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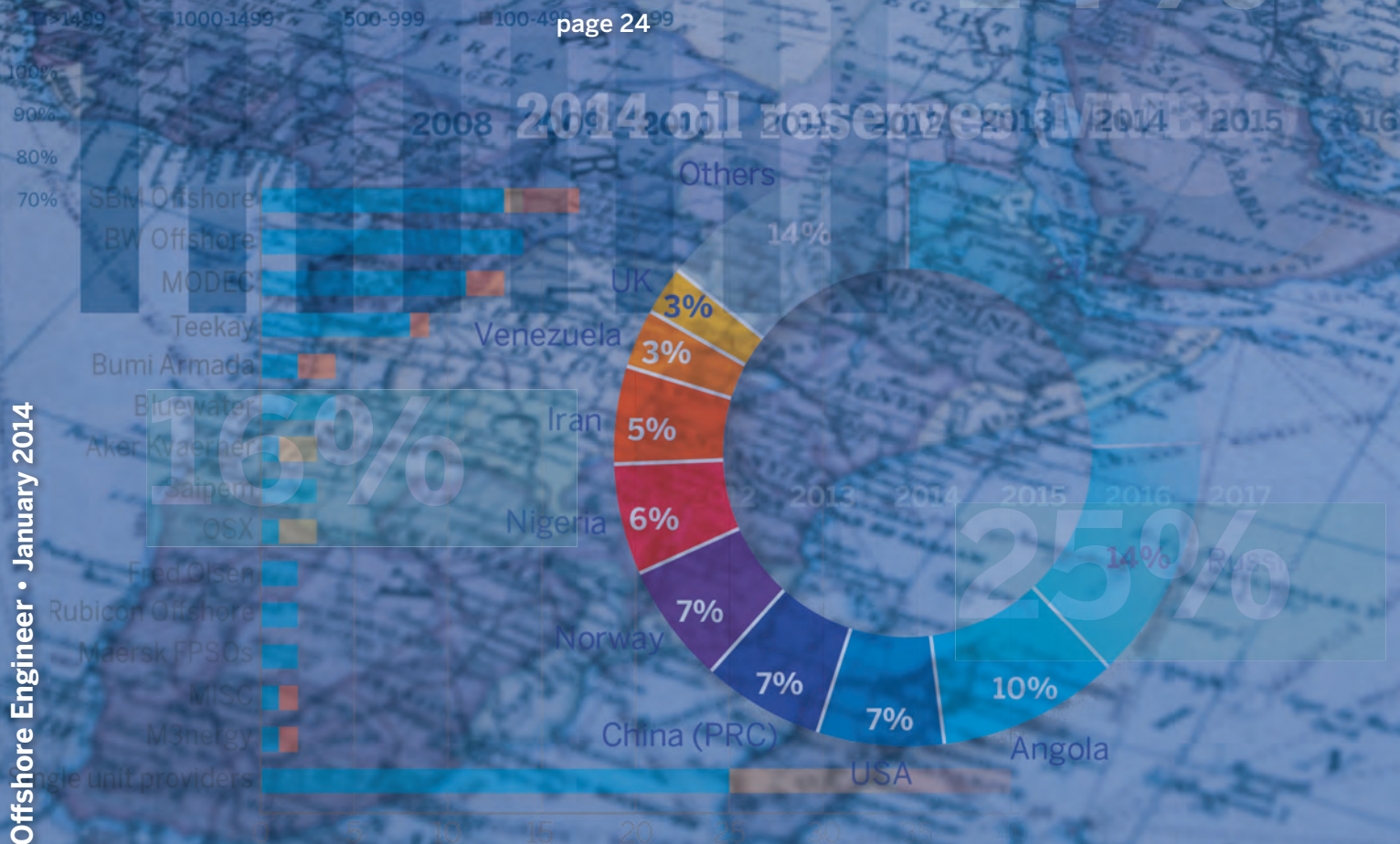
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## Global market forecast

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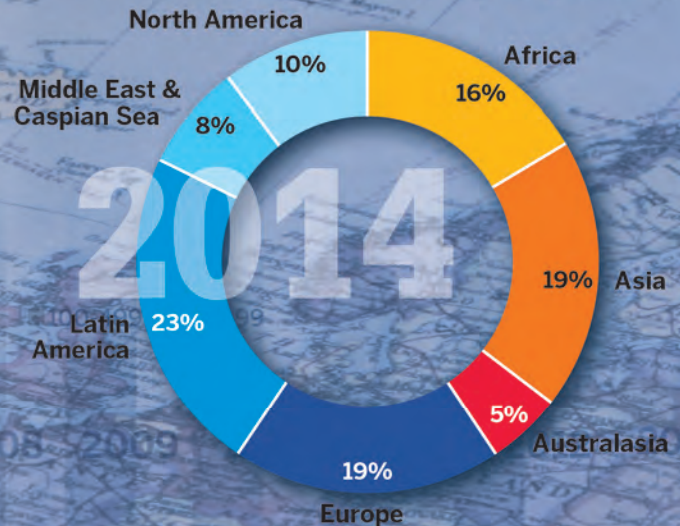
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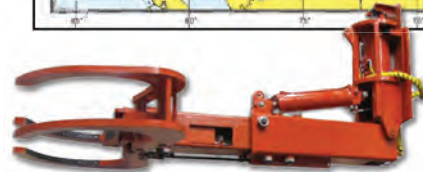
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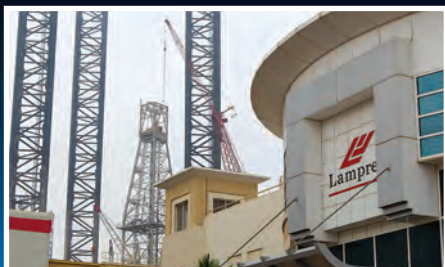


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## Online Exclusive

### Iranian opportunities beckon

An agreement to discuss lifting sanctions against Iran offers a glimpse of hope that its oil and gas sector could be reopened to international business. Elaine Maslin reports.

## What's Trending

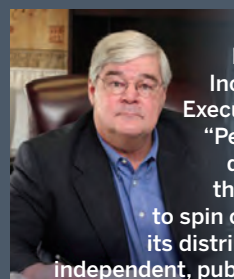
### Mexican congress passes energy bill

Mexico's Senate approved a new energy reform bill that will open the country's oil and gas industry to private and foreign investment. Audrey Leon reports.



## People

National Oilwell Varco Inc. Chairman and Chief Executive Officer Merrill A. "Pete" Miller, Jr. will step down, concurrent with the completion of plans to spin off to its shareholders its distribution business as an independent, publicly traded company.



## What's Trending

### Trouble in deepwater?

Deepwater drilling rig contractors are facing an uncertain future, with an increasingly fragmented market favoring those who contract the vessels, according to an analyst.



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# Voices

**New year, new focus.** OE asked,

**“What are the main technology trends for your sector this year?”**



In 2014, we expect to see an emphasis on automation and control systems to enhance rig efficiency and safety. Multi-Machine Control is one technology that will expand beyond the drill floor to improve the consistency of other complex handling situations such as delivering riser to the drill floor and automate the sand building process. Pipe Interlock Management and improved Anti Collision Systems will increase the safety of the machinery systems to prevent collisions and loose pipe incidents. Machine Control Diagnostic Tools will improve the ability of the operators and technicians to understand what interlocks are preventing an action that allows the driller to clear the interlock rather than reaching for the override. The newly developed simulators that are based on rig-specific software will help to improve HIL testing, software quality checks, and user training. This will be installed on several newbuild rigs for onsite training.

**Svein Ove Aanesland,  
Strategic Rig Packages Director, NOV**

Well intervention, whether it is slickline or coiled tubing, is carried out for many reasons, and in some cases, the purpose may be to fix a problem with the prize only being to restore the well to the previous production rate. However, whatever the reason, any additional information gained can be invaluable. Technology developments relating to data gathering during interventions will be a key driver for the future.

**Michael Taggart,  
Engineering Manager,  
Baker Hughes, and  
Chairman, ICOTA Europe  
Chapter**



Stringent testing protocols, including scenarios of survival loads or worst case discharge, have led to changes in string designs in order to safely meet challenges and drilling hazards in deepwater operations. Increased formation pressure and temperatures demand superior products with enhanced collapse and burst, increased remaining body wall, controlled yield range and extreme tight clearance. To meet these requirements, Tenaris has developed two new products for Shell's Olympus TLP project: the TenarisHydril Wedge 623™ Dopeless® connection featuring both internal and external metal-to-metal seals and the TenarisHydril Blue® Riser, which has an exceptional level of fatigue resistance and sealability performance.

**Julie Mathis,  
Technical Sales Manager, US, Tenaris**



Most oil and gas companies have had internal applicant tracking systems for a number of years to both advertise new career opportunities and manage applicants but what we are starting to find is that companies are now developing the connectivity of these systems to support a much wider range of functionality. With the advancement in technology companies can now manage benefits, provide new starter inductions, manage performance and career development, process payroll and support PTO policies, as well allowing managers to forecast future staffing budgets.

**James Bradley, Permanent Hire  
Recruitment Manager, NES Global Talent**

The biggest challenge we're seeing in our offshore business in the US is how best to work with partners to apply technology in ways that increases oil recovery from ultra-deep reservoirs in the Gulf of Mexico. Our experience in Norway with applying a wide range of advanced technologies that boosts recovery rates had led to significant increases in oil produced and extended field life, and we've now set a new target in Norway of achieving 60% recovery rates. We believe recovery rates may double in some GOM fields. At the same time, any technology we bring forward has to be aligned with our corporate priorities around safety and environmental responsibility

**Jason Nye,  
Senior Vice President, US Offshore, Statoil**



As the industry looks to exploit more challenging plays, delivering the most advanced technologies in a cost effective manner is an issue that the global oil and gas sector now faces. In well testing, increasing the value from wells and fields, optimizing well performance, and increasing efficiency, as well as reducing safety and environmental concerns is huge challenge. In response we've created a range of cost effective solutions, including our wireless gauges, clamp-on metering, trailer mounted packages for land wells and small footprint systems for offshore to answer the technological challenges in this area.

**Daniel More, Group Technology Director, Expro**



Finding and developing hydrocarbon resources is becoming more challenging and expensive, driving the need for more accurate subsurface images that can be quantitatively interpreted, such as those resulting from massive wide azimuth long offset surveys. In the marine environment, this requirement has made seabed seismic technology not only more price competitive but also more desirable due to the superior quality of the resulting images and the more complete physics. ION is taking a holistic approach to seabed seismic, including our seabed cable system, Calypso™, innovative acquisition designs, a full suite of processing algorithms for compressional and converted wave, and a full quantitative interpretation.

**Jacques Leveille, Senior Vice President, Technology Advisor, ION Geophysical**

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



Nina Rach

# Colloquy

## Projections for 2014 and beyond

As we start a new year at OE, we offer projections from companies about projects and markets. This issue features a Global Market Forecast, with analysts from Infield Systems, Douglas-Westwood, and Petroleum Geo-Services weighing in about exploration, production, and rigs. Managing Editor Audrey Leon asked industry representatives for their projections on technology trends for our Voices feature.

UK-based Lloyd's Register Group, QinetiQ, and University of Strathclyde-Glasgow spent two years researching the future of maritime industries, culminating in their report on **Global Marine Trends 2030**, issued in August 2013.

The authors say the shape of the marine world in 2030 will be driven by interactions between people, economies, and natural resources. They looked at the commercial, energy, and naval sectors and used three scenarios to model the future: Status Quo, Global Commons, and Competing Nations. They describe what maritime trade, sea power, and the offshore energy sectors could look like in 2030. Geopolitical influences will shift.

"Future competitions and conflicts between nations is more likely to involve future competition at sea," noted Richard Sadler, CEO of Lloyd's Register.

**China** - "Barring cataclysmic change, the China factor will still be the big story in 2030. China, consuming three times-as-much oil as it does today and 60% of the world's coal, will be the marketplace for maritime trade. The United States will... be the biggest consumer of natural gas."

China could triple its oil consumption by 2030, moving from about half the level of North American demand in 2011 to 35% more than North America in 2030.



Figure from **Global Marine Trends 2030**.

Natural gas demand in China will grow faster than the rest of the world in the next two decades, and natural gas consumption in the Middle East and Europe will overtake oil consumption, the authors say.

### Arctic

The Arctic may hold as much as 25% of the world's undiscovered petroleum reserves, predominantly off Russia, as shown above, denoted by orange circles. The retreating ice from global warming offers the possibility of new shipping routes and easier access to the Arctic, but technical, economic, and environmental challenges remain. Extreme temperatures, ice floes, and atmospheric icing (frozen spray) require new engineering solutions. Massive investment will be required to build infrastructure. The abundant marine life and pristine wilderness is vulnerable to industrial activity and accidents.

### Oil & gas

The energy sector is predominantly influenced by economic development and demand for natural resources. The authors expect global crude oil production to increase 38-63% by 2030, with the majority coming from the Middle East. Other significant and growing sources will be in Brazil, North American unconventional, Africa, and Russia.

The USA and Russia will be the largest producers of natural gas in 2030, according to the report. Russia's natural gas production will gradually shift from western to eastern Siberia and the Arctic, while most production growth in the US will come from shale gas.

By 2030, 48% of the world's oil production will be sourced offshore (mostly from deepwater fields), up from 34% in 2004. The authors expect DW production to increase 11.5%/yr, to 8.25million bo/d by 2015, when it will account for 25% of all offshore production, and increase to 45% of all offshore production by 2030. According to the report, natural gas production from offshore reserves is expected to increase from 28% of world-wide production in 2004, to 34% in 2015, and to 42% in 2030.

**Renewables** - Ocean energy resources include energy from wind, waves, tides, currents, temperature gradients and salinity gradients (osmotic). The authors expect increasing investment in offshore wind technology and a large increase in its power-generating capacity by 2030.

They cite wave energy as having the largest potential and note that it can be variously captured, using point absorbers, attenuators, overtopping, oscillating wave surge converters, and oscillating water columns. **OE**



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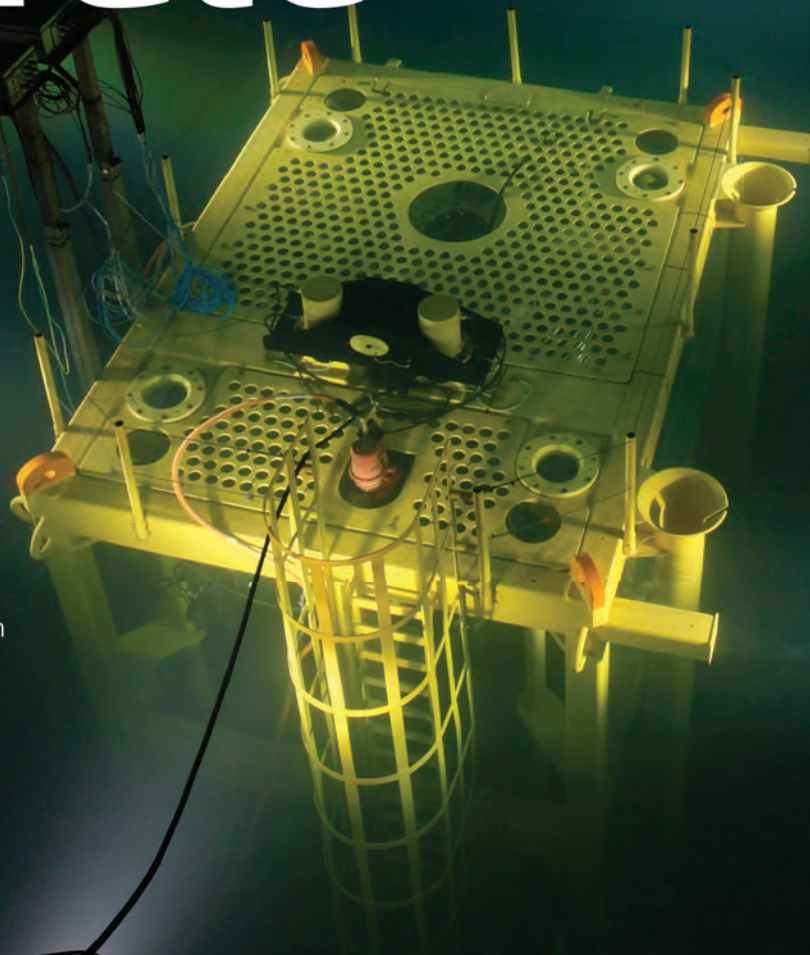


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Professor Alex Kemp, University of Aberdeen

# ThoughtStream

## Scottish oil independence

### North Sea oil and the constitutional debate in Scotland and the UK

The possibility of Scotland becoming an independent country is currently attracting much interest, and not just locally, but in the rest of the UK and elsewhere as a referendum on the issue, due in September 2014, draws closer.

Although the ramifications of such a major political change would extend throughout the economy, the position of the North Sea oil and gas sector has received particular attention. This reflects the importance of the industry to the Scottish economy, and to the prospective budgetary position of an independent Scottish government in particular.

Much less attention has been given to the implications of independence for the industry itself. All current oil company investors will be interested in the consequences for the status of their existing licenses, their tax position, and the myriad of regulations, which currently affect their operations. The assumption is generally made that the continental shelf in the North Sea would be divided between Scotland and the rest of the UK, on the basis of the median line currently used for fisheries management purposes. Adoption of this dividing line would result in well over 90% of oil production, and over 50% of gas production, being allocated to the Scottish sector.

The Scottish government has indicated it would honor existing licenses that relate to areas within the Scottish sector. The status of other license-related arrangements between industry and the UK government, dealing with issues such as third-party access to infrastructure, the fallow block initiative, the stewardship initiative on mature fields, and decommissioning obligations, would require clarification. These are all very live issues, and significantly affect industry operations and plans.

Efficient licensing and regulation of the sector, in areas such as assessing and monitoring field development plans, and the issue of new licenses, require considerable specialist expertise, backed up with the availability of large amounts of information on seismic and well data, existing field development plans, third-party infrastructure use agreements, and

**There are many possibilities that ensure that the political debate continues without agreement.**

decommissioning plans. All the relevant information would have to be transferred from the UK government to the Scottish one, to facilitate effective stewardship of the industry.

The taxation of North Sea oil has been the subject of lively debate and controversy ever since oil exploitation commenced in the 1970s. The last major tax hike, in 2011, was followed by increases in the complex field allowances for the Supplementary Charge, which have helped to fuel the current investment boom. A Scottish government would have to acquire the expertise and voluminous historic data to effectively operate this very complex system.

There have been recent assurances by the Scottish government that it has no plans to increase the level of tax take. Its priorities would be to incentivize production, exploration, and the maximization of economic recovery. The certainty regarding decommissioning tax relief, recently provided for by the UK

government, would be continued by a Scottish government.

The substantial revenues generated by the North Sea oil sector would be critically important to the budget of a Scottish government. But their volatility, and expected long term decline, pose problems. The Scottish government plans to have a stabilization fund to iron out the consequences of volatility for its budgets, and in due course to establish a fund to ensure that future generations also benefit. Whether the revenues will be large enough to satisfy both the budgetary needs of the government, and make worthwhile contributions to a fund, depends on the interaction of production, oil prices, and the various tax allowances. There are many possibilities which ensure that the political debate continues without agreement.

The industry has generally stayed neutral in this debate. It is primarily interested in the removal of uncertainty regarding the investment environment and provision of evidence that a Scottish government understands the policy requirements of a mature petroleum province. **OE**

---

*Alex Kemp is currently Professor of Petroleum Economics and Director of Aberdeen Centre for Research in Energy Economics and Finance at the University of Aberdeen. He has published more than 200 papers on petroleum economics. He was a specialist adviser to the UK House of Commons Select Committee on Energy in 1980-1992, and in 2004, and 2009. From 1993-2003, he was a member of the UK Government Energy Advisory Panel. He was awarded the OBE in 2006, for services to the oil and gas industries. He wrote *The Official History of North Sea Oil and Gas*, published in 2011, in two volumes.*



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# Global Briefs

## **A Mad Dog Phase 2 under development**

Following BP's September announcement that it was canceling its massive Mad Dog contract, the supermajor is now working with partners Chevron Corp. and BHP Billiton Petroleum to develop Phase 2. BP is reportedly entering topsides pre-front end engineering and design phase for different options to determine which is the most cost-effective.

## **B Noble Energy makes deepwater discoveries**

Noble Energy hit a deepwater discovery offshore the Gulf of Mexico. The Dantzler exploration well, located 12m west of the firm's Rio Grande development in Mississippi Canyon 782, has encountered over 120ft of net pay, mainly crude oil, in two Miocene reservoirs. The well was drilled to a total depth of 19234ft in 6580ft of water. Discoveries at the Dantzler well are estimated between 55-95 MMboe.

## **C BSEE cites 12 for SEMS non-compliance**

Brian Salerno, director of the Bureau of Safety and Environmental Enforcement (BSEE), cited 12 Gulf of Mexico operators for failure to comply with the Safety and Environmental Management Systems (SEMS) requirements of the Workplace Safety Rule, 30 CFR Subpart S regulations put into place during October 2010, following the *Deepwater Horizon* incident.

## **D Mexican congress passes energy bill**

Mexico's senate approved a new energy reform bill on Wednesday that will open the

country's oil and gas industry to private and foreign investment through production sharing agreements and licensing. President Enrique Peña Nieto's ruling PRI and opposition party PAN presented a united front against Mexican leftist party PRD, passing the energy reform bill by a vote of 95 to 28 in the Mexican Senate on Wednesday.

## **E Trinity spuds offshore Trinidad**

Trinity Exploration & Production spudded the El Dorado exploration prospect, located offshore the west coast of Trinidad in the PGB license in 6ft of water. The well is 2km from Trinity-operated production infrastructure. Trinity is operating the well and holds a 70% working interest in the prospect. El Dorado well is testing an undrilled fault block on the west flank of the Trinity-operated producing Brighton field.

## **F Aibel on Kristin/Polarled project**

Aibel will modify the Kristin semisubmersible platform in the Norwegian Sea as part of a project to connect it to the new Polarled pipeline. The contract, worth approximately NOK200 million (approximately US\$3.2 million), was awarded as a part of Aibel and Statoil's framework agreement on maintenance and modifications to Kristin.

## **G Statoil hits in the Barents**

Statoil ASA and partners Eni Norge AS and Petoro AS made an oil and gas discovery in the Skavl prospect in PL532, close to Johan Castberg in the



Barents Sea. Well 7220/7-2 S, drilled by the semisubmersible rig *West Hercules*, proved a 22m gas column and a 23m oil column in the Jurassic Tubåen formation, and a 133m oil column in the Triassic Fruholmen formation - a new play model in the area. Statoil estimates the volumes in Skavl to be in the range of 20-50 million barrels of recoverable oil.

## **H BW Offshore enters Polvo field**

BW Offshore has signed a letter of intent to acquire 30% of the Polvo oil field, located in the Campos basin in Brazil. Following the ongoing sale of BP's stake in the Polvo field to HRT Participações em Petróleo

S.A. (HRT), BW Offshore has the intention to acquire half of HRT's stake. BW Offshore owns and operates the FPSO *Polvo*, operating under a firm contract until Q3 2014, with additional options until Q3 2022. The field was brought onstream in 2007, with a 2013 year-to-date production of about 12000 bbl/d.

## **I Peru suspends offshore bid round**

State-run Perupetro suspended auctions for nine blocks located in the Pisco, Lima, Mollendo and Trujillo because the companies involved submitted requests to alter their respective terms. Perupetro began marketing the blocks in early May. As of





press time, the company has not yet rescheduled the auction round.

#### **J** **Topside installation underway on Caribbean FLNG**

The installation of topsides liquefaction equipment has begun on the Caribbean FLNG project that will be in service offshore Colombia, EPCIC contractor Wison Offshore & Marine Ltd. announced. The company said the vessel will be the world's first FLNG in operation. Topsides equipment will utilize the PRICO technology, supplied by subcontractor Black & Veatch, to liquefy natural gas. Owner Exmar will operate the vessel offshore Colombia.

#### **K** **Cobalt confirms presalt find**

Houston's Cobalt International Energy, Inc. reported that its Lontra #1 presalt discovery well in Block 20, offshore Angola, found more oil and gas than estimated. Drill stem test placed Lontra's well production at a stabilized flow rate of 2500 bbl of condensate and 39 million cu ft per day of gas. The well was drilled to a total depth of 4195m. The discovery well encountered both a high liquids content gas interval and an oil interval. Cobalt also has working interest (40%) in the neighboring Block 21 and the nearby Block 9. Drilling is underway in Block 21.

#### **L** **PSVM production underway**

Production commenced offshore Angola's first deepwater development, utilizing BP Exploration's (Angola) US\$14 billion *FPSO PSVM*, the largest deepwater project in Africa. PSVM consists of four oilfields - Plutão, Saturno, Vénus and Marte – all discovered between 2002 and 2004 in water depths of up to 2000m. It is BP's second development in Angola as operator.

#### **M** **Tanzania discovery for Statoil**

Norway's Statoil announced that a fifth natural gas discovery in Block 2 offshore Tanzania has opened up

new play in the region. The Mronge-1 discovery, drilled in 2500m water depth by the Discoverer Americas drillship 20km north of the Zafarani discovery, contains about 2-3Tcf natural gas in place at two separate levels. Mronge-1 is the Statoil/ExxonMobil partnership's fifth discovery in Block 2. The first three natural gas discoveries were made during the first drilling phase, with Tangawizi-1, Zafarani-1 and Lavani-1, and a deeper discovery in a separate reservoir in Lavani-2.

#### **N** **Total inks Oman deepwater drilling deal**

Total has signed an exploration and production-sharing agreement for deepwater Block 41 with Oman's Ministry of Oil & Gas, the company announced today. The block is off the northern Omani coast, northwest of the capital, Muscat. It spans 23850sq km, with depths ranging to 3000m, and has 3700km of previously acquired 2D seismic data coverage. Oman is a small, predominantly onshore producer and is not a member of OPEC.

#### **O** **Eni increases Russian ties**

Italy's Eni signed a string of agreements with Russian operators and a research institution. The first is a memorandum of understanding (MOU) between Eni and Novatek, which sees the two firms agreeing to future co-operation in offshore projects in the Mediterranean Sea. The agreement will give Eni access to Russian's technological innovation sector. In return, Eni will offer its industrial and technological expertise. The

company will contribute to the research and educational activities of the Skolkovo Foundation.

