Required reading for the Global Oil & Gas Industry since 1975

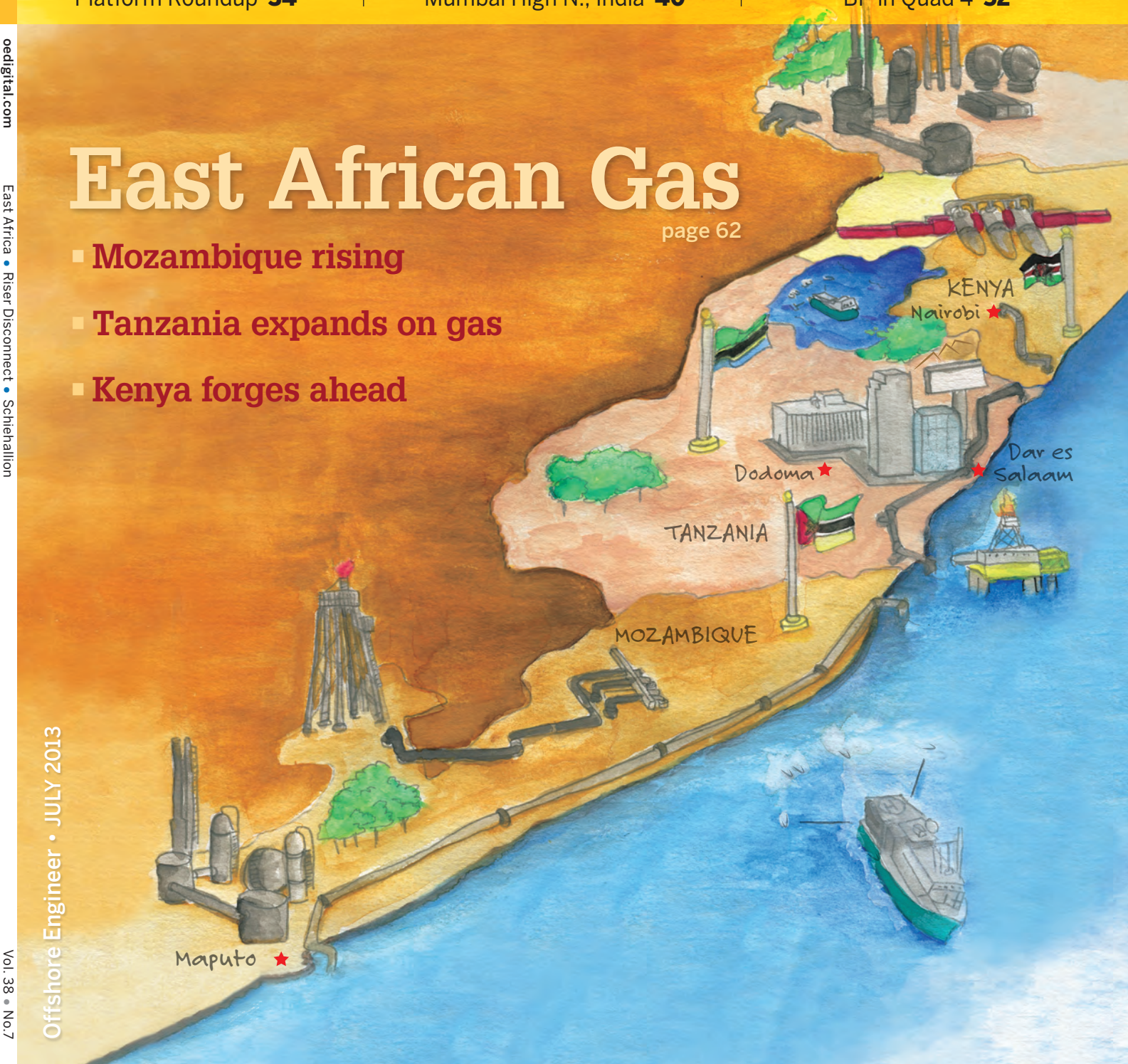
OE

oedigital.com

East African Gas

page 62

- Mozambique rising
- Tanzania expands on gas
- Kenya forges ahead



OE
JULY 2013
oedigital.com
East Africa • Riser Disconnect • Schiehallion
Offshore Engineer • JULY 2013
Vol. 38 • No.7

Subsea production and processing systems

You are looking at the 'subsea factory' – oil and gas production facilities located directly on the seabed. It's an ingenious response to today's challenges of declining reservoir pressures and longer step-outs, and the next frontier in offshore engineering.

Operating 24/7, it's a factory that runs continually throughout the life of the field, making long-term reliability and maintainability a critical part of every subsea component.

