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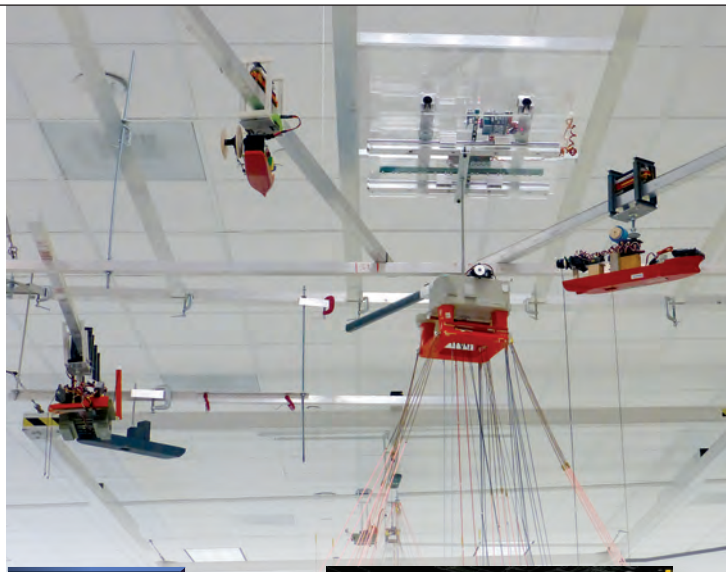

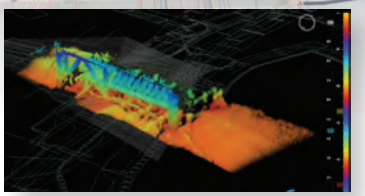

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Arctic spotlight shines on Russia

The challenges of operating in the arctic are multiple – not least offshore Russia, where most agree the largest resources are to be found. Elaine Maslin reports from the SPE Arctic & Extreme conference in Moscow.

What's Trending

Report shows NCS cost overruns

The Norwegian Petroleum Directorate (NPD) released a report appraising five field developments on the Norwegian Continental Shelf with investments exceeding NOK 10 billion (approximately US$1.7 billion).

People

BP Plc has selected **Richard Herbert** to server as head of exploration replacing Mike Daly, who is leaving BP at the end of 2013 after 28 years with the firm.

RWE Dea brings Breagh online

Production has begun on RWE Dea UK's Breagh gas field in the UK Southern North Sea

White Paper

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Voices

Innovate or die. Newer and better tech is always needed in the oil & gas industry –even when companies aren't exactly shouting to be first in line, OE asked:

"How can technology innovation improve?"

The offshore opportunity is vast. According to IEA, over 300 billion bbl of recoverable oil are estimated in deepwater. To maximize this resource, we need to innovate how we innovate; take ocean bottom seismic and wide azimuth sensing, combined with Shell's GeoSigns software. It delivers results beyond the usual. But to tackle future challenges in subsurface visualization, game-changing imaging solutions are needed. For Shell, it's about collaborating with the best and brightest minds wherever they are, whatever sector they're in, and however unusual the approach may be.

Gerald Schotman, Executive Vice President Innovation R&D and Chief Technology Officer for Shell

Universities and national laboratories routinely develop technologies having applicability in the petroleum industry. Most of these innovations will require substantial external investment. Early stage technology companies, funded by angel investors or venture capitalists, are a more appropriate source of innovation for the petroleum industry and these companies often welcome overtures from the oil industry. However, effective collaboration with small companies requires patience, a long term vision and constant recognition of the major organizational differences between large enterprises, such as oil & gas producers or oil service companies, and small start-ups.

John Barratt, CEO, Oil & Gas Innovation Center

Innovative technologies tend to come with an element of risk. They are disruptive, threaten existing product lines and often have no track record – particularly with start-ups. In such cases, the offshore oil & gas sector needs to adopt a more open mind set and see change as an opportunity for technology advancement rather than a threat to existing products and short-term revenues. At Camcon, we have managed to get the industry's support for our digital gas lift solution by partnering direct with operators but other innovations are not always as successful.

Ian Anderson, COO, Camcon Oil

Innovation thrives when there is sufficient reward to justify the investment and risk. Improving technology innovation is about putting the people and processes in place, and having the determination to drive through change. By taking a balanced approach, introducing technology in incremental steps, the benefits are realized and the process can be further stimulated and improved.

Ian Crowther, Sales and Marketing Director, WFS Technologies

Norway has always fostered a positive environment towards innovation and Mirmorax has been fortunate to have the support of the industry and operators in developing our sampling and oil in water monitoring solutions. We have also enjoyed access to some of the world's most advanced testing facilities to test our products and take us to the next level. However, there's always room for improvement from ensuring that the right skills are available in the marketplace through to more cost effective platforms being available at industry events.

Eivind Gransaether, CEO, Mirmorax

Access to new technologies and research is imperative for a company to continually improve. Companies need a great network amongst technologists around the world; at City, we have access to Honeywell's research labs. It is important to balance research between work targeting specific outcomes (i.e. a widget that is 20% faster and 50% lower cost) and "blue sky" research that focuses on fundamental enablers – i.e. MEMS technology, lasers, wireless etc. By embracing both approaches, real innovation and creative results can be achieved.

John Warburton, Strategic Marketing Manager at City Technology

Innovation happens in the interaction between qualified people. In my opinion we can increase and improve innovation by organizing people with different skills and qualifications in surroundings creating an open and relaxed atmosphere – however with a specific target to work against. When an idea for a technology innovation is born, it needs to be fertilized and developed. Then access to tools, resources and funding in order to continue the process is vital. Lack of means to follow up on ideas kills the innovative culture.

Trond Olsen, Chief Executive Officer, NCE Subsea

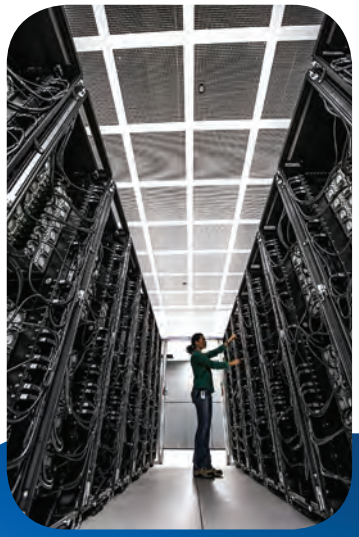
Go to OEDIGITAL.COM and give us your opinion on this month's topic!

Nina Rach

Colloquy

High-performance computing

BP will invest US$100 million in high-performance computing over five years, and part of that is being spent on a new facility at the Westlake campus in Houston, housing the world's largest super computer for commercial research – the Center for High-Performance Computing. The CHPC will serve as a worldwide hub to process and manage geophysical and geological data across BP's worldwide portfolio. BP said its computing needs are 20,000 times greater today than they were in 1999.



Jackie Mutschler, BP's head of upstream technology, said "BP's investment in this new supercomputing center not only highlights the increasingly high-tech nature of today's global oil and gas industry, it underscores our company's long-held belief in the vital role technology plays—and will continue to play—in solving the world's biggest energy challenges."

The three-story facility provides 110,000sq ft of space. The new supercomputer will have memory of 1000 terabytes (1 petabyte) and disk storage space for 23.5 petabytes – equivalent to more than 40,000 average laptop computers or 1.5 million 16GB iPads, which, laid side-to-side, would stretch from Washington D.C. to Philadelphia.

By the end of the year, BP's computing center will hold 6000 computers.

BP worked with HP and Intel to grow its computing power to over 2.2 peta-flops, nearly doubling the company's capability in one year.

In computing, FLOPS (for Floating-point Operations Per Second) is a measure of computer processing speed and performance. A kiloflop=10^3; mega-flop=10^6; gigaflop=10^9; teraflop=10^{12}; and a petaflop is a quadrillion (10^{15}) floating point operations per second.

IBM-built Roadrunner was the first supercomputer to reach 1 petaflop. It cost $120 million to develop at Los Alamos National Laboratory, and had a lifetime of just five years. It was the world's fastest supercomputer until June 2009 but was shut down in early 2013 because of inefficient energy consumption. Roadrunner required 2345 kW to hit 1.042 petaflops (444 megaflops/watt).

BP's new facility features improved electrical and cooling systems that reduce power consumption by 30% over the current computing facility.

While 2.2 petaflops is a massive facility by almost any measure, news broke this past June about a new Intel-based system in China, Tianhe-2 ("Milkyway-2"), that reached 54.9 peta-flops. This is more than twice the speed of any system in the US, said Jack Dongarra, a professor of computer science at the University of Tennessee. The Chinese government spent $290million building the new system, which replaces Tianhe-1, dubbed the world's fastest in 2010. OE

BP's new Center for High-Performance Computing opened in October. Photo: BP.

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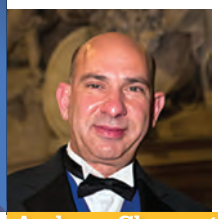

Andreas Chrysostomou

ThoughtStream

Shipping and Environment

Over many decades, shipping has actually become safer and cleaner, not to mention more cost-effective. International rules and regulations in relation to the safety of life at sea or safety in general have been traditionally developed and implemented with great success, not only improving the safety of the ship but also minimizing the loss of life at sea. Oil spills have been reduced, showing also that the focus placed in the 1990s on this type of problem was fruitful.

The marine environment is currently subject to a variety of threats, ranging from the loss or degradation of biodiversity and changes in its structure, loss of habitats, dangerous substances, nutrients and climate change and thus the civil society demands ships to be environmentally friendly and requires the industry to develop and implement measures that minimize the pressure exerted from shipping ons the environment.

Unfortunately, while there are measures to control and reduce pressures and threats on the marine environment, these have been developed in a sector by sector approach resulting in a patchwork of policies, legislation, programmes and action plans at national, regional and international levels.

This tendency can often create a burden without benefit. It also creates huge uncertainty, and uncertainty is the enemy of business. Sustainability can only be achieved if there is a coordinated and targeted effort to address environmental concerns.

Therefore, regulators must clearly define their goals so that the industry can estimate, well ahead, the cost in order to strategically plan its recovery, so that profitability is sustained.

The time is high to achieve environmental protection without the loss of operability, efficiency and, above all, retain shipping as the most economical transport mode for commodities and raw materials. While striving for sustainability and long term viability, it is important to see a number of incentives given to the industry so that technology uptake becomes a norm and efficient and cost-effective operations are no longer temporary actions but again the norm.

It is important to stress here that non-compliance is not an option.

The most challenging and highly politically fused environmental issue today for shipping is greenhouse gas emissions. The global regulator for shipping, International Maritime Organization (IMO), has addressed the problem for the new generation of ships by establishing a mandatory construction standard aiming to more efficient ships in the future. This is not the end of the story, I am afraid, the climate change issue is not something that needs to be addressed at a later stage. Many argue that shipping has to act immediately and will take action by themselves if IMO does not address the existing fleet as soon as possible.

It is, therefore, prudent for the industry to initiate proactive action so that the eventual regulatory regime reaches the industry in a soft way and in a manner that is expected by the industry, so that the industry benefits from it. This could be voluntary application of operational measures over and above of those required.

Achieving holistic and harmonized international maritime environmental rules and regulations requires a concerted effort by all involved: owners, operators and regulators.

Regulators need to have clear targets for environmental legislation and aim at creating a consolidated approach while tackling the problem.

The industry needs to be given incentives to achieve the environmental aspirations of the regulators and, at the same time, to use synergies that will lead to cost effectiveness and efficiency improvements.

Realities such as climate change will strain the industry more in the future and therefore proactive planning and action by the industry is highly recommended. OE

Andreas Chrysostomou *has been Senior Marine Surveyor and Head of the Maritime Policy, Multilateral Affairs and Standards Division in the Department of Merchant Shipping, Government of the Republic of Cyprus since 2004 and Chairman of the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) since 2003. He is currently the 111th President of IMarEST, the Institute of Marine Engineering, Science & Technology, which has more than 15,000 members in 100+ countries and 50 active branches around the world.*

He received a Bachelor of Engineering with Honors in Naval Architecture and Shipbuilding and a Masters in Business Administration from the University of Newcastle-upon-Tyne, and has worked with UN agencies and other forums including UNCTAD, ILPO, COPASS-SARSAT, the International Oil Pollution Fund, and the International Mobile Satellite Organisation.

Mr. Chrysostomou will present the IMarEST President's Day Lecture on 12 Nov 2013 at Trinity House, Tower Hill, London.

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Global Briefs

A Exmar signs LOI

Exmar signed a letter of intent (LOI) with LNG Partners, LLC and LNG BargeCo BVBA for the long-term charter of a Floating Liquefaction & Storage Unit (FLSU) to serve the BC LNG Project near Kitimat, British Columbia, Canada. The two companies have invested in a joint venture company appropriately named Marching Prospect Limited. The new company will acquire interests in the BC LNG Project upstream of the FSLU. In addition, Exmar has loaned US$47,600,645 to finance a non-refundable deposit for the FLSU's construction.

B Technip scores GOM gig

Houston-based LLOG Exploration awarded Technip a contract for the development of the Delta House field. Technip is tasked with project management, engineering, fabrication, installation and pre-commissioning of more than 200km of infield and export flowlines and risers. Overall project managemet will be handled by Technip's Houston office. The infield flowlines and risers will be welded at the company's spoolbase in Mobile, Alabama. The offshore installation is expected to be performed in the 2H 2014 by vessels from Technip's fleet: the *Deep Blue* will lay the deepwater infield lines while the G1200 construction vessel will install the export flowlines.

C Annova LNG files for export

Houston-based Annova LNG LLC has filed an application with the US Department of Energy to receive authorization to export domestic LNG to free trade agreement countries. Located in the Port of Brownsville, Annova's facility is in its initial stages and is expected to be in-service by mid-2018. The facility's output is expected to reach 2 MTPA (1 MTPA per train). Annova's facility was designed to be small enough to sell 100% of its volume in long-term tolling agreements to buyers in FTA countries, with the scalability in place to expand to 6 MTPA.

D Transboundary may head to committee

The US Senate bill ratifying the US-Mexico Transboundary Hydrocarbon Agreement, S. 812, is reportedly on its way to a conference committee. The Senate's version of the bill, passed last month (October), differed from that of the US House of Representative's version. The House ratified the agreement but exempted US companies engaged in joint exploration agreements with Pemex from complying with Dodd-Frank disclosures. Senate's version also ratifies the deal, but without the financial disclosure exemption. The US-Mexico Transboundary Hydrocarbon Agreement that would allow for joint oil and gas exploration between the two countries within the Gulf of Mexico (GOM).

E Keppel, PEMEX develop yard

Keppel Offshore & Marine signed a memorandum of understanding (MOU) at the Ministry of Affairs in Singapore with PEMEX to jointly develop, own and operate a yard facility in Mexico specializing in construction, maintenance, and repair of platforms and other larger vessels. The yard will be located in the Port of Altamira, in Tamaulipas state. The total yard development cost will be around US$400 million, with the first phase estimated at about US$150 million.

F Breagh in production

Production has begun on RWE Dea UK's Breagh gas field located in Blocks 42/13a and 42/12a in the UK sector of the southern North Sea, about 65km off the coast of north-east England. The first three wells brought into production had an initial total flow rate of 2.75 MMcm/d of natural gas, the company confirmed. Total reserves of the Breagh field are estimated at approximately 19.8 Bcm.

G Cyprus estimate revised

Noble Energy, Inc. downgraded the gross resource potential of its A-2 appraisal well, drilled on the Block 12 discovery offshore the Republic of Cyprus. With the reserve potential initially set between 5-8Tcf, the company has now lowered its figures to 3.6-6Tcf. The Houston-based company said the test was limited by surface equipment. Noble operates Block 12 offshore the Republic of Cyprus with a 70% working interest. Delek Drilling and Avner Oil

Exploration each have 15% working interest.

H BPZ spuds Peru well

Drilling has begun on Houston-based BPZ Energy's A-18D development well at the Albacora field platform, located off Peru in Block Z-1. Drilling and completion is expected to take up to 12 weeks. In February, the company conducted 3D seismic data acquisition of Block Z-1 to define its exploration program. Targeted depth of the well will be approximately 12,000ft subsea. BPZ Energy holds 51% interest in offshore Block Z-1, which it is developing in partnership with Pacific Rubiales Energy Corp.

I Parque das Conchas in production

Production has begun at Shell's second development phase of the Parque das Conchas (BC-10) project, located off Brazil's southeast coast. The BC-10 project is comprised of several subsea fields which are tied back to the *Espírito Santo* FPSO vessel.

Shell and its partners announced in July a plan to move forward with the project's third development phase, which will include the installation of subsea infrastructure at the Massa and Argonauta O-South reservoirs.

Once online, phase three expected to reach a peak production of 28,000 boe. Shell's partner ONGC Videsh Ltd increased its stake from 15% to 27%. Shell remains as operator in BC-10 with 73% interest.

J BP joins Moroccan blocks

Kosmos Energy has entered into three farm-out agreements with BP plc covering three blocks in the Agadir Basin, offshore Morocco. Under the agreement, BP will pick up 30% non-operating interest in Essaouira, 26.325% in Foum Assaka, and 45% in Tarhazoute.

The three contiguous blocks cover approximately 25,000sq km and water depths range up to 3,000m.

K Polarcus starts Gabon seismic

Polarcus commenced a 3D seismic acquisition program for Panoro Energy ASA in the Dussafu block off Gabon. The work is planned to cover an area of approximately 1260sq km in the outboard part of the Dussafu license. The primary objective is to upgrade leads that have previously been identified on 2D seismic data to be drillable prospects. These leads are expected to contain pre-salt Gamba and Dentale sandstones. The new 3D seismic acquisition program is expected to be completed by mid-November, with the first high quality seismic products available during Q2 2014. The fully processed seismic data is expected to be available for interpretation and mapping by the second half of 2014.

L Tullow joins Namibia license

Tullow Kudu Ltd entered a farm-in agreement with Australian explorer Pancontinental Oil and Gas NL for 65% of the company's EL 0037 license offshore Namibia. Pancontinental will retain 30% with partner Paragon Oil and Gas holding the remaining 5%. Terms of the agreement includes Tullow funding extensive 3D and 2D seismic campaign and drilling an exploration well. The 3D seismic survey is expected to begin next year.

M New MOU for Ivory Coast

Rialto Energy Ltd's Ivory Coast subsidiary signed a new memorandum of understanding (MOU) with the Cote d'Ivoire Ministry of Oil & Energy,

the state-owned oil and gas company PETROCI, and Vitol E&P to replace the existing production sharing contract for block CI-202. The new PSC reflects the new proposed entry of Vitol into the partnership, which was announced last April. Rialto agreed to sell 65% interest in CI-202 for an initial US$50 million to fund appraisal and development activities on the block.

N BKE in Dragon jackup deal

Dubai-based Dragon Oil plc has leased two LeTourneau S116E jackup rigs from BKE Shelf Ltd to use in its Cheleken Contract Area, offshore Turkmenistan. The Neptune and Mercury have been contracted for a period totaling three years. Neptune will be utilized for the first nine months of the project, and is expected to be available in the fourth quarter. Operations will then shift to the Mercury for the remainder of the three-year term. Dragon is the sole operator of Cheleken, which includes two offshore oil and gas fields, Dzheitune (Lam) and Dzhygalybeg (Zhdanov) in water depths of between 8-42m (26-137 ft).

O Lagansky block agreement

Lundin Petroleum AB and its partner Gunvor Group signed a heads of agreement with Rosneft Oil Company to jointly sell 51% of PetroResurs LLC. PetroResurs, the Russian subsidiary of Lundin, is the 100% owner of the Lagansky block license, located in the northeastern Caspian Sea. The Lagansky block license contains the Morskoye discovery with best estimate gross contingent resources of 157MMboe. Lundin currently controls 70% of PetroResurs, with Gunvor holding the remaining 30%.

P Kashagan offline

For the second time since it produced first oil in September, a gas leak has sidelined Kashagan's operations. As of press time, Kashagan has not returned to production.

Q Petronas approves Lundin's plan

Lundin Malaysia won the approval of its Bertam field development plan from Malaysia's Petronas. The Bertam field marked Lundin's first development project in the country.

R Roc surveys Bohai Bay

Roc Oil Company Limited announced the completion of its 162sq km 3D ocean bottom cable (OBC) seismic campaign in the 09/05 exploration license, located in the Bohai Bay, offshore China.

S Chevron, Tohoku agree

Chevron's Australian subsidiaries signed binding long-term sales and purchase agreements with Tohoku Electric Power Company, Inc. to supply LNG from the Chevron's Wheatstone Project in Western Australia.

T CGG completes Australian 3D survey

CGG completed completion its first BroadSeis-BroadSource survey in Australia in July. The 2810sq km 3D BroadSeis survey was acquired by the *Viking Vision* towing a 12 x 100 x 6000m spread of steerable Sercel Sentinel solid streamers and equipped with BroadSource, the company's proprietary broadband marine seismic source.

Contract Briefs

FMC wins TEN order

FMC Technologies, Inc. received an order from Tullow Ghana Ltd to supply subsea systems for its Tweneboa-Enyenra-Ntomme Development (TEN) offshore Ghana. The order has an estimated value of US$340 million in revenue. FMC Technologies' scope of supply includes subsea trees, manifolds, tooling, associated subsea control systems and systems integration.

CB&I UK, Foster Wheeler selected for FEED

Rosneft and ExxonMobil selected CB&I UK and Foster Wheeler Energy as the initial phase front end engineering and design (FEED) contractors for the two companies' Russia Far East LNG project. FMC Technologies' scope of supply includes subsea trees, manifolds, tooling, associated subsea control systems and systems integration.

Veolia subsidiary wins Ichthys

Daewoo Shipbuilding & Marine Engineering (DSME) awarded Veolia Water Solutions & Technologies a contract to supply an MPPE unit for the Ichthys LNG project FPSO. The INPEX-operated Ichthys LNG project will involve offshore preliminary processing of gas from the Ichthys Field to remove water and extract condensate before being transported to onshore via an 889km pipeline.

GMC Inc. awarded Moho Nord

GMC Inc. will deliver its high-strength fatigue-resistant mechanical connector as part of Total's Republic of Congo Moho Nord TLP project. GMC will supply over 100 sets of its concentric thread, pin and box type connectors under contract to Hutchinson Offshore's Techlam S.A., which is supplying the entire TLP tendon system to Hyundai Heavy Industries.

C-MAR wins EMAS work

C-MAR Group has announced that it has won a major crewing contract with EMAS AMC, which will see the business provide the marine crew for the 520ft, reeled pipelay vessel the Express, until summer 2015. The agreement means that C-MAR has now provided marine crews on board the Express for three different owners: Torch Offshore, Helix Subsea Construction, and EMAS AMC, since the vessel was commissioned in 2004.

Bourbon sells support vessels

Bourbon announced that it sold three vessels, including a tug, an MPSV (multipurpose supply vessel) from the Subsea Services fleet and a PSV (platform supply vessel), for an approximate total amount of US$38 million generating a total capital gain of approximately US$18 million.

The three diesel propulsion vessels were between 10 and 21 years old.

Maersk jacks-up Al Shaheen

Maersk Oil Qatar (MOQ) and Gulf Drilling International (GDI) have signed two new contracts; one two-year contract for the GDI jack-up drilling rig (rig B-341), and another three-year contract for a new GDI offshore accommodation jack-up. The total value of these contracts is more than US$205 million (QR 750 million).

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ExxonMobil's Harmony platform jacket, which stands in 1198ft water depth in the Pacific Outer Continental Shelf.
Photo: US Dept. of Interior, BSEE.

The piece small challenge

Large structures in deep water Gulf of Mexico are set to challenge established decommissioning methodologies in the basin, while the North Sea still awaits its bow-wave of activity. Elaine Maslin reports.

Globally, the offshore decommissioning market has largely been limited to two basins, the Gulf of Mexico and the North Sea.

Both are facing challenges. For the Gulf of Mexico, which has an established decommissioning supply chain, experienced in removing hundreds of platforms a year, the move to removing structures from deeper waters will be the key challenge in coming years.

For the North Sea, the challenge is aligning the supply chain and available capacity to an ever shifting cessation of production date, against high demand from greenfield projects and the emerging offshore wind installation market.