### **P Shah Deniz proceeds to stage 2**

The Shah Deniz gas field consortium in Azerbaijan will proceed with stage 2 development of the Caspian Sea field, opening its sources to Europe. Stage 2 includes offshore drilling and completion of 26 subsea wells, the construction of two bridge-linked platforms, and new onshore processing and compression facilities at Sangachal. This decision triggers the expansion of the South Caucasus Pipeline, as well as the construction of the Trans Anatolian Gas and Trans Adriatic Pipelines. First gas is targeted for late 2018, and yearly production is estimated at 16 billion cu m gas, carried approximately 3500 km

consumers in Georgia, Turkey, Greece, Bulgaria and Italy.

### **Q Prelude float out**

Shell's Prelude floating liquefied natural gas (FLNG) facility floated out of the dry dock at Geoje, South Korea's Samsung Heavy Industries yard, where the facility is currently under construction. Upon completion, Prelude FLNG will be the largest-ever floating facility, and is set to produce approximately 3.6MM tonnes of liquefied natural gas (LNG) annually. Prelude FLNG is the first deployment of Shell's FLNG technology and will operate in a remote basin around 475 km northeast of Broome, Western Australia for around 25 years.

### **R Hess sells Indonesian assets**

PTTEP and Pertamina agreed to form a 50:50 joint venture

to buy Hess' assets offshore Indonesia for US 1.3 billion. The companies will gain 75% stake in Pangkah field and 23% in the Natuna Sea A field. The Pangkah transaction will be finalized in Q1 2014, and the Natuna Sea A transaction will close by the end of 2013.

### **S Few bidders offshore Myanmar**

Twenty-one companies have dropped out of the final cycle of bidding in the Myanmar offshore license round. The licensing round offers 30 offshore areas, including 19 deepwater blocks. These blocks are predominantly in the Rakhine Offshore Area (12 blocks), followed by Tanintharyi (4 blocks), and Moattam (3 blocks). Myanmar reported that 79 companies participated in the first stage, declaring their interest by 14 June. Only 40 companies

submitted bids for the oil and gas blocks by the deadline.

### **T NZ awards five new offshore permits**

The government of New Zealand awarded five permits for offshore oil and gas exploration in Block Offer 2013. Australia's Woodside Energy Holdings and New Zealand Oil and Gas were jointly awarded two offshore permits - one in the Taranaki region, the country's only petroleum-producing area, and another off the southern tip off the South Island. New Zealand Oil & Gas also received one offshore Great South Basin South-Canterbury permit on its own. New Zealand Octanex received a permit to explore off Taranaki. Norway's Statoil Lambda Netherlands BV was given a permit to explore off the northwest coast of the North Island: Reinga-Northland.



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## Contract Briefs

### Petronas awards integrated contracts

Petroleum Nasional Berhad (PETRONAS) has announced a new gas discovery offshore Malaysia and the award of a three-year integrated offshore installation contract. PETRONAS awarded its Pan Malaysia Integrated Offshore Installation Contract to three local offshore installation contractors (OICs); TL Offshore Sdn Bhd, PB JV Sdn Bhd and GOM Resources Sdn Bhd.

The contract, split into four packages, and worth about RM10 billion (US\$3.1 billion), involves the transportation and installation for offshore facilities and includes all the necessary services required for the execution of the scopes such as marine spread services, required tools, specialized equipment and manpower services.

### CGG to operate parts of Diskos

French geoscience firm CGG is to operate parts of Norway's Diskos database from 2015 to the end of 2020 under a new contract signed with the Norwegian Petroleum Directorate (NPD).

The contract will see CGG implement software on the seismic, well and production modules in Diskos, the National Data Repository of Norway. The Diskos database is a shared solution that aims to streamline data management through shared electronic storage and distribution of seismic, well and production data of Norway.

It is the first major contract for CGG's Data Management Services group, since it joined CGG following the acquisition of Fugro Geoscience.

### FMC to deliver ROVs to Tidewater

FMC Technologies, Inc. will supply six work-class ROV systems to Tidewater Subsea for its subsea operations business. The systems will be supplied by FMC Technologies' schilling robotics business unit and are expected to be delivered by the end of the year. The contract is valued at approximately US\$30 million.

The ROV systems will be mobilized onboard Tidewater's deepwater vessels to service the global oil and gas offshore construction and inspection, maintenance, and repair (IMR) markets.

### LUKOIL awards three ice-class vessel contracts

Malaysia-based offshore oilfield services firm Bumi Armada Berhad has been awarded three contracts by LUKOIL-Nizhnevolzhskneft LLC to provide three ice-class vessels to service offshore platforms in the Filanovsky field, in the Caspian Sea, Russia.

Each of the ice-class contracts is for a period of 10 years, with the possibility of further extensions of up to another 20 years.

### Mermaid Maritime awarded Middle East subsea contracts

Mermaid Maritime Public Co. Ltd. announced that units serving the Middle

East were awarded a suite of subsea services contracts. The work includes air diving services and a subsea cable lay contract.

All contract awards were secured through Mermaid's wholly owned subsidiary Subtech Ltd. (Seychelles) and Mermaid's joint venture entity Zamil Mermaid Offshore Services LLC. They are scheduled to begin in December 2013 for an estimated duration of up to six months. The combined value of these contract awards is estimated at US\$30million.

### AMEC wins ADMA OPCO contract

AMEC has won a project management consultancy services contract by Abu Dhabi Marine Operating Company (ADMA OPCO) for their Umm Lulu Phase-2 full field development projects offshore United Arab Emirates (UAE). The contract is worth US\$124 million.

This five-year contract follows a previous award from ADMA OPCO in 2011 for the provision of services for the first phase of Umm Lulu and the Nasr phase 1 project.

Under this latest contract AMEC's scope of work includes project management of the engineering, procurement and construction contractors who are delivering a large offshore super complex located in the Umm Lulu Field.

The complex will comprise six bridge-linked platforms including gathering, separation, gas treatment and water disposal facilities, utilities and accommodation modules.

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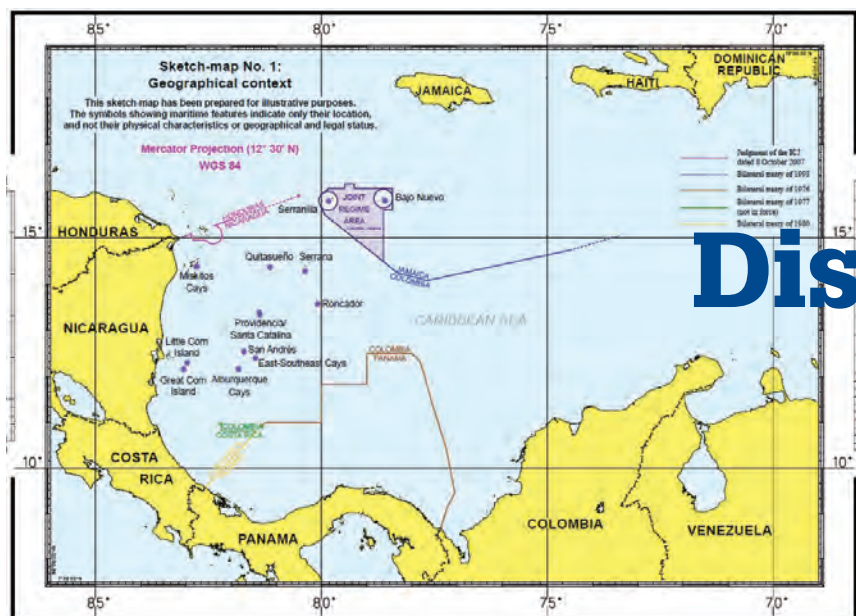
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Maps courtesy of Sebastián Machado.

# Disputed territory

Several Caribbean countries are embroiled in bitter maritime border disputes. Sarah Parker Musarra examines the history behind two of Latin America's most-monitored maritime clashes.

Research vessel *RV Teknik Perdana* was conducting a multibeam seabed survey on the deepwater Roraima exploration block offshore Guyana on Oct. 10, 2013. Contracted by Texas-based independent Anadarko, on behalf of the Guyana government as part of their 2012 agreement, the vessel soon found itself in unfriendly waters when an armed Venezuelan Navy vessel, the *Yekuana*, “obstructed the research vessel’s passage, requested them to change course and stop surveying,” according to a statement issued by the Republic of Guyana’s Ministry of Foreign Affairs.

The *Teknik Perdana*’s crew insisted that it was within the boundaries of Guyana’s economic zone; the Venezuelan Navy, however, did not agree. It maintained that the vessel was within Venezuela’s economic zone.

“One point is clear and that is that the *RV Teknik Perdana* was in Guyana’s waters when this incident took place,” Guyana’s Ministry of Foreign Affairs maintained. The crew was ordered to pick up speed and sail to Venezuela’s Margarita Island. The 285-ft survey ship’s 36 crew members were held onboard while Venezuelan authorities investigated. A statement was later released by the Venezuelan government saying that the vessel was performing unauthorized work on the disputed waters.

According to Guyana’s Ministry of Foreign Affairs, “[it] was then clear that the vessel and its crew were not only being escorted out of Guyana’s waters, but were under arrest. These actions by the Venezuelan naval vessel are unprecedented in Guyana-Venezuela relations.”

The Guyanese government held fast to its position that there were still many more steps involved before hydrocarbon production can begin, and that the survey was innocuous

in nature.

The statement continued, calling the action “a serious threat to the peace of the sub-region.” The strong move made by the Venezuelan government was the result of hundreds of years of strained relations between the two countries.

The disputed area is known as Guyana Esequiba, and its boundaries have been contentious since the mid-1800s, when Great Britain set out to delineate the borders of then-British Guyana. The government presented the newly-defined boundaries to Brazil and Venezuela.

In 1840, German surveyor and geographer Robert Schomburgk investigated and created the Schomburgk Line as a starting point for the neighboring governments to begin talks. He saw the Essequibo River as a natural boundary, and the UK claimed all territory west of this boundary. According to the US Department of State Office of the Historian, Guyana’s territory was augmented an additional 300,000sq mi as a result of the Schomburgk Line.

The government of Venezuela protested, wanting control of the mouth of the Orinoco River. Their protests went ignored by the British; in turn, Venezuela swiftly severed diplomatic



The *RV Teknik Perdana* was detained by the Venezuelan Navy. Photo courtesy of mgklingsick@aol.com

# 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](http://www.infield.com)).

## New discoveries announced

Depth range	2010	2011	2012	2013
Shallow (<500m)	86	105	75	57
Deep (500-1500m)	28	26	24	15
Ultradeep (>1500m)	37	20	36	26
<b>Total</b>	<b>151</b>	<b>151</b>	<b>135</b>	<b>98</b>

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 2014-18

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
<b>Brazil</b>			
Shallow	16	738.25	1,060.00
Deep	16	2,565.00	2,435.00
Ultradeep	44	13,717.95	18,730.00
<b>United States</b>			
Shallow	19	93.90	290.00
Deep	24	1,784.21	2,234.87
Ultradeep	34	5,019.50	4,890.00
<b>West Africa</b>			
Shallow	183	4,349.28	22,164.83
Deep	55	7,246.50	7,940.00
Ultradeep	21	2,580.00	3,760.00
<b>Total</b>	<b>412</b>	<b>38,094.59</b>	<b>63,504.70</b>
(last month)	(363)	(32,653.76)	(53,863.96)

## Greenfield reserves 2014-18

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow (last month)	1,372 (1,275)	55,384.39 (65,189.99)	788,267.31 (787,740.02)
Deep (last month)	188 (159)	15,381.68 (13,507.58)	113,341.57 (79,626.57)
Ultradeep (last month)	124 (98)	21,946.95 (17,516.45)	90,147.00 (66,727.00)
<b>Total</b>	<b>1,684</b>	<b>92,713.02</b>	<b>991,755.88</b>

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

	2012	2013	2014	2015	2016	2017	2018
Shallow (last month)	5,947.62 (5,998.15)	39,535.70 (49,549.97)	37,387.51 (27,950.84)	39,331.24 (39,766.34)	33,099.27 (34,249.15)	51,487.64 (53,103.15)	33,725.39
Deep (last month)	2,821.40 (2,500.15)	2,910.28 (3,387.61)	5,717.19 (5,706.11)	4,368.72 (4,368.72)	4,930.34 (4,930.34)	8,957.36 (9,153.17)	11,425.53
Ultradeep (last month)	737.15 (737.15)	3,240.07 (3,243.07)	2,871.43 (2,922.43)	2,067.04 (2,109.58)	5,666.75 (5,519.67)	15,950.97 (15,543.97)	11,284.32
<b>Total</b>	<b>9,506.17</b>	<b>45,686.05</b>	<b>45,976.13</b>	<b>45,767.00</b>	<b>43,696.36</b>	<b>76,395.97</b>	<b>56,435.24</b>

17 December 2013

## Pipelines

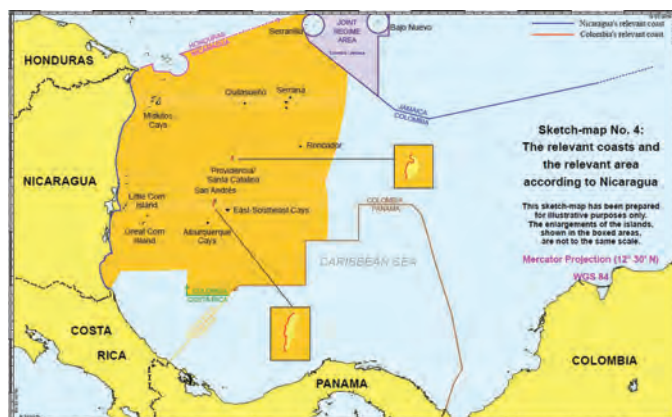
(operational and 2014 onwards)

	(km)	(last month)
<b>&lt;8in</b>		
Operational/installed	41,634	(41,918)
Planned/possible	25,383	(25,292)
<b>Total</b>	<b>67,017</b>	<b>(67,210)</b>
<b>8-16in</b>		
Operational/installed	78,085	(77,695)
Planned/possible	49,511	(48,610)
<b>Total</b>	<b>127,596</b>	<b>(126,305)</b>
<b>&gt;16in</b>		
Operational/installed	89,263	(89,156)
Planned/possible	49,726	(49,698)
<b>Total</b>	<b>138,989</b>	<b>(138,854)</b>

## Production systems worldwide

(operational and 2014 onwards)

	(last month)
<b>Floaters</b>	
Operational	277 (273)
Under development	44 (50)
Planned/possible	335 (324)
<b>Total</b>	<b>656 (647)</b>
<b>Fixed platforms</b>	
Operational	9,600 (8,705)
Under development	118 (125)
Planned/possible	1,474 (1,475)
<b>Total</b>	<b>11,192 (10,305)</b>
<b>Subsea wells</b>	
Operational	4,389 (4,400)
Under development	427 (414)
Planned/possible	6,350 (6,220)
<b>Total</b>	<b>11,166 (11,034)</b>



This series of maps, provided by Sebastián Machado, illustrate the various sides of the Colombia-Nicaragua maritime border dispute and were used for illustration purposes by the International Court of Justice.

relations in 1876, turning instead to the US.

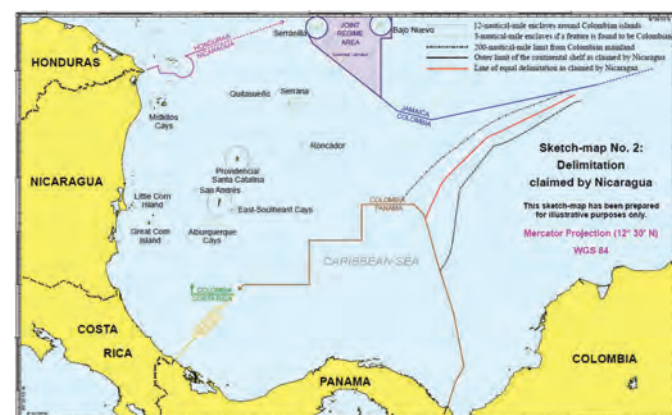
In 1881, Venezuela suggested a new boundary, and appealed to the US that the UK had violated the Monroe Doctrine. The offer of arbitration was the extent of the aid offered by the US.

By 1895, the situation reached crisis level. Then-US Secretary of State Richard Olney insisted on creating an Arbitration tribunal to settle the matter. Although grateful, the Venezuelan government decried as unfairly biased towards the UK. The tribunal ruled in favor of the Schomburgk Line.

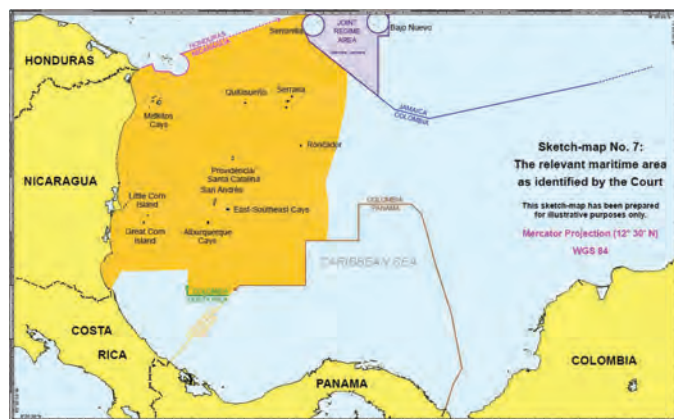
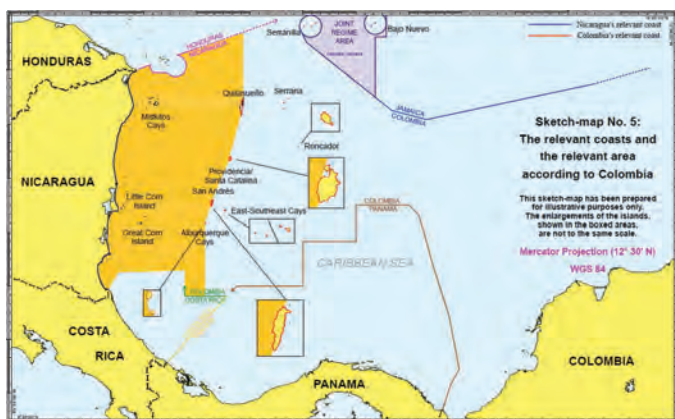
An already-tense situation was made worse when the mining and oil potential of the Essequibo River was made apparent. Venezuela tried to resettle boundaries again in the 1960s, and this time the country was under a deadline: Independence from the UK was imminent for Guyana. On Feb. 17, 1966, the Venezuelan, British and Guyanese governments signed the "Agreement to resolve the controversy over the frontier between Venezuela and British Guiana," which, rather than strictly defining boundaries, only established a regulatory framework to resolve these territorial issues. The parties never agreed to a solution. Guyana adhered to the 1895 arbitral award; Venezuela still did not agree.

Article V of the 1966 treaty reads: "No new claim, or enlargement of an existing claim, to territorial sovereignty in these territories shall be asserted while this Agreement is in force, nor shall any claim whatsoever be asserted otherwise than in the Mixed Commission [a commission defined in the treaty to resolve this matter] while that Commission is in being."

Several uprisings and periods of unrest followed. In 2011, Guyana appealed to the UN Commission on the Limits of the Continental Shelf (CLCS) to extend its continental shelf by







Maps courtesy of Sebastián Machado.

150nm. The Venezuelan government protested, saying that the extension fell into the disputed zone, and referred to the 1966 treaty.

Meanwhile, TDI-Brooks International was contracted by Anadarko to perform the survey and had three employees onboard. Following the *Teknik Perdana* incident, TDI-Brooks International Director of Operations Peter Tatro said that operations have not changed, but counted it as a lesson learned.

"We certainly don't want to do anything that puts our people or assets at risk. We would be reticent, very cautious to approach anything unless we had some confidence that there wasn't a dispute at play. We don't want to borrow trouble," Tatro said. "We are much more informed to the sensitivity of the nature of the dispute. We want to be cautious, out of respect for the countries [as everything else]."

Others, however, see the incident as more far-reaching. Although the US Energy Information Administration lists Venezuela as having the second-largest proven oil reserves in the world at 211 billion boe, operators might refuse to get involved in the Guyana Esequiba.

"Operators cannot be sure the rights given by one country will be respected by the other. Besides, Venezuela's record regarding respect for business and property rights is not particularly good," said José Molina, a professor at the Universidad del Zulia, in Maracaibo, Venezuela. "[Operations in the affected area] probably will be paralyzed unless there is an agreement between the two countries regarding oil exploration and production."



José Molina

Coincidentally, the *Teknik Perdana* sails under the Panamanian flag, the country at the heart of the history between another maritime border dispute in the area: that between Colombia and Nicaragua.

Although nothing as drastic as ships being detained has occurred in the countries' disputed area, as exploration continues into new frontier areas, industry eyes are on the two Latin American nations.

On March 24, 1928, at the height of what Mark Jones, Chair of the Department of Political Science at Rice University, called "the era of gunboat diplomacy," the two countries signed the Esguerra-Bárcenas Treaty, in which Nicaragua recognized Colombia's sovereignty over the Archipelago of San Andrés, Providencia and Santa Catalina. The 82<sup>nd</sup> meridian west was set as the division between the two territorial waters.

It was not recognized as the deceptively simple resolution that it is, the primary reason being the US-occupation of Nicaragua at that time. The US held a presence in Nicaragua

beginning in 1909, while José Santos Zelaya, of the Liberal Party, was president of the country. Following the execution of two Americans during an attempted overthrow by the Conservative Party, formal occupation by the US began in 1912.

"This was when the US was throwing its weight around with military intervention," Jones said. "Many Nicaraguans, particularly on the left, believe the US pressured Nicaragua to sign the treaty."

Later on, Nicaragua's Sandinistas fully renounced the treaty.

Another factor set the stage for future complications, according to Sebastián Machado Ramírez, professor of public international law at Universidad de los Andes, Bogotá.

"Colombia held it was a maritime delineation, and Nicaragua held that it was not. The court [agreed with Colombia]," he said. "Nicaragua denounced the treaty and ... the treaty wasn't valid because it was signed under coercion." The Nicaraguan government also claimed that Colombia and Nicaragua' economic zones overlapped. Nicaragua had no proof, but they filed nonetheless.

In Ramirez' paper on the subject entitled, "The Colombia – Nicaragua territorial and maritime dispute: sailing through murky waters," he explains:

"The law governing the extension of the continental shelf is found in customary international law as reflected in Article 76(1) of the CLCS...In other words, coastal states are entitled to claim a continental shelf the size of the natural prolongation of its land territory or 200nm, whichever is longer."

"It's a ridiculous application," To this day, I don't understand how the Nicaraguans came to file [with the United Nations International Court of Justice (ICJ), Hague] with the coasts being 400mi. apart. It was quite embarrassing."

The court ruled against Nicaragua in the delineation of the borders, and Colombia won its sovereignty claims.

As to the claims in the economic zone, the ICJ ruled relative to the coastline, which Ramirez said was consistent in situations such as this. The archipelago and the coast were ruled Colombian territory, but the court modified the north-south boundary following the San Andres to



# Quick stats

## RIG STATS SOURCE: INFIELDRIGS

### Worldwide

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	409	361	48	88%
Semisubs	192	171	21	89%
Drillships	94	88	6	94%
Tenders	31	21	10	68%
<b>Total</b>	<b>726</b>	<b>641</b>	<b>85</b>	<b>88%</b>

### Gulf of Mexico

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	89	72	17	81%
Semisubs	29	25	4	86%
Drillships	21	20	1	95%
Tenders	N/A	N/A	N/A	N/A
<b>Total</b>	<b>139</b>	<b>117</b>	<b>22</b>	<b>84%</b>

### Asia Pacific

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	117	108	9	92%
Semisubs	34	29	5	85%
Drillships	17	13	4	76%
Tenders	24	16	8	67%
<b>Total</b>	<b>192</b>	<b>166</b>	<b>26</b>	<b>86%</b>

### Latin America

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	8	7	1	88%
Semisubs	42	42	0	100%
Drillships	29	29	0	100%
Tenders	2	1	1	50%
<b>Total</b>	<b>81</b>	<b>79</b>	<b>2</b>	<b>98%</b>

### Northwest European Continental Shelf

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	45	41	4	91%
Semisubs	46	44	2	96%
Drillships	1	1	0	100%
Tenders	N/A	N/A	N/A	N/A
<b>Total</b>	<b>92</b>	<b>86</b>	<b>6</b>	<b>93%</b>

### Middle East & Caspian Sea

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	101	88	13	87%
Semisubs	3	3	0	100%
Drillships	1	1	0	100%
Tenders	N/A	N/A	N/A	N/A
<b>Total</b>	<b>105</b>	<b>92</b>	<b>13</b>	<b>88%</b>

### Sub-Saharan Africa

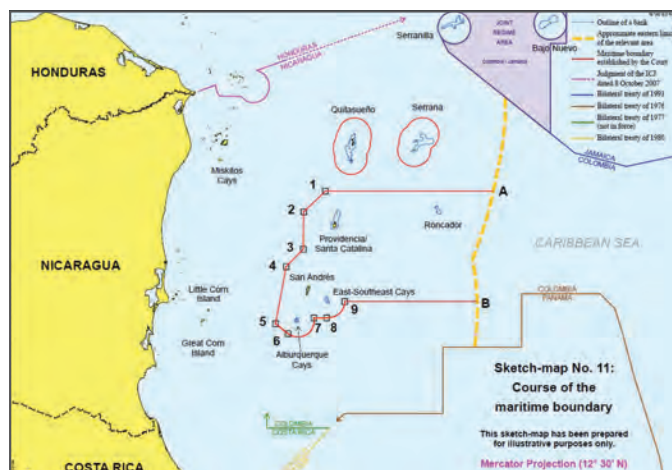
Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	25	23	2	92%
Semisubs	20	17	3	85%
Drillships	22	22	0	100%
Tenders	5	4	1	80%
<b>Total</b>	<b>72</b>	<b>66</b>	<b>6</b>	<b>92%</b>

### Rest of the World

Rig Type	Total Rigs	Contracted	Available	Utilization
Jackups	24	22	2	92%
Semisubs	18	11	7	61%
Drillships	3	2	1	67%
Tenders	N/A	N/A	N/A	N/A
<b>Total</b>	<b>45</b>	<b>35</b>	<b>10</b>	<b>78%</b>

17 December 2013

This data focuses on the marketed rig fleet and excludes assets that are under construction, retired, destroyed, deemed non-competitive or cold stacked.



