth stern drives to minimize slamming, and balance a relatively high cargo intake with low fuel consumption.

The 80.1m-long vessel has a 6.15m draught and deadweight of 3300-tonne, with a maximum weight on deck of 400-tonne. Maximum speed is 13.7 knots.

The vessel has new anti-roll tanks and increased deck space, 728sq m, a 10% increase over the previous design. It can transport crew and materials, is fitted with firefighting and oil pollution recovery capability, and can carry ISO containers on deck. It has accommodation for 16 crew members, plus six passengers.

Damen's other Offshore Series vessels include an X-bow-style anchor handler, the Damen AHTS 200, capable of working in 3000m deep water. Others are a construction support vessel, well stimulation vessel, fast crew suppliers, the Damen Offshore Carrier: a 7500 deadweight tonnage multipurpose vessel with heavylift, an offshore heavylift vessel, and an oil spill response vessel. ■

# Solutions

## Offshore gas detection

UK-based Groveley Detection Ltd. will join Emerson Process Management's Rosemount Analytical business unit. Groveley was the first to develop a pieso-electric based ultrasonic gas leak detector engineered for extreme industrial applications. Groveley's offers the ultrasonic gas leak dectector, GDU Incus, which detects ultrasound generated from pressurized gas leaks. The detector has four independent sensing heads, which are indestructible and unaffected by temperatures ranging from -40°C to 85°C.
http://www.groveley.com/

## Remote disconnect tool

**Hydratight** launched the quick release

nut, which uses the latest technology to reduce disconnection times to less than five seconds per stud. The nut uses imbedded hydraulic cylinders and incorporates a unique three segment nut design, set into a cage, to ensure maximum security of the nut when it is in position and during application and removal.
http://www.hydratight.com

### Eye protection

**3M** has launched SecureFit Protective Eyewear, the first range of eyewear to feature pressure diffusion temple technology, providing personal comfort and security of fit. SecureFit self adjusts to the size and shape of the wearer's head, reducing slippage and movement while in use. It also disperses pressure across the temple area. The eyewear weighs 18g and features three polycarbonate lens colors with anti-fog and anti-scratch coatings.
http://www.3m.com/

### ROV cable lay

The UTV 1200 acquired by **Pharos Offshore Group** is a short and wide ROV designed to bury submarine power cables. Enhancements to the ROV will facilitate effective post- lay/ installation burial and improve the handling and stability of the vehicle. Post-modification of the vehicle will provide a stable platform and retain jetting and hard ground cutting capability. The system has 2 x 400HP directly driven electric motor/pump sets for jetting operations and a single 400HP subsea HPU.
http://www.pharosoffshoregroup.com

### LED lighting

The HAL-PRM-150W-LED-100 surface mount hazardous area light by **Larson Electronics** features a powerful LED assembly fitted with 30 CREE XLamp XPG® LED emitters. The LED assembly is housed within a cast aluminum fixture with high-strength gasket and hinged tempered glass door with stainless steel hardware for protection against moisture and corrosion. The fixture mounts to flat surfaces using an included U bracket that allows the user to adjust the lamp vertically once installed for optimal coverage of the target area to be illuminated.
http://www.magnalight.com

### X-ray Lab

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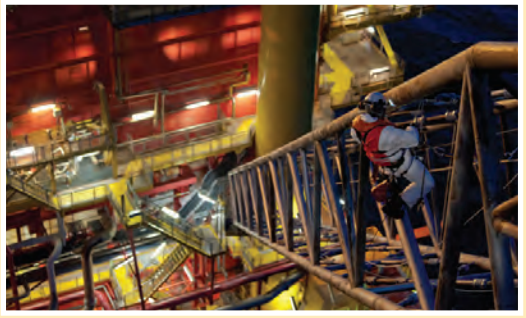
# Activity



**Aker Solutions** acquired Glasgow, Scotland-based **International Design Engineering And Services Ltd. (I.D.E.A.S.)**, an engineering company that has developed software and technology to improve the quality and accuracy of integrity and life time analysis for oil and gas assets.

"This technology can be used to predict the lifetime of an installation in a more effective manner," said Tore Sjursen, head of Aker Solutions' maintenance and advanced inspection and monitoring services. "It also helps us plan more targeted maintenance and inspection activities, and increases the quality and precision of our services."

Aberdeen-based **EnerMech** acquired Australian industrial sector firm **Vicon Services,** and UK-based pump equipment specialist **Total Reclaim Systems Ltd**, for a combined US$15.34 million. EnerMech will introduce new business lines and significantly strengthen its presence in the multi-billion dollar Australian energy sector through the Vicon deal. The acquisition of Total Reclaim Systems (TRS) increases the range of services EnerMech can provide to the drilling sector.

Houston-based **BassDrill Ltd.** is changing its name to **Atlantica Tender Drilling Ltd.** This change is part of a larger rebranding effort designed to reflect the growing strength of the company. "Atlantica is the name given to an ancient continent that once connected parts of West Africa and Eastern South America, our primary marketing area," said President Kerry Kunz. "The new name is an essential move that reflects our position as an increasingly global provider of tender assist drilling vessels."