US

The US Gulf of Mexico has an established decommissioning market, with about 4100 of approximately 700 structures removed today.

Annually, about 150-200 structures are removed per year, says Robert Byrd, vice president, consulting, of Houston-based TSB Offshore. Most weigh less than 2000-tonne and are typically removed in single lifts.

The decommissioning market benefited from "idle iron" regulations, brought in post-2005, when hurricanes Rita and Katrina damaged or destroyed close to 200 platforms. The iron regulations require operators to remove non-operational facilities after set periods of time.

This increased decommissioning activity, from about 100 facilities per year to closer to 200, says Byrd, bringing contractors close to capacity.

The US market also benefits from a relatively smooth decommissioning process, enabling it to plan and start executing decommissioning projects in months, as opposed to years in the North Sea, says Byrd, who was speaking at the Offshore Decommissioning Conference in St. Andrews, Scotland, in October.

This is not because the regulation is different—both regimes are quite similar, apart from additional post-decommissioning monitoring requirements in the UK, he says. The difference is that in the US operators work through one agency, which co-ordinates the different studies,

Table for Analysis - Decommissioning

Platform	Water depth(ft/m)	Jacket weight (st)	Year installed
EB 159 A - Cerveza Ligera	925/282	14,991	1982*
EB 160 A - Cerveza	935/285	19,952	1981*
EB 165 A - Snapper	863/263	20,503	1985
EW 873 A - Lobster	774/236	16,535	1994
GB 128 A - Enchilada	705/215	n/a	1997
GB 189 A - Tick	720/219	11,023	1991
GB 236 A	685/209	13,228	1980
GB 260 A - Baldplate	1648/502	57,267	1998
GC 18 A	761/232	14,881	1986
GC 19 A - Boxer	750/229	14,881	1988
GC 65 A - Bullwinkle	1348/411	54,427	1988
MC 109 A - Amberjack	1100/335	23,810	1991
MC 194 A - Cognac	1023/312	33,620	1978*
MC 280 A - Lena	1000/305	23,366	1983*
MC 365 A - Coral	619/189	n/a	1992
VK 780 A - Spirit	722/220	19,012	1998
VK 989 A - Pompano	1290/393	39,890	1994

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)	96	106	74	36
Deep (500-1500m)	28	26	23	11
Ultradeep (>1500m)	36	20	34	19
Total	160	152	131	66

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	28	128.30	1,226.50
Deep	23	1,378.71	1,624.87
Ultradeep	26	2,969.00	3,420.00
West Africa			
Shallow	148	3,416.55	18,047.59
Deep	46	5,454.00	6,320.00
Ultradeep	14	1,900.00	2,650.00
Total (last month)	363 (362)	32,653.76 (32,683.76)	53,863.96 (53,843.96)

Greenfield reserves

2013-17

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow (last month)	1,275 (1,271)	65,189.99 (75,101.59)	787,740.02 (813,262.02)
Deep (last month)	159 (161)	13,507.58 (13,657.58)	79,626.57 (80,626.57)
Ultradeep (last month)	98 (98)	17,516.45 (17,551.45)	66,727.00 (66,747.00)
Total	1,532	96,214.02	934,093.59

Pipelines

(operational and 2013 onwards)

	(km)	(last month)
<8in		
Operational/ installed	41,918	(41,886)
Planned/ possible	25,292	(24,998)
	67,210	(66,884)
8-16in		
Operational/ installed	77,695	(77,601)
Planned/ possible	48,610	(48,127)
	126,305	(125,728)
>16in		
Operational/ installed	89,156	(89,139)
Planned/ possible	49,698	(48,392)
	138,854	(137,531)

Production systems worldwide

(operational and 2013 onwards)

Floaters		(last month)
Operational	273	(273)
Under development	50	(50)
Planned/possible	324	(321)
	647	(644)
Fixed platforms		
Operational	8,705	(9,688)
Under development	125	(138)
Planned/possible	1,475	(1,465)
	10,305	(11,291)
Subsea wells		
Operational	4,400	(4,385)
Under development	414	(410)
Planned/possible	6,220	(6,197)
	11,034	(10,992)

Global offshore reserves (mmboe) onstream by water depth

	2011	2012	2013	2014	2015	2016	2017
Shallow (last month)	10,474.81 (10,467.31)	5,998.15 (5,996.47)	49,549.97 (65,183.42)	27,950.84 (29,947.35)	39,766.34 (36,875.97)	34,249.15 (34,291.26)	53,103.15 (52,732.53)
Deep (last month)	1,312.21 (1,312.21)	2,500.15 (1,735.15)	3,387.61 (3,387.61)	5,706.11 (5,710.92)	4,368.72 (4,363.91)	4,930.34 (5,106.65)	9,153.17 (9,303.17)
Ultradeep (last month)	199.94 (199.94)	737.15 (737.15)	3,243.07 (3,243.07)	2,922.43 (2,922.43)	2,109.58 (2,004.29)	5,519.67 (5,678.49)	15,543.97 (15,528.97)
Total	11,986.97	9,235.44	56,180.65	36,579.38	46,244.64	44,699.16	77,800.30

14 October 2013

applications and processes. In the UK, the operator deals with the different agencies, from the Department of Energy and Climate Change (DECC) to the Coast Guard.

Gulf of Mexico challenges

The Gulf of Mexico is facing some large challenges, however. Operators are beginning the process of decommissioning larger structures in deeper waters—jackets typically in excess of 10,000-tonne, in water depth greater than 1000ft (312m).

"A number of these facilities are getting into pre-feed phase of decommissioning and in the coming 3-5 years we will start to see some of these platforms start to come out," says Byrd. "This is going to be a significant challenge for us."

The challenge, he says, is the methodology used for the removal. "Our bread and butter is single piece jacket and topsides lift," he says. "These larger structures will not lend themselves to that process."

The Lena guyed tower, for example, is 1025ft in length, weighing 25,000-tonne. The Cognac platform, which was the first in excess of 1000ft jacket installed, he says, was installed in three pieces.

"We simply haven't really addressed the technology that's required for decommissioning these structures.

"One of the things the hurricanes did for us, in 2005, is push us in to development of new and better technology for heavy lift, and particularly for lifting large weights off the bottom in water depths of 300-400ft. But that still doesn't get us into the type of lifting technology for these 1000ft plus jackets.

"Piece small removal will very likely be required. But, while you talk here in the North Sea about small piece removal as a standard way of doing things, it's actually quite new for us in the Gulf of Mexico.

"The piece small process also presents challenges logistically—how to deal with the actual lifting and cutting. It's going to be a real opportunity for the contractors providing cutting services and ROVs."

The Gulf of Mexico does have the benefit of a strong reefing program, unlike the North Sea or the Pacific Outer Continental Shelf. It is likely that the very large jackets due to be removed will be reefed, says Byrd.

Since Louisiana's artificial reef program began in 1986, 71 offshore reefs utilizing the jackets of 320 obsolete platforms have been created off Louisiana's coast. Gulf-wide, more than 400 obsolete platforms have been converted into permanent artificial reefs, according to the state Department of Wildlife and Fisheries.

Many of the same issues are arising in the Pacific Outer Continental Shelf. Here there are 28 platforms, all quite large. "These will all be a challenge for us," says Byrd.

"In places like California, the barge transportation will be far more complicated than we have to deal with to date, because there is virtually no infrastructure.

"Creating infrastructure for large structure decommissioning is going to be a challenge everywhere. Even in the Gulf of Mexico we do not have the onshore facilities that are required to support the removal of some of the very large structures. In California there simply is no infrastructure at all."

UK

While the US market is well-established, the UK's North Sea Continental Shelf (UKCS) decommissioning market is still agonizing over when the anticipated bow-wave of decommissioning activity will start.

There are 297 platforms

in the UKCS, according to the UK Government. A Royal Academy of Engineering report in 2012 says 31 of those have large steel jackets weighing more than 10,000-tonne, and eight have large concrete substructures.

According to a survey of 27 UK North Sea operators (representing 87% of basin activity) by Oil and Gas UK, about £10.4billion will be spent on decommissioning over the next 10 years, peaking 2015-2019—a period later than the previous year's survey predictions.

This will include 2300km of pipelines, infrastructure in 74 fields, 800 wells, more than 70 subsea projects and more than 130 installations, says the report, released at the St Andrews conference.

The majority of the cost, 44%, will be in the deeper, harsher northern North Sea, with 32% in the central North Sea and 24% in the southern North Sea and Irish Sea.

Most of the cost, 43%, is expected to be spent on plugging and abandoning (P&A), with a further 21% on removal and 19% on overheads. The remaining cost will be on topsides preparation and making safe facilities and pipelines.

Average costs of well P&A in the northern and central North Sea, based on current spending, were estimated as £4.7 million for a platform well, £8 million for a subsea exploration and appraisal well, and £10.1million for subsea development wells.

In the southern North Sea and Irish Sea, average costs were estimated as £3.5 million for a platform well and £6.6 million for subsea wells, of which there are fewer.

The limitations in the North Sea are seen to be not having enough heavy lift vessels with the capacity to lift and remove the tonnage expected.

"If we look at the limited number of successfully decommissioned platforms to date, removal has been limited to below 5000-tonne," says Abigail Clark, analyst at Oil & Gas UK, also speaking at the conference, organized by Oil & Gas UK and Decom North Sea.

"A number of steel structures ranging from 4000-20,000-tonne have been approved for fabrication and many of these are expected to be ready for production before 2017, so competition for heavy lift vessels is expected to be high also, although flexibility in decommissioning is expected to alleviate this."

Capacity for onshore disposal, with 405,000-tonne expected to land on shore in the next 10 years, is thought to exist, but it has yet to be tested on management of materials, according to a Decom North Sea study.

A further capacity constraint is for rigs, already in demand for production, exploration and appraisal well drilling, associated services and human resources.

The UK industry is also behind the Gulf of Mexico in understanding the longer term effects of offshore installations on the North Sea eco-system.

"Through JIPs and work with Decom North Sea, there is a realization we don't know much about the interaction of installations with the North Sea eco system," says Mick Borwell, Oil & Gas UK's environmental issues director. "The Gulf of Mexico does, but the North Sea is different. We need to acquire new knowledge."

A scientifically independent research initiative, Insight, has now been launched to address this, added Borwell.

International

Outside the Gulf of Mexico and the North Sea, there are only potential markets, in places like West Africa, Middle East, India, south Asia, and southeast Asia, says Bryd.

"There are thousands of wells that have been suspended and dozens, if not hundreds, of platforms currently idle, particularly in places like the Gulf of Thailand," he says. "The problem in the broader international market is the lack of clear and firm regulations.

"This is an issue that is evolving, particularly in southeast Asia. A group of Asian countries recently adopted a broad outline for decommissioning regulations, but they have not been implemented. This is standing in the way of seeing a lot of actual decommissioning taking place.

"The other impediment, and perhaps an even more difficult issue to resolve, is the national oil companies, who are generally involved very heavily in places like Indonesia, and to some extent Malaysia and Thailand, are very reluctant to spend the money required on decommissioning." OE

CNR's central North Sea Murchison platform.

The Murchison platform is in Block 211/19, northern North Sea in 156m water depth. First production was in 1980.

It stands on an 8-legged steel jacket, weighing 24,640-tonne, excluding piles. It is a candidate for OSPAR derogation, which means part of the jacket could be left in place.

The topsides comprise 26 modules, weighing 24,584-tonne. It has 34 wells, one of which is subsea. It also has subsea infrastructure.

Murchison's total height is 254m (833ft).

Aker Solutions was recently awarded a three year contract for the engineering design, procurement and offshore execution to prepare the facilities for removal.

The estimated landing to shore of material period is 2015-2021.

Gaming technology goes upstream

Through its development in the gaming and defense sectors, gaming technology is being adopted by various industries, including oil and gas. Elaine Maslin reports.

The gaming industry has become big business - bigger than the movie business, says Gary Hufford,

head of engineering and design software firm Aveva's visualization center of excellence, based in Cambridge, England. He was previously CEO of Global Majic Software Inc., whose visualization and simulation software was bought by Aveva in late 2012.

Global Majic is one of an increasing number of simulation and visualization specialists that or are being used by the offshore oil and gas industry.

Gaming technology is now run on standard Windows systems, making it more compact and accessible, and more practical and economical to use, says Hufford

As a result, powerful graphics and rendering engines—computer software able to simulate the physical properties and appearance of objects—are being adopted by industries outside defense, gaming and science.

Within the oil and gas sector, Aveva recently launched its Aveva Activity Visualisation Platform (AVP). It enables the creation and secure distribution of training simulations, or "applications," which can be remotely accessed and used in single and multi-player modes.

The system uses computer-aided design (CAD) or laser scan data of

Aker Solutions' recently opened iPort at Forus, near Stavanger. Photo: Aker Solutions.

facilities to create 3D virtual reality (VR) environments.

The rendering engines include Nvidia's Physx, commonly used in graphics processing units to perform physics calculations in computer games such as Borderlands 2 and Metro: Last Light, creating "dynamic destruction, particle-based fluids, and life-like animation".

For AVP, the result is a training environment in which objects display the physical characteristics they would in the real world: wheels on machinery or vehicles rotate as they would in real life; you cannot run through walls; plant reacts to "player" inputs.

In AVP, each application is built from a library of elements of plant and the built environment in the AVP Studio part of the system. Almost everything about the simulation environment can be changed. Sessions can operate in training and test modes, offering more or less guidance for the user in order to test their capabilities.

It is all about combing data and gaming engines, says Jeremy Jones, marketing manager, Enterprise Solutions, AVEVA. "It is about creating a full and detailed integration between the gaming world and the 3D design and construction world."

Along with Santa Clara, California's Nvidia Corp., companies behind the physics engines include Montreal-based CM Lab Simulations Inc., with its Vortex software, and Ede, Netherlands-based Tree C Technology, with its VR4MAX software combining physics and rendering.

Reservations?

The push towards virtual (VR) or immersive reality systems could repeat the virtual reality boom and bust of the 1990s. Professor Bob Stone, director of the human interface technologies team in the Human Factors Integration Defence Technology Centre at the University of Birmingham, says issues with VR in the 1990s were the cost of graphics computers, display, and input technologies.

"The use of stereo displays, or 3D projection, is not all it is hyped up to be," says Stone. He quoted some research that suggests 53% of the population have some form of visual defect that prevents them from seeing stereo over a sustained period. Stone says there is little evidence that such environments deliver any performance benefits

The difference now is that VR is being replaced by gaming technologies more advanced than their VR predecessors, and they are operable on standard PCs.

Research also suggests that single-point simulators, such as drilling or crane simulators, are less affected and that users are more likely to engage with a system with greater realistic properties.

This was recently emphasized by the International Marine Contractors Association (IMCA) in its latest guidelines on simulator usage.

It emphasizes that a simulator's level of realism impacts the learning experiences' effectiveness on commonly-used simulators for equipment familiarization.

Physics

Gaming engines are being used for more than just training and simulation, however. Aker Solutions is using physics engines to inform its maintenance and modifications design and operations, says Geir Endresen, manager of Aker Solution's Visioneering, which recently took control of Aker Solution's new, purpose-built iPort center, near Stavanger.

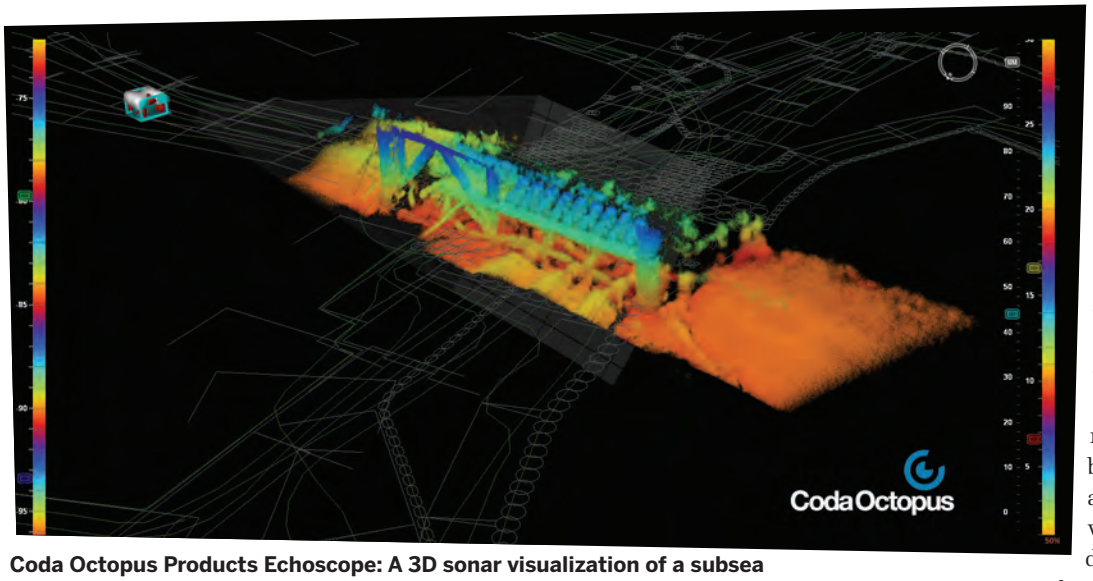
Visioneering is based on technology developed by Norway's First Interactive, which Aker Solutions has been using since the early 2000s. This has been primarily through its drilling unit, in order to plan, test and train on drilling operations in a simulated environment, complete with a staircase to the drill floor and walkie talkies to communicate to other team members on the simulation.

After buying First Interactive in 2010, Endresen says Aker Solutions now sees potential for its use in maintenance and modification operations. Using physics engines to test operations has improved operational engineering, increased efficiency, reduced risk and improved HSE—all of which are demanded by operators.

"One of the main drivers of this technology is the possibility to add the physics into the design," says Endresen. "In a normal engineering development,

AVEVA Activity Visualisation Platform

Inside Aveva's AVP system. Images: Aveva.



Coda Octopus Products Echoscope: A 3D sonar visualization of a subsea manifold, created in real-time. Image:Coda Octopus Products.

you don't have the physical aspect. This is particularly useful for brownfield modifications and installations."

One project, to install new lifeboat facilities on Statoil's Visund platform, used Visioneering to trial and train on the planned installation operation, a process involving lifting a structure onto a congested area on the deck.

As a result of the simulated trials, the procedure was optimized by adding a ballast to the platform in order to achieve a better installation angle when lifting new structures. Visioneering helped to train staff and project teams on a procedure before implementation.

This informed the layout of iPort, which meant creating separate simulation and engineering design workspaces, used as a local integrated operation center. "You can use the working rooms to carry out changes to the design as you are working in the virtual environment," says Endresen.

Graphics

Most of the simulation tools use graphics cards, which have reached high levels of fidelity and are compact, readily available, and relatively cheap.

But they are not limited to rendering 3D CAD data or creating virtual reality worlds. Edinburgh-based Coda Octopus Products has developed tools to allow engineers and operators to see, position and map subsea work sites in real time.

The firm's Echoscope sonar device is able to produce instantaneous 3D images of stationary and moving objects subsea. It uses phased array technology to generate more than 16,000 soundings simultaneously at an update rate of 12 Hz with an angular coverage of up to 55° x 55°.

When the sonar moves, the 3D data can be mapped or made into a mosaic, and users can view the 3D scene from different angles in real time using the firm's Underwater Survey Explorer (USE) software, which was developed using 3D graphics cards from the gaming industry.

Because the data density is so high, the USE rendering engine can reduce noise, resulting in high-quality, real-time imagery, says Robert Carsley, Coda Octopus Products' Commercial Director.

Echoscope and USE also work on moving objects, and when required, the moving images can incorporate visualizations based on data from a positioning system on a lifting device, augmenting the sonar-reality with a visualization of a lifting arm or crane. They can also overlay the image with previous 2D graphics or a worksite plan, for example detailing the infrastructure present in a subsea oil field. OE

Software augments reality

Aberdeen-based Return to Scene Ltd. has used spherical photography and software to create walk-through environments of assets—rust and all—complete with design data and historic inspection data

Image: Return to Scene.

The R2S tool was developed for the forensic community to photographically capture crime scenes into rendered visual environments embedded with searchable crime scene data. This data includes DNA swab information (whether or not it has been processed), and is accessible remotely through a secure online system.

R2S has since been adopted by security agencies and now offshore operators. One of its largest projects on one facility involved shooting spherical images at 7500 locations, each requiring two shoots and about 21 images per shoot, resulting in about 315,000 high-resolution images. These were then digitally reworked and compressed so they are easy to download or access, complete with embedded updateable data, including P&IDs, inspection histories, procedures.

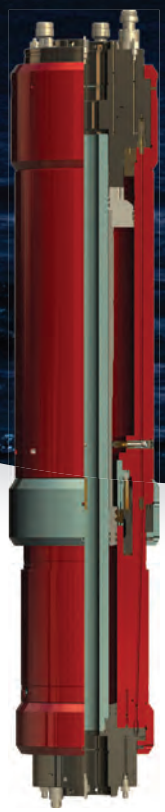
The next generation of the system will link into other systems, and allow users to go from a management system, to an image of the item, and related data.

Here, the driver for the technology is bed space on aging assets, says Bob Donnelly, business development director at Return to Scene. Maintenance engineers and technicians, internal and contractors, require access to assets. Images of the actual asset provide the ability to assess condition or corrosion levels remotely, become familiar with an asset, and carry out surveys.

CAD designs can be embedded into the images, and measurements can be taken from the images, to a higher degree of accuracy than by physical tape measure, says Donnelly.

Staff offshore can take images and embed them into R2S, allowing updates. Repeated photo shoots are necessary for condition and corrosion monitoring. ■

Test Safer.



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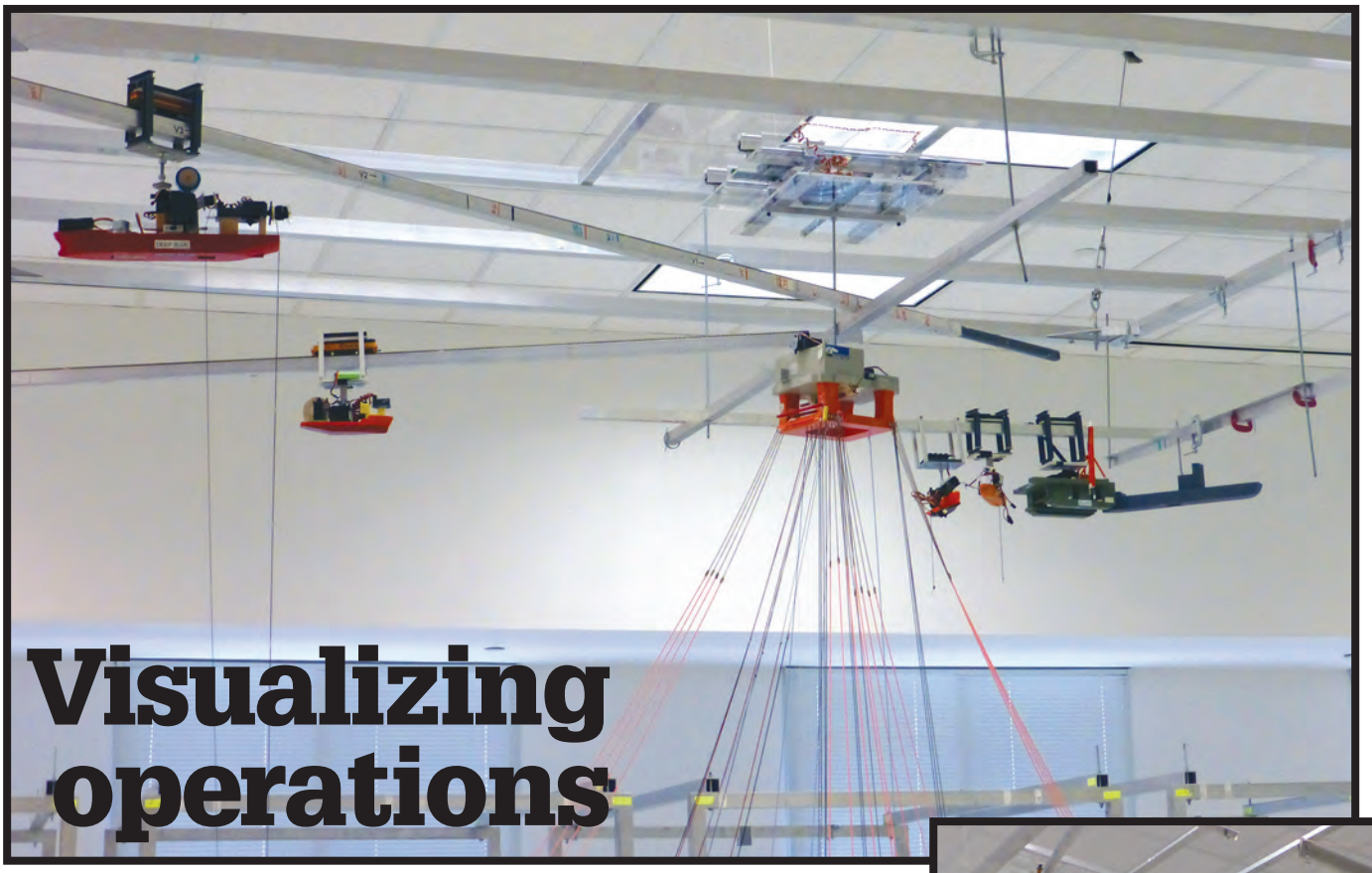


Visualizing operations in Technip's model lab

By Nina Rach

Physical modeling deep water projects can be a very useful tool. Despite the advent of computer modeling and immersive computer visualization environments, physical 3D models help vessel operators, riggers, and field engineers find potential problem areas and resolve spatial issues.