Maps courtesy of Sebastián Machado.

run east-west.

"At that point, Colombia lost some islands," he said.

It should be noted that Colombia did not lose sovereignty: only economic rights.

Ramirez explained: "In the case of islands, however, the overlapping entitlements originate not only from the relevant coasts but from the rights over the sea that are derived from the property over the islands. Falling back on the principle that islands, no matter how small, generate the same maritime rights as other land territory, Colombia argued that all of its high-tide elevations were entitled a territorial sea of 12nm."

Ramirez said that, in his opinion, the loss wasn't "that significant."

Colombians were enraged to lose any territory whatsoever.

"They didn't understand the technicalities of maritime law and the public thought we lost territory. The government [capitalized on] it," Ramirez said, explaining that it soon became a very political issue.

Colombian President Juan Manuel Santos withdrew the country from the ICJ, even though Colombia is still expected to comply with the Hague's directive. Nicaraguan President Daniel Ortega ordered his military to prepare for conflict with Colombia, exacerbating the issue. In return, Santos ordered the Colombian Navy to continue patrolling the waters belonging to Nicaragua.

Jones said that the perceived loss of territory hit the Colombians very hard.

"Any territory is still a loss. From a sovereignty perspective, it would lose sovereignty over a relatively large area of Caribbean – 30,000sq mi. From a nation-state point of view it is a loss," he said. "The loss of Panama is still very fresh in the minds of Colombians." While Jones doesn't believe that the situation will escalate into military action, there are consequences nonetheless. He explained that, because the political structures of Nicaragua and China are similar, Ortega is turning to the Chinese for petroleum exploration and development.

"At least the potential is the hope that the Chinese will help him with exploration and development with any hydrocarbons found in the area. The Chinese are more willing to go into these areas based on strong political ties with this government and would be willing to risk action by the Colombians," Jones explained. "Even if the petroleum resources don't pan out, it grants you greater access to fisheries and a greater area under your control." **OE**



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QED Testing Ltd has been established since 2010 and is currently one of the largest independent testing houses in the UK. The organisation has the facilities, experienced team and latest technology to undertake all types of tensile and compressive testing, up to 3000Te. QED Testing head office is based in Huntly, Aberdeenshire, where it has completed the design, manufacture and commissioning of a 3000Te Test Bed, which is the largest of its kind in Europe.



The 3000Te Test Bed has been manufactured using leading-edge hydraulic technology and utilises the latest computerised load monitoring software. The software pinpoints with the aid of a graph, the load applied and duration held, thus giving the client the best certification available.

In conjunction with client InterMoor Ltd, QED Testing has recently completed two major projects testing H-link connectors for a polyester mooring system for use in the Gulf of Mexico. 74 production units were proof load tested to 2200Te followed by 6 H-Links, tested to a minimum break load of 2600Te. All testing was witnessed by the client and ABS.



Additionally, the Huntly-based firm operates a 200Te Test Bed, a 500Te Test Bed and a 500Te Anchor Test Bed which can test up to 25Te anchors. All Test Beds including the 3000Te can be mobilised and transported worldwide to meet the client's requirements. The Anchor Test Bed has been currently testing for InterMoor Ltd in Aberdeen and to date has completed over 30 tests on anchors.

QED has been testing a variety of components for clients in the oil & gas and mooring sectors including mooring chain, mooring swivels, chain chasers, performing wire rope breaks, crane lifting blocks and spreader beams. The team will undertake any job within the facilities testing capabilities.



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# Global market forecast

# 2014

## A year of growth with caution

**W**ith the world economy once again on an upward trajectory, 2014 is likely to see a number of key oil and gas projects rise to the fore. Meanwhile, exploration and production trend towards evermore challenging waters and is anticipated to remain central to the leading operators' investment strategies over the coming year. At the same time, however, significant challenges remain; uncertain energy prices are likely to be reinforced by the changing international tide towards Iran, while political unrest within North Africa is unlikely to abate in the near future. On a global level, operators will need to accommodate the emergence of shale gas as an investment alternative as part of their development strategies. The re-assessment of development budgets may also rise as the industry moves into an increasingly capital-intensive stage of development, driven by the prospectivity of fields within harsh environments, and remote and deeper waters.

Altogether, Infield Systems expects 183 developments to enter production during 2014. A large number of shallow water, predominantly gas developments,

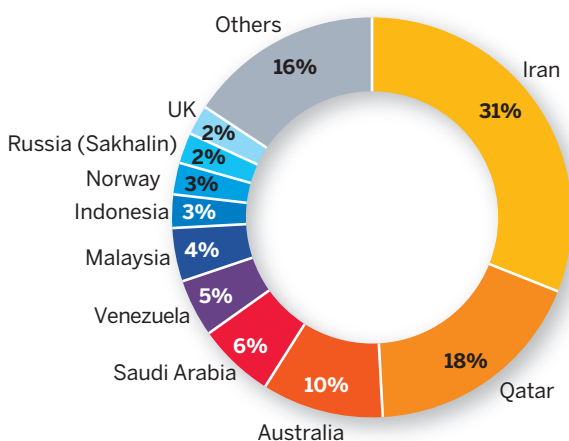
are expected to be brought onstream; driven by fields offshore Asia where Infield Systems forecasts a total of 27 gas developments to enter production during the year. Within the Middle East region the giant South Pars (Phases 13-14) and Qatar North Field dwarf all other developments, while offshore Europe, Infield Systems expects a total of 21 shallow water gas field developments to commence production.

Looking at those fields, which predominantly hold oil reserves, and beyond the giant shallow water development of Arkutun Dagi (Sakhalin 1), the trend towards deepwater development continues. Offshore Latin America and the Gulf of Mexico developments are also characterized by relatively short times between discovery and onstream date – averaging around ten to eleven years. By comparison, in the European region, discovery to onstream times average some 20 years, driven primarily by the growth of marginal field developments offshore UK. Within the African region, the nature of development is far more varied. Tullow's development of the Jubilee field offshore Ghana has been renowned for its

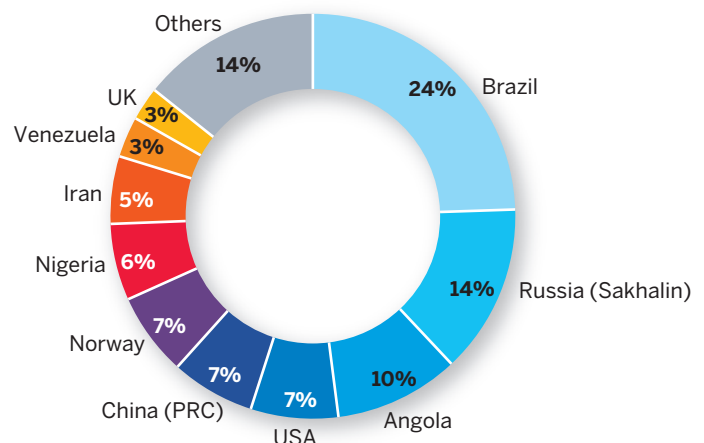
record-breaking discovery to production time of just 40 months, while Phase 2 of Jubilee (Hyedua) is anticipated to enter production during the course of 2014, taking just seven years from discovery to on-stream date. At the other end of the spectrum, Nigeria's shallow water fields expected to enter production during 2014 average discovery to production times of 26 years, reflecting the challenging operating environment within the country and preference of IOCs towards deepwater field development.

In capital expenditure (capex) terms, shallow water developments are expected to form the largest share of global investment during the forthcoming year, with the North West European Continental Shelf (NWECS) and Southeast Asia anticipated to require particularly high levels of shallow water spend. While developments in less than 500m are expected to hold the largest share of capex, when looking at the top ten operators in isolation, 63% of expenditure for 2014 is expected to be attributable to deep and ultra-deepwater developments. Although NOC Petrobras leads deepwater development, a significant share of deepwater

**2014 gas reserves (BCF) on-stream**



**2014 oil reserves (MMBBL) on-stream**



Source: Infield Systems' Market Modelling and Forecasting System



capex spending is attributable to IOCs, reflecting the general split in the market, with independents and most NOCs predominantly concentrating investments in shallow water prospects. That said, leading independent operators Anadarko and Noble are anticipated to continue their successful global deepwater campaigns during the year, with Anadarko expected to be the third largest deepwater spender within the Gulf of Mexico (GOM) after LLOG and Shell, and Noble expected to continue its development of Tamar and neighboring prospects within the Eastern Mediterranean.

On a regional level, Latin America is expected to continue to hold the largest share of total capex, with developments offshore Brazil expected to require 85% of regional capex for 2014. Indeed, despite Petrobras' recent financial issue resulting in foreign divestments, the operator is pushing ahead with planned developments at home. Infield Systems expects the NOC's capex to peak in 2014, driven by high profile projects such as Iracema Sul and Phase 2 of the giant Franco development.

Within Mexico's offshore sector, the long-awaited PEMEX reforms, which will potentially open up the industry to foreign investment, appear ever closer (*Ed. note: As of press time, the Mexican Senate passed the referenced energy reforms.*) Certainly, with Infield Systems recording a total of 46 field prospects with potential for development before the end of the decade, the Mexican offshore industry is now facing a crucial time which could see the country restoring its dwindling production levels. The forthcoming year is expected to see offshore investment focused upon the Sinan, Tsimin and Ayatsil fields in particular.

Elsewhere within Latin America, Infield Systems expects significant capital expenditure to be directed towards Venezuela, where the multi-phase Perla development remains on-track. Once completed, currently expected in 2015, Perla is forecast to deliver 1.2Bcf of natural gas per day to the domestic market.

Infield Systems expects the Asian region to hold the second-largest share of global capex during 2014, driven by developments offshore Malaysia, with Petronas's *Rotan* and *Kanowit* floating liquified natural gas (FLNG) projects leading expenditure. With construction of the *Kanowit* platform commencing

during the summer of 2013 at DSME's shipyard in Okpo, South Korea, the race to develop the world's first operational FLNG unit is also now underway, with the operator aiming for a start-up date of 2015. *Rotan* is expected to enter production a year later, while Shell's giant *Prelude* offshore Australia is unlikely to commence production before 2017. Offshore Indonesia, Infield Systems anticipates that NOC Pertamina will continue to hold the largest share of expenditure, with Chevron expected to be the most significant foreign operator in the country. The US IOC is expected to focus upon the Gendalo-Gehem project, which will see the re-tender of its floating platform units at the start of

and beyond.

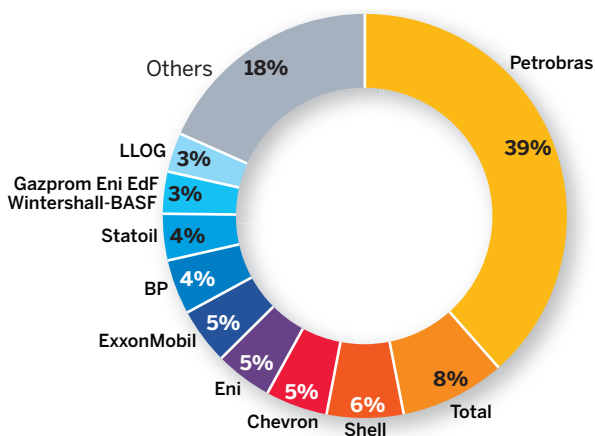
Offshore Europe, capex during 2014 is expected to be driven by developments within the NWECS region. Offshore Norway Infield Systems expects high profile projects such as Aasta Hansteen, Martin Linge and Edvard Grieg to drive expenditure. The forthcoming year is also expected to see the region's leading operator Statoil rise to the position of fourth-highest spender globally, behind Total, Chevron and Petrobras. With increasing development costs however, the Norwegian NOC has announced that it intends to keep exploration spending at its already-record 2013 levels. Offshore UK, the challenging Total-operated fields of Franklin West (Phase 2), Laggan and

Tormore are expected to enter production during 2014, while Statoil's Mariner field is expected to demand the highest capex during the year. As one of the largest projects ever undertaken within the North Sea, Mariner saw government approval in the early months of 2013. Once onstream, which Infield Systems currently expects for 2017, the development is expected to produce around 55,000 bo/d; equating to 5% of UK output. However, challenges remain within the NWECS, with both Statoil's Bressay and the Chevron-operated Rosebank hitting industry headlines during the final months of 2013 as each operator reassesses project finances.

Indeed, with energy price uncertainty expected to continue, such announcements may become more commonplace over the year as economic viability of capital intensive projects comes under the spotlight.

Offshore Africa, Angola is expected to lead capex demand during 2014. The West African nation is expected to see investment return to levels not seen since before the world economic downturn, with operators Eni, Total and ExxonMobil claiming the largest shares of capex spend on key projects including Mafumeira Sul and Chissonga. Projects offshore Congo (Brazzaville) are also expected to require a substantial proportion of the region's offshore investment during the year, with the giant Total-operated Moho Nord Marine anticipated to require the highest levels of investment, whilst the Lianzi field, operated by Chevron, saw several key contracts awarded during the course of 2013. However, a less than positive

**2014 Deepwater (>500m) capex (US\$M) by operator**



Source: Infield Systems' Market Modelling and Forecasting System

the year. Developments offshore India are expected to also require substantial capex spend during the year, with ONGC expected to hold a 92% share of the country's investment. China-destined capex is expected to predominantly focus upon shallow water developments during 2014, comprising 87% of total expenditure for the year, although Infield Systems also expects the global trend towards deeper waters to be reflected in China's offshore development going forwards. The Liuhua project, at a water depth of 723m, is expected to come on-stream during 2015 and successful exploration campaigns within the deepwater areas within Bohai Bay are also expected to continue during 2014. Elsewhere, with offshore licensing commencing for 19 deepwater and 11 shallow water blocks offshore Myanmar during Q4 of 2013, the expansion of exploration and production into the frontier waters of Asia's offshore zones is set to continue throughout 2014

# Global market forecast

outlook is expected for Nigeria. Despite significant expenditure being directed towards projects such as Egina and Bonga Northwest, total forecast investment is far below the country's potential. With IOCs reporting substantial revenue losses and the much-delayed Petroleum Industry Bill unlikely to be passed through government before the close of the year, future Nigerian capex may reduce further. Operators may turn towards the more stable operating environments of its West African neighbors and East Africa's emerging offshore sector. Offshore East Africa, Infield Systems expects increasing activity over the next year, with several operators announcing increased exploration budgets. Although Infield Systems does not expect offshore production to take place until 2015 on Aminex's Kiliwani North field, Tanzania, with Mozambique holding the potential to become the world's third largest exporter of LNG after Qatar and Australia, capex on developments offshore East Africa is anticipated to increase substantially over the upcoming five years. However, with shale gas exports expected to increase significantly over the same period, it is vital for operators looking to unlock this vast potential to bring on-stream projects to timescale.

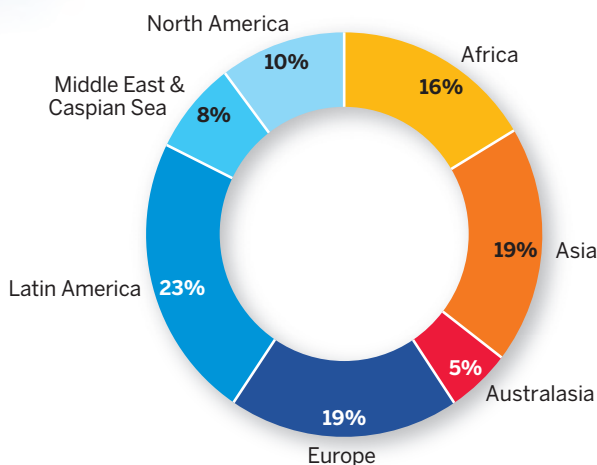
Within the North American region Infield Systems expects the deepwater GOM to continue to lead capex demand, with significant investment anticipated on Anadarko's Heidelberg and the LLOG-operated Marmalard developments, while the twin of the Heidelberg spar, Lucius, is expected to enter production during 2014. As the largest spar development undertaken by Anadarko, Lucius is designed to process some 80,000 bo/d. In addition, the platform also holds gas processing capabilities, necessitated by ExxonMobil's Hadrian South tieback, which is also expected to come on-stream during the course of 2014. While 88% of North America's capex for 2014 is expected to be directed towards GOM projects, the single largest expenditure during the year within the region is anticipated to be demanded by the ExxonMobil-led Hebron development, offshore Newfoundland.

Discovered in 1981, the economic viability of the giant heavy oil prospect

has long been in the balance, and with ExxonMobil now estimating a price tag in the region of US\$14billion, it will be crucial to maintain this budget in order to realise potential revenue gains going forwards.

In terms of capex, the Middle East region is expected to account for a relatively marginal 7% share of global demand. Abu Dhabi and Qatar are expected to lead capital expenditure demand during 2014, with key projects including the giant Qatar North (Barzan Gas Project) forecast to enter production

## 2014 Capex (US\$M) by region



Source: Infield Systems' Market Modelling and Forecasting System

during the first half of the year. Once the two trains of Barzan Gas are brought on-line, the entire development is expected to supply approximately 1.4Bscfd, making RasGas one of the largest single gas processors in the world. Projects within the Caspian Sea are forecast to also hold a significant share of 2014 investment within the Middle East, with Azerbaijan capex demand surpassing that of Saudi Arabia. At the time of writing, the BP-led Shah Deniz II is expected to reach its final investment decision before the end of December 2013. Due on-stream in 2018, 2013 saw the Trans Adriatic Pipeline winning the contract to transport Shah Deniz output through the Southern Gas Corridor, thus providing 10 billion cu m of gas per annum to the European market.

Elsewhere in the region, the giant South Pars (Phases 13 and 14) is expected to come on-stream during 2014, with Iran hoping to commence gas exports to Iraq by the middle of the year. With international relations appearing to soften towards Iran in recent months, the

prospectivity of Iranian fields may also increase going forwards.

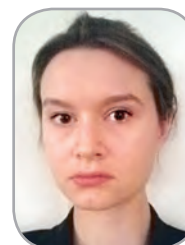
Whilst Australasia is only expected to hold 5% of total global capital expenditure demand for 2014, the North Western Australian market is fast developing into a hub for future liquefied natural gas (LNG) production, with the giant Prelude FLNG hull floating out of Samsung Heavy Industries yard at the end of 2013 and the ExxonMobil - BHP Billiton Scarborough FLNG gaining environmental approval a month earlier. During 2014, the Inpx-operated Ichthys LNG development is expected to demand some of the highest

investment levels of any project globally, while Chevron's Wheatstone LNG project is also forecast to require substantial expenditure during the year.

However, while recent years have seen Australia's LNG market touted as a prospective rival of Qatar's leading position within the sector, escalating costs and the emergence of shale gas may act to challenge this potential.

Indeed, the global offshore industry certainly has some significant challenges to face going forwards. Although investment once again looks strong, and a number of industry firsts are nearing fruition, operators and

contractors are simultaneously facing rising costs and technical challenges brought about by the steady movement into more challenging environments and the development of new production systems. Furthermore, with a number of capital-intensive projects in the planning phases, the energy price movements of 2014 will affect the overall economic viability of future developments, and will undoubtedly play the most pivotal role in deciding future offshore development. **OE**



**Catarina Podevyn** has been an analyst with Infield Systems Ltd. since 2008, has worked across various sectors, and authored numerous articles and publica-

tions. 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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## An overview of the FPS leasing market:

# Growth and changes

By Damilola Odufuwa,  
Douglas-Westwood

The leasing of floating production system (FPS) units is one of the main factors affecting the sector's supply. Over time, confidence in the ability of leasing contractors to deliver and operate facilities cost-effectively has increased, and the past decade has seen strong growth in the market for leased FPSs. Chartered vessels have been used to develop fields across a range of water depths worldwide.

Economic factors which affect the decisions to lease FPS units are:

- Application
- Expected field life
- Anticipated production rates
- Vessel day rates

The decision to lease an FPS unit can be seen as a trade-off between the low capital expenditure (capex) and the increased operational expenditure (opex) incurred from the leasing charges.

Leasing tends to be most attractive when developing a field for which a relatively short production life is expected. By chartering an FPS, operators can minimize the up-front capex burden, transferring part of the risk element onto the leasing contractor. Although field opex is increased, the extra expense will be born for a limited period and will be further offset by the reduced costs of abandonment at the end of the field life, as the responsibility for the cost of field abandonment and the removal of the FPS is held by the contractor rather than the operator.

### Major leasing contractors

The top three contractors in the leasing market are SBM Offshore NV, BW Offshore Ltd., and MODEC International LLC (Fig. 1). Collectively, these contractors account for 38% of the leased fleet, a 3% rise from last year. Netherlands-based SBM Offshore is the largest FPS leasing company with 17 units. Most of SBM's operational units are in Africa and Latin America – predominantly in the fields of Petrobras. The Brazilian company operates more leased FPS units than any other operator, with only one of the company's 20 contracted units located outside Brazil.

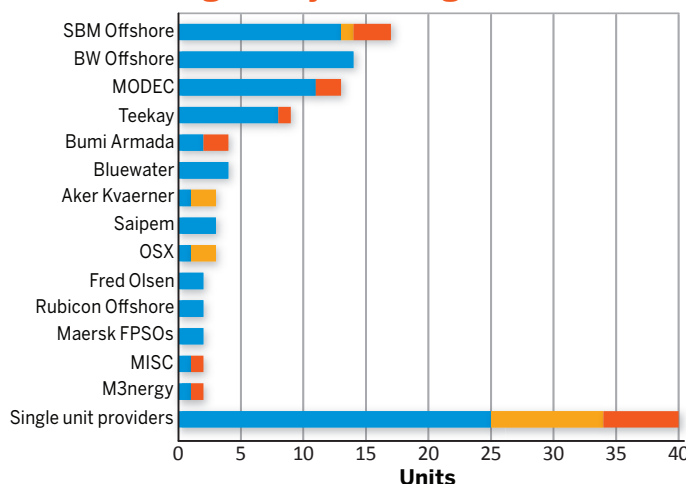
Norway's BW Offshore has 14 leased units on contract globally for a variety of operators. Of the 14 units, five are in West Africa and six in Latin America. This highlights the significance of these

Murphy Oil has revealed plans to terminate the contract for the unit from May 1, 2014, due to severe reservoir problems on its Azurite Marine field in West Africa. Nonetheless, BW Offshore has recently bounced back from its Q3 loss last year and looks to expand its fleet and extend its existing contracts.

Japan's MODEC is also poised for significant growth over the near term. The company has 11 units on contract, and two others under construction, which are expected to begin production by 2016. The company is currently focused on three geographic areas: Australia, Brazil and the Ivory Coast. Of the three leasing contractors, MODEC operates the most units in Australasia.

Overall, the utilization rate of the leased fleet currently stands at 87%, with much of the spare capacity being delivered by single-unit providers who may find it more difficult to secure new contracts than larger contractors.

Fig. 1: Major leasing contractors



two regions in the offshore oil and gas market. All of BW Offshore's leased units are floating production storage and offloading units (FPSOs) with one floating production, drilling, storage and offloading vessel (FPDSO). However, recent news from the FPDSO's operator

### Redeployment Opportunities

A notable feature of the FPS leasing market is that vessels are frequently redeployed to new fields once the leasing contract has expired. A short contract is one of the key drivers for selecting a leased vessel. Many redeployed units will operate for less than two years on a field before moving on. Once service has been completed, contractors will need to find employment for the vessel elsewhere and this almost invariably involves some form of upgrade or modification to the vessel's capabilities. Redeployments enable contractors to prolong the working life of vessels, allowing them to derive maximum value from their assets.



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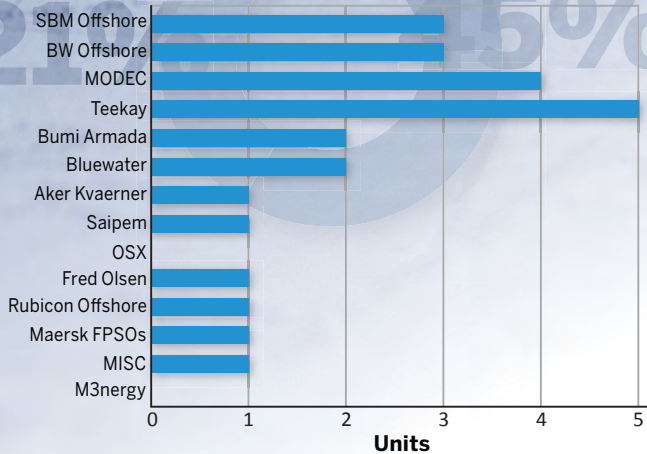
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# Global market forecast

**Fig. 2: Major leasing contractors' redeployment candidates**



This upgrade and redeployment strategy has been used mainly with conventional FPSOs, along with a smaller number of FPSs, rather than with tension-leg platforms and spars, as these units have lesser mobility. Spars, in particular, are challenging to transport unless the top-sides and hulls are disconnected.

Technical aspects that impact a vessel's redeployment potential relate to the topside process capability and the

hull design, including storage capacity, oil production capacity, hull configuration, etc.

It is difficult to predict with certainty the future availability of FPS units. Field plans change in response to product prices, reservoir performance, plans for third-party tiebacks, etc. Nevertheless, according to Douglas-

Westwood data from the major leasing contractors, 25 leased FPSOs are expected to end service by 2018, therefore making them candidates for redeployment (Fig. 2).

## Issues in the supply chain affecting leasing

Despite strong and growing demand, the FPSO supply chain is under considerable strain. This important sector of the

floaters' market continues to be beset by severe project delays and cost overruns, which threaten the ability to meet forecast demand in the years ahead. Leasing contractors are among the most severely affected by the status quo, often taking on considerable project risk that has been outsourced by the field operators.

The lessors themselves are in a difficult position. Recent years have seen at least seven lessors file for bankruptcy or be acquired. At least the same number have seen severe constraints on their capacity to execute new projects while the appetite to take on new projects of the remaining main players, including those mentioned above, is increasingly limited. Simply examining the equity stakes in North Sea-based FPSO players shows a dramatic deterioration over the past six years.