**ION Geophysical** established a GX Technology (GXT) seismic data processing center in Perth, to serve the needs of oil & gas companies in Australia and throughout the Asia-Pacific region. The new center is staffed with geoscience professionals with regional expertise and offers a range of seismic imaging services and technologies, including depth imaging and ION's patent-pending WiBand™ broadband processing technology.

**Emerson Process Management** opened a new European education facility at the valve manufacturing center of excellence in Cernay, France, in May. A unique feature of the facility is its flow laboratory, which provides a training infrastructure for control valves and instrumentation. The laboratory includes a flow loop and a dynamic performance loop, powered by Emerson's PlantWeb digital plant architecture.

**Clariant** inaugurated a new research a new development in Suzano, Brazil. The laboratory begins operations with a complete infrastructure, state-of-the-art equipment with a team of researchers dedicated to develop new generations of catalysts, and providing technical support to customers in the region. The company sees the increase in production from the pre-salt reserves and potential of shale gas as a platform for growth in Latin America.

**Vallourec** will launch a new research center in Rio de Janeiro, expected to be operational next month. The Rio center will focus on all pre-salt activities. Located next to Petrobras' CENPES research center in the Technological Park of Rio de Janeiro, the Rio center will allow Vallourec to work even more closely

with the Brazilian national oil company on the needs for pre-salt fields, which are characterized by extreme pressure, temperature, and corrosion conditions.

**Accelerated Production Systems Inc.** acquired **Texas Systems & Controls, Inc.**, strengthening Accelerated's capabilities in the design and manufacturing of well testing, artificial lift, pumping, and process and filtration equipment for their energy-industry customers. Texas System's products and services, including the FisherPump line of vertical centrifugal pumps and pump packages, will be integrated into Accelerated's line of services.

Technical consultancy **NEL**, a division of TÜV SÜD, invested US $767,700 in the development of a new high pressure multiphase flow facility at its Glasgow laboratories in the UK. The facility will operate at pressures up to 60 bar (equivalent to a subsea depth of 600m) to accurately reflect the increasing pressures at which flow meters must operate subsea. The new facility will be commissioned in 4Q 2013 fully operational by the end of the year.

**ALS Ltd** moved to acquire **Reservoir Group** for US$533 million from SCF Partners. Reservoir's existing senior management team has committed to continue in the business and is rolling over approximately 50% of their equity in Reservoir into ALS shares. Additionally, ALS moved to acquire Earth Data Pty Ltd for about $16.5 million. Earth Data provides gas sampling and analysis services to Australia's oil and gas industries, and safety monitoring sampling and analysis for fugitive emissions to Australian coal mines.

**STM Group Inc (STM)**, a global satellite communications and engineering company, will expand its Brazil operations by adding a third teleport in Hortolandia, complementing its existing teleports in Sao Paulo and Belo Horizonte. The satellite networking technology for the new teleport uses TDM/TDMA technology and is conformant with the open international standards.


Aberdeen-based oil and gas service company **QTEC** will implement a regulatory compliance service for the US market in response to the environmental focus on operations in the Gulf of Mexico. The firm opened offices in the US in 2011 and sees an opportunity in the region for its growth as a result of greater focus on the Clean Water Act and National Pollutant Discharge Elimination Scheme. Both pieces of legislation were introduced in 1972, but have gained more significance in relation to spillages and discharges following incidents in the Gulf of Mexico.

# Editorial Index

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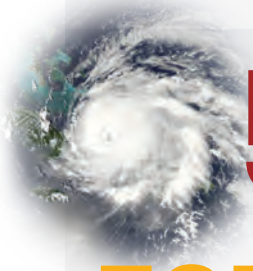
# Numerology

**90%** of successful attacks on company networks required only the most basic techniques. ▶ See Page 44



**5** Upwards of five major Atlantic hurricanes could hit this season.
*(Source: The National Oceanic and Atmospheric Administration).*

**525,000 bbl** Storage tank capacity of the *Gryphon Alpha* FPSO. ▶ See Page 116

**28%** of Danish oil production comes from the Dan field. ▶ See Page 124

**1977** The Clair field, 75 km west of Shetland, was discovered 36 years ago.
*(Source: BP)*

**22,000 ton**


The weight of the SHP jacket installed off Myanmar at Shwe field. ▶ See page 114

**46%** of new hires in the oil and gas industry are women.
*(Source: US Bureau of Labor)*

**10.2 billion** Mexico's proven oil reserves, in bbl, as of 2011.
*(Source: US Energy Information Agency)*

**15%** The decrease in Norwegian oil production since its peak in 2004. ▶ See page 126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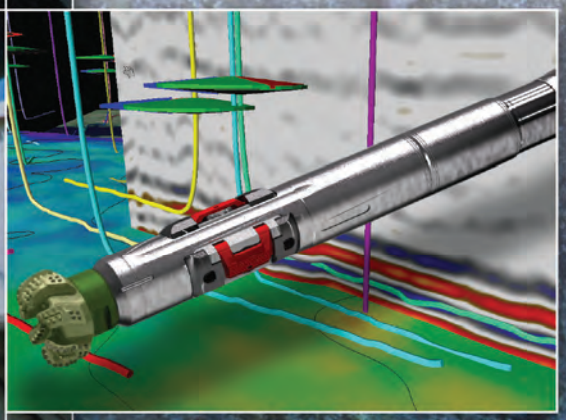

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