Robert (R.J. "Bob") Brown builds intricate 3D physical models to map the installation of complex subsea systems with many risers and mooring lines. Brown runs R J Brown Deepwater, a subsidiary of Technip that specializes in deepwater energy engineering. His models incorporate subsea system components such as pipelines, manifolds, risers, mooring lines, as well as floating facilities and support vessels.

Brown reviewed the benefits of physical modeling for deepwater pipeline and riser installations in a paper presented at the OTC in May 2009 (OTC 19962). Brown and Arash Razavinejad, a senior staff member at Genesis Oil and Gas, explained deepwater models and systems in Technip's Houston model lab in October.

Thunder Horse model

Thunder Horse production-drilling-quarters (PDQ) is the world's largest production semi-submersible, installed over the deepwater Thunder Horse oil field in the Gulf of Mexico, about 150mi. southeast of New Orleans. It's moored in 6075ft (1852m) of water in Mississippi Canyon Blocks 778, was completed in 2005, and delivered first oil in June 2008. Thunder Horse is a joint venture of BP plc (75%) and ExxonMobil (25%).

Technip's suspended model of the Thunder Horse PDQ includes catenaries and work vessels at a scale of 1:650. A catenary is the curve that an idealized hanging cable assumes under its own weight when supported only at its ends. Bob Brown said the shapes of all the suspended lines in the model are accurate catenaries. Although the mooring lines, umbilicals, production, water, test, and export risers are modeled with different lightweight cords, they respond to gravity in the same way as the actual risers. The only difference is the vertical load in the hanging point of each catenary.

Bob Brown, left, and Arash Razavinejad manipulate the Thunder Horse subsea model at Technip facilities in Houston. Photos: Nina Rach.

The PDQ can only move within a 350-ft radius due to constraints of the suspended umbilicals. The model is used to measure interferences between rigging, mooring, hull, vessels, flare booms, etc.

The work vessels have 2500hp, 6-wheel drive motors, and the suspended framework allows engineers to simulate yaw (rotation around the vertical axis; side-to-side movement of the ship's bow), surge (linear longitudinal, front-to-back motion), and sway (linear lateral, side-to-side motion).

Exact coordinates of the PDQ and each vessel is drawn on the seabed (floor of model room) using Autocad. The positions are projected using laser plumb bobs for accurate positioning.

The model was used during the installation of the 21 pipeline end terminations (PLETs) and BP Thunder Horse subsea manager John Bednar congratulated Brown and his colleagues Ken Cross and Kevin Feizkhah, saying the model "provided an unusually effective vehicle for analysis and procedure development, as well as for training and visual demonstrations."

Frade model

The Frade field is in the northern Campos basin, 122km off the coast of Brazil, in water 3280ft to 4429ft (1000m to 1350m) deep. The area has an irregular sea-bottom and is subject to high and unpredictable bottom currents. Chevron used Acergy's CSV *Polar Queen*, a flexible pipelay and subsea construction vessel, to install flexible flowlines, risers, PLETs and umbilicals at Frade.

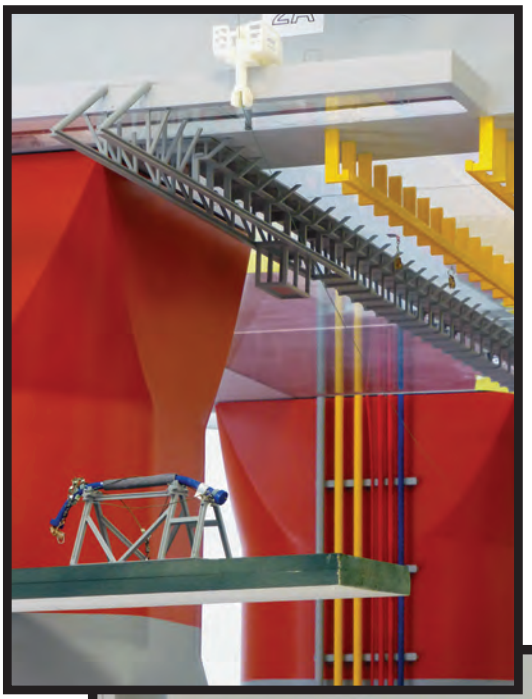
After field installation, Chevron needed to wet park 18 flexible pipe risers and 4 umbilical risers. Then, after the turret FPSO was in place, the risers and umbilicals needed to be recovered from 3494ft (1065m) water depth and transferred to the Frade FPSO.

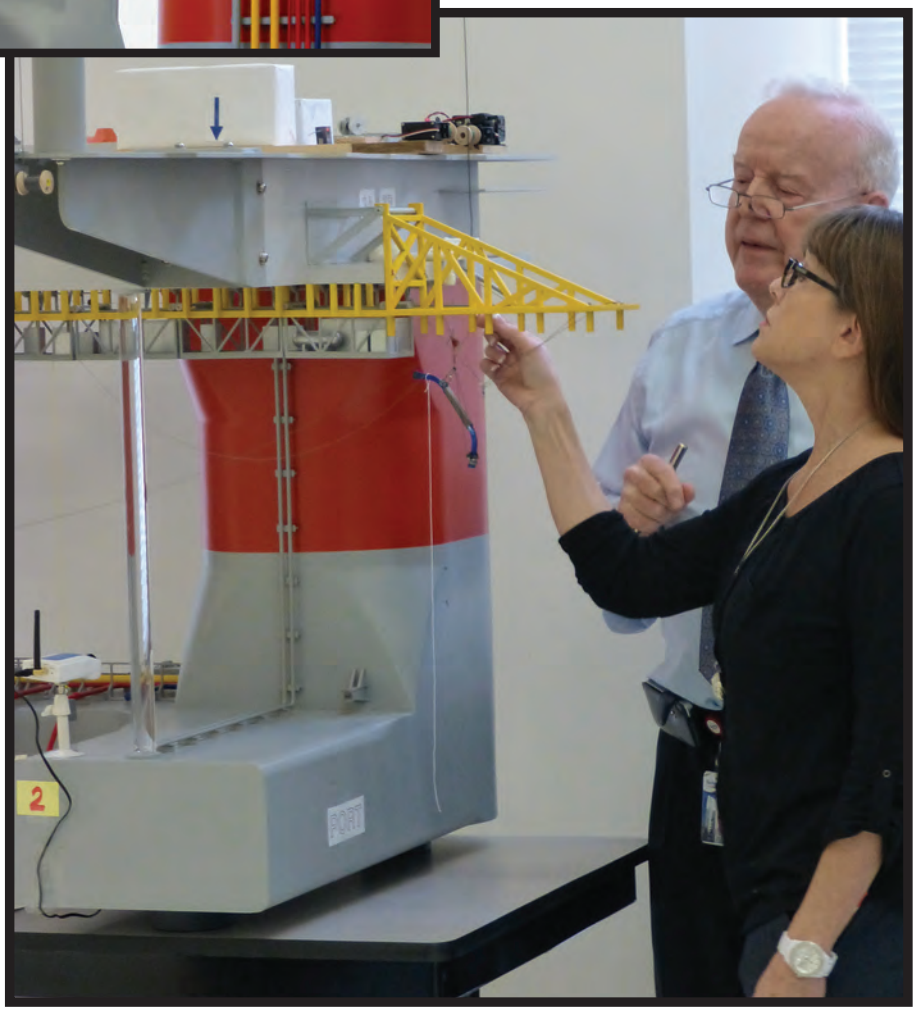
In October 2008, Chevron contracted the team from RJ Brown Deepwater to model the wet park, recovery, and installation of the risers, umbilicals, and 9 mooring lines before the work was done in the field. They constructed a 1:290 scale model and held five model simulations of Chevron's planned procedures (laydown, keel haul, mooring, POQ pull-in, NM pull-in), all videotaped in the Technip model room. The main challenges were examining the wet park curve, anchor clamp chain installation, riser recovery route, transfer depth, and assessing interference risk. The model work highlighted several problem areas with risers and orientation of the installation vessel, and improved the actual field procedures.

Acergy authors reviewed the results of the Frade work in a paper presented at the Offshore Technology Conference in May 2010 (OTC 20850).

Chevron's Frade flexible pipe coordinator, Antonio Critsenelis, said "the model exceeded expectations" and said he would "certainly recommend it for other projects as a high-value design assurance tool…Chevron and the installation contractor [Acergy]…certainly benefited from the insightful learning form the simulations."

Bob Brown reviewed the benefits of physical modeling for deepwater pipeline and riser installations in a paper presented at the OTC in May 2009 (OTC 19962). Brown's career was built on his early innovations in marine pipelining, and he was inducted into the Hall of Fame at Galveston's Offshore Energy Center in January 2009 as an Industry Pioneer, for innovations that made marine pipelining more efficient and much safer. OE





Bob Brown and assistant Carolina Sones discuss the tabletop model of the north half of the Thunder Horse PDQ.

Isometric sampling: The next milestone in integrated

After a decade of R&D spanning the globe, a new class of marine seismic technology has now been commercially deployed. Nina Rach spoke with Chris Cunnell of Schlumberger.

In an ideal world, a seismic survey would have a grid of sensors across the full area of interest, but the constraints of working at sea have never permitted this. The reality is that surveys have towed a fairly narrow spread of streamers. To approach the ideal, our industry has increased the number and width of streamers, but there are still limitations. In order to make seismic surveys efficient, previous common practice was to increase the size of the spread, with fairly widely spaced streamers, typically separated by 50-100m. In very specific circumstances, such as high-resolution site surveys, the spacing is narrower.

The problem is that although we're able to measure the seismic wavefield anywhere from 12.5m down to 3.125m on a Q-Marine point-receiver marine seismic system along the streamers, the sensor separation between the streamers is still 50-100m.

The multisensor streamer system deployed offshore Canada to acquire an IsoMetrix marine isometric seismic survey. Photo: WesternGeco.

Chris Cunnell

This results in an asymmetric sampling of the subsurface and it affects data conditioning and migration, ultimately leading to "smeared" images which add uncertainty to subsequent interpretation.

Marine isometric seismic technology offers a new approach to seismic acquisition and processing, based on isometric sampling, which improves the density of measurements, both inline and crossline. The benefits are wide ranging and include increased exploration efficiency, broadband imaging in three dimensions, and the potential for fresh geological insights from fine-scale subsurface characterization.

The company presented examples of the new technology at the recent Society of Exploration Geophysicists annual conference in Houston in September. Based on data collected in the North Sea, Dr. Malcolm Francis discussed advantages this high resolution imaging brings to shallow hazard analysis, well planning and the design of well bores, and enhanced reservoir characterization.

Theory

The cornerstone behind the technology is the premise that the gradient of the pressure wavefield (ΔP) in a medium is directly related to the acceleration of particle motion (the rate of change of velocity, ∂V/∂t) as follows:

$\Delta P = -\rho\, \partial V/\partial t$, where ρ is the medium density.

If we are able to measure particle acceleration in two directions, we can extract the gradient of the pressure wavefield and use this in the seismic processing workflow.

Measuring the pressure wavefield gradient enables two new developments:

- Full 3D deghosting (a specific type of multiple removal) to extend the seismic bandwidth.
- And by measuring the gradient in the crossline direction, then we can reconstruct the pressure wavefield between the cables, creating a set of very densely spaced virtual streamers.

IsoMetrix

IsoMetrix Technical Marketing Manager Chris Cunnell describes the 10-year development of isometric sampling techniques as one of the largest research and engineering projects in Schlumberger history. The company has developed a new type of multi-measurement point-receiver streamer which combines traditional hydrophone P-wave measurements with multi-sensor accelerometer measurements. These are based on micro-electromechanical systems (MEMS) technology, and are used to record both vertical and horizontal crossline measurements of pressure gradient. It is this combination of all three measurements that provide the information which allow 3D deghosting and proper wavefield reconstruction between cables.

OE: Why hasn't this been done before?

CC: The basic premise has been known for some time, but until now we were unable to create a multimeasurement sensor that captured high-fidelity and robust accelerometer measurements with good signal-to-noise separation across the full frequency spectrum.

During the early stages of development, we made an effort to understand the very complex sources of streamer-borne noise modes. Experimental and modeling studies helped us to design a system that would accurately measure noise and then filter it out.

3D marine seismic

OE: When was this system available to clients?

CC: We completed field testing in late 2011, close to our development site, in the Norwegian North Sea. The IsoMetrix system was officially launched in June 2012 at the EAGE conference in Copenhagen. Since then, we have completed seven projects in a wide range of settings; including the North Sea, offshore United Kingdom and Norway; South Africa; the Barents Sea; and a survey off Canada.

These surveys range in size and objective, from exploration to reservoir characterization for appraisal and development, including a 4D qualification in the UK sector of the North Sea, and cover a range of customers including independents, IOCs as well as Schlumberger multiclient projects. We have a strong backlog of activity into 2014, and will start a large program for Woodside off northwestern Australia this quarter.

All surveys to date have been acquired using the *WG Vespucci*, and we plan to upgrade more vessels in 2014.

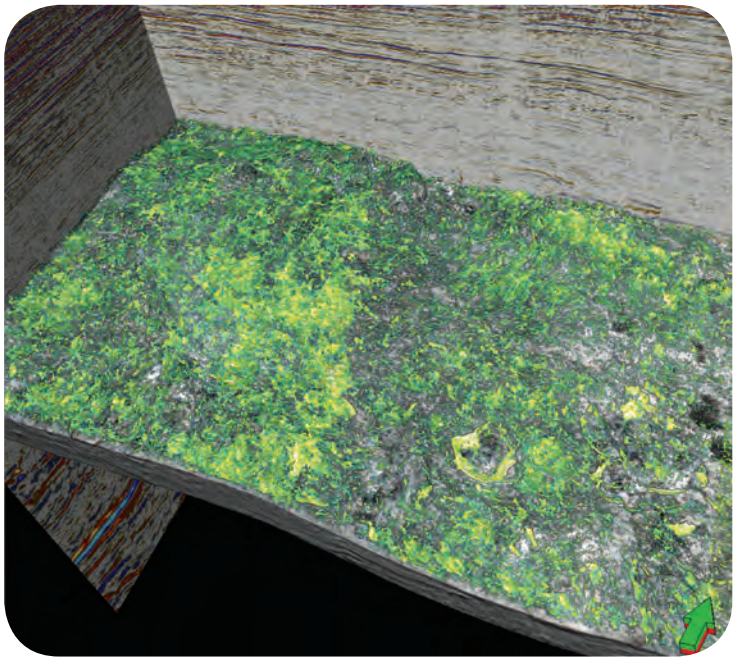
OE: How do you handle this much data?

CC: The large amount of data is a major step-change for marine seismic acquisition. It's not just the extra components we are measuring, which triples the amount collected. In order to characterize and remove the noise, we must sample data more densely along the cable. The legacy is 3.125m spacing, but we sample at shorter intervals. To handle this enormous quantity of seismic data, we've built an integrated acquisition and processing system that allows key elements of the processing to be done on board.

The compute power on-board the *WG Vespucci*—a vessel—makes it the fourth-largest Schlumberger data processing center, worldwide.

There are two elements to onboard processing:

1. Take raw measurements through an initial online pre-conditioning step to remove noise associated with the streamer construction and behavior in the water.



Broadband imaging in three dimensions for complex sand injectites using IsoMetrix technology. Photo: WesternGeco.

2. Production of a dense, isometrically sampled up- and down going pressure wavefield on a 6.25-m x 6.25-m surface grid.

Additional fast-track processing runs in parallel, and allows the client a quick look at the data. Then, we send the data ashore for further processing. Here we are able to leverage the experience of our petro-technical experts from data conditioning, through imaging, inversion and interpretation to extract the maximum value from the data.

OE: How does the client benefit?

CC: IsoMetrix technology offers quality, efficiency and operational (including safety) benefits. We are not bound by limitations on streamer tow spacing; so for example, in an exploration setting we can tow the cables further apart to efficiently cover an area more quickly, reducing turnaround time, whilst reconstructing the wavefield to replicate closer-towed streamers. Wider spacing also mitigates the chance of streamer tangling. We can tow cables deeper in the water, where the ambient environment is quieter and they are less affected by weather, but of course the tow depth also depends on the survey geophysical objectives.

The quality uplift can be clearly seen in the standard seismic image volumes, but it is necessary to look beyond these to 3D interpretational attributes and inversion products to extract the full value. For example, IsoMetrix volumes are showing great promise when partnered with ant-tracking to map faults and fractures, and with eXchroma^{SG} which uses coloration to isolate geologic information of other unconformities and lithology variations. Together, they allow for fresh geological and interpretational insights.

OE: Is the technology unique?

CC: Yes. Although there is a range of broadband solutions, only IsoMetrix provides fully 3D deghosted broadband data in all dimensions that is unique in the crossline gradient measurement, allowing accurate reconstruction of the pressure wavefield. The density of sensors along the cable is important in characterizing and removing the noise, to make best use of the accelerometer information.

What it really comes down to is the quality of images for explorationists and reservoir engineers. The fundamental benefits of the technology is that it provides fine isometric sampling to make data more suitable for a wide variety of applications. The system provides high-fidelity point-receiver seismic data, that allows us to capture the seismic wavefield on a 6.25-m x 6.25-m grid, and yields the first true 3D volume using towed streamers.

The earth is not simple, the subsurface is complex, and it is vital to get the full picture. OE

Well integrity matters

Metalmorphology uses established metal working principles to shape metal downhole with control and precision. Photo: Meta.

Meta has deployed its Metalmorphology technology in wells in the North Sea and Gulf of Mexico. Richard Craig explains.

Well integrity, particularly the structural and casing integrity of wells, is a key issue in the offshore oil and gas sector.

Certain parts of the world, such as the Far East, are still experiencing "light touch" regulation. The same cannot be said for operators and drilling contractors in other regions, such as the Gulf and Mexico and the North Sea.

Legislation that applies pressure on operators to establish well integrity and contingencies at the planning stage of all their wells includes the US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), whose duties have now been taken over by the Bureau of Safety & Environmental Enforcement, the UK's Health & Safety Executive (HSE), and Norway's Petroleum Safety Authority (PSA).

It is not just regulators pushing for well integrity. For operators, high-quality well architecture and strong structural and casing integrity are vital platforms for the future success and profitability of a well.

Strong casing and structural integrity will allow lifecycle asset teams to drill deeper and reach total depth without delay and or deviations from drilling plans and the accompanying costs. It can also help avoid operational setbacks through issues such as stuck or damaged casing, and pre-empt other well architecture weaknesses that can come back to haunt operators during the completion and production phases.

There are many well integrity technologies on the market today. However, more needs to be done to establish structural and casing integrity at the outset, plan for well integrity across the well lifecycle, and overcome existing technology weaknesses.

Metalmorphology has been developed to use established metal-working principles to shape metal downhole with control and precision to deliver a gas tight and durable metal-to-metal seal.

The technology balances the mechanical strength of steel with its elastic properties to create isolation solutions that instantly morph together to provide 100% conformance with the wellbore or casing. Metalmorphology provides a "morphing" ratio up to 60%, an axial load bearing rating up to 6 million lbs and a sealing rating of up to 15,000 psi.

The result is a gas-tight, axial load bearing, metal-to-metal sealing solution, which meets well integrity legislation.

Addressing stuck casing challenges in the North Sea

Meta has adopted its Metalmorphology technology to a number of well integrity solutions.

One, Meta Casing Reconnect, tackles

damaged or stuck casing by enabling operators to cut the original stuck or damaged casing at the required point, and deploy the reconnect solution over the existing casing, and reconnecting it to new casing with a connection capable of withstanding over 1,000,000 lbs of axial loading, and providing a metal-to-metal V0 gas-tight seal.

It has been used in the southern North Sea, where an operator was faced with a 9-5/8" leaking casing string and had lost significant rig time attempting to regain integrity, with the use of swellable technology being unsuccessful. Costs of the project were escalating and a solution had to be implemented within a small operating window to ensure integrity was regained.

Meta's Metalmorphology-based reconnection system was deployed and resulted in the placement of a metal-to-metal connection of the existing 9 5/8" casing string to the surface.

The operation allowed the operator to continue with their well plan without the need for intervention work and the pulling of the casing, leading to cost savings of nearly US$4 million. The well now has a reinstated life of well gas tight seal qualified to more than 5000 psi and a casing capable of carrying more than 600,000 lbs in tension and compression.

Meeting Regulatory Demands in the Gulf of Mexico

In the Gulf of Mexico BOEMRE/BSEE requests additional information on well planning activities in the form of a new worst-case discharge criteria, particularly applicable in deepwater wells. All assumptions made regarding well design, estimated flow rates, the maximum duration of potential uncontrolled flow and the total volume must all be considered.

This has made it necessary for operators to alter their well designs and strengthen well architectures—particularly at the earlier well lifecycle stage—to adhere to these regulations.

While there are a number of liner tieback solutions on the market, many are dependent on elastomeric elements. Elastomers come with a number of reliability issues relating to their sealing capabilities and duration and potential internal diameter (ID) reductions.

Meta has developed a liner tieback solution to enable operators to demonstrate and often exceed legislative compliance.

Through morphing the tieback casing into the Meta tieback receptacle, an ISO 14310 VO gas tight certified metal-to-metal connection is established with no reliance on elastomers. The durability of the metal-to-metal seal enables it to operate at pressures of up to 30,000 psi, and temperatures of more than 160°C. An axial load capacity of 1,700,000 lbs makes it suitable for deepwater environments, such as the Gulf of Mexico, with the axial loading bearing capabilities allowing for deeper drilling.

Additional benefits are reduced rig time for the landing and spacing out of the casing string.

A series of Meta tieback systems are due to be installed by Shell in a deepwater Gulf of Mexico field. The operating temperature will be 120°C and, once the tieback is installed, the deployment depth 10,000 ft. Hydrostatic pressure at this depth will be 3750-5800 psi, depending on fluid in the well.