With dependence on offshore and deepwater production growing, it is a source of considerable frustration that the industry continues to face such significant challenges with no obvious light at the end of the tunnel. A number of factors contribute to this situation and each present their own challenges as demand marches on.

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Operating companies are usually well-shielded from the difficulties beneath them. Contract terms generally dictate that day rates commence with first oil production. When engineering, construction, or commissioning delays occur, they directly impact the contractors' balance sheets. While frustrated by the delay to first oil, an indirect cost with investors demanding that barrels be brought to market quickly to maximize financial returns, the agreements in place are not typically adjusted.

The complexity of offshore production presents a unique challenge to the FPSO industry. Unlike drillships, the vessels remain in place for extended periods of time and must adjust to substantially different subsurface conditions over time. Although FPSO design is engineered in precise detail it is based on very limited knowledge of the field conditions, particularly in areas of extended production. As flow rates, hydrocarbon mix, and other factors become clearer, the premise for the specific designs can be wildly inaccurate, impacting the effectiveness of the vessel. Because each field development is unique, one-off designs have been employed, leading to a fleet of

units with varying characteristics. This brings difficulties when redeployment is required and increases the need for conversions and re-conversions, often the most challenging engineering, procurement, and construction projects when unknown qualities and difficulties arise throughout the latter stages of development. This has led to cost overruns above the already-high industry average.

Complexity in the decision making process also challenges FPSO project execution, particularly with the increased oversight and engagement of field operators (compared to drilling, for example) who require decisions made at project level and at management level. The impact of oil company requirements is further exacerbated by the lack of institutional experience when it comes to FPSO procurement. Few operators have completed more than a handful of projects, each materially different from the last. This limits the build-up of knowledge and process internal to the operators, worsened still by the turnover of personnel in the industry. It's particularly rare to find an FPSO team that has executed multiple projects at the same company.

Other challenges around the historic connection with the shipping industry, highly complex and immature regulation, and the sheer size of the investment required for each new project further burden the supply chain, limiting capacity and the effectiveness of FPSO production.

As confidence in leasing continues to grow, these and other serious issues will need to be addressed if the supply chain and leasing contractors are to meet demand over the next five years. **OE**



**Damilola Odufuwa** joined Douglas-Westwood as a researcher and primarily works on bespoke consultancy/advisory projects, including due diligence analysis and publications. Damilola is the lead author of *The World Floating Production Market Forecast, 2014-2018*. Odufuwa graduated from the University of Kent with a degree in Financial Economics and a master's degree in International Finance and Economic Development.



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## Rig refurbishment renaissance

Jackups fill the skyline at Lamprell's facility in the Hamriyah Free Zone, Sharjah, Dubai.

**Rising requirements for rigs in the Middle East is increasing competition for jackup refurbishment and conversion.**

**Elaine Maslin reports.**

About quarter of the world's 480-strong jackup drilling rig fleet resides in the Persian Gulf and demand for units in the region is predicted to keep on rising.

Much of the demand is coming from Saudi Arabia and Abu Dhabi (Saudi Aramco and Abu Dhabi National Oil Company, or ADNOC), whose offshore operations have been increasing, and also outside the region, including nearby offshore Egypt, and West India.

Earlier this year, Hercules Offshore said Saudi Aramco doubled its jackup fleet, between 2011 and 2013, with activity increasing on projects such as the US\$10 billion Karan offshore non-associated gas development.

ADNOC also has ambitious plans. It is working on the US\$10 billion Integrated Gas Development (IGD) project, which will see gas from the Umm Shaif field processed at Ruwais and Habshan.

In total, ADNOC says it is planning in

excess of \$US48 billion on upstream projects, with about 50% of that on offshore developments, including artificial islands, to raise its production capacity from 2.7MM bbl/d to 3.5MM bbl/d by 2017.

New markets are also potentially opening, with interest growing in the deeper waters of the Red Sea, and the potential for operators and contractors to return to Iran now on the horizon.

About 128 jackups are currently being built globally, but additional 130 need to be built by 2020 to meet demand, says Ian Anderson, marketing director of rig builder Lamprell's Hamriyah facility, citing comments by a Pareto analyst. In addition, about 80% of the global fleet is more than 30 years old and in need of updating.

"There is a lot of exploration in shallow waters (the Persian Gulf, also known as the Arabian Gulf, is mostly below 180ft water depth), so there is a lot of requirement for jackups," says Moss Daemi, director Middle East, India and North Africa, DNV GL Oil & Gas. "At the same time there is demand for refurbishment of old rigs and conversions to accommodation units."

Jackup operators in the region include

Shelf Drilling Holdings Limited, which has 38 shallow water-focused jackup rigs operating in the Arabian Gulf and elsewhere. Anderson says Shelf Drilling is looking to either sell or reactivate four rigs it has stacked, and is also looking at new builds. National Drilling Company (NDC), a subsidiary of ADNOC, lists 15 jackups. Noble Drilling operates 16 jackup rigs out of Qatar.

UAE-based Millennium Offshore Services, operates six jackup accommodation units, most of which are converted drilling units. Its latest, the *MOS Frontier*, is a LeTourneau 116, currently undergoing conversion, and destined to relocate to Asia Pacific.

Conversion to accommodation units could also be a strong market, but operators

prefer jackups with four legs, of which there are limited supply, Anderson says, rather than the majority three. The advantage of four legs is the ability to more quickly pre-load the legs, during installation, he says.

To meet demand in the Middle East, rigs are being brought in from areas including India. They

have typically deteriorated from heat and humidity, and can need 500-tonnes of



**Moss Daemi**



steel replacing, particularly in the splash zone area, Anderson says.

However, the work can still be cost-effective. Reactivating a 1981-built rig to work for Saudi Aramco for five years could cost US\$60 million, against US\$185 million for a newbuild 116E, depending on the deck and drilling equipment requirements. A JU 2000E would be US\$230-240 million, Anderson says, but would also command a US\$180,000 day rate. DNV's Daemi puts the cost of a new jackup for the region at US\$140-200 million, compared to US\$60-90 for an upgrade.

"To keep up with class, a lot of the existing jackups will need to be brought in to the yard," Anderson says. "We see a steady stream of rigs being reactivated or converted. There is talk about scrapping, but I've been in this business 25 years and I have never seen one scrapped." Some have gone into Iran, and have been used as fishing boat stations, he says.

With its entrance into the Middle East in 1974, Lamprell is one of the more established players in the region.

After a turbulent 2012 that saw multiple profit warnings, Lamprell fought back in 2013 with new directors, including Chief Executive Officer Jim Moffatt, and, more recently, Chief Financial Officer Joanne Curin. The company also underwent refinancing.

Lamprell's bread and butter are LeTourneau design jackups, of which it had seven in construction at the start of December. November 2013 saw the delivery of its 14<sup>th</sup> jackup drilling rig.

Lamprell's heritage, however, is jackup rig refurbishment, which started in 1992, 15 years before the first newbuild was delivered in 2007.

To date, the firm has seen more than 350 jackups docked for refurbishment,

repair or conversion. Anderson says Lamprell had 60% of the refurbishment market in the Middle East in 2012.

"One of the biggest operators right now is Saudi Aramco, which is looking for anything it can get, but rigs have to meet their standards," Anderson says. "Saudi Aramco is taking 30-year-old jackups, but they need work done on them. Abu Dhabi is another area beefing up its fleet right now." Standards required include zero discharge, helideck access and egress on both sides, resulting in upgrade periods of 12-14 months.

But Lamprell is no longer the only player in the region. Dubai's Drydocks World, Adyard Abu Dhabi (a subsidiary of Topaz Group), Nakilat-Keppel O&M in Qatar, a joint venture between Keppel Fels and Nakilat, Oman Drydock Company, and Asry in Bahrain, could all be potential competition.

Drydocks World recently signed a memorandum of understanding with Polish company MARS Fundusz Inwestycyjny Zamkniety (MARS Closed-End Investment Fund), which outlined an agreement to cooperate on various opportunities in the offshore services and maritime sectors, including the repair, refurbishment and conversion and new building of oil rigs.

The latest entrant is

Damen Shipyards Sharjah, set up by Albwardy Marine Engineering, a joint venture between Albwardy Marine Engineering and Damen Shipyards, which also operates repair, docking and diving facilities at Dubai's Shipyards Al Jadaf, Dubai Maritime City and Fujairah.

In November, the company headquarters moved to its new site in the Hamriyah Free Zone, Sharjah. Alongside ship dry-docking repairs and conversions, and new buildings of Damen and non-Damen designs, the company lists the oil and gas sector, specifically rig repairs and conversions, as one of its new areas of focus.

The Damen Shipyards Sharjah facility



Construction underway at Lamprell, Hamriyah.



Jim Moffatt

## A busy new year for Lamprell

Lamprell has facilities at Jebel Ali, Hamriyah and Sharjah. It also recently set up Lamprell Arabia in Saudi Arabia, and owns MIS Arabia, which mostly focuses on fabrication of pressure vessels for Aramco.

Hamriyah is home to the company's newbuild, conversion and upgrade operations, with 1.5km of deep water quayside.

Ongoing projects at

Hamriyah are: Four LeTourneau Super 116E jackups for National Drilling Company (NDC), part of ADNOC; Seajacks Hydra, wind farm installation vessel, for UK-based Seajacks; the second of two new jackup drilling rigs for Eurasia Drilling Company (EDC) for use in the Caspian Sea; the Jindal Pioneer, which is the second of two rigs for Jindal Pipes (Singapore) Pte., for use

offshore India; Super 116E jackup GreatDrill Chaaru, for India's Greatship Group; and refurbishment projects on Noble Drilling's Gus Androes, Roy Rhodes, and David Tinsley jackup drilling rigs.

The jackup for EDC is being built so that it can be transferred in nine pieces to the Caspian Sea via canal barges, before then being assembled at Astrakhan.

Lamprell's Jebel Ali facility is currently building a

10,000-tonne, two level well-head deck and 14,500-tonne, three level production, utilities and quarters deck, for Nexen's North Sea Golden Eagle development, and due to complete in May of 2014.

The Sharjah facility, at Port Khalid, focuses on newbuild jackups and currently has the MOS Frontier accommodation jackup conversion project, and offshore metering towers (jackets and decks) for Leighton Offshore. ■

# Global market forecast

Damen Sharjah Shipyard's newly opened facility at Hamriyah.

Damen Sharjah Shipyard's MD Lars Seistrup.



covers 284,000sq m, with 1.2km of quayside and up to 9m water depths. A 5200-tonne Rolls-Royce shiplift enables the yard to repair and launch ships up to 120m-long. For alongside repairs, DSS is limited to 140m, due port restrictions. Part of the facility is a 130m x 34m x 34m covered blasting and painting hall, which enables grit blasting and high-pressure water blasting on the repair berths.

The yard has a new build order book,

mostly from parent company Damen Group, comprising two multcats, two shoalbusters, two barges, for Kuwaiti firm Bimco, one aluminum crew boat, for an Abu Dhabi client, and 10 azimuth stern drive tugs, two of which are also for Bimco.

Lars Seistrup, its managing director, says: "The next step will be the oil and gas sector. A lot of rigs are coming into the Arabian Gulf and they will need some level of upgrade and modification."

However, refurbishment is not the core business stream for either company, nor for others in the market.

"(Rig repair is) good business for us, but it is not going to be the corner stone of the business," says Moffatt, who wants the business to maintain a spread of business streams, for business resilience.

New build is also very much still part of the plan, with Lamprell planning to launch a new rig design to operate in 400ft water depth. Currently, it has designs up to 350ft. **OE**

## FURTHER READING

**Read more on OEdigital.com:** Iranian opportunities beckon: An agreement to discuss lifting sanctions offers a glimpse of hope.

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## Global exploration prospects: 2014 and beyond

**Tom Ziegler, Vice President  
of Global MultiClient,  
Petroleum Geo-Services (PGS)**

In recent years, the oil and gas sector has focused heavily on exploration in frontier regions, seeking new opportunities in areas previously under-explored. However, given the competitive landscape, opportunities in more mature areas have also captured the industry's interest, often viewed as lower risk for exploration due to existing infrastructure and an existing breadth of knowledge.

There are understandably some strong tensions between the appetite for risk and perhaps the opportunity to be part of a big find in frontier basins. Some companies are taking a more cautious, but perhaps not necessarily less expensive, approach to exploration in mature basins. Whichever route is favored, pressures on budgets mean that potentially not all good exploration ideas can be followed through.

In the future, how can oil companies better identify the best exploration opportunities? Basing these decisions on better data, which in turn is based on sound acquisition and processing, is a start. Applying interpretative techniques such as lithology prediction and leveraging geological and geophysical (G&G) knowledge and experience to delineate prospects effectively are good subsequent steps.

It is core to PGS' strategy to tackle these challenges head on. We developed our unique dual-sensor cable acquisition technology, GeoStreamer, in order to reduce the risks inherent in poor and band-limited seismic data. We have now deployed GeoStreamer across most of our fleet of acquisition vessels, including the recently launched *Ramform Titan*-class vessels, each of which can tow up to 24 streamers. We use GeoStreamer extensively for both proprietary client surveys as well as for building our multi-client data library, meaning that recorded data will be richer in frequency content, ultimately enabling better geological

modelling and improved prospect definition and identification.

We employ in-house G&G staff, our Reservoir department. Their focus is on setting our direction towards the most prospective places globally to acquire new multi-client data. Additionally, clients are requested for input on the early stages of multi-client survey design, the best processing flow to adopt, and also to better understand what they believe are the most interesting exploration areas of the future.

So, where should the industry explore next? Every expert will have his or her own opinion, but in this article, I'll talk about a few of the most promising areas: the eastern Mediterranean, Africa, North America, Brazil, the Arctic, Southeast Asia, and northwest Europe.

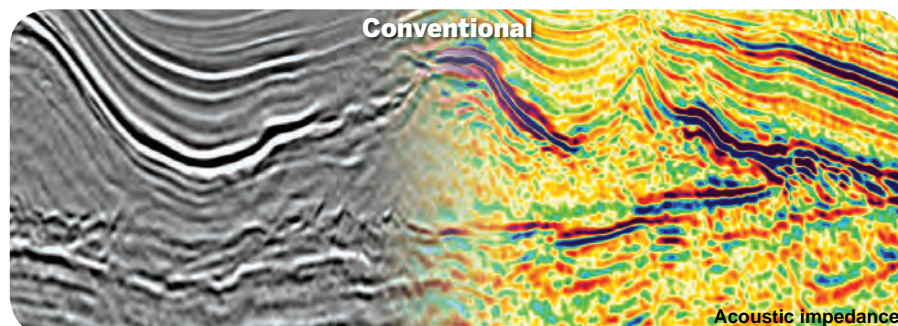
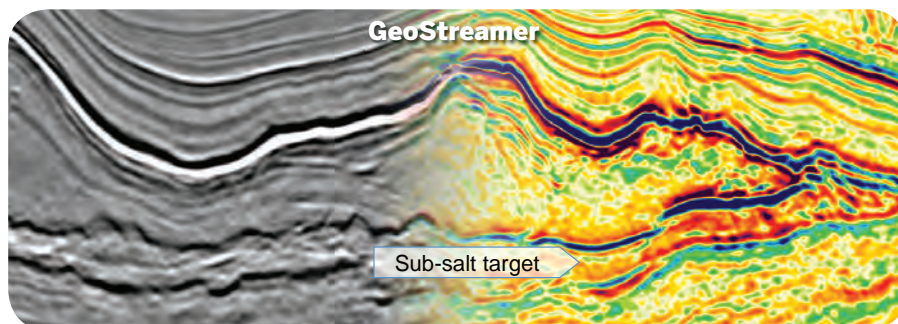
### East Mediterranean

Recent years have seen an increased focus in the eastern Mediterranean, triggered by the giant deepwater gas discoveries in the region.

Greece is set to become a hot prospect in 2014 exploration plans; the Greek Ministry of Environment, Energy &

Climate Change will be launching an offshore licensing round mid-year, with more than 200,000sq km of acreage to be made available. PGS has played an instrumental role in providing seismic data over areas to be included in the licensing round, thus enabling companies to properly evaluate opportunities. Greece offers political stability and an EU transparent framework for hydrocarbon exploration. Offshore, Greece has working petroleum systems in place with several promising plays, analogues to discoveries in adjacent countries, and good frontier potential in unexplored basins.

PGS has also been an official data provider for the First Offshore Licensing Round in Lebanon, which is scheduled to close in 2014, with block awards thereafter. Our extensive 3D and 2D data coverage shows prospective plays and potential analogues to the recent major gas discoveries in the vicinity, and the potentially more oil-prone Levant Margin. Currently, the Ministry of Energy and Water has estimated that Lebanon's territorial waters may have up to 96Tcf of gas reserves and 850MMbbl of oil.



**GeoStreamer: a clearer reservoir image.**



Cyprus also presents opportunities in 2014, after its second license round closed in 2013, in which several blocks were awarded. In October 2013, Noble Energy indicated that it foresees the potential for 150MMcfd well rates offshore Cyprus in the Aphrodite field. Currently, proven reserves are estimated at about 4Tcf of natural gas, and there is also potential for oil.

## Africa

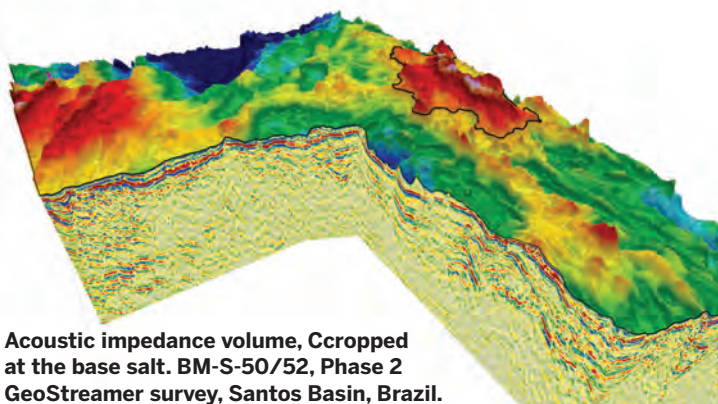
Sonangol will be leading an onshore licensing round in Angola in 2014 – the onshore oil blocks on offer are in the terrestrial areas of the Kwanza basin (Blocks KON 3, 5, 6, 7, 8, 9, and 17) and Lower Congo basin (Blocks CON 1, CON 5, and KON 6). These onshore areas cover approximately 50,000sq km, with large parts only minimally explored thus far; earlier onshore exploration phases have resulted in the discovery of 23 oilfields and two small gas accumulations. The Kwanza and Congo basins are examples of the classic passive margin basins on the West African margin which developed as a result of the rifting of Gondwanaland during the Mesozoic, and subsequent separation of the South American and African continents. Areas have been identified where there are thick pre-salt sedimentary depocenters and adjacent structural highs which could contain potential reservoirs, trapped under the Aptian salt. Consequently, onshore Angola is set to be a very interesting prospect for exploration in 2014.

The Congo Republic recently announced that it plans to award 10 onshore and offshore oil blocks, by early next year, in a new licensing round. A series of recent discoveries has meant that interest in the area has been growing again and fresh exploration is expected. In August 2013, Eni Congo SA announced that two recent discovery wells have proven resources of 600MMbbl of oil and 700Bcf of gas in place. In September 2013, CNOOC and Oryx made an oil discovery and spudded a second exploratory well on the Haute Mer A license offshore Congo (Brazzaville). The second well, targeting the Elephant (formerly Xiang) prospect, is expected to be tested in early 2014.

In late October 2013, Gabon moved to

award 13 oil and gas blocks in an effort to double its production output – 43 blocks altogether have been made available. Earlier this year, Total made a discovery in the deepwater pre-salt area offshore, which has led to a renewed interest in the area. As a result, many international players have become involved through the recent licensing round, with 11 companies assigned blocks.

South Africa represents another very interesting opportunity. Several international oil companies have taken stakes in offshore blocks. Recent interest has moved from the west and south of the country to the eastern offshore area, likely chasing the southward extension of plays that have been identified further north in East Africa, where upstream investment will increase substantially over the next



**Acoustic impedance volume, Ccropped at the base salt. BM-S-50/52, Phase 2 GeoStreamer survey, Santos Basin, Brazil.**

few years. Wood Mackenzie has forecast that investment in East Africa will hit \$7 billion annually by 2018.

## North America

First, a frontier province: East Canada. The area offshore Newfoundland and Labrador represents strong untapped potential with an estimated 6 billion bbl of oil and 60Tcf of natural gas yet to be discovered. To date, there have been only 20 deepwater wells drilled off Newfoundland and Labrador. The east coast basins alone cover an area bigger than the Gulf of Mexico and are largely unexplored. Initial interpretation of recently acquired 2D data in the Labrador Sea has led to the discovery of three new basins in this untested, deepwater frontier. Recent drilling successes, such as Statoil's Bay du Nord discovery, north of the oil producing Jean D'Arc basin, confirm strong potential – this opportunity alone is assessed at 300-600MMbbl of recoverable oil. Statoil's earlier discoveries in the Flemish Pass— Harpoon and Mizzen— help to further reinforce the prospectivity of this area.

Next, the Gulf of Mexico. Yes, it's a mature petroleum province, but there's still huge potential here. In the past few seasons and in the coming year, we continue to deploy leading-edge approaches to acquisition. We are adapting technology and survey designs to overcome the challenges of conducting seismic surveys over targets obscured by salt structures. Improving subsalt imaging fidelity will help reduce exploration risk as oil companies explore ever deeper. There has been success here in 2013, with several discoveries, including Anadarko announcing in mid-June that it made a major new discovery in the deepwater Shenandoah play, after Chevron announced a discovery at the Coronado prospect in May. The Gulf of Mexico continues to represent an important part of oil company portfolios, and as technological advances continue, new opportunities will be revealed.

## Brazil

Brazil has been an exciting destination for exploration for many years, where we have acquired substantial volumes of multi-client data to assist oil companies in their exploration. Our Brazil Mega Survey in the Santos

and Campos basins is an extremely large regional combination of PGS and ANP/BDEP open-file 2D and 3D surveys that have been re-gridded onto a common azimuth and amplitude and phase matched. This yielded an improved and consistent regional geological and structural perspective, aided by integrating well information. This has helped identify subtle prospects, play fairways, and migration paths within a regional framework. We started acquiring GeoStreamer data in Brazil in 2009 and more recent surveys have thrown up some exciting potential over, and adjacent to the pre-salt hydrocarbon trend.

Discoveries in pre-salt carbonate reservoirs continued, throughout the year, to yield promising results in the Santos basin. In May, Petrobras doubled the estimate for its Libra field to 12-15 billion bbl and the interest from international oil companies continues to gain momentum. The SEAL-11 block offshore the stage of Sergipe was determined to contain large amounts of high-quality light crude and natural gas (more than 3 billion bbl of oil in place, according to some sources).

# Global market forecast

Undoubtedly, with the resumption of bid rounds in 2013 (following a hiatus that started in 2009 as the government established the pre-salt regulatory framework), many believe that Brazil is going to continue to attract inward investment.

## The Arctic

In 2008, the US Geological Survey estimated that the undiscovered, technically recoverable hydrocarbon reserves in the Arctic include 90 billion bbl of oil, 1670Tcf of natural gas, and 44 billion bbl of natural gas liquids. These figures suggest that the region will add greatly to the undiscovered conventional global hydrocarbon reserves.

Russia is actively ramping up its exploration activities and engagement with international oil industry players to explore its offshore potential in the Barents and Pechora Seas. Recently, PGS together with *Geology Without Limits*, acquired a regional program of 2D covering the Barents and Kara Seas within the framework of an international scientific program.

We've also been working for many years on the Norway side of the Barents Sea. Here, the Wisling and Skrugard discoveries have created a lot of interest. OMV recently released news of a discovery in September 2013, uncovering a reservoir that could contain up to 160MMbbl of recoverable oil. Statoil and OMV also announced another discovery in the Hoop area of the Norwegian Barents Sea in the same month, expected to range from 65-165MMbbl of oil. Oil companies are increasing their focus on the Barents Sea, with several wells in the pipeline. The previously disputed zone with Russia is being opened up, with the Norwegian government encouraging the acquisition of new data to enable the exploration of this area that is thought to have high hydrocarbon potential.

## Southeast Asia

2013 has been a good year for Australia, with a continued natural gas discoveries in the Carnarvon basin offshore Western Australia and one of the biggest onshore oil discoveries ever at Cooper Pedy.

Since 2009, there have been 21 offshore discoveries, which together amount to 10Tcf. Apache and Santos, in particular, have had success in 2013

finding gas offshore Western Australia. Eni successfully drilled the Evans Shoal North-1 appraisal well in the Timor Sea. Chevron also had success in April 2013 in the Carnarvon basin, encountering about 40m of net gas pay in the upper Mungaroo sands at the Elfin-1 well. Santos has had a string of successes in the Jurassic Angel and Triassic Mungaroo formations in the Carnarvon basin, as well as those at Crown, Bassett West, and Bianchi. Shell has flagged that innovation will play a key role in the competitiveness of Australia's LNG industry, as global production grows substantially in



**Ramform Titan acquired her first multi-client survey in Northwest Europe in 2013.**

the next decade, with supply from several sources expected to rise significantly.

Generally within Southeast Asia, advances in deepwater production technology, innovations in circumventing the lack of infrastructure in some parts of the region, and the strong growth in the regional gas market in Asia also mean projects previously considered economically unviable are now being explored again.

## Northwest Europe

Offshore Europe is a more mature but competitive area, with recent new large discoveries ensuring that it remains in many oil companies' exploration plans. The potential of this region is exciting: the Norwegian Petroleum Directorate (NPD) currently estimates undiscovered recoverable resources on the Norwegian Continental Shelf (NCS) at 935-5420 million scm oe. The UK government's Department of Energy and Climate Change suggest that UK oil reserves range from 405-1064 million tonnes and natural gas reserves range from 244 - 699bcm for fields already in production, under development, or where development plans are in discussion.

The NPD states that there are currently

40 confirmed plays across the NCS and 33 additional unconfirmed plays, one of which will enter the confirmed list for 2014 following the recent Gohta discovery in the Barents Sea. The Gohta discovery (7120/3-1 well, October 2013) proved petroleum in a Permo-Carboniferous carbonate reservoir (Røye Formation). A 25m gross gas column was found above a 75m gross oil column in karstified and dolomitized limestone. With technological advances helping to image the subsurface more than ever before, the ability to find such resources should improve significantly.