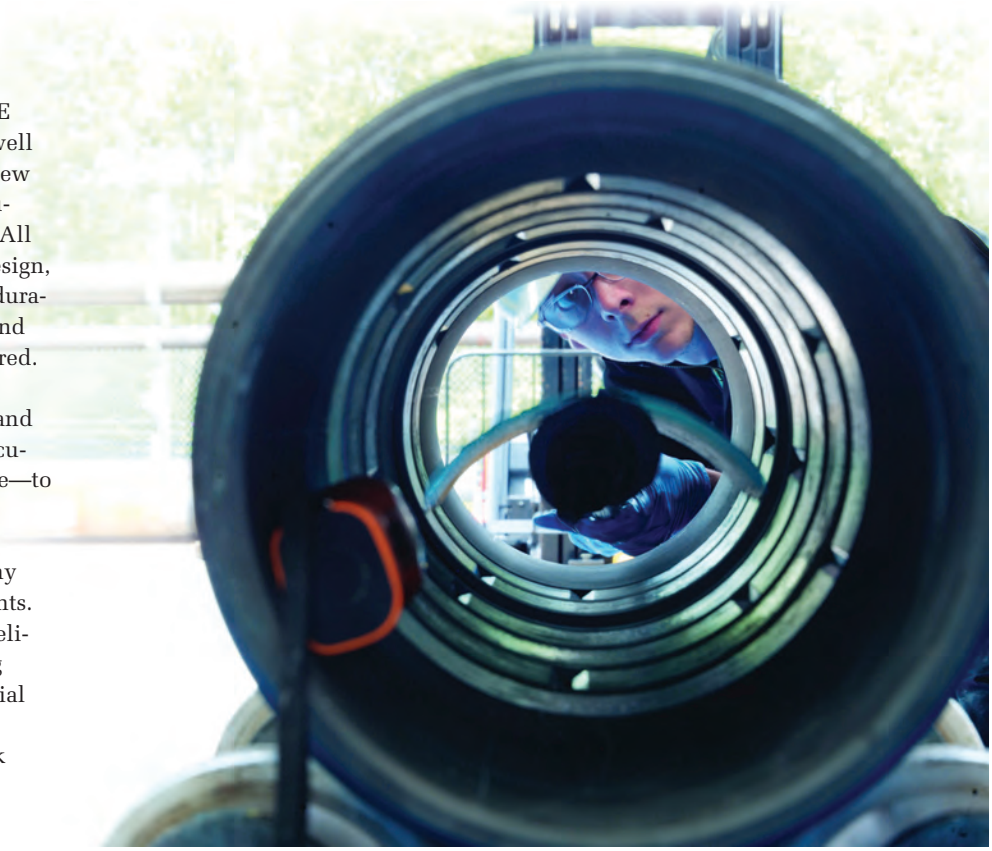
Through the incorporation of the liner tieback into its well architecture, Shell will ensure the well architecture remains fully compliant with current regulations; overcomes limited IDs in casing strings to achieve high load bearing capabilities; allows asset teams to plan for drilling deeper; and provides flexibility of space out.

Redefining well integrity

These examples focus on structural and casing integrity. Metalmorphology is also playing a role further along the well lifecycle, allowing for the proactive planning of zonal and barrier integrity as well as restoring well integrity and enabling operators to isolate selected zones during production.

Metalmorphology is proving how well integrity can be planned and how pre-existing technology limitations can be overcome, reducing risk, protecting and maximizing future production. OE

***Richard Craig**, vice president of business development at Meta, has 25 years' experience in the offshore and onshore oil and gas sector, primarily within the drilling sector. Previous roles include business development manager at Enventure International and technical sales director at Global Drilling Supplies. He also spent 16 years at Noble Drilling.*



Inside the Meta liner tieback.
Photo: Meta.

Long series for IHC Merwede

The *Seven Waves* following launch at IHC Merwede.
Photo: Alan Thorpe

By Alan Thorpe

Over recent months, IHC Merwede's Offshore Division has been successful in securing orders for the design, engineering and construction of a total of 10 pipe-laying vessels. These vessels will be built in the covered hall at the IHC Krimpen facility.

The main order comes from Subsea 7 for seven vessels, all of which will be chartered out to Brazil's Petrobras. The original order from Subsea 7 was for four ships. The first in the series, the *Seven Waves*, having already been launched and is due for delivery during the first quarter of 2014. Seabras Sapura, the partnership between SapuraKencana and Seadrill, also had three similar ships on order. Then, during August this year, IHC Merwede received another order, worth €1 billion, for another six sisterships – three each for Subsea 7 and Sapura.

IHC Merwede will supply three fully integrated pipe-laying vessels to Seabras Sapura. These will include the complete pipe-laying spreads, which comprise a twin-tensioner tilting lay tower, two below-deck baskets and support equipment for the loading, spooling and routing of products. The integrated automation system, full electrical installation and electrical machinery package will also be designed and delivered by IHC Merwede. In addition, to assist Seabras Sapura in the training of its offshore personnel, a pipe-laying simulator will be provided. When combined with existing orders, the confirmation of this latest agreement means that IHC Merwede is now working on a total of six pipe-laying vessels for Seabras Sapura. The first of these ships, the *Sapura Diamanta*, was launched in late September.

New designs from Damen

During August, Damen Shipyards Galati (Roumania) handed over the second PSV in a series heralding a new era in offshore construction for Damen Shipyards Group. *World Peridot*, built to Damen's innovative PSV 3300 design, has been delivered to World Wide Supply (WWS) and comes just seven weeks after the handover of the first of class PSV 3300, *World Diamond*, and is part of a six-ship series.

New designs from Damen Group include: oil spill response vessels, survey vessels, ROV support vessel, construction vessels, Arctic study vessels, and cable layers. Damen is also working on a 120m Arctic Fast Inspection Repair and Maintenance (FIRM) vessel, which will normally operate at 22 knots in flat water. Other new designs include an LNG-powered PSV, which is being developed with assistance from Delft University of Technology (The Netherlands) and Finland's Aker Arctic, this design also including an Arctic version.

Within the Damen Group there are 35 shipyards, with two new yards in Sharjah and Vietnam due to open very shortly. The Sharjah facility has a syncrolift for repair and newbuilding operations - an order for two Stan Tugs is already signed. The Vietnam facility is due to open during Q1 of next year, and will concentrate in the design and building of 60m workboats.

More newbuilds for Sea Trucks Group

Sea Trucks Group (STG) is currently increasing its fleet by two newbuildings, the first, the *Jascon 18*, is currently undergoing outfitting operations in Singapore's Kwon Soon Engineering, the hull having been built in China. She is due for delivery in Q3 of 2014. The second newbuilding, the *Jascon 35*, is currently in China, where the hull is complete.

STG has a large operational office in

Rotterdam, and operates a fleet of five specialized DP3 offshore construction vessels, with the two more newbuilding on their way. STG has a philosophy of having ships, which operate in three main offshore sectors – pipe-laying, heavy lift and accommodation - all its vessels having all three functions.

The main area of operation is West Africa, where three ships are booked for projects in Nigeria (2) and Angola (1) for the next 18 months. Another of the fleet is currently on a similar time charter offshore Australia.

Arctic design from Ulstein

Recently Ulstein's Rotterdam office has been involved in Hereema Marine's new Deepwater Construction Vessel (DCV) *Aegir*, which is about to enter operation. This vessel is capable of executing complex infrastructure and pipeline projects in ultra-deep water, while offering sufficient lifting capacity to install platforms in relatively shallow water. What makes *Aegir* even more unique is that it is the first vessel in the world to make use of a portable reel system, which offers huge time savings as she no longer needs to sail back and forth to shore.

The *Aegir* was built by Daewoo Shipbuilding & Marine Engineering (DSME). In Schiedam earlier this year, she arrived at the Huisman Yard, where the pipe-lay equipment was installed, including J-lay - Heavy J-lay: 2000m (using collar clamps) - Light J-lay: 600m (using friction clamps) Rigid Reel lay – 800m Flex lay – 520m. This followed the supply of lifting equipment onboard Subsea 7's *Seven Borealis*, which was built in Singapore by Sembawang Shipyard. *Aegir*'s first project will be the installation of risers at a depth of 2000m in the Lucius field in the Gulf of Mexico for Anadarko.

Another current project is the *Deepwater Enabler*, a multi-purpose offshore construction vessel (MOCV) to be built at Hyundai Heavy Industries (HHI). The DP 3 vessel is designed and equipped for ultra-deepwater installation and construction, flexible lay, pipe-lay, cable lay and topside construction support.

For the Arctic, Ulstein has come up with two main ideas. The first is the Ulstein XDS 3600 design, which is a 227.6m drillship with 20,000psi well control equipment, dual derrick configuration, a second BOP and a fold-down drill tower patented by Norway's Northern Light Solutions.

The second design is the Ulstein AXDS concept of an arctic drillship, which would have an operational profile out of the range of existing drill ships. Winterization of existing design would not meet defined requirements therefore it has been designed from scratch with proven components. The vessel would be able to operate in ice-thicknesses of between 1.2m and1.5m. This concept was prompted by Norway's Statoil, which solicited bids for an arctic design, which would be required in the future.

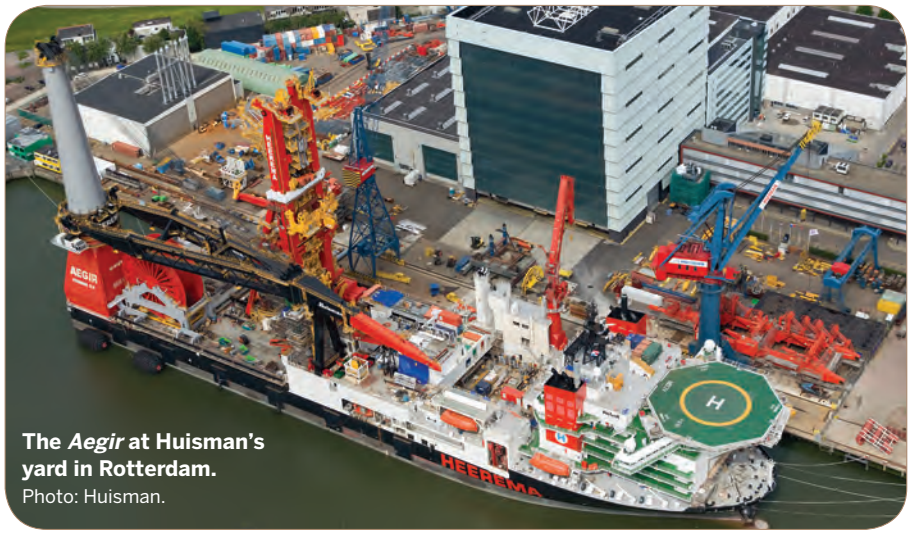
More FPSO contracts for SBM

SBM is involved in the *Cidade de Ilhabela* project - the conversion of a VLCC to a FPSO, the marine work being carried out by China's Chengxi Shipyard, Guangzhou. The process modules will be installed at SBM's Brasa yard in Rio de Janeiro and the FPSO will enter service for Petrobras by March 2015.

SBM has also recently signed a contract with Petrobras for the supply of two further FPSOs – the *Cidade de Marica* and the *Cidade de Saquarena*, both being converted VLCCs. SBM will again use Chengxi Shipyard for the marine work and Brasa yard for the installation of the process modules - deliveries due at the end of 2015 and early 2016.

Another recent contract is Shell's Stones project, which involves the supply of a FPSO to the Gulf of Mexico under a 10-year lease to Shell. This conversion is underway in Singapore's Keppel Shipyard and is due for delivery during 2016. An interesting aspect of this unit is that it has to be hurricane-safe, with the turret having the capability to be removed during the hurricane season, the FPSO leaving the area while the turret is positioned below sea level, and then reconnected after the hurricane has past.

Apart from the FPSO conversion market, SBM is also extensively involved in the FPSO life-extension market, involving the refurbishment of existing FPSOs. Currently SBM is working on the Kiki FPSO, which was originally converted by MSE (now MMHE) in Malaysia. OE



The *Aegir* at Huisman's yard in Rotterdam.
Photo: Huisman.

The *Cidade de Ilhabela* undergoing conversion work in Chengxi Shipyard.
Photo: SBM.

Intervention operations: Coiled tubing remedial intervention work starts on Taqa Bratani's Tern Alpha platform.
Photo: Taqa Bratani.

Sharing intervention lessons

By Elaine Maslin

A group of operators in the North Sea is taking a joint approach to barrel chasing through well intervention. Could other regions do the same?

In many cases, total annual production associated with well intervention operations exceeds annual production from new wells drilled in the same year.

That is according to the Well Intervention Excellence Network (WIEN), a group initiated by Shell Europe three years ago.

Performance benchmarking across participating operators

	Onshore	Offshore platform	Offshore NUI	Subsea	Total
Number of participating operators	5	9	7	5	**13**
Total number of wells	964	616	389	135	**2104**
Total number of interventions	824	236	117	23	**1200**
% of interventions	85%	38%	30%	17%	**57%**
Technical success rate	66%	57%	66%	96%	**65%**
2010 production	384	157	107	194	**842**
Intervention gains (MM bbl)	35	25	6	8	**74**
% contribution to production	9%	16%	6%	4%	**9%**

Yet, it says, the industry needs to do more to raise the visibility of the value of well interventions. It also needs to share technical experiences among operators within a similar "playing field", such as the North Sea.

WIEN, whose organizing committee includes Shell, Marathon Oil, TAQA Bratani, EBN (Energie Beheer Nederland), and Oil & Gas UK, is attempting to change the situation through use of benchmarking data, sharing the results, and extending its initiative into other regions.

Results to date indicate a broad range of performance in well intervention activities, suggesting there are opportunities for raising operator and industry performance.

European benchmarking

Using 2010 data from 13 companies, that included 2104 wells and 1200 well interventions, WIEN set out to benchmark the performance of well intervention activities in Europe, targeting production optimization and improvements.

All types of well intervention activity were first predefined and standardized. Then, using an independent third party, agreed anonymized performance data related to well interventions from the participating operators is collated.

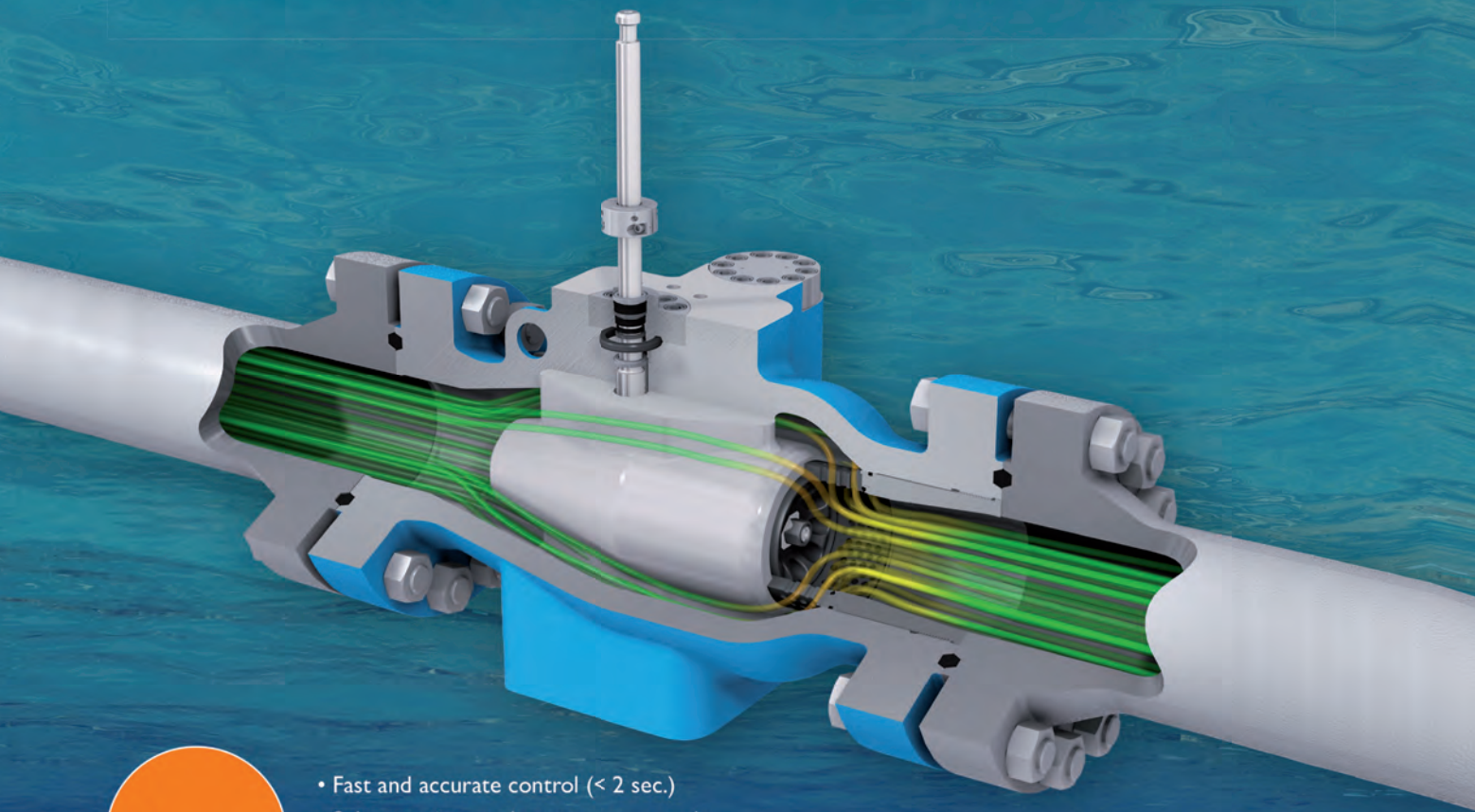
Oil & Gas UK provided data from UK operators and EBN, (Energy Administration of Netherlands), provided data from European operators outside the UK.

The data covered: total number of interventions performed during the calendar year; total cost of each intervention; category types; technical success rate for those interventions; and total production contribution during the first year post-job.

To compare performance data, interventions were differentiated as oil and gas wells, and by type of well: onshore; offshore platform wells; wells on normally unmanned installations (NUI); and subsea wells. Intervention techniques were sorted into three broad groups, based on whether they restored production, for example integrity fixes, or if they maintained production, such as through water washes, scale squeezes, or if they generated additional production, for example by adding perforations.

A low success rate in plunger lifting

Subsea axial control valve



Features

- Fast and accurate control (< 2 sec.)
- Subsea anti-surge / compressor recycle
- Subsea separator control
- Subsea severe duty / special control / axial choke valve

Qualifications

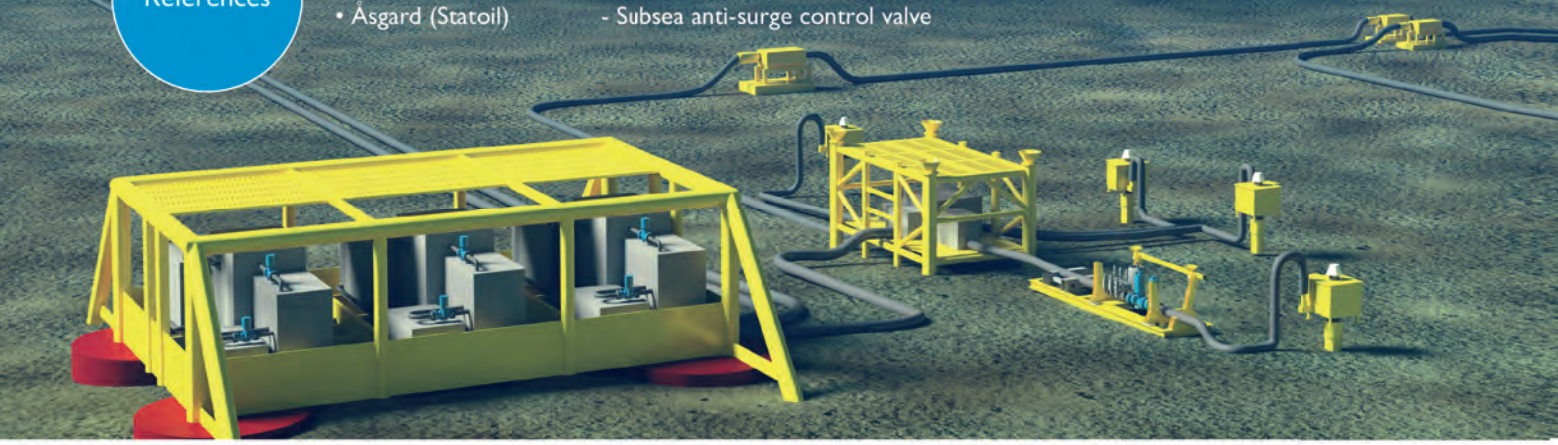
- API 6A PSL3 PR2
- Endurance testing (> 500.000 cycles)
- Hyperbaric testing

Other subsea products

- Subsea axial check valves
- Subsea axial HIPPS
- Subsea axial choke valves

References

- Ormen Lange (Statoil) - Subsea anti-surge control valve
- Åsgard (Statoil) - Subsea anti-surge control valve



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Intervention operations: A sand frac main treatment line from a pumping spread is linked up to the rig floor tie in point on the tree on Taqa's North Cormorant platform.
Photo: Taqa Bratani.

Intervention unit costs

Onshore	Offshore platform	Offshore NUI	Subsea
SCSSV repairs	GLV repairs	Water washes	Scale squeezes
Water washes	Scale squeezes	SCSSV repairs	Water shutoffs
Foam lifting	Water washes	Foam lifting	Perforations
Scale removal	SCSSV repairs	Other	SCSSV repairs
Plunger lifting	Other	Water shutoffs	Other
Tubing clean outs	GLV change outs	Perforations	
other	Water shutoffs	Acid stimulations	
GLV change outs	Scale removal	Tubing cleanouts	
Acid stimulations	Tubing cleanouts	VS/TP extensions	
Perforations	Perforations		
VS/TP extensions	Acid stimulations		
DP for deliq	Foam lifting		
Hydraulic fracturing			
CT kick-offs			

Key
SCSSV = surface-controlled subsurface safety valve
GLV C/Os = gas lift valve change outs
CT = coiled tubing
VS/TP = velocity strings/tailpipe extensions
DP for deliq. = downhole pumps for deliquification

Unit cost (boe) ranking of intervention costs executed in 2010, highest cost at the bottom.

was attributed to it being a new technology. WIEN says the industry is still "climbing up the learning curve" here. Plunger lifting was on liquid loaded gas wells below a safety valve, with packer completions, as opposed to plunger lifting in the USA and Canada in packerless completions, without a subsurface safety valve.

Results

WIEN noted that the diversity in performance among operators demonstrates a significant scope for technical collaboration to raise industry performance.

The highest intensity of well interventions was in onshore wells (85%), decreasing rapidly in the more costly offshore environment, to 38% on offshore platform wells, 30% on NUI wells and 17% subsea.

The greatest percent contribution to production via well interventions was from offshore platform wells, at 16%, despite having a lower intensity of activity compared to onshore wells. The lowest contribution came from subsea wells, at 4%, despite having the highest technical success rate at 96%. On average, the total contribution to annual production via well interventions was 9% in 2010.

One of the key messages, says WIEN, is that there seemed to be a strong risk averse culture in subsea well interventions, which showed the lowest intervention intensity, at 17%, the highest technical success rate (96%) and reasonable unit costs (not shown).

The high intensity in onshore wells suggests the industry is more prepared to take risk in trying new techniques or technologies in this relatively inexpensive environment, although the technical success rate was the same as on offshore NUIs, at 66%.

Thus, onshore wells provide fertile ground for de-risking new types of intervention techniques prior to implementing them in the more costly offshore environment, according to WIEN.

Unit costs

Ranking the different types of intervention in the order of unit costs, water washes were found to provide some of the cheapest barrels—in all but subsea wells—and were commonly used.

Foam lifting was also quite attractive for onshore wells, on a unit cost basis, but it was not as attractive in the more expensive offshore environment. This technology is fairly new in Europe and WIEN considers it encouraging to see it used in the more expensive offshore environment.

Foam and water washes also had higher technical success rates onshore, being used frequently because they were quick to undertake, despite low gains per job.

Offshore, perforating and tubing cleanouts had a low success rate, but when successful they added significant gains per operation.

A low success rate in plunger lifting was attributed to it being a new technology. WIEN says the industry is still "climbing up the learning curve" here (plunger lifting liquid loaded gas wells below a subsurface safety valve, with packer completions as opposed to plunger lifting in the USA and Canada in packerless completions, without a subsurface safety valve).

Collaboration projects

As a result of the 2010 benchmarking, seven areas of potential collaboration were identified and four areas were eventually selected:

1. Mobile wellhead compression for deliquifaction

A solution to address identified common needs is being sought, with 11 operators sharing technical experiences and targeting multiple applications within 2-4 years.

2. Use of downhole pumps/plungers for deliquifying gas wells with operable subsurface safety valves.

Collaborative push by eight operators

Schlumberger's *Big Orange XVIII* well stimulation vessel working on Marathon Oil's Brae Bravo platform wells. Photo: Marathon Oil.

for technology development and deployment, agreement to share candidate selection, build a trial sequence and share trial results (includes SCSSV solutions and or alternatives).

3. Use of foam to deliquify liquid loaded subsea wells

Pumping batch foam treatments via umbilicals. One operator had expertise with foam treatments and a number of subsea wells showing initial signs of liquid loading. Collaboration between three operators led to export support in the design of the initial trials on the condition of access to detailed trial results. First trial conducted in 2013 with follow-up trials identified.

4. Gas lift valves (change-outs/repairs)

One operator has now embarked on a comprehensive gas lift system health check using CO_2 tracer analysis.

Conclusions

WIEN says the benchmarking so far has meant operators have gained a collective and overall improvement in oil and gas recovery from their wells through sharing what works.

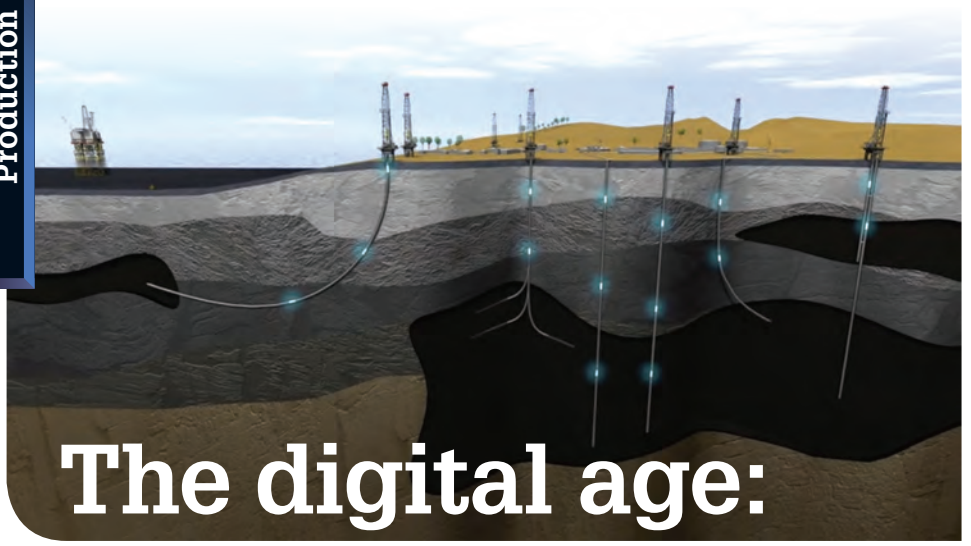
The credibility of the data will increase as more data is benchmarked on an annual basis to identify further technology needs, inform well intervention strategies and support further collaboration projects.

Further to the 2010 benchmarking data, WIEN has received data relating to an additional 1167 and 1288 well interventions executed in 2011 and 2012, respectively.

The next step will be further improving results by bringing vendors or technology forums into the technical collaboration projects to fastrack developments and implementation.

WIEN is also encouraging other regions to replicate the initiative, with West Africa the first target.

To participate, contact efsthathios.kitsios@shell.com. OE



APOLLO can be deployed in a wide variety of challenging geologies and conditions. Photo: Camcon.

The digital age:
Gas lift goes modern

Gas lift is recognized for enhancing well stability – but it has its drawbacks. Camcon's digital gas lift has begun field testing onshore Oman, with offshore installations anticipated. How does it differ from traditional gas lift technology? Camcon's Ian Anderson explains.

The growth in artificial lift

From the North Sea, where operators including Statoil look to achieve average recovery rates of up to 60%, to the United Arab Emirates' Upper Zakum expansion project, to offshore Malaysia, home to the world's biggest enhanced oil recovery (EOR) project, increasing oil and gas recovery is one of the offshore industry's greatest challenges.

At the center of these developments is artificial lift. The artificial lift market's growth is so substantial that Markets and Markets' 2013 Artificial Lift Systems Market Report predicted it would be worth as much as US$16 billion by 2018.

Gas lift and its applicability offshore

While techniques including electrical submersible pumps (ESP) and multiphase boosting are more widely known, another artificial technology with significant applications offshore is that of gas lift.

In gas lift, gases such as CO2, natural gas or nitrogen, are injected into the production tubing to reduce the impact of the hydrostatic pressure. This action reduces bottomhole pressure, allowing reservoir liquids to enter the wellbore at higher flow rates.

Today, the side pocket mandrel (SPM) technique in gas lift that makes use of injection-pressure-operated (IPO) lift valves is one of the industry's most widely recognized products

Gas lift today remains particularly effective offshore and in countering well instability - something which is becoming increasingly prevalent in older fields.

Such instability can result from a number of factors, including water and gas breakthrough in the wells; slugging; or increased well pressures. In addition, as wells and reservoirs age, liquid rates begin to decrease resulting in wells being more sensitive to flow instabilities.

In such cases, gas lift can operate effectively in a wide range of well conditions and high-volume high pressure/high temperature (HP/HT) wells. Additionally, gas lift can handle abrasive elements such as sand, and gassy and corrosive fluids in deviated wells. Furthermore, SPM and gas lift injection valves allow for a deeper gas injection in the tubing.

The APOLLO Digital gas lift solution. Photo: Camcon.

It is these characteristics as well as its flexibility with different production rates that make gas lift more suitable to fluctuating well conditions in offshore operations than ESP and rod pumps. For example, Senergy's Dr. Rick Lemanczyk recently estimated that gas lift enabled fields can lead to a 2-5% increase in field-wide production.

Technology limitations

Despite its growing popularity, gas lift also comes with limitations.

Making injection rate changes in SPM-related gas lift, for example, requires wireline interventions. These types of interventions can damage existing infrastructure (if the wire snaps, for example); choke the gas supply at the surface; and even halt production as a new SPM unit is installed.

SPM tools also have no instrumentation on board; operators have little real-time information on pressures and temperatures at the point of gas injection and limited control and flexibility over altering injection rates. In addition, the fact that these tools are IPO with the SPM functioning at a pre-determined annulus gas pressure can lead to severe restrictions and increase the possibility of unstable wells.

All too often with such limited information, monitoring gas lifted wells is confined to a basic approach, focusing on wellhead pressure and the occasional fluid level or downhole pressure reading rather than consistent real-time data. It is this lack of flexibility which requires operators to make certain assumptions about the field conditions and the perceived characteristics of the well at a given time.

Consider, for example, a field with 50 offshore wells all using lift gas as the preferred artificial lift technique. How can the field operations team optimally produce all the wells when they are interrelated and interact? Making a change to optimize the performance of one well might negatively impact the

performance of another. Moreover, such limited information can actually increase the chances of well instability, leading to potential surges in liquid and gas flow.

The growth of digital gas lift

It's with these issues in mind that Camcon is introducing a new digital gas lift solution that enables operators to vary injection rates and depth in real-time without production interruption and well intervention. It eliminates the need for SPMs and wireline intervention, with settings tuned as well-bore conditions change through the life of the installation, giving greater downhole control over gas-usage and preventing well instability.

The solution is based around binary actuation technology (BAT), consisting of a low-energy pulse control which signals to switch an actuator between two stable positions to digitally operate a valve. The need for SPMs is thereby eliminated. The electrically-operated valve; actuation configuration; and six control actuators for injection variation enable the real-time setting of injection rates, which is not possible on traditional artificial gas lift technologies.

Putting it to the test

With such technology, it was essential to produce some real-life data to demonstrate its potential prior to test installations in actual wells. This was achieved through a simulation modeling analysis program, conducted by Laing Engineering & Training Services (LETS).

The example well developed was based on a modern subsea well in moderate water depths, drilled to a total depth of 17,600 ft. measured depth (MD) with a 4.5 ft. by 5.5 ft. production tubing string. The key variables examined during the testing were the well productivity index (PI), reservoir pressure and water cut.

LETS used the analysis software PROSPER to create production system models with a number of well life scenarios developed for early life (one day to three months), mid-life and late-life. The analysis revealed a wide range of possible injection depths from 3,000-17,000 ft. MD, and a wide range of optimal gas injection rates from 1-8 MMSCFD. In order to make the comparative modeling exercise practical in multi-variable scenarios, 2 MMSCFD was selected as the allocated gas injection rate.

The analysis found that the two scenarios deriving most benefit from gas lift are at the early life stage after three months and the mid-life stage with water injection support.

PI bpd/ psi	Conventional design orifice at 6,770 ft.		Single orifice at 4,190 ft.		Digital gas lift		
	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Depth of Injection
7	2,865	2	2,360	2	3,125	2	10,555
14	4,625	2	4,060	2	4,650	2	6,970
21	5,895	2	5,330	2	5,920	2	6,970

Figure 1 - Life cycle stage: early life – 3 Months

PI bpd/ psi	Conventional design orifice at 6,770 ft.		Single orifice at 4,190 ft.		Digital gas lift		
	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Depth of Injection
7	2,165	2	1,550	2	3,005	3	15,615
14	3,455	2	2,715	2	4,245	3	10,555
21	4,360	2	3,575	2	5,240	3	10,555

Figure 2 - Life cycle stage: mid-life – water injection support/higher casing head pressure (CHP)

PI bpd/ psi	Conventional design orifice at 6,770 ft.		Single orifice at 4,190 ft.		Digital gas lift		
	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Oil bo/d	Gas lift MMSCFD	Depth of Injection
7	750	2	-	2	1,570	2	15,615
14	1,205	2	-	2	2,210	2	15,615
21	1,500	2	-	2	2,595	2	15,615

Figure 3 - Life cycle stage: mid-life –no water injection support

Figure 1, for example, shows the bo/d comparisons at the three month life cycle stage for three PI values with digital gas lift already showing increased bo/d. Figure 2 shows improved bo/d at the mid-life stage with digital gas lift, which can also set higher injection rates at 3 MMSCFD. Furthermore, even without water injection support as demonstrated in Figure 3, the bo/d generated through digital gas lift is significant higher than the alternatives.

The model's final conclusions were that digital gas lift can deliver as much as 1,000 bo/d more oil production from a typical well and, in one scenario, showed a 110% increase in production compared to traditional gas lift equipment.

With this modeling data, the digital gas lift solution is currently being deployed in an onshore well in Oman.

Although a test installation, the equipment has been selected as the chosen method of lifting for the well and is likely to lead to offshore installations in the near future. The deployment is part of a normal work over program for a highly-productivity well where the intelligent gas lift method will be used to improve its production performance. The tool is currently fully activated in the field. Operators today are looking for greater control over their gas lift operations. It is encouraging to see that technologies such as the emergence of digital lift are rising to the challenge with significant applications for offshore operators. OE

Ian Anderson *is chief operating officer of Camcon Oil, part of the Camcon Federation of Companies, where he has been working since 2003. Previous roles include director at management consultancy Thespian Ltd; Business Unit Director at IT services company Unisys; and vice president at Atex Systems, a systems integrator.*

A cross-section of a typical bundle fabricated at Subsea 7's Wick facility. Photo: Subsea 7.

Embracing towed pipeline production systems

Subsea 7 demonstrates the effectiveness of pipeline bundle solutions and a subsea depressor device in the North Sea.

By Meg Chesshyre

"Subsea 7 is currently experiencing the busiest period of bundle design/installation activity ever," the company's Bundle Design Manager, Martin Goodlad, revealed while presenting a paper at the Society of Petroleum Engineers' (SPE) Offshore Europe Oil and Gas Conference and Exhibition in Aberdeen last month. A record eight bundles were installed throughout 2011-2012, with eight more confirmed installations to be completed by mid-2015, bringing the total number of bundles installed over the last 35 years to more than 70. He added that a number of the installed or currently in-design bundles are firsts for Subsea 7.

Using a number of North Sea case studies as examples, Goodlad discussed the technical and commercial benefits of bundle technology for new subsea structures, as well as for rejuvenating and extending existing ones. In all cases, coating the bundle's interior with BuBi, a mechanically-bonded bimetal pipe developed by Butting, reduced overall cost compared with solid corrosion resistant alloy or clad pipe.

Apache's 5.5km-long Bacchus bundle ties the Bacchus drill center back to the Alpha Platform on the Forties oil field, the North Sea's largest, which lies 170km east of Aberdeen. This was achieved by utilizing produced water to heat the production fluid, meeting challenging flow assurance requirements. Reusing the produced water as a heating medium reduces the CAPEX and operating costs of the field, as no additional heat-generating plant is required to be installed on existing facilities and very little power generation is required to support the heating.

The 27.8km-combined length of the four bundles in the Andrew oil field, located 230km northeast of Aberdeen, is currently the longest subsea tie-back using towed pipeline bundles. These bundles connect BP's new drill center at Kinnoull back to Andrew's lone platform. The advantage of the bundle was that it could be installed underneath the floatel at the Andrew platform while on site, reducing development timescale. The increased flexibility of the bundle method also lessened the risk of impacting the other scheduled on-site operations.

At 155ºC, the Conoco Phillips Jasmine oil field bundles were the highest-temperature bundles designed at the time of installation in 2012. Two 4.1km-bundles tie the Jasmine wellhead platform to the Judy riser platform. The combination of the bundle's expansion and resistance to lateral buckling made the bundle an ideal solution for this high-temperature application; both potential design issues of high axial force and lateral buckling are accommodated without need for expansion loops or buckle initiators.

At 160ºC, the Jasmine bundles are now being overtaken by Total's West Franklin bundle, which also consists of the largest diameter carrier pipe at 56.64-in. in the fortified sections. The 6.7km single bundle connects the West Franklin wellhead platform to the Elgin well head platform. The use of a bundle meant that

Wick bundle fabrication site upgrade

Subsea 7 is currently investing over £5.5 million in refurbishing its pipeline bundle fabrication site at Caithness, Scotland. Established in 1978, the fabrication site is located six miles north of Wick, Caithness in the North of Scotland. The site runs 7.8km inland, covering a total area in excess of 300,000sq m and has a sheltered bay in which to launch the pipeline bundles. The refurbishment program will be carried out in two phases. It includes new, state-of-the-art equipment for five firing lines, a 230m extension to the main fabrication shop, and a new office and welfare complex at the landward end of the facility. The first phase, which began in 2012 is now complete, with the second phase of refurbishment is scheduled for completion in 2014. ■

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the respective pressures of the main and fortified zones could be fully strength-tested onshore. This could not have been done with a single flowline laid in-field. Bundle expansion reduces the build-up of axial forces, and allows field development without a cooling spool. System weight and tensile forces on the sleeve and carrier prevent the bundle from global lateral buckling.

The 5.1km bundle for BG Knarr project will be the deepest bundle installed to date at 410m. It will tie back the Knarr production manifold to the floating production, storage and offloading (FPSO) unit. The integrated design of the bundle flowlines and structures (cooling spool length) allows the system to be tuned to BG's specific flow assurance requirements. The bundle will be installed under the drill rig while on site, reducing the development timescale, and the increased flexibility of bundle installation method again de-risked the schedule impact of other on-site operations.

The bundle for Shell Fram was the first bundle designed with two-midline structures, tying two drill centers back to a single FPSO. Unfortunately, due to poor drilling results, the Fram development in its current configuration has been cancelled. Using bundles would have reduced the number of risers.

Goodlad's Subsea 7 colleagues Renaud Gueret and Subhajit Lahiri presented a paper in the same session on last summer's installation of the 127km umbilical between the landfall at the Shetland Islands and the Laggan manifold. It consisted of a bundle arrangement, including two-way fiber optic communication, high voltage electricity supply, chemical supply and hydraulic power.

The installation was particularly challenging as it consisted of laying a low-density product (127mm diameter, 10.6 kg/m submerged weight) along a route with particularly high currents and a large range of water depths (20 to 600m). As a result, large umbilical deflections were expected, and a subsea depressor device (SDD) was devised to aid installation and act as a ballast to weigh down the catenary and oppose current.

The SDD was made of a weight element with a bellmouth funnel opening on each side through which the umbilical ran and was suspended from a deck winch. The original unit weighed 2.5 tons, but was ballasted with steel blocks to reach a weight of 4.6 tons to handle the unusually high currents. The wire length was tuned to control the SDD height above the seabed.

Gueret and Lahiri's paper concluded that the use of the SDD has been successful in stabilizing the umbilical motion in the touchdown region and preventing it from being dragged from the vessel under the harsh current conditions met offshore the Shetlands. It enabled longer lengths of umbilical to be laid in higher sea-states and stronger currents for longer durations. As a result, the SDD is now the primary option for this kind of installation.

In the event of a storm, a through contingency procedure was planned to secure the umbilical in a lazy S-wave configuration; however, due to clement meteorological conditions, it was never required to be deployed. OE

Subsea 7's autonomous inspection vehicle (AIV) designed in collaboration with SeeByte. Photo: Subsea 7.

AIV will be commercially available later this year

Subsea 7, in collaboration with SeeByte, software solutions provider for unmanned underwater vehicles, has developed an autonomous inspection vehicle (AIV), which will be commercially available later this year from the company's life-of-field division. With its ability to recognise and respond to its surroundings, instinctively correcting its trajectory in real time based on information it gathers from its on-board sensors, the AIV is set to become a cost-effective, low-risk inspection tool to aid field survey and integrity management and intervention activities. Subsea 7 says that the AIV, which can be operated directly from a host facility such as an FPSO or platform, or from infield support vessels or mobile rigs, will transform life-of-field projects. ■

A vessel towing out a bundle, with the towhead in the foreground, at Wick, Scotland. Photo: Subsea 7.

The firing line in fabrication hall's at the Wick facility. Photo: Subsea 7.

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Pipeline market to grow in Europe, Asia, and Africa

By Catarina Podevyn, Infield Systems Ltd.

Since the turn of the millennium, global pipeline investment has undergone sustained and, in recent years, robust growth as a result of favorable market conditions and industry trends, including: the continued high levels of investment in offshore development, and the increasing focus on deepwater production and the development of remote fields. The pipeline sector is expected to account for a 39% share of total offshore capex for 2013, while 2014 is expected to witness the number of kilometers installed return to levels not seen since 2006. Although key developments for 2013 are led by the ultra-deepwater Gulf of Mexico (GOM), going toward 2017, Infield Systems (Infield) expects pipeline development offshore Europe and Asia to become the largest markets for global demand, Fig. 1.

Asia

During 2008-2012, Asia accounted for the largest share of pipeline capital expenditure, with China leading regional pipeline investment. Historically, the Asian region has been predominantly driven by conventional shallow-water developments associated with fixed infrastructure. Over 2008-2012, Southeast Asia led this conventional shallow-water market. Going forward, conventional activity is expected to focus on Mumbai High redevelopment offshore India, the Bongkot and Arthit expansion projects in Thailand, and the Bao Vang field, Vietnam.

Across the entire pipeline market, Malaysian developments are expected to require the largest expenditure over the next five years. The Indian pipeline sector is also expected to remain robust to 2017, with Mumbai High forecast to require the greatest investment from 2013-2015. Domestic firm Punj Lloyd was confirmed as the subsea pipeline and platform topside contractor in May 2013.

Over the next five years, Infield expects development across this region to become increasingly polarized as new areas of deepwater activity emerge and remote prospects become viable for production. As such, the proportion of regional expenditure directed toward conventional pipeline development is expected to decrease by 8%, compared with 2008-2012, while both the SURF (subsea, umbilical, riser and flowline) line and export line sectors are anticipated to hold a larger share of total regional capex over the period, Fig. 2.

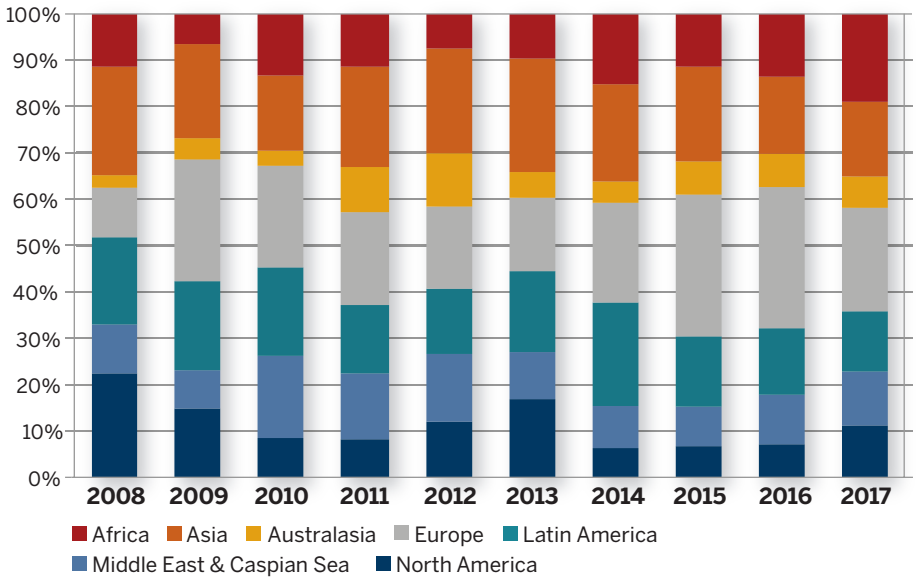
Key developments are expected to include the PTT-operated Erawan Gas export pipeline development off Thailand, and the Shell-operated Kasawari project, Malaysia. Within the deepwater market, ONGC and Reliance are expected to account for the largest investments as a result of the Krishna-Godavari and Dhirubhai projects. Operators Chevron, Shell, and Murphy are also expected to direct substantial expenditure toward deepwater pipeline installations over the next five years.

Europe

Over the 2013-2017 timeframe, Asia's share of the global pipeline market is expected to decrease, while Europe, driven by a number of large export line projects, is anticipated to account for the largest share of global expenditure. During the previous five years, European pipeline expenditure was dominated by the development of the Gazprom-led consortia's Nord Stream 1 and 2 lines. Going forward to 2017, European demand is expected to continue to be dominated by these long-distance export lines, with substantial investment also expected on possible Nord Stream extensions to the Netherlands, and the South Stream; the latter saw construction commence in December 2012. Statoil's Aasta Hansteen and Johan Sverdrup fields are anticipated to require some of the highest levels of investment over the next five years, with the latter development seeing field appraisal completed during June 2013.

In the longer term, with increasing global energy demand and improvements in technology, the economic viability of developing remote prospects far from shore is increasing. With this, SURF line activity is expected to become an

Fig 1. Global pipeline capital expenditure
(%) 2008-2017 by region



Source: *Offshore Pipelines & Control Lines Market Report to 2017.*

The global pipeline sector is anticipated to account for 43% of total offshore Capex over the 2013-2017 timeframe.

increasingly important sector of the market. While export and trunk lines are anticipated to drive the increase in capital expenditure within the pipeline market offshore Europe over the medium term, Infield expects to see an increase in the number of fields in remote waters. Offshore northern Norway and West of Shetland will enter production, with key remote fields Snohvit, Johan Castberg, and Rosebank all requiring substantial SURF line expenditure during the period.

While Infield's *Offshore Pipelines & Control Lines Market Report to 2017* examines this emerging trend within its global context, the role of SURF line development within the European region going forward is particularly significant; between 2013 and 2017, European SURF line expenditure is expected to increase by a CAGR of 18%, with the highest demands for SURF installations anticipated for the Johan Castberg development.

Africa

Over the previous five years, Africa held a 10% share of global pipeline capital expenditure, led by developments off West Africa and within Egypt's Mediterranean waters. While historically conventional pipeline developments have been the primary source of expenditure demand, with the growth in the West African deepwater market, led by Angola, SURF line investment has recently increased to form a leading share of regional pipeline expenditure. Going forward to 2017, Infield expects this trend toward deepwater SURF line investment to continue, thereby providing significant opportunities for the supply chain.

Although this expected demand is likely to be driven predominantly by Angola and Ghana in the short to medium term, the key theme is the re-emergence of activity in Nigerian waters toward the end of the forecast period. Capital expenditure on pipeline developments is anticipated to increase by a CAGR of some 39% over 2013-2017. Nigerian activity is expected to be driven by SURF line expenditure on the Total-operated Egina and Shell/Chevron Bonga Southwest developments, in particular. Over the next five years, Infield also expects significant pipeline investment offshore Congo (Brazzaville) and Equatorial Guinea; while in the north, pipeline activity off Libya is also anticipated to pick up, with capital expenditure increasing by a CAGR of over 60% over the next five years.