Ireland is an area which is experiencing an upsurge in industry interest, with drilling likely in 2014 following the 2013 Dunquin North well in the Porcupine basin. PGS has acquired a 3000km 2D survey to better delineate the Fastnet and Celtic basins area to the southwest of the Barryroe field. This was acquired simultaneously with towed electromagnetic data, with some impressive results.

There are, of course, many other areas that I haven't

mentioned that the industry would consider having very strong potential. The opportunity to constantly explore and forge new ground is what makes this industry such an interesting place to be in. The risk involved is part and parcel, but our focus is on investing in new technology, utilizing innovative techniques and geological understanding to reduce that risk. We're keeping an eye on the areas around the world that show the best exploration potential – and this continues to inform our seismic acquisition strategy. **OE**



**Tom Ziegler** is Vice President of Global MultiClient at Petroleum Geo-Services, based in London. He joined PGS in 1995, focused on exploration

offshore Europe and Africa, and became head of MultiClient for EAME in 2003. Prior to PGS, he worked as a North Sea geologist for Clyde Petroleum. Ziegler earned a BSc in Petroleum Geology at Imperial College London and an MBA at the University of Strathclyde.





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# Gaining new access to old wells

By Jimmy Land and David Moran,  
Schlumberger

In an age of increasingly hard-to-tap resources and high demand, operators are continually searching for reliable, cost-effective ways to extend production and improve recovery in mature or damaged wells. A cased hole whipstock system that uses dynamic modeling software to engineer a wellbore exit design, is providing new access to old wells that might otherwise be abandoned.

A North Sea operator used the whipstock system to successfully sidetrack an aging, abandoned well and perform a slot recovery that created access to a new wellbore. The system set a mechanically anchored whipstock in the existing casing, milled a full-gauge 18.5-in. window and set the world's largest tight-tolerance liner in the 20-in. casing, saving the operator five days of rig time.

The Schlumberger TrackMaster CH cased hole whipstock system is designed

**Table 1: Modeled versus actual wellbore trajectory**

Top of milled window	Depth, ft	Inclination	Azimuth
WhipSim software model	1,444	7.6	201.3
Gyro measured	1,444	7.76	201.15
Bottom of rathole			
WhipSim software model	1,485	9.8	194.4
Gyro measured	1,488	10.75	191.02

to mill clean, full-gauge windows for access to wells with high-grade steel and chrome casings, and in formations with unconfined compressive strengths of more than 40,000 psi. The technology, which can be configured to provide fast, high-quality windows and sidetracks for any application, is enhanced with the use of sophisticated casing exit simulation software that helps ensure subsequent drilling and completions strings are

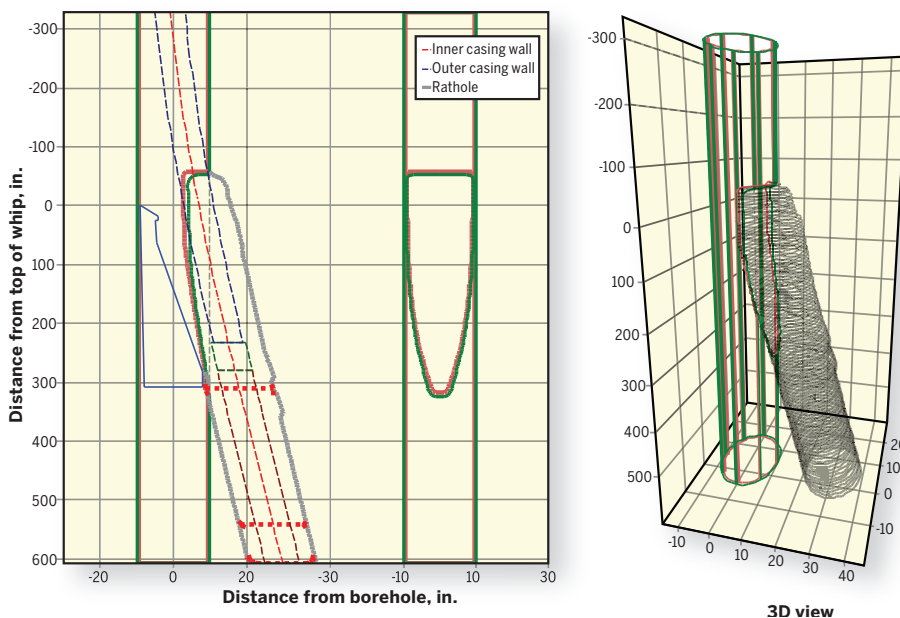
not impacted by the dogleg across the whipstock. A drillstring analysis program models the sidetrack and provides real-time analysis of the modeled parameters.

In the North Sea project, Schlumberger selected the whipstock technology for a customer wanting to perform an efficient, cost-effective slot recovery operation on a well that had been drilled in 1974 and recently plugged

and abandoned because of damage to the existing completion and casings. Such an endeavor is typically costly and requires several days of rig time.

The objective was to set the whipstock in the original 20-in. casing, mill a clean, full-gauge 18 1/2-in. window to provide access for the new wellbore and then run a large, 17-in. liner through a casing exit with the dogleg optimized for the completion string. Pre-job analysis, modeling and planning were integral to optimizing the design of an operation that would deliver a successful outcome.

**Fig. 1: Casing exit simulation – window geometry**



By calculating DLS for the casing exit, the WhipSim software helped ensure that completion strings were not affected by the dogleg across the whipstock.

Images courtesy of Schlumberger

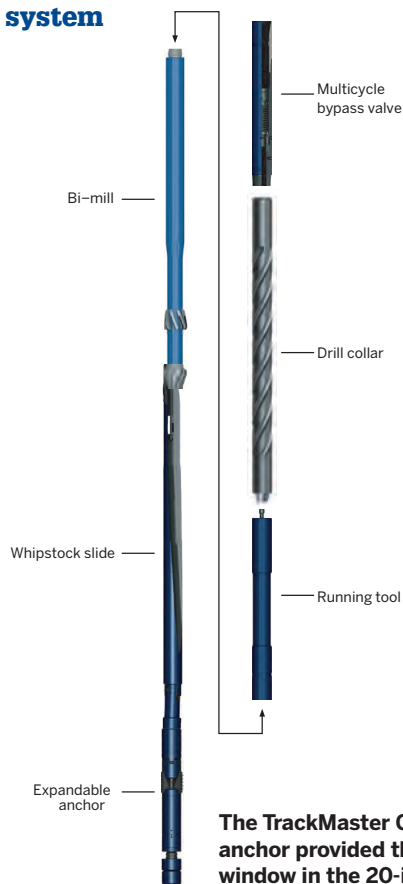
## Planning the Installation

During the planning stage, simulations provided realistic predictions of how each bottomhole assembly (BHA) would perform, while calculations were made to indicate the stresses of all the components as they passed through the window. The WhipSim\* whipstock simulation software was used to ensure the tight-tolerance liner could be installed with the large-size whipstock assembly and window.

This was accomplished by modeling the milling operation and the geometry of the milled window, and by testing the pass-through assemblies for the completed window. An advanced mill design platform validated the milling string design and operating procedures. The Runner drillstring analysis program modeled shear setting operations, jar placement, dogleg severity (DLS) and full-well contact force profiles for the



**Fig. 2: Cased hole whipstock system**



**The TrackMaster CH system's bi-mill configuration and expandable anchor provided the flexibility to mill a clean, full-gauge 18 1/2-in. window in the 20-in. casing, which allowed running the 17-in. liner.**

subsequent strings.

The operation involved running the whipstock system in the hole and anchoring it at the planned depth and orientation. Parameter recommendations from the pre-job modeling were used to complete milling of the window. The milling operation left a 15-ft rathole to accommodate the BHA. After a trip to change out the BHA, the sidetracked well was drilled to section total depth.

The 17-in. liner with a maximum outer diameter of 17.2-in. was then assembled and installed; the largest ever run through 20-in. casing, setting a world record. The shoe track passed over the whipstock and through the window within the Runner program's predicted drag, which was monitored as the liner was being installed. The DLS predicted by the Runner program and the actual DLS matched, as confirmed by gyro survey data.

By isolating the damaged 20-in. pipe, mechanically anchoring the whipstock in the original 20-in. casing, and milling the full-gauge 18 1/2-in. window with

the dogleg optimized for the completion string, the customer was able to eliminate five days of rig time and significantly reduce costs in revitalizing this aging well. As a result of the success of the project, the operator plans to deploy the whipstock system with dynamic modeling on all future workovers where a new intermediate barrier casing and liner string are necessary. **OE**

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***David Moran** is the SETC Advisor for Bit Selection and Real Time Optimization at Schlumberger. He has been in the role since 2010. David began working in the oil and gas industry in 1980, and joined Smith International in 1991. He has a BS in Geology from Skidmore College, Saratoga Springs, New York.*

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# Freeport-McMoRan in deepwater GoM

By Nina M. Rach

**F**reeport-McMoRan Copper & Gold (FCX) is one of the world's largest mining companies, but it is expanding its interests in North American oil and gas. FM O&G has about 1200 Houston-based employees, and has additional offices in California, Louisiana, and Texas.

FCX Executive Vice President and Chief Financial Officer Kathleen L. Quirk gave an update on 11 December at Macquarie Global Metals & Mining Conference, saying the Gulf of Mexico represents about 47% of the FM O&G's Q3 cash operating margin of US\$1.1 billion. Other areas are the Eagle Ford shale play (28%), California oil (23%), and Haynesville (2%). About 90% of FM O&G revenues are from oil and natural gas liquids.

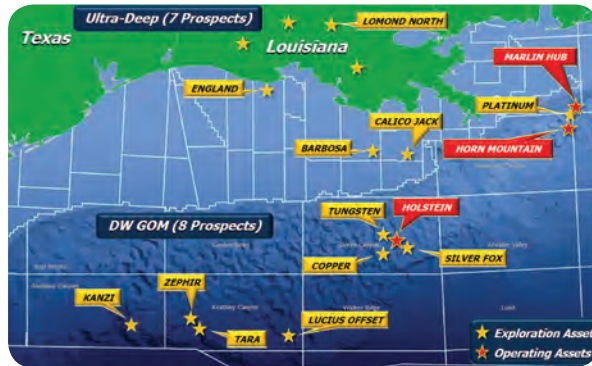
FM O&G is an active player in deepwater GoM, with current production of 59,600 boe/d in 3Q 2013, Quirk noted. FCX holds about 827,000 gross acres in the deepwater GoM (beyond 500ft water depth), and is involved in twelve deepwater projects, with a risked net resource of 318 MMboe (PV-10 \$6 billion).

**Operator** The company operates three properties: Holstein, in Green Canyon Blocks 644-645 (688 untested); Horn Mountain in Mississippi Canyon Blocks 127 (126-128-171-172 untested); and the Marlin hub, with Dorado in Viosca Knoll Blocks 915-959, King in MC 40-41-84-85-129, and Mercury in MC 41.

**Holstein** is produced from a 149ft diameter truss spar, installed in 4300ft water depth in GC Block 645. It has the capacity to produce 113,500 bo/d and 142,300 Mcf/d. Production began in December 2004.

The company is reactivating the Holstein platform rig for drilling in 2014 with production at Holstein Deep expected by early 2017.

**Horn Mountain** is produced from a 106ft diameter truss spar, installed in 5400ft water depth. It has the capacity to produce 75,000 bo/d and 72,000 Mcf/d. Horn Mountain is in the northeastern corner of Mississippi Canyon, adjacent to King and Mercury developments and to



**Near-term GoM deepwater & ultra-deep exploration prospects.** Image courtesy of Freeport-McMoRan.

Platinum in southeastern Viosca Knoll. Production from Horn Mountain Alliance is expected in late 2017, followed by Tango and Lion in 2018.

**Marlin Hub** - Marlin is produced through a dry tree and subsea production system and a tension-leg platform (TLP) installed in 3240ft water depth. It has a capacity of 60,000 bo/d and 235,000 Mcf/d. Marlin is directly north of the Dorado development in 4000ft water, Viosca Knoll Block 915, operated by BP.

Freeport-McMoRan holds acreage in two non-operated projects: Lucius, in Keathley Canyon Blocks 874-875-918-919, and Phobos, in Sigsbee Escarpment Blocks 39 (untested in 40, 83), just south of the southern boundary of Keathley Canyon.

Lucius has a thick Pliocene oil column, with "large upside Miocene potential," FM O&G says.

Operated by Anadarko, FM O&G touts the project as being on time and on budget. The Lucius truss spar was offloaded at Ingleside, Texas, in June 2013. The topsides have a processing capacity of 80,000-120,000 bo/d and 450,000 Mcf/d. First production from the Lucius development is expected by 2H 2014.

Phobos is a discovery made in April 2013, with 250ft (net) oil in Upper Wilcox, and upside potential in Lower Wilcox. It's a long-term project, with first oil slated for 2019.

**Prospects** The company has eight deepwater exploration prospects with risked net reserves of 242 MMboe: Kanzai, in Alaminos Canyon; Zephyr, Tara, and a Lucius offset in Keathley Canyon; as well as Tungsten, Copper, Silverfox, and Holstein in Green Canyon.

**Ultra-deep** Quirk says that Freeport-McMoRan has an "industry-leading" position in the emerging ultra-deep play in coastal Louisiana, from onshore to shelf to deep water, with an extensive inventory of large natural gas prospects. Drilling activities have confirmed the geologic model of the trend spanning 200 miles in shallow waters of the GoM and onshore in the Gulf Coast area.

Deepwater extensions of the Miocene trend are seen at Shenandoah-Kaskida-Tiber, farther out at Tahiti - Mad Dog in Green Canyon, and even further out, at Jack - Cascade in Walker Ridge.

The company plans to complete three ultra-deep wells in 2014:

- Blackbeard West #2 (69.4% WI) targets middle and lower Miocene and upper Oligocene, drilled from 79-ft water depth on the shelf in Ship Shoal Block 188. Production anticipated in early 2015.
- Lineham Creek (36% WI; onshore Cameron Parish); production anticipated in late 2015, early 2016.
- Davy Jones #2, in South Marsh Island (75% WI) is in shallow federal waters on the shelf; testing Wilcox and Tuscaloosa (Upper Cretaceous). Production anticipated in mid-2016.

**Expenses and forecasts** Operating costs for the Gulf of Mexico shelf and deepwater were \$14/bbl in 2H 2013, based on LLS/NYMEX pricing. Sales included about 57 Mboe/d, including 5 Mboe/d of natural gas liquids, and 84 MMcfd.

Quirk said the company's estimated capital expenditures in for oil and gas in 2013 will be US\$1.5 billion (June 1-Dec 31), rising to \$2.7 billion in 2014, and \$2.9 billion in 2015.

The company has the potential to double its production in the next five years, said FCX President and Chief Executive Officer Richard C. Adkerson at a management presentation in June 2013. **OE**





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# Longer lasting super-duplex

**Topsides corrosion and short life span issues, particularly in tropical waters, are being tackled with a super-duplex steel. Joseph Osta explains.**

Growing global demand for energy is driving oil and gas companies towards deeper wells in more exposed locations. Such environments subject offshore rigs and platforms to even greater threats of localized corrosion.

On offshore platforms, stainless steel tubing is used in process instrumentation, hydraulic lines, chemical inhibition and utility applications. Many of these applications are topside, and, in tropical waters, corrosion of ASTM 316L stainless steel tubing often occurs, primarily due to marine atmospheric corrosion.

The result is mostly pitting and crevice corrosion, often in inaccessible locations,

such as beneath clamps, support trays, and connections. Both pitting and crevice corrosion depend on chloride concentrations and moisture levels. They can be further exacerbated by surface contamination, caused by iron particles from welding and grinding operations, surface deposits from handling, drilling and blasting, and from sulfur-rich diesel engine exhaust. Even periodic testing of seawater firefighting systems can leave undesirable chloride salt deposits.

The normal lifecycle of ASTM 316L steels can exceed 100 years, in non-corrosive environments. Tests in environments



**Fig. 1: Sandvik super-duplex tubing.**

containing chloride have demonstrated that tubing made from ASTM 316L has a service life shorter than five years and, in some cases, less than one year.

This was based on field trials conducted in tropical waters by Shell, Swagelok, and BP, and laboratory testing by Sandvik.

Operational experience in tropical waters, such as the Gulf of Guinea and the Gulf of Mexico, has mirrored test results, with ASTM 316L tubing service life seen at less than five years. In some extreme cases, it can be less than one year.

One ASTM 316L test sample on a floating production, storage and offloading unit in the Gulf of Guinea showed severe signs of corrosion in small diameter tubing in several locations in the topside facilities, less than a year after the unit was moored in place. Low levels of Molybdenum (Mo) in ASTM 316L steels was a contributing factor.

This has serious implications, not least the potential for accidents, causing injury, or worse, due to sudden failures, as well as the potential serious damage to the platforms.

In topside process systems—consisting of various vessels, heat exchangers, separators and compressors—poor equipment life-spans pose a risk of sudden equipment failure, and may even lead to costly accidents.

Materials need to have resistance to stress corrosion cracking (SCC), pitting, and crevice corrosion in chloride-bearing environments, in order to be suitable for hydraulic and instrumentation tubing applications on offshore platforms.

Some companies are turning to corrosion resistant alloys (CRAs), ranging from grade 13Cr and upwards, as well as 6Mo austenitic steel types (containing 6% Mo), such as 254 SMO, AL-6XN, and alloy 625. These cost more than super-duplex steels, because they have higher levels of Ni and Mo, and there is lower market availability.

An alternative to CRAs are super-duplex steels, which have higher strength, enabling a reduction in wall thickness of tubes and pipes in hydraulic and instrumentation systems, reducing cost and weight.

Sandvik has developed a super-duplex

**Fig. 2: ASTM 316L stainless steel and SAF 2507 super-duplex tubing, installed side by side, with the ASTM 316 tubing showing extensive corrosion and the super-duplex tubing showing none.**



austenitic-ferritic steel, SAF 2507, which has a pitting resistance equivalent (PRE) value of 42.5, due to its chemical composition of 25% Chromium (Cr), 4% Mo, 7% Nickel (Ni) and 0.3% Nitrogen (N), compared to other steels (see Table 1). The 4% Mo gives it performance levels comparable to 6% Mo austenitic stainless steels like 254 SMO and AL-6XN.

SAF 2507 was designed for highly corrosive conditions and chloride-bearing environments. It has high mechanical strength, with weight savings of up to 50% over standard steels.

Its ability to endure long equipment durations was

shown in a two-year long test, alongside ASTM 316L, in the Gulf of Mexico.

The ASTM 316L experienced heavy corrosion in the tests. No signs of corrosion were detected in the super-duplex tubing.

## Pitting and corrosion comparison

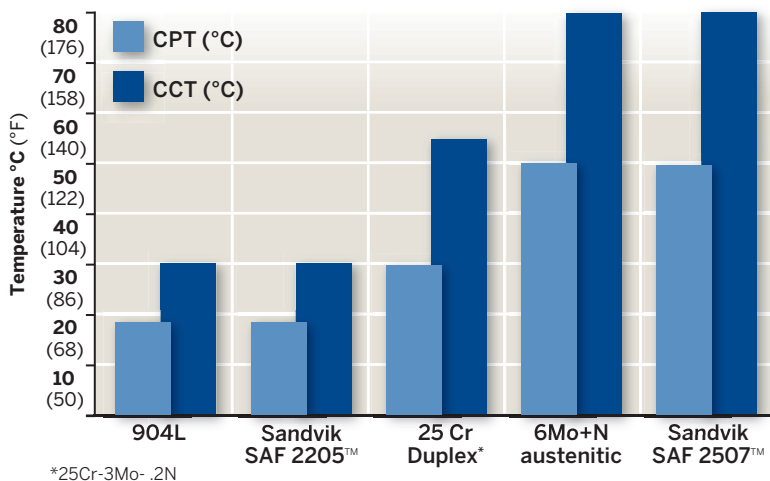


Fig. 4: Critical pitting temperature (CPT) and critical crevice corrosion temperature (CCT) in 6% FeCl<sub>3</sub>, periods of 24 hrs - ASTM G48 modified: ASTM G48 is the most commonly employed standard for testing materials resistance against pitting and crevice corrosion, aiming the comparison of the materials by performance classification. The nominal values for Sandvik SAF 2507 are CPT = 80°C (176°F) and CCT = 50°C (122°F), according to ASTM G48A and G48B respectively.

The super-duplex tubing's mix of austenite and ferrite provides a minimum proof strength of 550 MPa (N/mm sq)—nearly twice that of high-alloy austenitic steels.

SAF 2507 has also been tested using

organic acids, to compare it to high-alloy austenitic stainless steels and nickel alloys in topside applications.

Testing over two years to compare corrosion rates of ASTM 316L and SAF 2507 was performed in 80% acetic acid, with 2000 ppm chloride ions at 90°C (194°F). The results showed ASTM 316L has a corrosion rate of up to 1mm/year in such conditions, compared with roughly 0.01mm/year on super-duplex stainless steel.

Tests for pitting corrosion were carried out, in accordance with industry-recognized criteria, including American

Society for Testing and Materials (ASTM) G48. Samples were immersed in a highly corrosive 6% FeCl<sub>3</sub> (iron chloride, or ferric chloric) solution, high in chloride ions and oxidizing ferric ions.

After cleaning, the samples were weighed and inspected for pitting. Figure 2 shows Sandvik SAF 2507 compared to standard steels in chloride-heavy environments (Figure 3).

The PRE is calculated from the level of Cr, Mo and N present in an alloy,  $PRE = \%Cr + 3.3\% Mo + 16\%N$ .

For offshore applications the common specified minimum PRE number is 40. ASTM 316L and its variants, like ASTM 317L, have maximum PRE numbers of 27.9 and 34.8 respectively. Sandvik SAF 2507 has a minimum PRE of 42.5. Other 25Cr type duplex stainless steels, that are not super-duplex, have insufficient corrosion resistance. For example, UNS S31260, has a PRE number of 33.

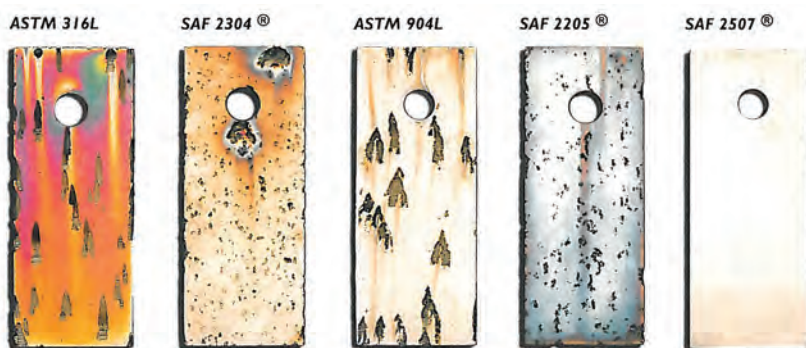


Fig. 3: Test samples after pitting corrosion tests in accordance with American Society for Testing and Materials (ASTM) G48.

	Composition Ranges								PRE	
	Cr		Mo		W		N		Minimum	Maximum
AISI 316	16	18	2	3	-	-	-	-	22.6	27.9
AISI 316L	16	18	2	3	-	-	-	-	22.6	27.9
AISI 316, >2.5%Mo	16	18	2.5	3	-	-	-	-	24.3	27.9
AISI 317	18	20	3	4	-	-	-	0.1	27.9	34.8
AISI 317L	18	20	3	4	-	-	-	0.1	27.9	34.8
Alloy 20	19	21	2	3	-	-	-	-	25.6	30.9
Alloy 825	19.5	23.5	2.5	3.5	-	-	-	-	27.8	35.1
22Cr Duplex	22	23	3	3.5	-	-	0.14	0.2	34.1	37.8
25Cr Duplex	24	26	3	5	-	-	0.24	0.32	37.7	47.6
Al-6XN®	20	22	6	7	-	-	0.18	0.25	42.7	49.1
254 SMO™	19.5	20.5	6	6.5	-	-	0.18	0.22	42.2	45.5
Alloy 625	20	23	8	10	-	-	-	-	46.4	56.0
Alloy C276	14.5	16.5	15	17	3	4.5	-	-	69.0	80.0



**Jospeh Osta** is product manager for hydraulic and instrumentation tubing at Sandvik. He was previously in business development at SMT, and before that worked at Sandvik Coromant on marketing communications and planning. An Economics graduate, he gained his masters in international marketing and business at the University of Gothenburg in 2002.

# Using RFID technology to improve offshore logistics



**A stainless steel identification plate, and a drill pipe tag fitted with RFID.**

Photos courtesy of Trac ID Systems AS.

**RFID is nothing new, but companies are adopting the technology in hopes of streamlining the way they do business offshore.**

**By Audrey Leon**

Offshore logistical operations can be complicated. Companies need to keep tabs on all equipment and products necessary to keep exploration and production moving. Operators and service companies such as Brazil's Petrobras and Schlumberger are contemplating ways in which to simplify the process of tracking assets locally and around the globe. One such topic up for discussion at OTC Brazil was RFID (radio frequency identification) technology, and its applications in the warehouse and out in the field.

"Twenty years ago people didn't know what RFID technology was. People are still into barcodes, but not RFID," says Martin Swerdlow, managing director of UK-based Tracked Assets Ltd. The primary role of Swerdlow's company is to support adoption and implementation of RFID technology. He says it can take anywhere from 24-48 hours before deliveries can show up in the stock file. "How do I know the stock file reflects

what I know is in the yard," he asked. "Logistics represents a need for real-time intelligence."

Swerdlow told the panel that RFID cannot replace barcodes and enterprise systems such as SAP and Oracle, but RFID tags can centralize control of physical processes with little localized real-time process visibility, monitoring, and decision making.

"RFID & RTLS (real-time locating system) can provide an effective and proven real-time bridge and report actual process events as they happen," he says. "The result: cost-effective and accurate localized decision-making, reduced time latencies, and enhanced business intelligence.