Other changes in the market include the expected increase in activity in the deep and ultra-deepwaters offshore East Africa. While remaining a marginal area of pipeline investment, compared to the established production zones off West Africa, Infield anticipates pipeline expenditure to begin off Mozambique on the Prosperidade development during 2016.

Middle East/Caspian

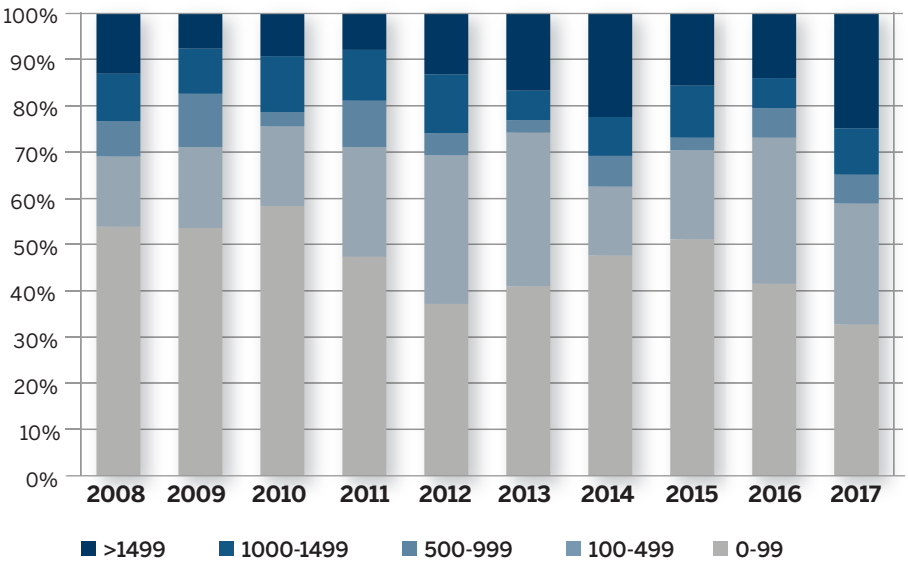
The Middle East and Caspian region is dominated by the presence of conventional shallow water activity across Azerbaijan, Saudi Arabia, Qatar, Kazakhstan and Iran. Over the historical five year period to 2012, the region accounted for a 13% share of global pipeline capital expenditure, 55% of which was directed toward conventional pipeline developments. Trunk and export pipelines have also historically formed a significant share of regional spend. Going forward, despite an increase in actual spend, the region's market share is expected to reduce to 10% of the global total, as a result of higher incremental spending from other regions. During this period, the conventional pipeline sector is anticipated to remain dominant within the region, although its share is expected to reduce to 53% due to a continued increase in trunk and export line activity, Fig. 3 and 4.

A key driver of historical development in the Middle East and Caspian has been the strong growth in natural gas demand from the Persian Gulf and the wider Middle East. The Persian Gulf region has abundant natural gas reserves, but at present only Qatar is a significant exporter. Iran, faced with continued sanctions, finds itself a net natural gas importer, despite holding the world's second largest gas reserves. Despite this, over the previous five years, Iran remained the largest destination for operator pipeline expenditure, with the giant South Pars comprising around 20% of the entire region's pipeline expenditure during 2008-2012.

Going forward, Israel is expected to emerge as the region's largest area for pipeline investment, driven by Noble's giant Leviathan project. Another key area of pipeline demand across the Middle East is likely to be Azerbaijan, where BP is anticipated to direct significant capex toward phase 2 of the Shah Deniz development, while pipeline capex demand is also forecast to remain significant offshore Abu Dhabi and Iran. The giant Kashagan development offshore Kazakhstan is also anticipated to require significant pipeline investment.

Fig. 2. Global pipeline installations

(km) 2008-2017 by water depth (m)



Source: *Offshore Pipelines & Control Lines Market Report to 2017.*

North America

The North American pipeline market has a mature asset base, which has primarily focused on conventional shallow-water developments and, over recent years, has been significantly affected by the rise of onshore shale gas production, with operators diverting investments to this emerging market. The level of conventional pipeline activity is forecast to decline by 39% over the next five years, compared to the previous five-year period. However, with increasing deepwater activity, the decline in the shallow-water conventional sector is anticipated to be buffered to an extent.

Simultaneous with the decline in conventional pipeline investment, Infield expects the region to witness a growth in SURF activity. Driven by deep and ultra-deepwater developments in the US GOM, key fields demanding significant SURF line expenditure are anticipated to include: Keathley Canyon's Lucius, Moccasin, and Hadrian South fields. Indeed, as a proportion of global pipeline expenditure, the North American region is expected to see a decrease to 9% over 2013-2017, from 13% over 2008-2012. Infield expects opportunities to remain within the region, particularly from deepwater work that is expected to comprise 71% of the region's pipeline expenditure; the majority of which is expected to emanate from fields that are being developed using tie-backs, rather than with trunk/export line infrastructure.

Latin America

The Latin American market is polarized between the conventional Mexican market and the extensive Brazilian sector. Each country is dominated by the presence of a national oil company. In the case of Mexico, Pemex is seeking to increase production from the Bay of Campeche; while in Brazil, Petrobras seeks to develop its discoveries within the pre-salt Santos and Campos basins. Opportunities are diverse across SURF, conventional, and trunk line infrastructure and, as such, the development of the region will be key to overall industry appetite.

Over the previous five years, Brazil dominated the region across all areas of offshore demand, and this will continue during the forecast. Offshore, key pipeline projects over 2013-2017 are expected to include Roncador, Iracema Sul, and Lula Central. In terms of water depth, 78% of Brazil's pipeline capital expenditure demand will be required by developments in water depths of 1499m and greater.

In contrast to Brazil, the Mexican market has not focused on deepwater exploration and production in recent years. Pemex has sought to increase its production from the giant Cantarell and Ku-Maloob-Zaap fields and this investment has been characterized by shallow-water conventional installations. Over 2013-2017, Infield expects 64% of pipeline expenditure off Mexico to be directed toward shallow-water developments. Elsewhere, Infield also expects pipeline expenditure to be required off Trinidad and Venezuela.

Australasia

The Australasian region is expected to comprise 6% of global pipeline capex over the following five-year period. The large West Australian gas fields, such as Wheatstone, Ichthys, and Gorgon, define the majority of the Australasian pipeline market. Going forward to 2017, significant pipeline investment is anticipated on the Calliance and Poseidon/Kronos developments.

The current Australasian pipeline market is primarily shallow water based; however, the implementation of secondary and tertiary stage developments is set to see the deepwater segment of the market grow. In pipeline segment terms, Australasian developments over the previous five years have been characterized by trunk and export line installations, forming a 59% share of the region's pipeline expenditure during 2008-2012. Going forward to 2017, while retaining the largest share of demand, the trunk and export line market sector is forecast to decrease to 56%, as a result of the growing trend to SURF line development.

With the global pipeline market sector forming an increasing share of total offshore capex, the next five years are anticipated to see the emergence of Europe as the leading market for investment, while Asia and Latin America, in particular Brazil, are also expected to undergo significant increases in capex over the period to 2017. The trend toward SURF line installations is anticipated to continue, with a year-on-year increase forecast in capital expenditure. The conventional pipeline market, despite a rise in actual spend, is expected to experience a decreasing overall market share. The trunk and export line market is anticipated to undergo a substantial increase; driven by European activity over the short term and, over the longer term the Australasian and Middle East markets. OE

Fig. 3. Global pipeline capital expenditure
(%) 2008-2012 by segment

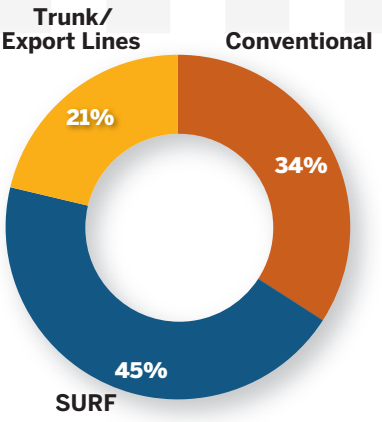
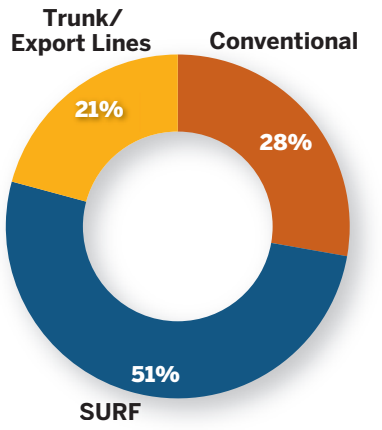


Fig. 4. Global pipeline capital expenditure
(%) 2013-2017 by segment



Source: *Offshore Pipelines & Control Lines Market Report to 2017.*

Catarina Podevyn *has been an analyst with Infield Systems Ltd. since 2008, has worked across various sectors, and authored numerous articles and publications. Her core expertise is the floating platform sector, and both the deepwater and ultra-deepwater markets, particularly offshore West Africa and Latin America. Podevyn earned an Economics degree from Loughborough University.*

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ABB's Luis Duran explains how proper asset integrity management can cut down human error, reduce risk, and make the offshore oil and gas industry a safer environment in which to work.

Offshore Safety: People power with technology

Safety and asset integrity are costs that can pay back big dividends in the offshore oil and gas industry in decreased downtime and improved productivity, efficiency and profitability. To fully realize there is a need to eliminate human errors and squeeze the most out of automation technologies.

A perfect case in point for process safety and integrity management come into play when you look at the *Piper Alpha* disaster 25 years ago in the North Sea on July 6, 1988.

The human factor played large in the disaster where a series of mistakes cascaded into a catastrophe that left 167 men dead, 61 survivors and a loss of $3.4 billion. But it didn't have to be that way.

As it is with most disasters, there were a series of errors that added up to a major catastrophe. It started with the two condensate pumps, designated A and B. On the morning of July 6, Pump A's pressure safety valve ended up removed for routine maintenance. Crew members planned to overhaul the pump, but had not started it. They temporarily sealed the open condensate pipe with a disk cover. Because the crew did not complete the work by 6 p.m., the disc cover remained in place. The on-duty engineer filled out a permit that stated Pump A was not ready and no one should switch it on under any circumstances.

The engineer failed to inform the on-duty custodian of the condition of Pump A. Instead he placed the permit in the control center and left. This permit disappeared. Meanwhile, there was another permit issued for the general overhaul of Pump A that had not yet begun.

Just over three hours later, because of problems with the methanol system earlier in the day, hydrates started to accumulate in the gas compression system pipework, causing a blockage. Due to this blockage, condensate Pump B stopped and they could not restart it. As the entire power supply of the offshore construction work depended on this pump, the manager had only a few minutes to bring the pump back online, otherwise the power supply would fail completely. A search ensued through the documents to determine whether they could start Condensate Pump A, which would alleviate the problem.

Workers found the permit for the overhaul, but not the permit that said the pump must not start under any circumstances due to the missing safety valve. The valve was in a different location from the pump and therefore the permits were in different boxes because they ended up sorted by location. No one was aware that a vital part of the machine was not there. The manager assumed from the existing documents that it would be safe to start Pump A.

Pump A switched on. Gas flowed into the pump, and because of the missing safety valve, produced an overpressure

Statoil's Tjeldbergodden control room Photo: ABB.

which the metal lid could not handle. Gas leaked out at high pressure and triggered six gas alarms including the high level gas alarm. Before anyone could act, the gas ignited and exploded.

It didn't take long for the ensuing fire and explosion to take over and destroy what was left of the platform.

Yes, looking at *Piper Alpha* 25 years after the incident, it is easy to point fingers, but the reality is technology like an asset management/asset optimization/maintenance system would have allowed workers to know the actual status, along with a single common storage area for all permits. Procedures were in place to follow a proper safety process, however, the total lack of people coordinating and remaining vigilant rendered the technology and process moot. Add in today's advanced technology to help cut down on human factors, and it is much easier to avoid any kind of disaster offshore.

Reducing Risk

In the offshore environment, it is all about reducing risk and to do that an inherently safe process a manufacturer has to design in inherently safe processes. Offshore processes have a built in danger and that means accidents should always be at the forefront of everyone's mind. Knowing that, incidents remain lower than in other industries.

In 2011, there were 2.3 incidents of injury and illness per 100 oil and gas workers, according to the US Bureau of Labor Statistics. The US offshore industry experienced an even lower rate of 0.8 incidents per 100 full-time workers. That compares with 3.5 incidents per 100 for the entire private sector.

Additionally, a 2012 Interior Department report examined spill records from 1996 through 2010 (the year of the *Deepwater Horizon* incident). Researchers found offshore spill frequency was actually "relatively low" despite the fact Gulf of Mexico deepwater oil production had risen sharply over that time.

With a strong safety culture, the potential for accidents will significantly lower through a constant assessment of the significance of safety events and issues to ensure each receives the appropriate level of attention.

One area manufacturers need to focus on is not just reacting to a problem, but also assessing near misses. All factors should come into play in a true safety lifecycle management program. A cycle for continuous improvement in safety performance also should be in place to track any near misses, analyze them for root causes, and use the results to further improve safety system performance. This is another area where technology can help operator track the right KPIs which plant management already established.

In the case of *Piper Alpha*, dismissing what may seem like an insignificant issue in the past may not seem important, but after a period of time of ignoring a seemingly small issue, that may lead to other slights, which starts the countdown to a disaster.

Proper management of the safety lifecycle requires trained and certified workers. Along those lines, maintenance of safety-related equipment often goes overlooked and that means operations and maintenance personnel need training and certification in testing safety systems.

Better adherence to maintenance practices is a must. Asset integrity management systems can help bring about a more proactive maintenance strategy and can even reduce maintenance costs.

Part of those assessments will include the idea that system design must follow safety standards that include an ongoing continuous improvement cycle based on periodic hazard analysis or HAZOP.

That ongoing analysis will continue to determine the type of safety protection needed, such as an Emergency Shutdown system. The next task is to assess the appropriate Safety Integrity Level (SIL) the system must meet.

The IEC 61508 and IEC 61511 developing standards define, among many items, four safety integrity levels. Most production facilities in the oil and gas and petrochemical sectors have critical safety applications that range from SIL 1 to SIL 3 (the three levels referenced in the ANSI/ISA S 84.01 guidelines).

In addition, asset management systems must undergo regular testing and maintenance in accordance with safety procedures. Proper asset management must include an alarm management strategy with warning or event indication to alert the operator and maintenance when maintenance is due.

Offshore installations service specialists. Photo: ABB.

Integrated Safety

Integrated safety with automation systems can be an important technology trend where critical information or alarms are on display. Utilizing common reporting tools for safety and control systems creates an environment for consistent analysis and breeds familiarity with safety systems for the operator. Along those lines, operator ergonomics that facilitate fast and correct operator decision-making and produces measurable improvements in plant productivity, information flow, and safety can improve the work environment and have a positive impact on remaining alert, which removes the potential to miss critical information due to fatigue.

The design allows for the system to react properly to an incident, but it can't just stop there. Inevitably, operators need training. The system cannot prevent every little discrepancy, but the right problem solvers in the right culture married to the technology will solve issues before they escalate.

One way to deal with safety is to implement lifecycle management that will not only allow the user to work with issues known today, but also take care of those that appear down the road.

Review the entire lifecycle. When the designers created the system, did they understand the risks? Did they use reasonable levels of probability? How about the consequences? Did they mitigate those factors?

Equipment will continue working for years, but other factors intervene. Just how sure is everyone that valves that have been in place for 20 years or so will open or close as they should during an emergency situation? Have they undergone any testing and how do you know they will work? What about the pumps?

Safety Culture

Technology will not fix a problem unless the right processes and the right best practices are in place. Technology will help enable people to make the right decision. But the safety culture has to be there to enforce them to make the decision in the first place. Even with multiple technology protective layers,

Reducing Human Errors

Through a series of advances, the sophistication of hardware and software technology has advanced tremendously over the past 30 years. Through the use of automated procedures, proper audit trails, management of change process, alarm management, situation-based displays, human-centered HMIs and control room design, humans still remain at the pulse of the design, operation or maintenance.

It would be possible to reduce errors by keeping a focused eye toward asset optimization, where the user could easily access procedures and configuration guidelines. An integrated control and safety system would be likely to catch alarm failures and the lack of adequate safeguards and use of outdated process design.

In addition, today's technology would issue a warning or event indication that would be able to alert the operator or maintenance workers if there was a recirculation automated level control valve left closed or if there were failures or breakdowns not attended where a work order ended up closed without the job completed. In the *Piper Alpha* scenario, if a safety valve was out for maintenance and Pump A was out of service there would have been warnings available at the system level and the automated log would have explained the situation to

The system 800xA extended operator workstation. Photo: ABB.

users need to enforce a strong safety culture that reaches every level — and it has to start at the top.

The following are some recommendations to keep everyone tuned into safety:

Use check lists: Create a check list and then have a co-worker verify the checklist. With tablets becoming more commonplace, that will be a big help.

Foolproofing: Understand and recognize which operations are highly critical and sit down and make sure everyone understands that and then find the answer to the question of how can we make this foolproof.

Flag changes: Operators and maintenance users get a flag that tells them when systems or devices end up moved off automatic and into manual or in the case of *Piper Alpha* which are not usable. Flagging should make workers aware.

Communication: Workers need to cross check and talk through an issue; create a collaboration table where people can have a look at the plant digitally where they can cross check and look at diagrams and understand the ramifications behind decisions.

Don't rush.

Safety and Integrity Management

Along with keeping people tuned in, there is also the point where process safety and integrity management can come together. Process safety is the prevention of unplanned and uncontrolled loss of containment from plant and process equipment that might cause harm to people or the environment. That definition works hand in hand with integrity management which is the assurance that plant and equipment are fit and ready to go by establishing competent people, effective systems and dependable assets.

Operators understand to achieve safety, reliability and plant integrity goals requires a holistic approach to integrity management. They need to understand safety, integrity and reliability all link. In essence, they all tie together into a management system that should operate cohesively to manage risk and achieve the economic goals of the business.

There are three elements in play when undertaking any integrity management review: The reliability and integrity of the assets, the effectiveness of the systems and procedures in place to control operation and maintenance of the assets, and the knowledge and competence of the workforce managing and maintaining the assets.

Human factors end up being a key factor in the review from management understanding and support, communications across the lifecycle, establishing effective information systems, and an understanding of the design and construction features and deterioration mechanisms by all the relevant groups.

Benefits from integrated safety and integrity management include:

- Being in control, resulting in improved health, safety and environmental performance; full regulatory compliance, and business performance benefits, including higher plant availability, improved output and more reliable customer provision

allow for better decision making, averting a disaster.

There must be an understanding that mistakes will happen. It is just how high, or low, the user wants that risk to be. Humans will make errors, so a robust system is necessary, one that takes in everything from understanding and utilizing automation procedures and putting everything in proper context all the way to control room ergonomics that allow the operator to remain on his or her toes at all times. Today's automation technology can lower the risk factor. While not removing human error entirely, it can help tighten the human error factor. ▪

A man demonstrates how to use a 3D KPI Board. Photo: ABB.

- Reduced costs, including maintenance costs.
- Compliance with the ability to reliably meet ever more demanding regulatory requirements
- Technology backbone to a culture that ensures safety and integrity are integral parts of day to day operations.
- Delivery of performance which means a more proactive approach and managing improved performance sustainably

Continuous Training

A majority of the industrial accidents that occur every year are a result of human error. Every year, a majority of accidents occur as a result of improper training of personnel. Systems can have the right design to react properly to an incident, but manufacturers need properly trained workers to ensure the safe handling of a problem.

Manufacturers need to have an action plan of best practices to ensure a safe environment. They need to:

- Set up procedures for reducing incidents that include proactive asset management and written standard operating procedures.
- Perform comprehensive hazard assessment after every incident or accident to ensure equipment meets baseline protection levels at minimum.
- Manage process safety as an all-inclusive effort where all parties (including third-party contractors) possess appropriate process safety knowledge and expertise. Root cause analysis of incidents leverages lessons learned and adds to the overall body of knowledge.
- Consider an integrity management system to gain more knowledge of the current state of all equipment as it relates to safe operations.
- Do retrospective HazOp implementing "what if" scenarios. If the plant has been running 10 to 15 years, every five years the plant should do a HazOp test to make sure everything is working.
- Layers of protection analysis (LOPA). This is to overcome human factors where plants undergo changes over the years. People have modifications like add ons or close offs. This type of analysis would inform what was working and what was not.
- Asset integrity management. This is for the mechanical items on a production plant. Make sure the control valves, the emergency relief valves, piping and pressure vessels, etc. undergo inspections at defined frequencies.
- Alarm management. A root cause of the Three Mile Island nuclear plant incident was the operators ended up swamped with alarms. Operators had dozens of flashing lights and they couldn't tell the wood from the trees. Alarms need to be in context. Now there are emergent standards coming out that allows for a certain amount of alarms in 10 minutes.

Safety goes beyond just ensuring processes remain stable. By having a solid plan and ensuring a strong safety culture where users and automation technology remain intertwined, there will be a direct link to increases in production and decreases in incidents. Producers need to look at the big picture and realize just what a strong safety program brings to the bottom line. OE

Luis Duran *is Product Marketing Manager, Safety Systems, at ABB. Duran holds a Functional Safety Engineer certification from TÜV, and an MBA and a degree in Electrical Engineering from Universidad Simon Bolivar Caracas, Venezuela.*

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LET'S WORK.

Drilling and investment in Southeast Asia

By Nina M. Rach

Two countries – Malaysia and Indonesia– hold nearly two-thirds of the region's reserves, and national oil companies outstrip international oil companies in regional capex.

According to the *Infield Systems Offshore Asia Oil & Gas Market Report to 2017*, four countries control 88% of the oil and gas reserves in Southeast Asia: Malaysia (44%), Indonesia (19%), Vietnam (14%), and Myanmar (11%). Four other countries control only 12% of reserves: Thailand (6%), Brunei (3%), Philippines (2%), and Cambodia (1%).

Oddly enough, the four countries with the largest reserves accounted for a disproportionately low share of offshore drilling activity in the region, even when Chinese drilling is excluded. Based on Baker Hughes International offshore rig count data for the last year (see table), drilling activity in these four countries has dropped from a high of 78% of all regional rigs in October 2012, to only 57% in September of this year.

Looking at the same data for Thailand, Brunei, and the Philippines (Cambodia had no offshore drilling), those countries with a combined 12% of reserves rose from using 26% of all offshore rigs in the region in October 2012, to using 41% in August and September of this year.

Capital expenditures of the three most active IOCs in Southeast Asia, Chevron, Shell, and Murphy Oil, account for only 25% of total regional spend, while the five most active NOCs spent 35% of total capex:

- Malaysia's Petroliam Nasional Bhd (Petronas), 20%
- Thailand's PTT Exploration & Production (PTTEP), 6%
- Thailand's PTT Plc., 4%
- Brunei government, 3%
- Vietnam Oil and Gas Group (PetroVietnam), 2%

Divesting

While return on investment is a likely cause of shifting focus, there may be other competitive factors affecting IOC's decisions to abandon certain Southeast Asian assets. Local government policies, driven by social and political pressures, are not always market-oriented. Foreign investors may question whether they are facing fair competition in the alliances between consumer and producer NOCs and local suppliers.

The upshot is that some US energy companies and drillers are unloading assets in favor of more strategic and profitable projects:

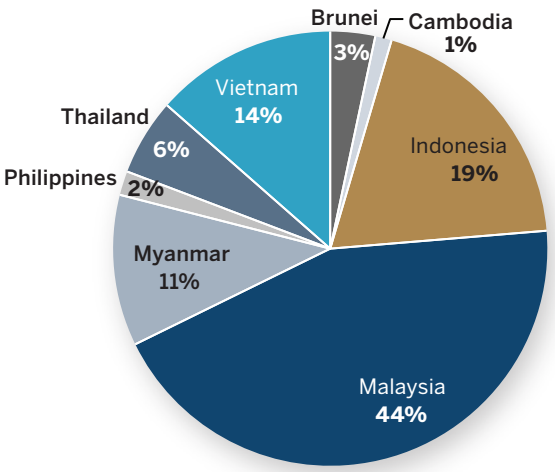
- In February, Newfield Exploration said it was exploring the sale of its Asian assets.
- In June, Hess announced it would sell assets offshore Indonesia and Thailand.
- In October, Otto Energy announced it would stop offshore Visayas exploration, on block PM 323, offshore Malaysia.

At the Barclay's CEO Energy Power Conference, 12 Sept 2013, Newfield CEO Lee Boothby said the company was now focused on North American "liquids" plays, and confirmed that the international sales process was underway.

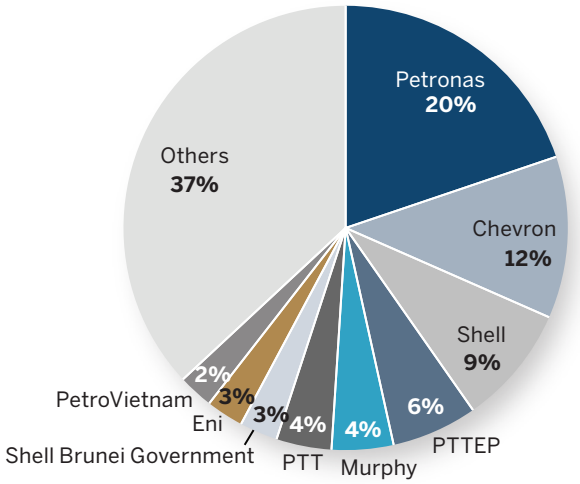
Newfield is the fourth-largest oil producer in Malaysia and owns an interest in about 3.3million net acres offshore Malaysia and about 290,000 net acres offshore China. The Malaysian fields accounted for 39% of NFX's revenues in 2012. Petronas operates some of the blocks in the Malay Basin in which Newfield holds an interest.

In late October, the company announced that it would sell all of its equity interests in Newfield Malaysia Holdings to SapuraKencana Petroleum Berhad for a total cash consideration of RM2.85 billion (US$898 million). The

Southeast Asian total reserves on-stream
(MMbbl, est.) 2013-2017



Southeast Asian Capital Expenditure
(by operator) 2013-2017



Source Infield Systems Offshore Asia Oil & Gas Market Report to 2017

deal is expected to close in early 2014 and Newfield said it would use the proceeds of the sale to pay down existing debt and for general corporate expenses. The announcement has not yet significantly affected NFX stock price, while SapuraKencana stock (SKPETRO) has increased.

Among the unsuccessful bidders for Newfield Malaysia are Exxon Mobil, Royal Dutch Shell, Talisman Energy, and Petrofac.

Newfield also announced, on 14 October, that Terry W. Rathert, a Newfield founder and the Executive Vice President and Chief Financial Officer (CFO), will retire in 2014, after more than 25 years with the Company. Newfield's Board of Directors will appoint Lawrence S. Massaro to succeed Rathert as Executive Vice President and CFO effective November 11, 2013.

The newbuild *Tungsten Explorer* is drilling off Myanmar (Burma) for Thailand's PTTEP, in 3379ft water depth. Photo from Vantage Drilling Co.

Investments

Damen Group will open a new shipyard in Vietnam in Q1 2014. It will design and fabricate 60m workboats.

Malaysian shipbuilder Coastal Contracts (COCO) announced in October that it had clinched deals for six offshore support vessels worth 318million ringgit (US$100million).

UMW Oil & Gas Corp Bhd plans to set up a local drilling academy to ensure a steady supply of trained manpower for the industry. The company runs a fleet of four jackup drilling rigs.

Deep water

Southeast Asia has not been a major deepwater arena. Most drilling has been in shallow water, with jackups or drilling tenders. That said, six drillships are in the area, four of which are undergoing inspection, modification, or are ready stacked in Singapore. Two others are drilling.

Transocean's Discoverer Seven Seas is working off Indonesia for Japanese oil and gas company, INPEX.The contract, announced in December 2012, runs May-December 2013 at US$500,000/d.

Houston-based Vantage Drilling Co. has its newest ultra-deepwater drillship, *Tungsten Explorer*, working under a 90-day contract at US$750,000/d.The ship began operations on 20 September off Myanmar, in 3379ft water depth, for Thailand's PTT Exploration and Production Public Co. Ltd. (PTTEP). This is the second-deepest water depth currently being drilled in Southeast Asia. Vantage has contracts pending to drill as many as four additional wells before the ship heads to West Africa to begin a two-year contract in the second half of 2014, working on the Moho Nord development project.

There are 21 semisubmersible rigs in Southeast Asia, but only 9 are actively drilling: 4 in Malaysia, 3 in Vietnam, 1 each in the Philippines and Indonesia.

Most are working in water greater than 1000ft deep, and *Ocean Rover*, operated by Diamond Offshore Drilling, is working in the deepest water in the region: 4542ft deep off Malaysia, for Murphy Oil. This ODECO Victory-class semisubmersible is one of five rigs upgraded by Diamond, since 2000, from deepwater to ultra-deepwater capabilities, with 15k blowout prevention equipment. *Ocean Rover* can work in water to 8000ft deep, and drill to 35,000ft. It's under contract for $305,000/d until March 2014, at which time it begins a new 2-year contract at $465,000/d.

Sovereignty

Sovereignty over several areas of the South China Sea remain under dispute, involving China, Vietnam, Malaysia, Brunei, and the Philippines. In mid-October, Chinese Premier Li Keqiang visited several ASEAN countries to discuss maritime boundaries. We hope for a harmonious outcome. **OE**

Offshore Rigs, June 2012-Sept 2013

	6/12	7/12	8/12	9/12	10/12	11/12	12/12	1/13	2/13	3/13	4/13	5/13	6/13	7/13	8/13	9/13
Brunei	2	0	0	0	0	0	0	0	2	1	2	2	1	1	1	3
China	13	13	12	16	17	18	17	18	17	17	20	18	20	16	15	17
Indonesia	9	9	7	9	11	9	9	9	10	14	14	11	9	9	9	9
Malaysia	12	15	15	15	14	14	13	12	13	10	11	10	11	11	9	11
Myanmar	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	2
Philippines	0	0	0	0	0	0	0	0	0	1	1	1	2	2	1	1
PNG	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0
Thailand	12	13	13	11	11	12	9	11	13	15	14	15	16	12	14	14
Vietnam	6	7	7	7	7	5	3	3	3	4	1	3	3	4	3	2
Total	**55**	**58**	**55**	**59**	**61**	**59**	**51**	**53**	**59**	**63**	**64**	**62**	**63**	**57**	**54**	**59**

Data from Baker Hughes Inc. International rig count, 25 Oct 2013

SE Asia comes to LAGCOE

Laissez les bons temps rouler. Deep in the heart of Louisiana oil country, US representatives from two Asian trade organizations made the case for local investment at the 2013 Louisiana Gulf Coast Oil Exposition (LAGCOE), held in Lafayette.

By Audrey Leon

The International Energy Agency (IEA)'s new World Energy Outlook 2013 report, which releases this month, noted that Southeast Asia's energy demand has risen 250% since 1990, and the region's energy demand is set to increase 80% by 2035. IEA's data states that oil demand will rise from 4400b/d today to 6800b/d in 2035. Natural gas is expected to increase by 80% to 250 Bcm. The IEA's data shows costs and potential supply disruptions.

Representatives from Malaysia and Singapore's trade organizations were two of the featured speakers at this year's international presentations at the 2013 LAGCOE conference. The delegates were there not only to drum up business partnerships but to drive the kind of technology sharing that will allow the two Asian countries to develop their oil and gas, and manufacturing assets.

Boon Ho Toh, director for the International Enterprise Singapore, based in Los Angeles, believes Lafayette's oil and gas industry could benefit Singapore as the country seeks to develop more deepwater, and harsh environment fields. In addition, with Asia's strong demand for LNG imports, Singapore is in better position than most, as it is one of only 20 countries holding a free trade agreement (FTA) with the United States.

"Now with Sabine Pass winning approval, there's a very strong market in Southeast Asia, Japan, and China. There's a strong opportunity for Louisiana, when it comes to LNG exports," Toh said to OE following his presentation.

Singapore already represents a very important market for the state of Louisiana. According to a recent report by the World Trade Center New Orleans, Singapore is Louisiana's third largest foreign export partner – behind China (second) and Mexico (first) – representing US$1.53 billion in 2Q 2013, up 44% over the same period last year.

"Once Congress approves those export markets and LNG flows come in, it will be very positive for Louisiana and for Lafayette," Toh said. "We [Singapore] definitely look forward to that. There's a strong LNG demand in Asia, and if you have the supply, I can assure you, that we will be standing in line, ready to buy."

IEA's data shows that declines in mature fields coupled with limited

Boon Ho Toh, director for the International Enterprise Singapore, addresses crowd at LAGCOE.

Expert Access

LIVE SESSIONS GLEAN EXPERT KNOWLEDGE

Left: Adrian Goodwin, Bolshoy Bhattacharya, Paul Hutton, Martin Brown and Ian Frazer, from GL Noble Denton

Below left: Will Watson, offshore drilling and production marketing manager, Caterpillar Marine & Petroleum Division and Dr Peter Longstaff, ExxonMobil Fuels & Lubricants

Below: Offshore Engineer's Paul Hutton (standing) with Will Watson, offshore drilling and production marketing manager, Caterpillar Marine & Petroleum Division and Dr Peter Longstaff, ExxonMobil Fuels & Lubricants

SPE Offshore Europe 2013 saw Offshore Engineer host three live Expert Access sessions, featuring senior staff from ExxonMobil, Caterpillar and GL Noble Denton.

The first, Optimising Safety, Environmental Care and Performance in the Oil & Gas Industry, was with ExxonMobil Fuels & Lubricants/TLC/Caterpillar.

Dr Peter Longstaff from ExxonMobil Fuels & Lubricants set out the change in lubricant technology over the past 25 years, and how lubricants can help engineers improve safety, environmental care and productivity.

Will Watson (offshore drilling and production marketing manager, Caterpillar Marine & Petroleum Division) discussed offshore products that meet emissions standards and safety regulations, and how these can meet the needs of the future.

This was followed by two further sessions, organised in association with GL Noble Denton.

The first was dedicated to floating production, specifically, understanding the technical, environmental, and regulatory aspects. The session saw GL Noble Denton's Ian Frazer outline the functional requirements for floating production, storage and offloading vessels and the key drivers to consider during the early concept stages.

GL Noble Denton's Martin Brown then set out the different types of mooring systems available for floating production and the importance of integrity assessments.

Bolshoy Bhattachary discussed dynamic positioning and how it can give an insight into future incidents, what can happen if a failure occurs and a brief insight into how a system works.

Adrian Goodwin then talked about third party inspections and how important it is to capture defects at an early stage. He also detailed the importance of making sure equipment, when being fabricated, is exactly to specification.

The second seminar was titled Floating Production: Advanced Inspection and Maintenance Strategies.

GL Noble Denton's Steven Coull spoke on fitness for purpose assessments. The process for structural assessment of a floating unit and its three-stage process, including data recovery, review of data and reassessment process.

Samuel Ogunkolade, from GL Noble Denton, then went on to discuss process safety, changing needs, duty of equipment, life of assets and how to identify a change. This included a case study on Piper Alpha.

GL Noble Denton's Stewart Myles discussed refining inspection, using integrity operating window management system, how to set limits for critical process variables and how to keep within the parameters.

All three live sessions were also recorded and are now available to be viewed by going to: **www.oedigital.com/oe-oe.**

Sikh Shamsul Ibrahim, Director of Malaysia's Investment Development Authority (MIDA) discusses development opportunities at LAGCOE.

large new prospects could cause oil production across the region to fall by almost one-third by 2035. As a result, the southeast Asia region is poised to become the world's fourth-largest oil importer, behind China, India and the European Union with oil import dependency doubling to 75%, as net imports rise from 1900b/d to just over 5000b/d. The region's spending on net oil imports is set to triple to US$240 billion in 2035. Thailand and Indonesia's spending on net oil imports tripling to nearly $70 billion each in 2035.

Malaysia's oil and gas industry boasts impressive stats with 4 billion bbl of proved oil reserves. The country is the second largest oil producer in Southeast Asia, producing 642.6 Kb/d in 2012. However, Malaysia's output is in decline, having hit its production peak of 861.8 Kb/d in 2004, according to recent EIA production statistics.

The EIA further said that recent foreign investment in deep water and technically challenging fields primarily in the Sarawak and Sabah states provides impetus to maintain natural gas production levels over the next few years. However, production declines at Malaysia's mature fields have led to investments in enhanced oil recovery (EOR) and the development of marginal and deepwater fields.

Sikh Shamsul Ibrahim

Sikh Shamsul Ibrahim, Director of Malaysia's Investment Development Authority (MIDA), based in Houston, discussed current challenges to production, and some of the ways the country is looking to boost oil recovery efforts on its mature fields. In 2011, both Shell and ExxonMobil opted to make billion dollar investments in enhanced oil recovery projects off Malaysia.

ExxonMobil put up RM$10 billion to fund development and drilling activities, as well as to upgrade and build new oil and gas facilities. ExxonMobil along with PSC partner Petronas concentrated improvements on seven mature offshore fields, including Tapis, Guntong, Tabu, Palas, Seligi, Irong Barat, and Semangkok.

The Tapis EOR project, located offshore Terengganu in the South China Sea, is on track for start up by the end of this year following the installation of the 23,500 tonne Tapis R platform jacket back in July. The project aims to boost the life of the Tapis field by an additional 30 years, and recover an additional 180MMbbl of crude. The field, which was discovered in 1969, is expected to reach peak production of 30,000 b/d by 2016-2017, according to a September report by Platts.

Shell similarly invested RM$38 billion for EOR projects offshore Sarawak and Sabah, East Malaysia. In November 2011, Shell announced the signing of a heads of agreement for two, 30-year production sharing contracts with Petronas to extend the life and increase recovery at the Baram Delta (BDO) and North Sabah fields. Shell said the EOR projects could boost production by an additional 90 to 100 Kb/d of oil and field life past 2040.

Shell has four producing oil fields off Sabah operated under a new PSC signed with Petronas. Shell is also participating in the development of five deepwater fields including Gumusut-Kakap (33% operating interest) and the Malikai field (35% operating interest). In Sarawak, Shell maintains 40% interest in the 2011 Baram Delta EOR PSC.

Malaysia also boasts impressive natural gas numbers in addition to oil production and reserves. Malaysia is the second-largest natural gas producer in the region, according to recent EIA data, and it is second only to Qatar in LNG exports. Malaysia's natural gas production has risen over the past two decades to meet growing domestic and export demands.

Toh and Ibrahim used their presentations at LAGCOE to tout several perks of doing business in their respective countries, namely stable local governments, a large talent supply, and well-developed infrastructure for oil, gas, and petrochemical projects. Both Malaysia and Singapore serve as manufacturing hubs for the Southeast Asia region, with both countries presenting easy access to nearby Asian markets. Singapore, especially, is already an established player in the shipbuilding industry with the likes of Sembcorp Marine and Keppel Corp. based in the country. Singapore, Toh said, is now a global leader in shipbuilding with >70% of global market share in the building of rigs, jackups, semisubmersibles, and FPSOs.

As of press time, a trade mission between from the city of Lafayette, Louisiana, to Malaysia has been proposed at LAGCOE, but no details have been announced. OE

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OE REVIEW

DEEPWATER INTERVENTION

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Pictured is Marine Well Containment Company's capping stack. Read more on the technology's evolution since Macondo inside this month's special ***OE Review*** on Deepwater Intervention. Photo: MWCC.

Evolution for deepwater intervention

Expro Group says lightweight, mobile systems are needed to meet future deepwater intervention needs.

A riser control module (RCM), a component which makes up the full subsea landing string.
Photo: Expro Group.

*By **Alistair Geddes**, president of strategy, resource development and support and **Daniel More**, group technology director, Expro Group.*

Demand for deepwater subsea well intervention services continues to grow. However, to date, the focus remains on completions for new field developments.

As subsea field age and production rates begin to decline, operators are looking towards subsea intervention to maximize reserves across the field.

The technical challenges of deepwater intervention are well documented in the industry, including the need for costly rigs or vessels to undertake this work.

Expro has forecast the demand for deepwater intervention across several of its major business regions over the next five years, including the Gulf of Mexico, West Africa and Brazil.

We anticipate high market demand for lightweight portable systems, which will support deepwater fields with increasingly complex issues—as opposed to one-off solutions.

There is now a critical mass of maturing subsea wells and architecture in place, therefore there will be an increasing demand for well intervention services.

It is important that we look towards planned intervention, assessing operator's demands, current technology in place, limitations and how we can develop a solution to address these combined needs.

Indeed oil and gas operator's demands may change with market developments, not only in terms of equipment that can be utilized from smaller vessels, but a move towards emphasis on the full life cycle of a field.

Both operators and service companies have a need for streamlined technology, as neither want to be driven into deploying expensive large rigs or vessels. Lighter weight and flexible systems that could be pre-loaded on to vessels, to provide a multifunction system, are much more desirable—and economically viable.

At present, the market is served by two conveyancing methods. These are wire in water, where wireline is deployed from a dedicated vessel via a subsea lubricator, and riser-based systems, capable of operating in deepwater and able to run coiled tubing.

The riser-based systems on the market are mostly provided by Christmas tree vendor companies and run by operators. Intervention systems are sold as part of the overall subsea tree package, which can be used to run the trees and clean up wells. However, this isn't fully utilized until intervention is required. This can create issues in terms of maintenance and integrity of the equipment at the point of use.

Operators are still looking for a "one-stop shop" that can intervene in a well, provide a full conveyancing system, subsea and surface hardware, and riser services.

Working directly with operators, Expro has set up a project team that has started work on conceptual studies for a new system, to adapt existing field-proven technology, currently used in completion, and which could be mobilized on different vessels.

This lightweight riser-based system, capable of deepwater operations, is being designed for use on Category B mid-size rigs or vessels, with a view to being mobilized and demobilized quickly.

The design of the intervention system will be based on the latest subsea landing string as, fundamentally, both systems perform the same function. The only difference is that a landing string is deployed within a blowout preventer and marine riser, which isn't exposed to the same global loads as an open water intervention system.

In parallel, Expro is also developing designs for a new landing string compliant with API 17G, including cut and seal capability and high-angle disconnect, which is due to reach the market in 2014-15.

Expro has drawn on its experience developing the AX-S system, which was aimed at the lightweight intervention market, but still relied on large vessel mobilization.

Significant investment is needed to develop technology. It is essential that the industry works together and moves forward on a partnership basis to ensure alignment. Operators need assurances that solutions can be provided that will fill demand and service companies need commitment that technology once developed will be deployed.

However operator feedback is consistent — the need to advance subsea well intervention technology exists and will increase. A "technology transfer" approach is the route forward to encourage the evolution of existing technology and modify this to apply to the challenges of deepwater intervention. OE REVIEW

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Deepwater well decommissioning

Houston-based Helix ESG recently completed a deepwater well decommissioning project in 7919ft. ***Darin Hilton*** *explains the steps and options involved in plugging and abandonment.*

Over the past several years, there has been a growing demand in the industry to safely and efficiently plug and abandon wells in the Gulf of Mexico (GOM). Having successfully decommissioned over 30 wells in more than 3,500ft water in the GOM, Helix ESG has enabled clients to achieve a more efficient, safe, and cost-effective method of securely and permanently abandoning deepwater subsea oil and gas wells to meet regulatory and industry standards for several years.

The key elements to Helix's success is purpose-built vessels with a dedicated Intervention riser package and experienced crew and project management teams to support the client in planning the job.

THE *Q4000* AND PURPOSE-BUILT VESSELS

The *Q4000* has been the main vessel utilized by Helix for riser-based GOM plug and abandonment (P&A) work for the past decade, with one reason being that the open decks and large cranes provide efficient mobilization of client equipment. Another advantage to the *Q4000* is that The open multi-purpose tower (MPT) on the *Q4000* allows unrestricted access on three sides, allowing for easier change of operational modes from, electric line, slick line, or coil tubing. In most cases, with a purpose-built vessel and a dedicated intervention riser system (IRS), stack-up and surface image testing (SIT) can be completed in transit, reducing

The Q4000, Helix's vessel of choice in riser-based GOM work for the past decade.

Photo: Helix ESG

the amount of testing time on critical path. Once mobilization and testing is complete, the vessel runs the multiplex (MUX) controlled intervention riser system to depth, utilizing a dual-string riser. The intervention riser system is unique and is comprised of a lower riser package (LRP) with a 7 3/8" production through bore. The LRP also provides cut and seal fail-safe barriers on both the annulus and production sides.

The IRS system is also equipped with a emergency disconnect package (EDP) to quickly detach and seal in the event of an emergency or station keeping incident. The EDP itself is equipped with a valve to ensure riser fluids are retained within the pressurized riser should the emergency disconnect sequence be required. The IRS system is a lighter package than a traditional blow-out preventer (BOP), minimizing stress on the supporting well tree during latching.

Managing down lines, MUX cables, and a separate annulus line while operating an IRS requires proper set-up and an experienced crew. The riser also should be pressure-tested periodically to confirm riser integrity while running.

ACCESSING THE WELL WITH THE IRS PACKAGE

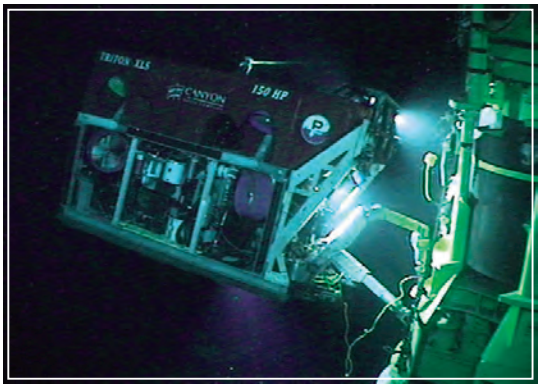
Once the IRS package is ran to depth in an identified safe zone, riser space out is confirmed by moving the IRS package over the well. The surface system is then rigged up with flow head, coil tubing lift frame and coil tubing BOPs once it returns to the safe zone. The system is then landed and latched up on the well utilizing passive and active heave compensation. ROVs will then connect the installation workover control systems (IWOCS) and electric down line (EDL), utilizing hydraulic flying leads (HFL) and electronic flying leads (EFL) jumpers for tree control. The IRS will then be pressure-tested to confirm integrity and the riser will be displaced with working fluid prior to opening the well.

WORKING DOWNHOLE

Downhole work begins once well access capability is established. If the well is designed with a horizontal tree, the first run will be for slick line to pull crown plugs. Coil tubing is usually a contingency to slick line in case of stuck crown plugs or embedded debris. The IRS and riser can usually increase pressure on the bottom of the crown plugs to assist with retrieval. Once the well is opened, tubing fluids are displaced and the production zone is then killed with kill weight fluid. Another option is to run a tubing punch on electric line to create a flow path above the production packer, allowing for packer fluid in the annulus to be bull headed into the formation rather than circulating it out to surface. Either option is achievable in most cases.

Once the well is killed, a gauge ring ran on slick line is conducted to ensure vertical access in the production tubing. Coil tubing is then rigged up and ran to bottom. Coil tubing ensures the plug is correctly located, provides an additional means of circulation if problems are encountered, and protects the tree and well control equipment from exposure to cement.

A crane atop the Q4000 rigging up coiled tubing to perform deepwater P&A work.
Photo: Helix ESG



An ROV engaged in operations.
Photo: Helix ESG

After the cement is cured, the production plug is tested to confirm integrity. Once the pressure test is satisfactory, the first of two balanced cement plugs is set, sealing both the production tubing and annulus above the production packer by taking returns though annulus. Coil tubing would then be recovered and electric line prepared. Once the cement is pressure-tested and its integrity with the balanced plug is confirmed, an electric line could then be ran into the well to act as a mechanical barrier in the production tubing above the cement plug. Electric line then perforates the tubing to

Open decks and sizable cranes aboard the vessel provide more efficient mobilization. Photo: Helix ESG

prepare for the second balanced plug to be circulated into place with coil tubing.