"Barcodes are very accurate. On the other end of the spectrum, GPS relies on satellites and depending on what kind of user you are, you can get accuracy down to 1m. It can tell you what side of the street you are. The difference between barcodes and RFID, barcodes read one at a time; RFID is a class of technology that allows you to read multiple sets of data. You can change information."

Swerdlow mentioned a case study regarding Petrobras's RFID showroom and innovation center, which has RFID hardware installed. "The hardware shows how goods can be received, inspected, and tagged, as well as how to pick operations for customer orders, and dispatch," he says. "The technology then is able to search on warehouse shelves for where particular orders are. The showroom brings together in one location, RFID technology and applications that can be applied throughout Petrobras operations. It provides training as well as development and testing of new RFID-enabled processes in Petrobras' business."



**Speakers from Petrobras, Schlumberger, Tracked Assets Ltd., NorSea AS, and X2X Maritime AS, appeared at a panel on offshore logistics at OTC Brazil in Rio de Janeiro.**

Photo by Audrey Leon.



## Petrobras

Nathalia da Silva Sena, technical consultant, Petrobras, presented some of the challenges Petrobras has to deal with in terms of meeting E&P demands. With continued growth in both the Santos and Campos basins, Petrobras has to meet both long-distance and infrastructure challenges, all the while deciding how to best utilize the equipment the national player already has. Petrobras transports 93,000 passengers per month using 155 helicopters, da Silva Sena says.

"Platforms and oil rigs are far from the coast," da Silva Sena says. Petrobras is in need of both bigger helicopters and boats, which are spread, causing difficulties, she says. Another challenge is infrastructure. "In the Campos, we don't have a lot of available infrastructure to support activities. In [the] north and northeast, it is difficult to get [it]." Da Silva Sena says Petrobras is currently working on projects to improve these issues.

## Schlumberger



Schlumberger's Brazil research & geoengineering center. Photo courtesy of Schlumberger.

Mario Faria, vice president for Shared Services, Latin America, Schlumberger, discussed the global service company's transition toward RFID technology. "The challenge has not only been the technology, but adoption of [it] by our own operators," he says. "The process is completely integrated and simple to utilize. It ends up on the shop floor integrated with repair and maintenance."

Schlumberger, Faria told the audience, has 37 manufacturing and research facilities around the world, including one in Rio de Janeiro, where OTC Brazil was held. Faria said Schlumberger reorganized itself internally with one common platform, "one umbrella" that hosts multiple functions. "The idea is the whole is larger than the sum of its parts," he says. "By combining the parts, we can give much better response to the market. We can improve scalability and manage cycle."

The challenge, Faria says, is coupling the largest centers and delivering to the rig site. "We want to do this in a seamless, efficient way."

Schlumberger has 150,000 mobile assets, 2,500 facilities, and 125 research and engineering centers. Additionally, the company makes approximately 80,000 shipments per month, conducts 150,000 transactions per day, and works with 80,000 suppliers, according to data supplied by Faria at OTC Brazil.

"We are tagging those 150,000 high value assets. We know when they are producing, when they are offline, producing revenue, down for parts, or not performing to standard," Faria says. "This is a massive effort, worldwide."

To do all these transactions, Schlumberger is backed by 800 IT connected wellsite units, and 27 petaflops of computing power, Faria says.

For some assets, Schlumberger deploys GPS for tracking that is intertwined with a fleet management system, Faria says. "For those high-dollar, high-risk operations, we deploy more sophisticated technologies."

Faria says that, with regards to integrating all this new technology into Schlumberger's business, the hardware is not the major hindrance. "The system's integration element is significant. Many companies our size have many different systems, many different flavors, and different languages," he notes. "The hardware is easy compared to the last part, which is change. We want 50,000 employees to change their routines of the past few years – that's

a major challenge. The size of the challenge is enormous, but so is the benefit."

## The NCS and Brazil

Bjornar Aas, CEO X2X Maritime AS, used his presentation to compare Brazil's offshore challenges to that of the Norwegian Continental Shelf (NCS). "There is a major lack of supply chain visibility in the offshore logistics at the NCS," Aas says. "This leads to inefficiency, lack of control, and has a negative impact on both cost and HSE."

The logistical challenges (in Brazil) are basically quite similar to NCS, he said. The operators' goals are basically similar. The size of (Petrobras') operations are larger, but the savings and benefits should be larger.

In 2007, Aas noted, the Norwegian Oil and Gas Association (formerly OLF) came together to issue guidelines regarding RFID technology implementation. Guideline No. 112 (Part 1-9) dictated what kind of RFID equipment a supplier should choose. "The first step in this history was a common agreement on technology," Aas says. "The kind of readers, RFID tags, and how can it be packaged, and put on forklift."

Aas said implementing RFID technology shouldn't be looked at as a one-company-only solution.

"This is not a Statoil solution," he says. "This is an industry solution." **OE**



An offshore rig near Sugar Loaf mountain offshore Rio de Janeiro.

Photo by Claudio Paschoa.

# Extending umbilical life

**Viper Subsea's V-LIFE is increasing insulation resistance to extend subsea systems' life expectancy.**

By Neil Douglas,  
managing director, Viper Subsea

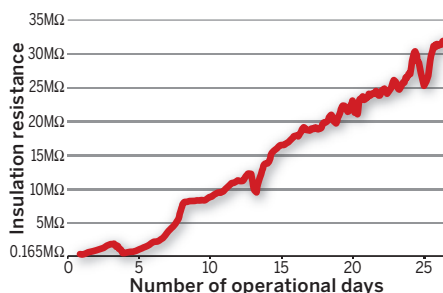
It is well understood that water and electricity don't mix well. Since the advent of electro-hydraulic control systems, this fact has presented an ongoing challenge to subsea engineers as they try to ensure electrical conductors within cables and connectors are kept dry for the design life of subsea production systems.

Design, quality, manufacturing, and test processes have improved over time. However, the industry still has to work with the legacy of installed equipment that was designed and manufactured some time ago. If sea water penetrates electrical insulation barriers, operators face an expensive problem, as well as a potential safety issue.

The introduction of sea water into the electrical cables and connectors causes a reduction in insulation resistance (IR), which nearly always continues to deteriorate to a point where a complete failure occurs. Such a failure could potentially lead to loss of production.

Seabed-based components form part of the subsea distribution system

## Improved resistance



**Insulation resistance increased during testing.**



susceptible to water ingress, include subsea umbilicals, distribution units, electrical connectors, and flying leads. All of these are used to transport electrical power and communication signals from a surface facility to the subsea production equipment.

Along with the potential loss of production, failing insulation resistance can also mean extra electrical hazards for technicians working on topside electrical power units.

Previously, in the event that sea water penetrated electrical cables, there was no alternative to a costly subsea intervention to fault find and replace failing equipment.

Viper Subsea has been working on a solution to overcome the effect of water penetration. V-LIFE uses a combination of dynamic electro-kinetic and electro-chemical processes to reverse the effect of water penetration into or through electrical insulation material. It is connected to the umbilical at the topsides only, which means installation requires no subsea intervention.

The outcome is an increase in the insulation resistance of electrical distribution components, which increases life expectancy on failing equipment.

V-LIFE is designed to be compatible with all ageing and new subsea production control systems, including those operating with both separate power and communications networks, and systems where communications are superimposed on the power.

The V-LIFE unit automatically logs various system electrical parameters

and diagnostic data, with accurate real time IR measurements, down to <1Kohm, and line current and voltage measurements.

To maintain their efficiency, data from the units is periodically analyzed, and configuration updates carried out on the installed units.

V-LIFE underwent a field trial on a North Sea field with known IR problems. The field trial started in July 2012, and the IR was increased from less than 50kΩ to 25MΩ in less than two months.

The unit remains operational, with the IR being kept at a high level and has been independently verified.

Centrica Energy's exploration and production business was one of the first companies to commercially use V-LIFE. Centrica's Birch, Larch and Sycamore wells, located in the UK North Sea, are all tied back to the Brae Alpha platform via a single subsea umbilical. These had been shut-in, having experienced some electrical power problems with the control system.

Centrica used V-LIFE to improve the electrical insulation on the umbilical. The IR has been increased by a factor of more than 200. This increase avoided the need to procure and install a new umbilical. Production has since increased from the Birch and Sycamore Fields and safety has been improved.

V-LIFE has since been adopted by a number of other North Sea operators to extend subsea equipment life expectancy, postpone early field abandonment, negate the need to install new umbilicals, or to increase technical margins to improve operability and safe working of production control systems.

To date, it has a 100% success rate in increasing IR.

Details of the exact technique used remains confidential, as patent is pending and has not yet been published. V-LIFE has been verified by an independent UK University. **OE**



**Neil Douglas is the founder and managing director of Viper Subsea. He graduated with an electronics degree from Bristol University before joining GEC Marconi.**

**He served as global technical director for GE Oil & Gas before leaving to co-found Viper Subsea in 2007.**





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# JIP addresses subsea wellhead monitoring

**Bernard Herman van Bilderbeek, CEO of Plexus Group, explains how its friction-grip technology can be applied to subsea wellheads**

Since early 2000, the US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the Minerals

Management Service (MMS), has considered the impact of sustained casing pressure (SCP) on the safety of offshore operations in the Gulf of Mexico.

A detailed survey of operations disclosed that the vast majority of surface wells at some stage experience SCP, and in 2002, the MMS concluded that if such incidence occurred on platforms, then the same things must be happening subsea. However, the fact remains that subsea wellheads – although similar in design to unitized surface wellheads – do not have outlet valves

through which events in the various casing annuli can be monitored.

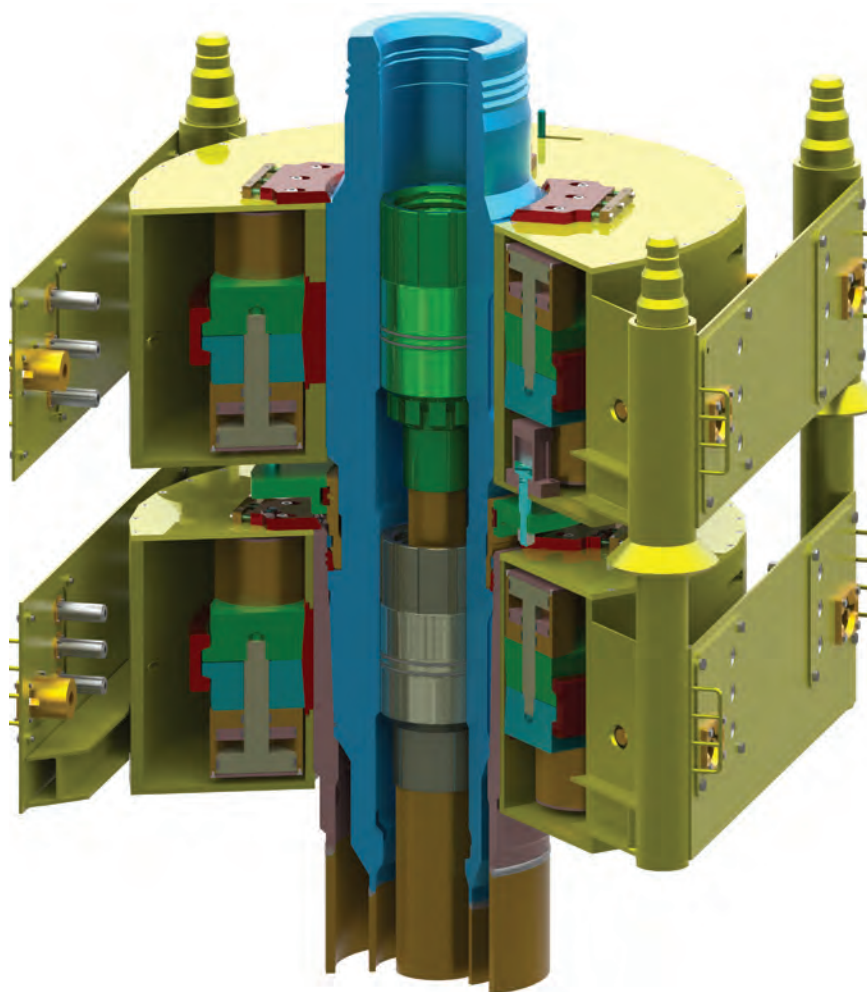
Effectively, subsea wells are “out of sight, out of mind” where it comes to annuli, and as a result, the MMS did not have data to back up its supposition. The agency did conclude that SCP is a threat to operations and the environment, and statistics show that it has a point. In 2002, the MMS asked US operators to do something about subsea annulus management. After years of “toing and froing,” it was concluded that the available solutions were too complex, involved too many additional risks, and were too expensive in the long term. The MMS abandoned the project in December 2005. In its final report, it lamented that subsea monitoring would only come about through regulator intervention.

Fast forward to 2013, and suddenly, at least in the UK, the quest to stop “flying blind” is once again rearing its head in the form of a call for solutions by UK industry organization ITF.

Following Macondo, Plexus Holdings was asked by a group of operators to study the application of its patented friction-grip technology to subsea wellheads. As a direct result of this inquiry a joint industry project (JIP) was formed, supported by major operators, including Shell, Wintershall, E.ON, Total, Tullow and Maersk. The project is now 18 months underway with the aim to come up with a new approach in wellhead engineering, focused on addressing the systemic shortcomings of conventional subsea wellhead techniques, as exposed by Macondo.

The problem is the limited amount of energy one can remotely deliver subsea through the drill string from thousands of feet away. Ten thousand feet of drill pipe feels like a rubber band and inside the bore of a wellhead space is limited. Yet an enormous amount of energy is needed to clamp moving parts together and to energize metal seals so that well forces

**A POS-GRIP clamp can be configured to squeeze the outer pipe so that it grips the smaller pipe inside.** Image courtesy of Plexus Ocean Systems Ltd.





cannot cause hangers to move and seals to fail over time.

On the surface HPHT wells mainly use wellheads that are clamped together so that the force generated between inter-connecting flanges can be used to hold things firm.

This approach cannot be done subsea, where loose fitting lock rings, often a source of trouble, are used to hold things together.

A better way was necessary, and thus, the HGSS subsea wellhead JIP came into being.

From the start, the project was designed to solve the subsea casing hanger lockdown problem. With Plexus friction-grip technology far more energy is available than required, even subsea.

The technology uses massive hydraulically power rings on the outside of the wellheads, which crimp the wellhead body inwards until it grips and seals the casing hanger and holds the casing. This arrangement is instant and timeless, as fit cold welding the pieces together, although it happens within the materials elastic range and is fully reversible.

Simple, releasable, rigid and most importantly reusable, which is the technology can be used to solve the perennial subsea annulus access conundrum.

In fact, Plexus is so sure about the feasibility of its system that it made subsea monitoring, bleed-off and remedial capability one of the ultimate goals of the HGSS JIP. The solution works as follows; porting is provided past the casing hanger and internal to the wellhead body. As these ports terminate above the casing hanger in the wellhead bore a seal sleeve, similar to a wear bushing, is located across the ports in an area of the wellhead that can be shrunk inwards with the externally fitted POS-GRIP® gripping rings. Once fully energized, the seal sleeves provide metal-to-metal bump seals on either side of the monitoring port gallery. All this is done within the elastic range so that, once released, the sleeve can either be retrieved or moved down (Plexus is still working on this one); the ports can be directed into the subsea tree, through the tubing hanger, thereby allowing a continuous peek in the B and C annuli, depending on requirements. **OE**



**Bernard Herman van Bilderbeek** is Chief Executive Officer of Plexus Group. He has more than 35 years' experience in engineering and management roles

and previously held senior positions with Vetco Offshore Industries, Dril-Quip, and Ingram Cactus.

In 1986, he founded Plexus and went on to merge the wellhead division of his company with Ingram Cactus, where he became President Eastern Hemisphere.

In 1996, van Bilderbeek regained the Plexus Ocean Systems Ltd. name through which POS-GRIP technology was invented, developed, and commercialized for the oil services wellhead equipment market.

Van Bilderbeek earned a BS in Mechanical Engineering from Southern Methodist University in Dallas.



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# Ultrasonic in-line inspection enhances deepwater pre-commissioning

**A topside pipeline launcher receiver at Tamar**  
Photo courtesy of Weatherford

**New technology improving baseline survey accuracy was required to respond to challenges associated with Israel's Tamar project.**

**By Mark Slaughter, Weatherford**

The cost of deepwater pipeline repair makes inspection accuracy critical to assessing pipeline integrity. Advanced ultrasonic wall measurement (UTWM) technology was recently used to achieve a new level of baseline survey accuracy in a Mediterranean pipeline project. Conducted in conjunction with pre-commissioning operations, the in-line inspection (ILI) also helped eliminate logistical and scheduling constraints for overall project success.

These deepwater operations are logistical and technical challenges that typically require a significant amount of vessel time, support, and budget. For the Tamar pipeline project, a new Weatherford solution was successfully executed using ultrasonic in-line inspection tools and specialized subsea

commissioning technology to mechanically displace and introduce pipeline fluids.

## **Deepwater challenge**

The long-distance, deepwater Tamar pipeline project for Noble Energy is a subsea gas production and transportation system that connects the deepwater gas field in the Mediterranean Sea to an offshore receiving and processing platform linked to the existing Mari-B Platform.

Gas in the Tamar field comes from five high flow rate subsea wells produced through separate infield flowlines to a subsea manifold. Dual subsea pipelines transport production from the subsea manifold approximately 149km to the Tamar Offshore Receiving and Processing Platform. The processed gas is delivered



to the existing Ashdod Onshore Terminal (AOT) for gas sales into the Israel Natural Gas Line (INGL).

Weatherford's Pipeline and Specialty Services (P&SS) group was contracted to provide the pipeline pre-commissioning and inspection, including tieback pipelines, monoethylene glycol (MEG) pipelines, infield flowlines, gas and condensate injection pipelines, Tamar sales gas export pipeline and utility pipelines. Integrating these services through a single contractor was key to reducing logistical and scheduling constraints for overall project success.

The Tamar project's challenges and solutions involved subsea flooding, testing and MEG injection; dewatering, MEG conditioning and nitrogen purging; and base-line inspection of the system's 16-in. tieback. The inspection was successfully conducted using Weatherford's latest generation of highly accurate UTWM tools.

Pre-commissioning operations were successfully conducted using Weatherford's Denizen subsea pre-commissioning system. Flooding, cleaning, and gauging the twin 147km x 16in. pipelines were completed from a vessel at the shallow end of the 240m to 1700m water depth run.

In-line inspection surveys were conducted during the flooding operations. A caliper tool was pumped to verify minimum bore, followed by a UTWM tool for the wall thickness baseline survey. After the inspection, dewatering operations were conducted for all 5 km of the Tamar in-field and tieback pipelines.

Tight scheduling constraints for the subsea launch presented a challenge for the 16in. UTWM in-line inspections. Normally, there would have been sufficient battery life to run the inspection tool. However, in this case, the time needed for a subsea launch required a delayed activation.

The ILI tool first had to be inserted into the pipeline launcher receiver (PLR) onboard the vessel. A vessel crane moved the launcher with the ILI tool to the pipeline end manifold (PLEM) and a hydraulic lock secured the pipeline end termination (PLET) to the pipeline. An ROV was used to turn the subsea valves and launch the pig.

The time consuming process increased the risk of delays that could drain battery life and cause a failed run. To account for the time and unforeseen delays, a two-hour window was built into the schedule. This resulted in a 12-hour delayed activation from the time the tool was inserted into the PLR on board the vessel. The delay was programed into the system and the inspection was successfully conducted.

### Ultrasonic inspection

Non-destructive ultrasound testing has been used for in-line inspection since the 1980s. The technology measures wall thickness based on ultrasound compression waves directed into the pipe wall. Ultrasonic transducers positioned 90° to the pipe wall use an impulse-echo mode to transmit an acoustic wave and receive return echoes. The echoes represent the locations of the internal and external pipe wall, and other metallurgical anomalies such as laminations.

A UTWM baseline inspection identifies and classifies non-injurious signals such as mid-wall laminations and other mill-related anomalies; a baseline corrosion survey provides wall loss sizing data. Greater accuracy is important when assessing anomalies, assigning risk, and prioritizing maintenance and expenses. Accurate anomaly classification and sizing is particularly valuable

when comparing baseline data to future inspection results and integrity measures such as engineering assessments and determining growth rates. For deepwater subsea lines, where normal onshore non-destructive examination (NDE) validation practices are cost prohibitive, accuracy is key to managing costs.

Compared to magnetic flux leakage (MFL) tools, ultrasonic technology yields better sizing accuracy in determining wall loss and pipe wall thickness. This is because ultrasonic pulse echo physics are a more direct measurement of wall loss. But in some cases, MFL is a better solution because it can be more forgiving of dirt, debris, rough internal pipe surfaces, and waxy liquids. This necessitates a comprehensive pre-inspection assessment prior to selection of the appropriate technology.

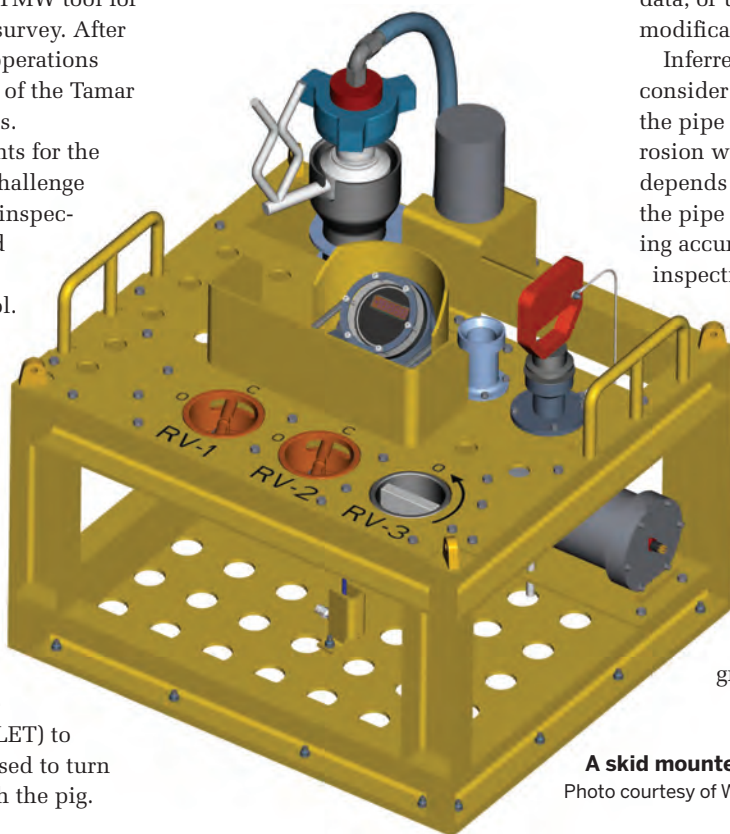
### Accuracy is important

Accurate measurement of wall thickness directly influences the calculation of a corrosion feature failure pressure. MFL tools do not typically measure wall thickness but instead infer it from several sources, including API pipe specification, pipeline construction data, and/or estimated variations in the magnetic field. This provides only a relative assessment due to pipeline data inaccuracies, or difficulty in obtaining data because of asset ownership transfers, unavailable data, or unrecorded pipeline reroutes and modifications.

Inferred measurements also do not consider wall thickness tolerances from the pipe mill. As a result, an MFL corrosion wall loss depth measurement depends on a relative measurement of the pipe wall, which decreases the sizing accuracy beyond the normal in-line inspection (ILI) tool sizing tolerance, because in addition to tolerances associated with tool anomaly sizing, there are also tolerances associated with the actual pipe spool wall thickness from the mill.

Acceptable tolerances from the mill can be as high as  $\pm 10\%$  for pipe wall thicknesses between 5 mm and 15 mm in welded pipeline.

Tolerances for pipe walls greater than or equal to 15 mm



**A skid mounted remote logger**

Photo courtesy of Weatherford



**Nitrogen dewatering spread**  
Photo courtesy of Weatherford

are  $\pm 15\%$  in welded pipe. These pipe mill tolerances and the high corrosion-anomaly sizing tolerances of an MFL tool mean the calculated failure pressure from

an ILI survey can be significantly over or under as the result of sizing inaccuracies caused by quantifying depths as a percentage of the assumed wall thickness.

Greater corrosion sizing accuracy also provides better data to feed an assessment standard, such as B31G, modified B31G, or RSTRENG effective area assessment, the preferred method for determining the remaining strength of the pipe. Of the three, RSTRENG effective area assessment has the most accurate results based on actual versus predicted burst pressure tests.

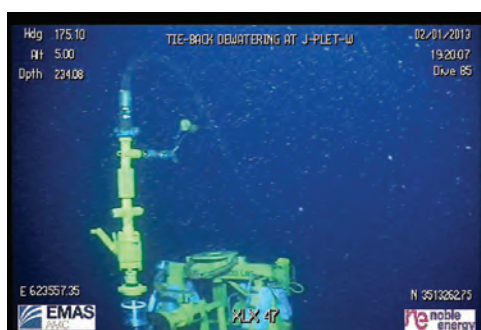
New sensor technology in current Weatherford UTWM devices helps enhance detection and accuracy capabilities to limit the occurrence of echo loss due to adverse pipeline conditions. This loss has been demonstrated over many years of experience.

Engineering tests and field work data analysis to API 11636 standards have shown the new sensor technology improves sensitivity and reduces signal degradation. The advance is critical to achieving successful deepwater subsea baseline surveys. The same sensor technology is used for in-line crack inspection with accurate sizing results that can

be used for API 5797 integrity assessment methodologies.

### Deepwater inspection solution

Deepwater in-line inspection using ultrasonic technology provided the Tamar project with the accuracy demanded for subsea operations. Conducted in concert with the pre-commissioning, the inspection ensured pipeline integrity while helping to achieve high levels of logistical and scheduling efficiency. **OE**



**Top: Denizen flooding and MEG skids subsea.**  
**Bottom: Downline connection to subsea manifold.** Photos courtesy of Weatherford.



**Mark Slaughter** is Pipeline and Specialty Services Global Product Line Manager, In-line Inspection at Weatherford in Houston. He has 24

years in the oil and gas industry with expertise in Product Line Management. Slaughter earned a Bachelors of Business Administration, Accounting and Information Systems at The University of Texas at San Antonio, and an MBA from University of Texas at Tyler.





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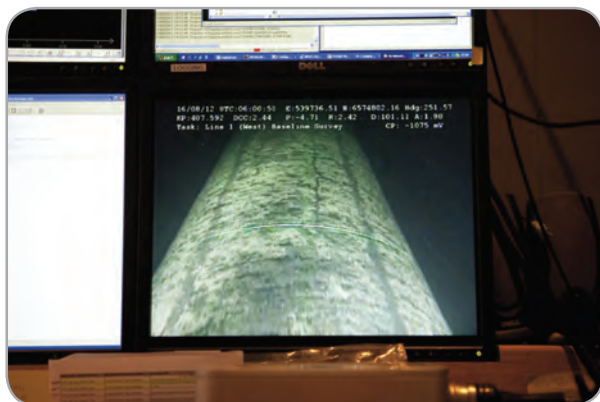
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# Nord Stream PIG run sets records

**The longest pig run was performed along the Nord Stream pipeline between Germany and Russia last year. Elaine Maslin found out more.**



At 1224km (759mi.) long, the Nord Stream's twin offshore pipeline gas transportation system from Russia to Germany, through the Baltic Sea, offers its operator a number of challenges. One of those is inspection. In 2013, for the first time since the pipelines became operational in November 2011, and October 2012, respectively, operating company Nord Stream AG carried out an internal inspection along the full length of the lines.

Pipeline-specific equipment had to be built for the inspection, which was recorded as the longest run performed by a pipeline integrity gauge (pig).

The internal inspection set a world record, in terms of length and

**ROVs carry out external inspections of the pipeline.**

thickness of pipe walls (up to 41mm) to be analyzed.

The inspection means Nord Stream now has baseline data to confirm the quality of the Nord Stream pipeline building process, and provide a data set, against which all future inspection results can be compared.

Andrey Voronov, offshore manager operations, Nord Stream, said: "Never before has a pipeline with the similar dimension been 'pigged:' two 1224km-long 48-in.-diameter pipelines with wall thicknesses up to 41mm and up to 110mm of concrete coating around it. Both the length and the thickness are unique and posed engineering challenges for which our inspection team and our partners at Rosen Group had to find solutions."

Inspection, as part of integrity management measures for the system, was part of the pipelines' design from the start, says Nord Stream.

Integrity management measures on Nord Stream cover its automation systems, landfall installations, and





**Arrival of the inline inspection tool at Lubmin, Germany.** All images: Courtesy of ROSEN Inspection Technologies.

the 1224km offshore section of the twin-pipeline.

The offshore section runs from Vyborg, Russia, to Lubmin, Germany. Each pipeline is made up of about 100,000 concrete segments, each around 12.2m-long, with a constant 1153mm inner diameter.

The pipes are made of 41mm-thick, high-tensile steel, with an internal anti-friction coating—a two-component epoxy resin, which increases flow capacity by reducing friction—and an external anti-corrosion coating.

### Inspections

An external visual and instrumental inspection was carried out by remotely operated vehicles (ROVs) operated from support vessels.

For the internal inspection, three different tools were sent through the pipeline, propelled by the gas flow.

All three were designed and built by

Germany's ROSEN Group, specifically for Nord Stream. They are: a gauge tool, a cleaning tool, and an in-line inspection tool, which maps potential corrosion and metal loss, as well as the exact curvature of the lines via an inertial navigation system.

Before its use on Nord Stream, each tool underwent extensive testing, which included the inline inspection tool being tested on a similar, shorter, 48-in. pipeline in Malaysia.

### A pig run

The inspection process started on the first pipeline on July 1, 2013. The gauge pig, like all the other pigs, started its run at the Landfall Facilities Russia (LFFR), at Portovaya, by being inserted into the line via a pig launcher.

The gauge tool, at 2.2m-long and weighing 1.5-tonne, is used to detect substantial anomalies of the internal diameter along the pipeline, which may potentially obstruct the inline inspection tool during its run. The gauge tool's aluminum plates are designed to detect any anomaly starting at 3% (35.5mm or 1.4-in.).

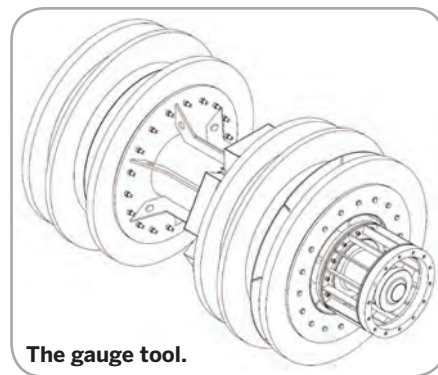
Any protrusion would chip away at the gauge plate, with the damage later analyzed to determine the extent of the potential obstruction.

The gauge tool took five days to travel with the gas flow to Germany, where it was retrieved. The plates were found to be undamaged, which indicated that the pipeline had not experienced any mechanical impact since construction.

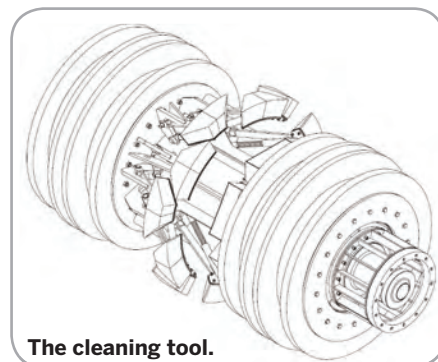
### The cleaning tool

At 2.6m-long and weighing 1.8-tonne, the cleaning tool removes any dust or particles of coating material from the pipeline's insides that may have accumulated or become loose.

It has brushes, to pick up dust particles. The dust is also pushed ahead



**The gauge tool.**



**The cleaning tool.**

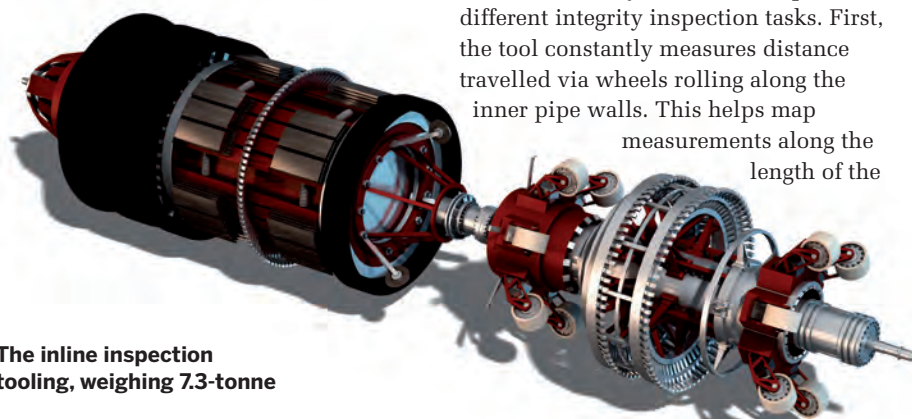
in front of the tool by sealing discs sized larger than the pipeline's interior diameter. "Differential pressure is used in order to guide an amount of natural gas through the cleaning tool body to the very front where nozzles create a flushing effect. This setup is comparable to a pressure washer on a dry basis," says Nord Stream.

The cleaning tool run also took five days. The tool was then cleaned, with the material collected on the run analyzed. Results from the tool confirmed the pipeline was clean. The amount of the material collected during the internal inspection program was small, as expected, and a second run was not required.

The inline inspection tool

The pipeline was then prepared for the 7.3-tonne, 6.3m-long inline inspection tool to be sent through.

The inline inspection tool is also called an intelligent combo tool, because it combines arrays of sensors to perform different integrity inspection tasks. First, the tool constantly measures distance travelled via wheels rolling along the inner pipe walls. This helps map measurements along the length of the



**The inline inspection tooling, weighing 7.3-tonne**



**The inline inspection tool arrives at Lubmin, Germany.**

pipeline. The tool works best at a speed of 1.5m/sec. A speed control valve is mounted to the front of the tool. It allows the regulation to a preset tool velocity in order to optimize measurement conditions independent from the gas flow. A high-density memory device is used to record during the inspection, for later analysis.

An internal diameter (ID) mapping caliper detects and characterizes any deviations from the original pipe shape, some even smaller than 1mm. Internal diameter changes, ovalities and dents, will be detected, localized and identified. The tool is also able to detect and map any misaligned welding joints.

The sensors function by measuring incremental changes in how far any of the spring-loaded caliper arms that guide the sensors along the pipe wall are bent when the sensors run through even very small dents or ovalities.

The inline inspection tool is able to detect variations in the pipeline manufacturing process to a sub-millimeter level (below 0.04-in.) and provides a very accurate baseline for future inspections.

At the end of July, the inline inspection tool was received at the German Landfall Facilities, after a run time of 10 days.

The recorded data on the tool was retrieved and sent to post processing and a three-stage analysis. The inline inspection tool was then completely

refurbished by Rosen and taken by land back to the Russian Landfall Facilities to start its run down the second pipeline.

Inspecting the second Nord Stream pipeline with the three tools started mid-August, and was finished at the end of September.

Nord Stream believes the data from the inspection tool is the longest data set from an inline inspection ever recorded. With more than 2000 measurement channels and one sample recorded every 2.5mm over the pipeline length of 1224km, each tool arrived in Germany with more than 1,000,000,000,000 (1012), or more than one trillion, data samples.

Data sets recorded in both lines are being evaluated. Preliminary results have shown the pipelines are free of any corrosion spots or deformation.

Corrosion was not expected during the operation of the pipelines. Gas going through them is constantly measured at the inlet, to exclude contamination from water. The internal flow coating seals the steel from potential corrosive influences.

The inline inspection tool also has a shallow internal corrosion sensor, consisting of a proximity sensor attached to the caliper arm, which can map surface metal loss defects. Small defects on the surface of the inner pipe wall change the sensor's proximity to the pipe wall, which the sensor is measuring.

A magnetic flux leakage sensor detects any material loss or corrosion in the steel, or between the steel and the outside concrete coating. A strong magnetic field magnetizes the pipe wall and an electromagnetic sensor records any changes in magnetic feedback from the pipe steel through its entire 41mm thickness.

Nord Stream believes this is the strongest magnetic field ever developed for an inline inspection tool: even inside a 41mm pipeline joint, it creates a magnetic field leaking out to 6m (approx. 20ft.) distance.

An inertial navigation system, or XYZ-unit, on the inspection tool, maps the pipeline's geometry, to detect any incremental movement in the pipeline that could result in bending strains. The tool measures the strain placed on the inertial gyroscope sensor when it traverses a curve in the pipeline.

It was used together with information from the external inspection, and confirmed that the twin pipelines shifted only marginally after operating under pressure.

An inline inspection is now scheduled to take place every few years on the Nord Stream pipelines, to confirm the absence of corrosion or mechanical defects, with reference to the extensive baseline data now gathered, including its geographical coordinates. **OE**



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(check one box only)

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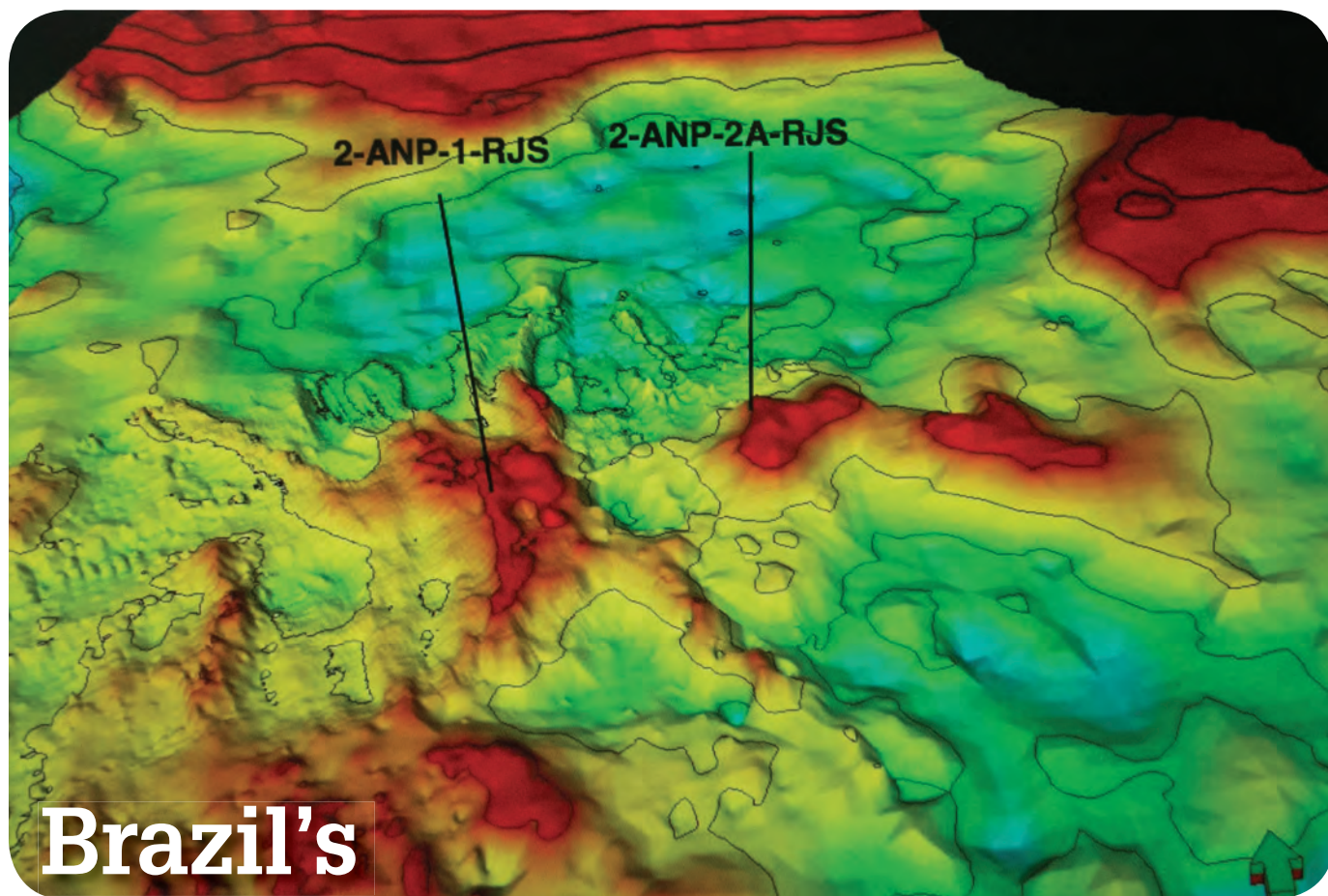
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# Brazil's 1<sup>st</sup> pre-salt auction

**For Brazil's first pre-salt auction, new production sharing rules changed the playing field, attracting fewer, but more substantial bids.**

**By Claudio Paschoa**

**B**razil auctioned its first pre-salt field, Libra, back in late October. Libra, located in Block SS-AUP1, in the Santos Basin, has estimated recoverable oil volumes of 8 to 12 billion boe and in place volumes of between 25 and 40 billion boe. Supermajors such as Exxon Mobil, Chevron and BP and other players such as BG Group and Statoil, decided not to participate in the auction in part due to the new production sharing rules. Many industry analysts were surprised that state-owned players from China, India, and Malaysia dominated the list of companies that agreed to the controversial terms imposed by

the Brazilian government, through its National Petroleum Agency (ANP).

Magda Chambriard, head of ANP, said that she had expected “more than 40 companies to bid for Libra,” expressing surprise at having only about a quarter of the expected interest actually materializing. She may well have been surprised, but it is highly doubtful that the policy-making nucleus in Brazil's government was in any way surprised, as the state policy is to maintain tight control over pre-salt exploration and production. The new rules being implemented for this auction, such as Petrobras being the sole operator of the field and having a minimum 30% stake in any consortium, along with the highly-criticized decision to create another state-owned company, Pré-sal Petróleo S.A. (PPSA), to act as manager of the winning consortium, without imputing capital and having 50% vote in the Operational Committee's deliberations, along with veto rights, are a reflection of the government's policy.

Local industry analysts, who asked to remain unnamed, maintain that these

and other new rules, such as the production-sharing scheme, were designed to attract other state-owned players, in detriment to the international supermajor players, which are mostly private companies. The reasons for this preference is that these state-owned players participating in the auction, having significantly less, if any, experience in operating deepwater pre-salt fields, are therefore more agreeable to Petrobras' operational control, and the significant fact that these state-owned players are more interested in obtaining the physical oil than in the profits from oil sales, because they need the oil for their own national development. Petrobras still considers it important to have experienced players in the Libra consortium, and the operator has expressed its contentment that Shell and Total were in the winning bid, due to the vast experience these companies have in deepwater E&P.

Eleven companies agreed to the auction terms and paid the roughly US\$1 million (R\$2 million) participation fee, after which they received the



data package concerning the Libra field. Of these 11 companies, seven can be considered supermajors because of their market value, according to Bloomberg/PFC Energy estimates as of Dec. 12 2013. The fact that they paid the participation fee does not necessarily confirm that they would definitely participate in the auction and the payment fee was compulsory and individual to each company, even those wishing to submit bids through a consortium. Therefore, some of the companies listed could choose to forfeit the fee and not participate in the auction and some did just that, with Repsol pulling out of the auction at the last moment. Mitsui and Petronas failed to deposit financial guarantees and also didn't participate. With the high investments involved, which include EWTs and other field development costs, along with around US\$7.5 billion (R\$15 billion) as bonus on signing the 35-year, non-renewable E&P contract, virtually guaranteed that the companies involved will form consortiums, with no company competing individually. The ANP has estimated that it could take as much as R\$400 billion to develop the Libra field.

When the rules were changed in 2010, many local and international oil industry leaders and analysts expressed concern that the production-sharing model would reduce investment interest in Brazil's pre-salt provinces, which include areas in the Santos, Campos, and Espirito Santo Basins. After the rules were confirmed for the Libra auction, more than 200 requests for changes were made and turned down by the ANP, who said the area's size and potential meant that the government could charge almost anything it wanted for the rights. "Libra is beyond any possible comparison nowadays to other fields," said Magda Chambriard during a global road show to promote the auction. "If companies participate, it is because they see potential value. This is the biggest auction in 30 to 40 years around the globe." Brazil's government expects to receive around US\$300 billion in royalties and other taxes from Libra over 30 years. Oil rights in the rest for Brazil's post-salt plays will continue to be sold on a concession basis, where oil companies own all

the oil, but pay royalties of at least 10% on production.

João Carlos França, President of the Brazilian Petroleum Institute (IBP) had this to say: "What surprised me was Exxon not participating. But every company has its strategy. Libra is very large, it demands high investments, with high risk and many regulatory uncertainties in the sharing model. It's not known how the PPSA will perform managing the fields. It's a great doubt."

The PPSA may be viewed with skepticism and considered a risk by some, but the fact is that the company was created specifically to manage the pre-salt resources efficiently. The risk is still there, yet by choosing a CEO with a technical background instead of a political appointee, Brazilian President Dilma Rouseff showed how seriously the PPSA is being taken by the Brazilian government. This is an important indicator that the government expects the PPSA to keep a tight managerial and supervisory control over the winning consortium in order to guarantee that the oil costs, in terms of CAPEX and OPEX do not skyrocket, which could adversely affect the amount of oil delivered to Brazil, and to the winning consortium.

Local content requirements for equipment and services also pose serious concerns to major players. According to executives from major oil companies operating in Brazil, there is a growing

fear that local industry will not be able to fulfill demands and meet deadlines, thus slowing down Libra's development, possibly even delaying Libra's production startup, which would also delay any profit gains. By contract, the minimum local content during the exploratory phase is set at 37%. During the EWT, this drops to 15%. For the development phase modules to begin by 2021, local content requirements reach 55% and for development phase modules beginning in 2022 this increases to 59%. President Dilma Rouseff announced in September, that the development of the Libra pre-salt field would require between 16 and 18 new rigs or FPSOs in order to reach the goal of producing 1 million boe/d. This goal has since been raised to 1.4 million boe/d. Between 60 and 90 support vessels are also forecast to be required.

### Libra Auction Result

With the first pre-salt auction scheduled to take place at a hotel located in Barra Beach on the west side of Rio de Janeiro during a commercial holiday on Oct 21, 2013, the Brazilian government made comprehensive security plans in order to impede demonstrators from reaching the event venue. Workers and Teacher's demonstrations have been commonplace in Brazil during the last six months and although they usually end in some form of confrontation with security forces, the fact that these demonstrations are

allowed shows that democracy in Brazil is solidly rooted. Before the bidding round started, there were demonstrations by oil workers and others totaling around one hundred persons, about 500m from the venue, where the security cordon was placed. There were also confrontations, with some demonstrators and also some of the 1,100 soldiers used as security suffering slight injuries. All this happened as holiday beachgoers sunbathed and surfed along the beach. Which highlights the fact, that even with all of its social problems, Brazil is a solid democracy.

Back at the event venue at the Windsor Hotel, there was a bit of an anticlimax, as in the end only



**ANP's Magda Chambriard and President Dilma Rouseff**

Photo: Alberto Stuckert Filho

one consortium deposited its bid in the ballot. With the lack of competition, the consortium comprised of Petrobras (10%), Shell (20%), Total (20%), CNPC (10%) and CNOOC (10%) offered the established minimum 41.65% in profit oil to the Federal government, winning in the first pre-salt bidding round held by the Brazilian National Petroleum Agency (ANP). With this result, the consortium has acquired rights and obligations to the Libra block. As set forth under the law, the National Council for Energy Policy (Conselho Nacional de Política Energética - CNPE) established a 30% stake to be acquired directly by Petrobras. Therefore, with the auction results, Petrobras' total participation in the consortium will be 40%. A signature bonus of around US\$7.5 billion (R\$15 billion) is to be paid by the winning consortium in a single payment and the total amount payable by Petrobras will be around US\$3 billion (R\$6 billion) relative to its participation in the consortium. The Libra block is located in Santos Basin ultradeep waters in the pre-salt polygon and is considered a prospect of high potential. The total extension of the area is 1,547.76sq km, and was discovered by well 2-ANP-0002ARJS, drilled in 2010. Petrobras has stressed that recoverable oil volume estimates, costs, investments and



## “Libra field in Brazil is one of the largest deepwater accumulations in the world.”

Mr. Li Fanrong,  
CEO, CNOOC

schedule of the production systems of this block, will be progressively released in a timely manner, as the minimum exploration program is developed.

Petrobras believes that the integration of expertise and experience of the European partners, Shell and Total, with their expertise in deepwater development and their long experience in managing the design and implementation of large projects, will contribute to achieving good production results in Libra. The participation of the Chinese companies, CNPC and CNOOC, complements the requirements for a strong and active consortium, leveraged by the financial

strength of the Chinese companies.

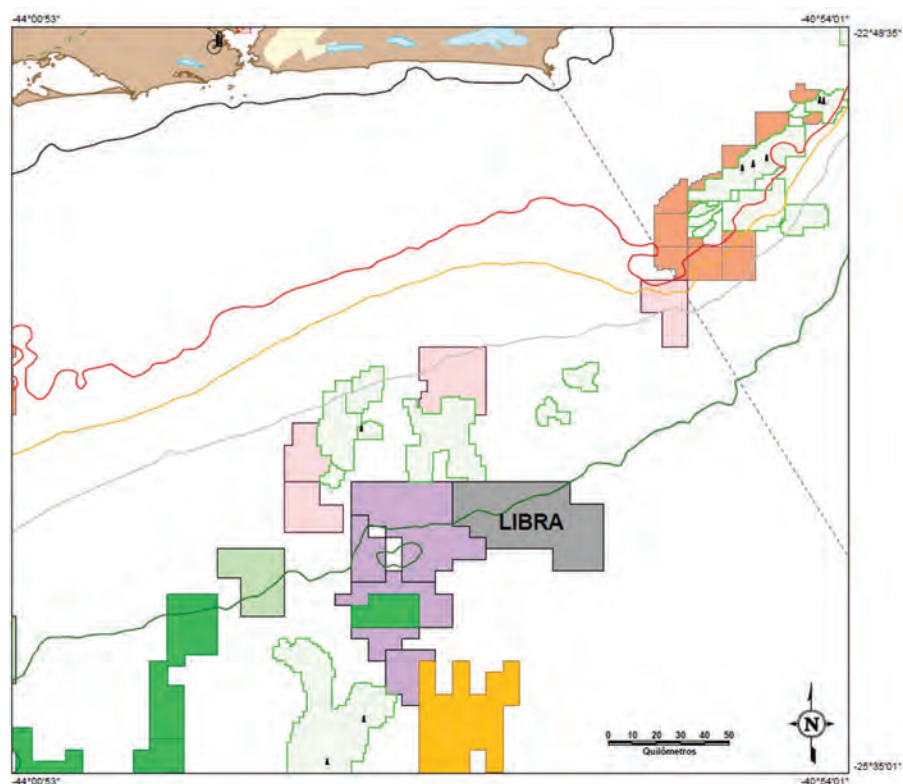
Shell commented that, “The Libra oil discovery in Brazil is one of the largest deep water oil accumulations in the world. We look forward to applying Shell’s global deep water experience and technology, to support the profitable development of this exciting opportunity,” said Peter Voser, Chief Executive Officer, Royal Dutch Shell.

Total explained that this acquisition is part of its strategy to increase its presence in Brazil. “This stake in a block close to the very prolific block BM-S-11, where the Tupi, Iara and Iracema oil fields were discovered, will enable Total to participate in the promising exploration of the pre-salt area of the Santos Basin,” stated Marc Blaizot, Senior vice President, Geosciences at Total E&P.

Mr. Li Fanrong, CEO of CNOOC commented, “Libra field in Brazil is one of the largest deepwater oil accumulations in the world. The participation of CNOOC Limited in Libra project not only signifies the milestone of a strategic entry into ultra-deepwater field for the Company, it also aligns with our philosophy of seeking partnerships to expand our global footprints.”