Once the second balanced cement plug is set and successfully pressure tested, electric line is directed into the well with a tubing cutter. The production tubing would be cut above the balanced plug to allow for the recovery of production tubing. Prior to unlatching, a negative test is performed with sea water and then well circulated to ensure kill weight fluid on both production and annulus sides in the well.

OPEN WATER AND SETTING THE PLUG

Prior to pulling the trees during the riser-based portion of the P&A, ROVs flush and remove any flow line jumpers by pre-rigging them with slings and cutting the jumper into manageable sections for the subsea crane to recover concurrently to the P&A work. This eliminates the need for a construction ROV vessel to perform any pre-work prior to arrival on location of the P&A vessel.

Once tubing is clear of the well the vessel will move to a safe zone to finish recovery. If the well was designed with a vertical tree, the IRS would be recovered through the riser and the tree would be concurrently recovered by the subsea crane. A tubing hanger running tool would then be tripped to bottom on drill pipe to retrieve the tubing after the IRS was recovered.

The open water-portion of the P&A can been done in many different ways, with different approaches to testing casing annuli. The most common method is utilizing the easy drill subsurface valve (EZSV) and a tubing-conveyed perforated (TCP) gun to allow access to the annuli. This method is performed by tripping the EZSV and TCP guns to depth and setting the EZSV. Once EZSV is pressure tested from below to confirm it was properly set, the TCP guns will be fired, perforating the production casing. Pressure is monitored and recorded during firing. Any existing pressure will be bled off and monitored again.

An injection test is then conducted at a pressure greater than leak-off test pressure to check the integrity of the annulus. If injection is possible, a squeeze-cement job will be performed on the annulus. If injection is impossible, then a negative test is performed to confirm integrity. The string is then retrieved from the retainer.

Once integrity of the squeeze is confirmed by both the pressure test and the negative test, a cement plug is set above the EZSV. The process would be repeated for the intermediate casing to 20in annuli perforating through two sets of casing with TCP guns.

Another option is to cut the production casing and recover to surface once annulus integrity is confirmed between production and intermediate casing, allowing for a mechanical barrier to be set in the intermediate casing. If this option is elected to be performed, the TCP gun would only be required to perforate the intermediate casing to ensure integrity rather than perforating two sets of casing to access the intermediate to 20in annuli. Once complete, a surface plug would be set. The surface plug is weight tested, utilizing drill pipe to tag the top of the plug and set down weight to confirm the plug has integrity.

Upon completion of the surface cement plug, an ROV will set a debris cap on the wellhead, completing the well work. The vessel will then perform a final survey with the ROV and complete demobilization from the well site. OE REVIEW

Darin Hilton *has been Helix's commercial manager for Well Operations in the US since 2012, and has worked for Helix Energy Solutions Group for more than five years. He has more than 18 years of experience in the offshore industry. Early in his career, Darin worked at Marine Transport Lines. Darin also worked at BP as a marine supervisor with and a superintendent for three producing fields.*

At Helix, he has served in three roles, including a three-year stint as Master/ OIM on the Q4000 during the oil spill response at Macondo.

Darin holds a BS in Nautical Science with a minor in Marine Engineering from Maine Maritime Academy. Darin also has a USCG Master Unlimited Tonnage license with OIM-unrestricted endorsement.

EXCLUSIVE RESEARCH

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Technology Needs Assessment 2013

The 2013 Deepwater Intervention Technology Needs Assessment, a research study done in partnership with Gelb Research, is a 55-page report providing an in depth assessment of the subsea industry's present condition and its known needs. Technical needs were assessed based on water depth, reservoir depth, metaocean conditions, and service/supply for all the major deepwater regions. Technical challenges were prioritized based on economics, risk, strategy, and frequency. The evaluation led to an overall value rating for the topics examined, which included: intervention incidence, intervention triggers, intervention solutions, and flow assurance methods. ~~Cost $895.00~~ **Special Offer $495**

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OE ATCOmedia PUBLICATION

Gelb An Endeavor Management Company

Marine Well Containment Company's 15,000 psi capping stack was successfully deployed offshore in the deepwater GOM to a simulated well site at a depth of 6900ft subsea. Photo: MWCC.

The evolution and advancement of the capping stack

Following the Deepwater Horizon incident in 2010, a group of leading oil companies came together to form Marine Well Containment Company (MWCC), an independent company tasked with developing, owning and maintaining a system to respond to a deepwater well control incident. The capping stack is the centerpiece of this well containment system. MWCC's ***Charlie Miller*** *explains.*

The capping stack creates a connection and seal to prevent well fluids from escaping. The assembly contains a suite of adapters and connectors to interact with various interface points for the variety of well designs and equipment used by oil and gas operators in the US Gulf of Mexico. Capping stacks and their corresponding system equipment now safeguard the US GOM, providing a sound response solution and peace of mind for both regulators and industry.

As of August 31, 2013, 119 permits to drill have been approved by the regulator that cite MWCC's system.

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Go to www.utc.no to find the Call for Abstracts invitation, topics and submittal guidelines.

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AN INTERIM SYSTEM FOR THE GOM

Formally established in December 2010, MWCC provides containment technology to respond to a well control incident in the deepwater US Gulf of Mexico. Today, the company is composed of ten members, all active in the GOM. MWCC's containment system is available to any company planning to drill in the deepwater GOM, either as a member or as a non-member on a per well basis. As a company whose purpose and mission is to be continuously ready to respond, the capping stack is at the core of our response system.

> The operating environment in the US GOM encourages technology development to meet the evolving needs of operators. The need to move to deeper depths and greater pressures may not be too far off the horizon.

MWCC has two capping stacks designed for use in the GOM, and is currently building a third which will be delivered in 2014. The capping stack is an integral part of our overall containment system, and has come a long way since 2011. The first capping stack is rated at 15,000 psi and weighs 100 tons. It provides a dual barrier for containment – a blowout preventer ram, plus a containment cap. This massive piece of equipment is about 30ft tall including the necessary lifting gear, and 14ft wide. When first introduced in 2011, the capping stack could function in 8,000ft of water, but was later confirmed capable of capping a well in up to 10,000ft and cap and flow a well in up to 8,000ft. The system has the capacity to handle up to 60,000 b/d of liquid, and handle up to 120MMscf/d of gas.

However, as our members looked for new and deeper sources of hydrocarbons, we made additional enhancements to these initial capabilities to keep pace with their needs. For example, in August 2011, procedures were developed to provide containment operations for deepwater drilling wells under floating production facilities (TLP/SPAR). These procedures were necessary to be able to install well containment equipment under floating structures. Additionally in September 2012, the capping stack was upgraded for use at well temperatures up to 350 degrees and pressures up to 12,750 psi; for higher pressures up to 15,000 psi, the temperature rating remains at 250 degrees.

In July 2012, at the direction of the Department of the Interior (DOI), MWCC initiated mobilization of its interim containment system, including a physical deployment of the capping stack. Working with member company, Shell Oil Company, MWCC successfully conducted the demonstration on a simulated well in the Walker Ridge block in the deepwater GOM. The demonstration included deployment to a simulated wellhead in 6,900ft of water using the heave compensated landing system. All necessary functions were completed, and pressure testing confirmed the ability to control a well. This capping stack demonstration validated that the right equipment and processes are in place to safely and effectively cap a well.

In January of this year, MWCC introduced a smaller 10,000 psi capping stack with a dual ram that is designed to reach deepwater areas where well casing and riser systems are closely spaced. This smaller capping stack can cap a well in depths up to 10,000ft. The completion of the 10,000 psi capping stack – which stands 25ft tall including the necessary lifting gear and weighs approximately 50 tons – is an example of our collaboration with our members, listening to the needs and, in turn, meeting them. Its 9ft by 9ft frame makes it easier to maneuver where wells are closely spaced such as tension leg platform (TLP) applications where wells are beneath a floating production facility. This 10,000 psi capping stack is another example of the evolution of containment technology and the ongoing enhancements to the overall system.

Marine Well Containment Company's 10,000 psi capping stack stands 25ft tall and weighs approximately 50 tons. Photo: MWCC.

AN EXPANDED SYSTEM WITH GREATER FLEXIBILITY

As mentioned above, an expanded system is under development. Building on current system capabilities, an expanded containment system (ECS), which represents an investment of more than US$1 billion by the members of MWCC, is currently being built. The ECS will provide greater flexibility to accommodate varying member needs, including greater containment capacity and use in deeper water depths. The expanded system will build on current capabilities to cap and flow a well in up to 10,000ft and can handle up to 100,000 b/d of liquid, and handle up to 200MMscf/d of gas.

This system required a number of firsts for the industry including the deepest production risers (reaching 10,000ft water depths) and the shallowest free-standing adjustable risers (reaching 2,000ft depths) ever built. Additionally, the subsea flexibles are the deepest ever

supplied for production.

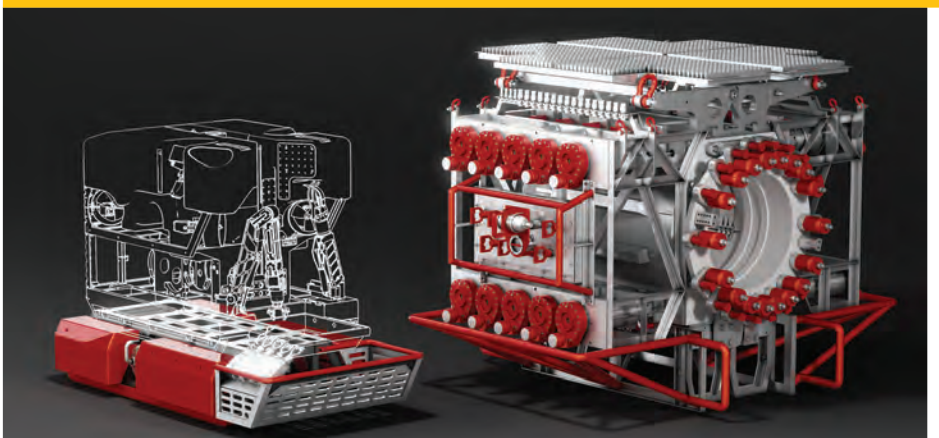
The system will also offer new technological enhancements to the capping stack including the ability to allow operators to function valves and chokes remotely via an umbilical. Moreover, the umbilical, which is the deepest ever built, will function in 10,000ft water depths and provide continuous, real-time pressure and temperature data to the modular capture vessels (MCVs) on the surface. Should the response require a cap and flow scenario, the expanded system flowlines will allow the MCVs to be up to 5,000ft from the wellhead to decrease vessel congestion at the site.

The capping stack connects with two capture vessels – which are modified Aframax tankers each with up to 700,000 bbl of liquid storage capacity – through the riser assembly which directs the flow from the subsea components of the system. The MCVs can process, store and offload liquids to shuttle tankers, which can then safely take the liquids to shore for further processing. The vessels' turret also allows for a quick disconnect should the MCVs need to move away from the incident site due to a storm in the Gulf. These MCVs are the first of their kind and part of MWCC's dedicated equipment offering that will be available to operators in the US GOM as part of our expanded system.

As our members continue to look for new and deeper sources of oil, MWCC will continue to advance well containment technologies – including the capping stack – to keep pace with their needs. The next step in these efforts will be the delivery of our expanded containment system, and after that; time will tell. The operating environment in the US GOM encourages technology development to meet the evolving needs of operators. The need to move to deeper depths and greater pressures may not be too far off the horizon. When those needs come to reality, MWCC will be there to lead the industry with its containment systems and continue to deliver upon its mission to be continuously ready to respond. OE REVIEW

Charles A. Miller *serves as chief technology officer for Marine Well Containment Company. His responsibilities include development of MWCC capabilities to accept and operate the expanded containment system as well as enhancements to the interim containment system in response to members' needs. Most recently, he served as vice president of production for Shell Brazil Ltda., where his responsibilities included management of production activities in offshore Brasil and onshore Argentina. A seasoned oil and gas professional, Miller has 35 years of experience in the upstream industry, including 20 years of offshore experience. Miller holds a B.S. in Mechanical Engineering from Oklahoma State University.*

Solutions



TDW's Clamp Installation Tool

T.D. Williamson Offshore Services (TDW) introduced the Clamp Installation Tool (CIT), a lightweight, remote-controlled system that installs any proprietary clamps or fittings on subsea pipelines in need of repair or to prepare for tie-ins to new pipelines. The CIT can be controlled onboard a platform or a diving support vessel (DSV), enhancing operational safety is enhanced, and improving control over clamp installation. It provides direct control of clamp installation operations during deepwater pipeline repair and tie-ins.
www.tdwilliamson.com

Tritech Gemini Narrow Beam Imager

Tritech's Gemini Narrow Beam Imager (NBI) has been field-proven by Reef Subsea. The NBI successfully monitored the trenched installation of 6-inch and 2-inch cable, while using controlled flow excavation techniques. The seabed conditions around the site varied considerably; however even with high turbidity Reef was able to clearly monitor the cables. The Gemini (NBI) provides operators with real-time high-speed acoustic images from a narrow vertical beam covering a 130° swath. Operating at 620kHz the NBI provides imagery at a 10mm range resolution and with a 0.5° horizontal angular resolution delivers sharp sonar imagery.
www.tritech.co.uk

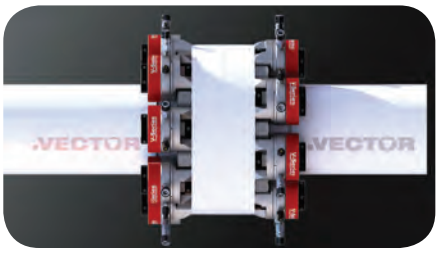
Photo: Reef Subsea Dredging & Excavation

Subsea inspection camera

Norway-based **Imenco AS** brought its new products including its Lizard Shark pan and tilt camera at the Norway pavilion at Offshore Europe 2013. The Lizard Shark, designed for use in subsea inspection and tooling technology, combines a 10x optical zoom color video camera with four dimmable LED lights in a revolving head providing 340° pan and 270° tilt with either RS232 or RS485 control.
www.imenco.no

City Technology gas detectors

Established by a team of scientists in 1977, **City Technology** has grown into a global business, with 50 million people worldwide using its gas detection sensors. With a range of more than 300 products detecting 28 different gases, City Technology, a Honeywell company, showed extensive growth in the industrial gas detection sector, a market reaching $2.2 billion in annual worldwide sales. With more companies focusing on safety regulations in harsh environments, the demand for City's hydrogen sulfide (H2S) sensor has risen sharply. The H2S sensor can withstand temperatures of -40°C, where methanol is commonly used as a solvent in de-icing agents.
www.citytech.com



Compact tensioners

Bolt-tensioning, equipment firm **Tentec** is showcasing its new V-Series of compact flange bolt tensioners. The V-Series is a range of tools designed for use on SPO compact flanges and the Norsok L-005 compact flanges. The range consists of 11 bolt tensioning tools covering bolt sizes from ¾-4in. Tentec says the preferred way to tighten SPO compact flange bolts is by using bolt-tensioning tools, but, due to the small size and relatively high bolt-load requirements of the flanges, many conventional bolt tensioners either do not fit or do not have a high enough bolt-load capacity.
www.tentec.net

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Activity

TAM's new manufacturing facility doubles the manufacturing size of the company's previous facility.

TAM International marked its 45th anniversary and the opening of its recently-built manufacturing facility on October 18 with a tour of the facilities in Houston, Texas. The new site was open to employees in September. TAM specializes in inflatable packers; swellable packers; and associated downhole products and services. The 26-acre site is housed contains 126,000sq ft of manufacturing space and 17,000sq ft of office space. It is a 24-hour manufacturing site operated in three shifts. It includes an autoclave to cure rubber, colanders to cut rubber into strips, a packer-testing unit, and a unit to pre-torque packers to spec. The facility also boasts a fully-automated parts machine, improving efficiency and safety.

▪ The European branch of the **Intervention Coiled Tubing Association** (ICoTA Europe) has announced the finalists of its Innovation Awards ahead of its annual SPE ICoTA Well Intervention Conference.

The award is presented annually to an organization that, in the eyes of the ICoTA Europe committee, represents the most innovative product or service to be developed or introduced to the European market in the last 18 months.

Pre-qualified companies will present their innovative offering to the committee prior to the conference, being held in Aberdeen on November 13-14.

Finalists are:

Antec, with its Acrobat Gyro compass system

OneSubsea, with its MARS fluid injection system

READ Cased Hole, with its adapting multi finger calliper technology

Interwell, with an expandable junk catcher

Previous winners of the award include, **BP, Oilenco**, and **Baker Hughes**.

ICoTA Europe chairman Michael Taggart, said: "This award is intended to recognize the tremendous hard work that an organization, its personnel, suppliers and clients must commit to when introducing new technology or an existing technology to the area."

The winner will be announced on the first day of the conference.

▪ **Louisiana Gulf Coast Oil Exposition** (LAGCOE), one of the world's pioneer oil and gas expositions, recognized the 2013 Spotlight on New Technology award winners at the CajunDome in Lafayette October 23. This awards program recognizes companies with revolutionary technologies that advance the process of discovering and producing oil and natural gas.

LAGCOE dedicates a technical session to recognize the winning technologies. Each winner presents a 10-minute overview of their innovation to industry leaders attending LAGCOE. The technologies were reviewed by a panel of judges who evaluated submissions based on the five criteria of new, innovative, proven, broad interest, and significant impact.

"We had outstanding applications from companies presenting exceptional technological advancements," said Chuck Schaub, P.E., LAGCOE Technical Sessions Committee Co-Chair and EDG, Inc. Project Manager. "This year's award winners have pushed industry limits through creativity, efficiency and safety."

5D Oilfield Magnetics
Open Hole Net
Baker Hughes FASTrak LWD™
Fluid Analysis Sampling and Testing Services
Baker Hughes SC-XP – SC-XPTM
Extreme Performance Frac Pack and Gravel Pack Tool System
E&B Green Solutions
G – Clean Products
Hickman Sales & Service
Stable Data System
Newpark Mats and Integrated Services
Advanced Composite Mats
Zahroof Valves
ZPV High Efficiency Modular Valves For Gas Gathering and Distribution Applications

▪ **Statoil Gulf Services**, the North American subsidiary of the Norway's **Statoil**, has signed a lease for 581,000 square feet in CityWestPlace in Houston, Texas, to serve as their North American headquarters. The company already 225,000 square feet in the complex. Statoil will over time occupy the entirety of CityWestPlace Building 2, comprising 431,000 square feet, as well as extend their existing lease for 150,000 square feet in CityWestPlace Building 4.

▪ UK-based engineering firm **Wood Group** will form a joint venture (JV) with Germany's **Siemens** to provide integrated rotating equipment services. The JV will comprise the maintenance and power solutions businesses of Wood Group GTS (excluding its Rolls Wood Group, TransCanada Turbines and Sulzer Wood joint ventures) and Siemens' TurboCare business unit, which provides aftermarket gas turbine, steam turbine and generator design, repair and manufacturing services.

Spotlight

By Anthresia McWashington

University launches subsea engineering program

The University of Houston's Subsea Engineering program is the first of its kind in the US. The program—founded by mechanical engineering professor and director of UH Subsea, Matthew Franchek—is in its inaugural year operating with a 10-course Master of Science curriculum since receiving approval from the Texas Higher Education Coordinating Board in 2012.

Franchek received an overwhelming response from companies about starting the subsea engineering program. Engineers and executives throughout the industry helped formulate the curriculum and joined the program's staff and advisory board.

"It's such a new field that there really weren't any textbooks or faculty available with experience in the subsea field," said Franchek. "They decided to come in and serve as adjunct professors for us. They're sharing their knowledge with the next generation of engineers and people who want to come over to subsea engineering."

The program has 70 students enrolled and Franchek predicts that the numbers will triple by January 2015, when the university implements interactive classrooms for students unable to physically. Courses now offered include subsea processing and artificial lift, riser and pipeline design, and the program's most popular class, flow assurance.

According to Franchek, flow assurance—taught by FMC engineering manager Dr. Phaneendra Kondapi—has created many career opportunities.

"Students enrolled in Dr. Kondapi's flow assurance course are getting job offers just on taking that class." Franchek said. "I don't have anyone in subsea coming up to me and saying they can't find a job."

Kondapi recently won the SPE teaching excellence award, presented to active faculty who use innovative teaching techniques. His decision to integrate practical problems from industry and promote networking between students and professionals cemented his award.

"I didn't want to make it a typical course like other classes,"Kondapi said. "I wanted to make this as complicated as an industry-related or industry application course, while creating motivation towards the subject."

Kondapi assigns his students projects that are used within the industry, without identifying information. He teaches shows how to use industry standard software, and provides insight into what they can expect after graduation.

"I also teach them how to present their projects as though they are presenting to the customer, and I invite industry professionals to come to the classes as guest lecturers, and to judge student presentations," Kondapi said. "I take them on field trips so they can see what is happening and be prepared for the industry. This course exposes them to the science, and real-world problems. It usually takes them at least six months to go through the training."

Kondapi said his flow assurance course now has more than 40 students, the largest graduate course at the university.

The advisory board plans to add more courses, such to the curriculum, said FMC Technologies Director Brian Skeels. As the program grows, Skeels says that employees of FMC and other companies work to stay ahead of the industry's need for different skill sets. He teaches subsea processing and pumping, and helps teach the downhole portion of gas lift.

There is a strong need for young professionals to gain the skills necessary to maintain the industry, Skeels explained. The subsea program at the university saves companies that hire recent graduates significant time in training.

"As more of the older generation retires, the industry is losing experienced people and subsea is getting more complicated and more extreme,

Kondapi

Skeels

so it's important for younger generations to get up to speed that much faster," Skeels said. "You could easily shave a year or maybe even a year and a half off of that learning curve for students coming out of the master's program."

The program is funded by student fees and contributions from companies such as Cameron, FMC Technologies, GE Oil and Gas, and Weatherford. Franchek said they are coordinating with other universities across the globe that offers subsea engineering programs. The Global Subsea University Alliance that he created is evaluating trends within the subsea industry, and plans to present a more detailed outlook for the subsea sector at OTC 2014. The alliance is looking to offer student exchange programs and international research opportunities for students as well as industry professionals involved with the program. OE

Students in the University of Houston's subsea engineering society join Subsea director Matthew Franchek (in green) at the 2013 IMarEST conference.

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Numerology

1,000 bo/d

The potential increase in oil production that modeling shows digital gas lift can deliver over traditional gas lift equipment, according to Laing Engineering & Training Services (LETS) model. ▶ See page 38.

US$**340**million

The estimated revenue value of FMC Technology's subsea systems order from Tullow Ghana Ltd. for its Tweneboa-Enyenra-Ntomme Development (TEN) offshore Ghana. Photo: Tullow Ghana Ltd. ▶ See page 17.

25,000tonnes

The weight of Lena guyed tower. ▶ See page 19.

1,700,000lbs

The axial load capacity of a metal-to-metal seal after morphing the tieback casing into the Meta tieback receptacle. ▶ See page 30.

39%

of 2013's total offshore capex is spent on pipelines. ▶ See page 44.

19.1mmbo/d

Total US petroleum deliveries (measured by demand) in the month of August, according to the most recent data released by the API.

6,900ft

The depth to which Marine Well Containment Co.'s capping stack was successfully deployed during deepwater Gulf of Mexico testing. ▶ See page 68.

10

pipe-laying vessels have been ordered from IHC Merwede by Subsea 7 for Petrobras contracts. ▶ See page 32.

155°C

The design operating temperature of ConocoPhillips' Jasmine oilfield bundles, the highest-temperature bundles at the time of installation, in 2012. ▶ See page 40.

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i-DRILL system design ensures reamer placement does not interfere with RSS directional capabilities.

Rhino RHE

DUAL-REAMER RATHOLE ELIMINATION SYSTEM

Dual-reamer system enlarges rathole, avoids a run, and saves 16 hours on a deepwater rig.

Rhino RHE rathole elimination system enlarged 178 ft of rathole while drilling a deepwater well in the Gulf of Mexico, saving 16 hours of rig time. The Rhino RHE system's dual-reamer process uses a hydraulically actuated reamer positioned above the MLWD tools to open the pilot hole and an on-demand reamer located near the bit to enlarge the rathole. The dual-reamer system eliminated a dedicated rathole cleanout run.

Read the case study at
slb.com/RhinoRHE

Schlumberger