After the auction proceeding were completed, Brazilian President Dilma Rouseff, defended the production sharing model used for the Libra auction and also the much contested fact that foreign companies were allowed to participate. “The two Chinese (companies) are big international oil companies, and it is good to say, in Brazil, in order to end this absurd xenophobia, that they are great international partners and that the two private companies (Shell and Total) are great oil producers,” President Rouseff said. She also explained that the oil in Libra is of high value and that the concession model implies high exploration risks in order to discover the oil, and that production sharing is the best way to go in the pre-salt. “The concession model entails many risks to discover the oil. You don’t know where the oil is and the success rate is low. In the production sharing model, we know that there is oil there and how much there is. We can estimate what will be produced,” said President Rouseff. She also highlighted that 75% of the oil will go the Brazilian state, while 25% will go to the companies doing the E&P. She also said that by official projections, in 35 years the Libra field will generate around R\$1 trillion (roughly US\$500 billion) for Brazil. **OE**

**Map of the Libra field.** Image courtesy of Brazil’s Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP)





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# Norwegian know-how

**The Statoil-operated Peregrino field, one of Brazil's most significant offshore producers, is a wealth of resources, including Norwegian-developed technology. Sarah Parker Musarra chatted with Statoil Brazil Country President Thore E. Kristiansen.**

## Peregrino FPSO Peregrino.

Photo courtesy of Øyvind Hagen / Statoil.

While pre-salt has become topic du jour with regards to Brazil's offshore resource wealth potential, there is one field still capable of drawing attention away from pre-salt-filled eyes, the massive heavy oil Peregrino project operated by Norwegian giant Statoil.

Identified by Statoil as the company's largest internationally operated field, Peregrino is located 85km (53mi) off the coast of Rio de Janeiro in the 115,000km (71,457mi) Southern Campos Basin area.

Peregrino, originally discovered by Petrobras in 1994, produces 100,000 bo/d from 22 producers and three water injector wells. Thirty-seven (30 horizontal producers and seven water injectors) wells are planned. Estimated recoverable resources hand somewhere between 300-600 MMbo.

"The [focus] of the core business of Statoil in Brazil is Peregrino," Statoil Brazil Country President Thore E. Kristiansen said from Statoil's Rio de Janeiro offices.

Peregrino is in Phase I production and is expected to produce until 2034. Platforms Peregrino A and B are tied back to the floating production, storage and off-take unit (FPSO) *Peregrino*, which has a storage capacity of 1.6 MMbo and produced more than 50 MMbo since achieving first oil in April 2011.

"It's a significant field by any standards. We believe there are 2.5 billion bo in place where we are currently operating," Kristiansen said, adding that a newer discovery in the area, Peregrino South "is maturing."

At a recent technology briefing Statoil held in its Houston office, three Statoil executives discussed the company's focus on specific and specialized technological solutions.

Statoil places a heavy emphasis on increased oil recovery (IOR), mostly developed in the Norwegian Continental Shelf [NCS] and deployed elsewhere, to boost production at the field.

In Houston, Lars Høier, senior vice president, TPD research, development and innovation referred to the NCS as "[Statoil's] laboratory."

"By applying our technology [developed in the NCS], we thought we could



recover more resources from Peregrino. We saw that long horizontal wells could improve technology and possibly double what the previous owners predicted,” Kristiansen said.

Horizontal wells in particular were a “key technology” for Peregrino, Kristiansen said. They were previously lengthened to boost production, and Statoil is planning on modifying them again. Multilateral branched wells are also utilized: Used extensively in heavy oil fields in the NCS, they make their entrance on the Brazilian stage in Peregrino.

“Peregrino’s oil is very heavy and very viscous. We saw that long horizontal wells...could improve recovery.

“We have long horizontal wells, and we’re currently drilling them out to 6.5km step out of the platforms. We are stretching them out in future towards 8km. We are branching out the wells to ensure that we are optimizing the reservoir we are attacking.”

Statoil partnered with service companies to develop and patent a version of autonomous inflow control devices (AICD), already tested on the NCS in two Norwegian fields to reduce water production. AICD distinguishes between high-viscosity oil and low-viscosity water and gas to allow in only the high-viscosity oil.

Produced water is combined with treated sea water and pumped back



**The Peregrino A platform.**

Photo courtesy of Øyvind Hagen / Statoil.

**“Peregrino is a significant field by any standards.”**



**Statoil Brazil Country President  
Thore E. Kristiansen**

into the reservoir to maintain pressure, a method called produced water reinjection.

Other ways Statoil combats the difficulties that heavy oil like Peregrino’s brings is through water as a way to transport the crude from the wellhead platforms to the FPSO.

Further IOR strategies are underway.

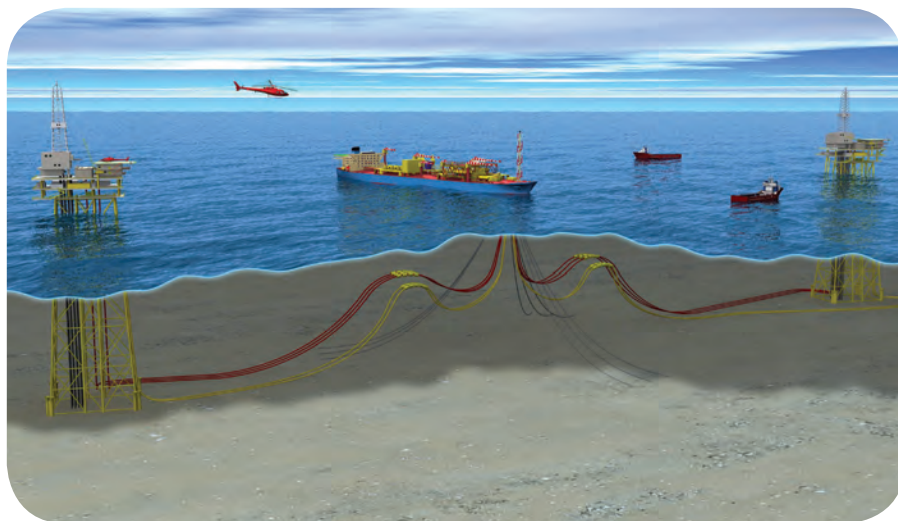
“We are at least on the drawing board to use polymers injection to increase the viscosity of water to improve displacement of oil/water mobility,” he said.

At the Houston technology briefing Margareth Øvrum, executive vice president, technology, projects and drilling (TPD) named Brazil at as a possible front-runner for Statoil’s first subsea factory, planned to be in place by 2020. Kristiansen, however, said that the world-first wouldn’t be located in Peregrino.

Kristiansen said that Peregrino’s Phase II is imminent.

“We believe the whole field has 4 billion bo in place. We will hopefully make a investment decision on Phase II towards end of 2014,” he said. “It would consist of another wellhead platform tied back to the existing FPSO.”

Statoil hold the operatorship stake in Peregrino with a 60% working interest (WI). The Sinochem Group purchased the remaining 40% WI in 2010 for US\$ 3,070 MM. **OE**



**An illustrated layout of the Peregrino field offshore Rio de Janeiro.** Image courtesy of Statoil.





The final decks being installed on *Amazon Warrior* after its naming ceremony on November 8, 2013. Photo courtesy of WesternGeco.

# Designed for seismic

**WesternGeco christened the company's latest seismic vessel, the *Amazon Warrior*.**

**Paul Bidmead shares insights.**

**E**fficient acquisition of high quality marine seismic data requires very large spreads of specialized in-sea equipment deployed by vessels with a unique set of operational characteristics. The vessels need to be efficient and cost-effective at their normal production speed of 5 knots, which on average represents approximately 80% of their time at sea. Seismic companies have identified various types of existing hull designs they considered suitable for their operations, and converted the top decks to accommodate and deploy the specialized equipment. A feature common to all is that they were originally optimized for another purpose, which in most cases was to enable economic transit from one seaport to another at high cruising speeds. In November, WesternGeco christened *Amazon Warrior* – a newbuild vessel designed from the bottom up to deliver optimum performance while also providing fuel-efficiency during its estimated project-to-project transit speed of 17 knots.

## Vessel design trends

The marine seismic survey business saw rapid development in

the 1980s, coinciding with over-capacity in many of the world's fishing fleets. Several fishing trawlers were converted to tow multiple (typically 2-4) seismic streamers laterally separated behind the vessel by 50m (168ft) or more. Seismic service companies subsequently built new vessels capable of acquiring large 3D surveys. Meanwhile, developments in source and streamer technologies, combined with continuing improvements in 3D data processing and analysis techniques, have delivered increasingly accurate and reliable information for imaging the subsurface and mapping reservoir fluid movements. This knowledge supports optimized well placement and efficient field development strategies.

Most modern newbuild seismic vessels have highly-specialized back decks designed to store and deploy 1-2 arrays of airguns and at least 8 streamers, each up to 12km long, towed up to 200m (672ft)

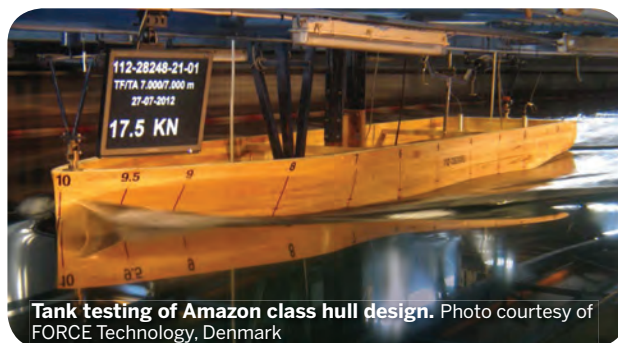
apart. Companies have implemented a range of strategies to provide suitable back and gun decks, but all have been combined with existing hull designs.

## A new bottom-up approach

WesternGeco reviewed long-term forecasts for E&P activity and decided the future of the global seismic market was sufficiently buoyant to support an overall extension its seismic fleet. WesternGeco embarked on a project to design and build a new marine seismic platform capable of supporting all of its present and potential technologies and acquisition techniques for at least the next 10 years while also optimizing operational performance. The company decided to design the new vessel from scratch, having first defined its operational requirements. This approach is aligned with the Schlumberger philosophy of maintaining competitive advantage through techno-

logical differentiation; health, safety and environment (HSE) leadership; efficiency in different environments; and a “bottom-up” approach to design.

While the back and gun decks are designed to fit a hull, this project started with defining the seismic elements and operational criteria for the working areas through extensive research and analysis. Then, starting with



Tank testing of Amazon class hull design. Photo courtesy of FORCE Technology, Denmark



clean sheet of paper and no preconceived ideas, engineers were tasked with designing a hull, propulsion system, and all the other vessel components required to optimally meet the seismic requirements while making sure that there were no compromises in HSE or operational efficiency.

### People power

A key feature of the design process, especially for the back and gun decks, was that it involved considerable input from experienced equipment users. The extensive WesternGeco HSE knowledge management database was used to evaluate and mitigate potential safety risks identified from a wide range of industry incidents and lessons learned. Workshops were organized that brought together designers, management, and numerous crew members with up-to-date and relevant experience of the various elements of marine seismic operations. HSE was a top design priority.

The first Amazon-class vessel is being built in Flensburg, Germany. The shipyard has been using 3D visualization technology in its design processes for more than 12 years. Initial designs were used to create virtual versions of specialist working environments, in which crews were able to provide realistic feedback on practicalities such as equipment handling, stepping, handling, and the safe movement of people and equipment.

The final vessel design addresses operational and HSE issues in all areas. Seismic and maritime workshops, stores, and supply handling are all on the same level and as close as possible to the equipment or machinery being supported. Passages and stairs are designed to reduce trips, slips and falls. The main deck is designed and positioned at a height designed to minimize potential for sea ingress. A new hands-free source deployment and recovery system is being designed within the Amazon project capable of being retrofitted into the existing fleet. In addition to a helicopter deck for offshore crew changes, a built-in offshore gangway is available for at-sea transfer of personnel, avoiding the need for small boats. Workboats designed for safe, efficient, replacement of streamer sections are located in both the port and starboard sides of the hull. The davit deployment design allows more than one small boat to be retrieved at any

one time, ensuring that one or more can always be recovered on the lee side.

### Unique design

The hull may appear conventional, but it was derived to meet detailed specifications for seismic operations. Flensburger Shipyard carried out seakeeping analyses and extensive tank testing, which was performed at the facilities of FORCE Technology in Denmark. WesternGeco maintained control and owns the vessel design. It also identified key suppliers with the best knowledge of the needs of



the seismic industry, while the yard used its expertise to select suppliers and contractors required for building the vessel.

Specifications for the “Amazon-class” vessels include the ability to work worldwide in all operating arenas, including frontier areas. They will have a production endurance of 120 days, which is important in environmentally sensitive areas and where resupply may present challenges. Routine maintenance can be done during live operations and the docking interval is five years.

At 126m (413ft) long, 28-32m (92-105ft) wide, the vessel provides a large, powerful and stable platform for forward motion and maneuverability during operations in inclement weather conditions. The knife-shaped bow reduces slamming, helping to maintain streamer control and reduce noise in the seismic data. There is capacity for more than 200km of streamers and 18 streamer tow points. A “quad-deployment” design enables four steamers to be handled simultaneously. The vessels will be suitable for a variety of acquisition geometries including long offset, Coil Shooting, Dual Coil Shooting, and Continuous Line Acquisition. High streamer capacity and ample working space enable at-sea reconfiguration of streamers.

### Environmental performance

The propulsion system, matching the hull, includes independent, ergonomically designed, port and starboard engine rooms. Full redundancy in the propulsion and steering systems means that normal production can be maintained in the event of a breakdown, which is important for production continuation and critical in mitigating safety risk within obstructed or environmentally sensitive areas. The propulsion pack is quiet, which benefits seismic data quality and will be welcomed by the crew. Cabins are designed to minimize external noise and the funnel is based on a cruise liner concept that avoids exhaust fumes on deck.

The newbuild uses only marine gas oil (MGO), which although more expensive, produces lower emissions than standard heavy oil. It has a low-loss electrical power distribution system, energy recovery air-conditioning systems, and energy efficient (variable speed) machinery. LED lighting systems provide power, safety and maintenance benefits. The vessels are designed to meet DNV CLEAN Class and CLEAN Design specifications and have ICE-1A class winterization for Arctic operations to Polar Class 7. Benefits include heated handrails, reduced risk of heavy ice buildup that could cause instability, and avoiding risk of anchors freezing to the deck. ICE Class does not necessarily mean that the vessel can work in icy waters, as the in-sea equipment could be vulnerable to damage; however, it does enable the vessel to safely enter a survey area earlier and leave later in a summer season.

### A successful project

The first Amazon-class vessel is scheduled to start operations in Q2 2014. The second is expected to be in service by Q4 2014. Construction is achieving all milestones on pre-planned dates, which will result in the new vessels going into production approximately 12 months after cutting first steel. **OE**



**Paul Bidmead** is WesternGeco's marine marketing manager. He has 22 years' experience in seismic operations and technical development.

# Solutions

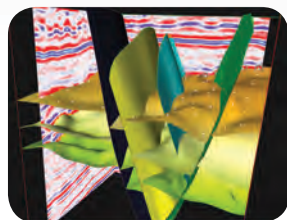


## EV releases new well diagnosis technology

EV launched its Optis HD Electric line camera, which provides vital diagnosis to the well intervention market. It has the capacity to stream color video at a maximum of 25 frames per second. The new camera features improve speeds and picture quality in comparison to similar downhole video cameras currently on the market, allowing for advanced inspection of oilfield surface equipment for integrity issues.

[www.evcam.com](http://www.evcam.com)

## Emerson creates new reservoir modeling software



Emerson Process Management released Roxar RMS 2013, the latest version of its

reservoir modeling software. RMS 2013 includes model-driven interpretation capabilities and new solutions for seismic interpretation that are linked to geological model-building to provide users with a full seismic-to-simulation workflow. RMS 2013 modelers create thousands of models by estimating uncertainty in their interpretations, and the interpretations allow geoscientists to guide and update a 3D geologically consistent structural model directly from the data.

[www.roxarsoftware.com](http://www.roxarsoftware.com).

## N-Sea launches TUP Diving System®



N-Sea's TUP Diving System® can be equipped with a

hyperbaric lifeboat, offering a safer, more efficient solution to the market. The system consists of a 3-man diving bell,

launch and recovery system, triple-lock decompression chamber, gas diver control, and hyperbaric rescue craft. Now with Nitrox, efficiency begins at a shallower depth range when compared to traditional surface oriented air diving. A diver's workable bottom time in the 25 to 33m water depth range is increased by more than 60 minutes.

[www.n-sea.com](http://www.n-sea.com)

## GAC presents eco-friendly hull cleaning solution



GAC EnvironHull has launched HullWiper, a new innovation offering diver-free, cost effective and eco-friendly underwater hull cleaning. The compact, remotely-oper-

ated vessel cleaning vehicle is capable of cleaning up to 2000sq m of hull per hour without damage. After cleaning, vessel speed and performance is significantly improved as a result of reduced resistance, which in turn decreases carbon emissions and fuel consumption. HullWiper cleans the vertical sides of a VLCC (approximately 8000sq m) in seven hours, half the time taken in using conventional cleaning methods with

divers. The machine enables hull cleaning to be carried out alongside during loading or discharge.

[www.gac.com/hullwiper](http://www.gac.com/hullwiper)

## Aker Solutions enhances existing tubular handling equipment



Aker Solutions developed the Casing Stabilizer Arm (CSA), which eliminates the need for a person to be elevated on a derrick for tubular make-up. The stabilizing mechanism is stowed approximately 33 ft. above the drilling floor and includes an internal hydraulic cylinder that extends and closes the padded jaws operated by a radio remote control. Aker's unit also provides increased safety features that allow the device to interface with the rig's anti-collision zone management system. Additionally, it offers wireless remote control and local manual control.

[www.akersolutions.com](http://www.akersolutions.com)

## Schlumberger introduces new surface multiphase flowmeter



Schlumberger released the Vx Spectra surface multiphase flowmeter, which enables operators to obtain flow

rate measurements in production testing and permanent monitoring. The Vx Spectra 19mm monitors low-rate producing wells down to 30 b/d, and the 40mm venturi version introduces a mid-range multiphase meter with high flexibility to match oil and gas production flow rates. Modular design configurations offer easy integration with operators' production facilities.

[www.slb.com/VxSpectra](http://www.slb.com/VxSpectra)



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# Activity

## Safetec unveils new competence center in Bergen, Norway

Safetec, part of the ABS Group, recently opened a new Competence Center in Bergen, Norway, to provide education and training for industry-focused organizations. According to the company, the center's specialized training courses will be based on ABS Group and Safetec's multi-disciplinary expertise and experience in the onshore and offshore markets.

Newly-appointed Department Manager of the Competence Center Vibeke Francisca Een will oversee the facilities located at Bredalsmarken 17-19, Bergen.

Safetec plans to expand the center to include several lecture rooms where the company will host courses and trainings focused



on risk management, safety and emergency management. The courses will use a combination of scenario-based training, role play, skills training, workshops and lectures.

Safetec has more than 2,000 employees in 35 countries and nearly 30 years of experience in the areas of risk management, safety, reliability and emergency preparedness.

## ABS breaks ground on offshore energy center

ABS, the leading provider of classification services to the global offshore industry, is establishing a new office in Houston's Energy Corridor near the intersection of Interstate-10 and Highway 6 in January 2014. The dedicated offshore energy facility will co-locate members from ABS engineering, project management, technology and business management.

In addition to class services, ABS' West Houston facility will offer education and training seminar rooms for local industry to use on demand to facilitate information sharing among operators, service providers, academia, and regulatory bodies. The facility is scheduled to open in the first quarter 2014. **OE**

## Saudi Aramco opens new research center

Saudi Aramco opened a research center in Cambridge Massachusetts. The new center is adjacent to the Massachusetts Institute of Technology (MIT) and will support computational reservoir modeling, nanotechnology and advanced gas membrane system research. The 32,000sq ft office in Kendall Square will eventually employ about 50 scientists.

## Fugro's AG to join its geoconsultancy practice

Fugro's wholly-acquired Advanced Geomechanics Pty Ltd. (AG) will become part of its global geoconsultancy practice. The nearly 20-year-old, Perth-based AG provides geotechnical and geophysical engineering and consulting services, and partnered with companies including Woodside, Chevron Australia, INTECSEA, Shell Development (Australia), and Technip Oceania in offshore projects. The majority of AG's offshore projects are concentrated in Australia. The acquisition is expected to be completed by the end of 2013.

## MSc energy students shine

MSc papers from students studying at the University of Aberdeen and Robert

Gordon University (RGU) were pitted against each other at the Aberdeen branch of the UK's Energy Institute's annual MSc Energy Student Best Paper prize.

The winner of was Christoph Knedel of RGU (MSc Oil and Gas Engineering with Distinction) with his thesis Well Plug & Abandonment: Critical Analysis of Conventional and Unconventional High Temperature Deep Sour Gas Well. A Case Study of the Lacq Field in France.

The runner up was Loli Angraini, of the University of Aberdeen (MSc Oil & Gas Engineering), with thesis title: Buckley - Leverett Analysis of Waterflood Oil Recovery from Mixed-Wet Rock."

In third place was Toochukwu Onwuliri of RGU (MSc Petroleum Production Engineering with Distinction) with thesis: Dynamic Reservoir Modelling of a Mature North Sea Field.

## Ampelmann acquires Offshore Solutions

Dutch-company Ampelmann acquired Offshore Solutions. With the acquisition, Ampelmann adds seven offshore access systems (OASs) to its fleet, and an office in Qatar, as well as the personnel to operate, maintain and continue development of the systems. The acquisition follows a recent acquisition of a majority stake in

Ampelmann by IK Investment Partners. The company also plans to open an office in Singapore in December, and an office in Houston in early 2014, following its first project win in the region recently.

## Interwell wins ICoTA European Chapter Innovation Award

(EJCA). The EJCA enables clients to deploy bridge plugs and retrieve bridge plugs in a single trip. The EJCA has saved two wireline runs per intervention and has ensured the plugs can be equalized even in high debris well environments.

## Ikon Science acquires Terra Geotech

Geoprediction firm Ikon Science acquired the software, services and intellectual property of Bergen, Norway, headquartered Terra Geotech AS.

Eamonn Doyle, the founder of Terra Geotech, has joined Ikon as the VP, real-time operations, bringing with him Terra's real-time pore pressure prediction consulting business.

Remote and real-time well monitoring software and services are available from Ikon with immediate effect. Ikon, based in London, was formed in 2001, with Enterprise Oil plc and Tullow Oil as founding shareholders.



# Spotlight

By Anthresia McWashington

## Baker Hughes initiates first STEM event for high school students

Baker Hughes kicked off its first STEM event for high-school students in the Houston area this past summer, inviting 22 students to visit its drill bit manufacturing facility in The Woodlands, Texas. The success of the program, and positive feedback throughout the industry, is propelling the company to expand its STEM program throughout the globe.

Students and their parents were required to each submit an essay on why the student should be invited to participate in the event. Upon selection, they were sent invites by Shelly Cory, new technology business development manager, drill bits, and head of the STEM event. Cory said that this event has opened doors for expansion with educators and other companies within the industry.

During the event students toured the facility, attended presentations on what went on in the facility and what it would be like to work in the industry, and they also got the opportunity to interact with some of the company's interns. "The real STEM connection was created during the sessions with the interns, which is the high school student's next step in the future," Cory said. "The students were the most comfortable in this setting, and felt a comfort zone to ask the real nagging questions they wanted answered about college life which is their next big decision before entry into our industry. The interaction was

instantaneous and dynamic."

Mentorship opportunities have also arisen through the company's efforts to recruit younger generations to the industry. Baker Hughes is in the developmental phase with its Bridging Mentorship Program, and is projecting to launch the program in 1Q 2014. The availability of the mentors selected is an important requirement to be truly successful and Cory explained how this may impact the effectiveness of the mentorships for both mentors and mentees.

"We consider the availability factor heavily as we select our mentors that will eventually become team leads, not only create but steer the development, accept the time commitment, and show the passion to become STEM program role models to future students," Cory said. "We also need mentees to understand their role and make a commitment as well. Both of these elements are essential to the

success of any STEM-student mentorship program."

Initial expansion for the STEM event was internal, but after gaining avid support from the Baker Hughes leadership team and resource group, plans for expansion were underway. As the program continues to grow, Cory said that the company has already gotten started on branching out to other regions.

"After presenting the Baker Hughes STEM message at the Women's Global Leadership Conference this past October, the networking web for future collaborations was triggered," Cory said. "More than 10% of the attendees registered at this global conference requested the STEM toolkit, encouraged chances to learn more about STEM, and offered to volunteer their time for future STEM initiatives moving forward into 2014 and beyond."

"Within the western hemisphere, we have stretched STEM from the United States to Canada," Cory said. "More recently, we began the first expansion to the eastern

hemisphere in Egypt and hope to leverage more opportunities through global conferences and networking. In all honestly, the STEM expansion has been contagious from one country to the next and has been a pleasure to watch it flourish while helping all types of students pursue STEM."

As the demand for more professionals within the industry increases, the need for similar informational and recruiting programs like the one initiated at Baker Hughes flourishes as well. Individuals or companies interested in implementing their own STEM program have a wealth of resources to assist them in getting started. Shelly encourages anyone interested to obtain a STEM toolkit from Baker Hughes.

"The STEM toolkit is a tangible resource that can be used for any size STEM program that is in the first stages of being developed," Cory said. To receive the toolkit, companies can send an email request to shelly.cory@bakerhughes.com. **OE**



Twenty-two students participated in Baker Hughes' first-ever STEM event.

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# Numerology



**1224**km

is the length of the Nord Stream PIG run, which extends from Germany to Russia ▶ See page 56.

**10,000**tonne

is the weight of the two -level well-head deck that Lamprell is building for Nexen's North Sea Golden Eagle development ▶ See page 32.



US\$**300**billion

is the amount that Brazilian government expects to receive in royalties and other taxes from the Libra basin. ▶ See page 60.

**100,000**bbl

of oil/day are produced in the Peregrino project, in the Southern Campos Basin area off Rio de Janeiro. ▶ See page 64.



**126m x 28-32m**

the dimensions of the *Amazon Warrior*, WesternGeco's latest seismic vessel. ▶ See page 66.

**25**

the maximum number of frames/sec in which EV's Optis HD Electric line camera can stream color video ▶ See page 68.



US\$**1.3**billion

the amount paid by PTTEP and Pertamina to buy Hess's Indonesian assets ▶ See page 14.



**12,428.45**

million bbl is the amount of liquid reserves in Brazilian ultradeep waters. ▶ See page 19.



**2114**

**100**years

the normal lifecycle of ASTM316 steels in non-corrosive environments. ▶ See page 44.



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