Today only Aker Solutions offers the right subsea technology portfolio, multidisciplinary knowledge and large-scale project experience required to build, run and maintain a production system on the seafloor.

We are making the subsea factory vision a welcome reality.

Subsea: just another example of **ingenuity delivered** by Aker Solutions.

AkerSolutions™

www.akersolutions.com/subsea

Contents

Cover Story 62

East African Gas

OE dives deep into the East African waters to discover more about the region's biggest projects and hydrocarbon finds. Audrey Leon looks into the push to turn Mozambique into a major LNG exporter, while Elaine Maslin highlights London-based Ophir Energy's operations in Tanzania. Nina Rach reports on activity off Kenya.

ON THE COVER

After decades as a frontier exploration area and vastly under-explored, East Africa is emerging as the world's newest hotspot, with significant gas discoveries offshore. (Art by Marlin Bowman)

BIGGER
TOPSIDE SOLUTIONS

In an amazingly compact package.

FLOW EQUIPMENT LEADERSHIP

Topside Solutions from Cameron.

Less size, space and weight. More productivity.

Increase efficiency, save space and reduce costs with bigger topside solutions in a compact package from Cameron. Smaller, lighter and highly innovative, Cameron's Topside Solutions feature NATCO® Dual Frequency® electrostatic technology, CYNARA® CO_2 membranes, CONSEPT® high-efficiency separators, TST-CFU™ next-generation compact flotation units, and more. You benefit from more space on deck, less weight to consider and less transport time to the ship. For the biggest ideas in compact topside solutions, look to Cameron.

Learn more at www.c-a-m.com

CAMERON'S PRODUCTS

Produced Water Treating
Seawater Treating
Solids Treating
Oil Treating
Gas Treating
Reciprocating Compressors
Valves
Actuators
Automation & Control
Measurement

AD00135PCS

RAISING PERFORMANCE. TOGETHER™

CAMERON

Volume 38, Number 7 July 2013

Departments & Columns

OE

PUBLISHING & MARKETING
Chairman
Shaun Wymes
shaunw@atcomedia.com
President/Publisher
Brion Palmer
bpalmer@atcomedia.com
Associate Publisher
Neil Levett
neil@aladltd.com

EDITORIAL
Editor
Nina Rach
nrach@atcomedia.com
Senior Editor
Victor Schmidt
vschmidt@atcomedia.com
European Editor
Elaine Maslin
emaslin@atcomedia.com
Associate Editor
Audrey Leon
aleon@atcomedia.com
Geosciences Editor
Andrew McBarnet
Asia-Pacific Editor
John Mueller
Contributing Editors
Meg Chesshyre
Anthresia McWashington
Jeannie Stell

ART AND PRODUCTION
Production Director
James W. Self
Design and Layout
Bonnie James
Marlin Bowman

CONFERENCES & EVENTS
Events Manager
Lisa Zadok
lzadok@atcomedia.com
Exhibition/Sponsorship Sales
John Lauletta
jlauletta@atcomedia.com

PRINT
RR Donnelley & Sons, Pontiac, Illilnois, USA

SUBSCRIPTIONS:
To subscribe or update details, email: subservices@atcomedia.com or visit oedigital.com. Rates $160/year for non-qualified requests.

CIRCULATION:
Inquiries about back issues or delivery problems should be directed to subservices@atcomedia.com

REPRINTS:
Both print and electronic reprints are available for an upcoming conference or for use as a marketing tool. Reprinted on quality stock with advertisements removed, our minimum order is a quantity of 100. For more information, call Rhonda Brown at Foster Printing: +1-866-879-9144 ext. 194 or email rhondab@fosterprinting.com

DIGITAL:
www.oedigital.com
Facebook: www.facebook.com/pages/Offshore-Engineer-Magazine/108429650975
Twitter: twitter.com/OEdigital
Linked in: https://www.linkedin.com/groups/OE-Offshore-Engineer-4412993

AtComedia
1635 W. Alabama
Houston, Texas 77006-4101, USA
Tel: 713 529-1616
Fax: 713 523-2339
email: info@atcomedia.com

OE (Offshore Engineer) is published monthly by AtComedia LCC, a company wholly owned by IEI, Houston. AtComedia also publishes **Asian Oil & Gas**, the **Gulf Coast Oil Directory**, the **Houston/Texas Oil Directory** and the web-based industry sources **OilOnline.com** and **OEDigital.com.**

US POSTAL INFORMATION
Offshore Engineer (USPS 017-058) (ISSN 0305-876X) is published monthly by AtComedia LLC, 1635 W. Alabama, Houston, TX 77006-4196.
Periodicals postage paid at Houston, TX and additional offices.
Postmaster: send address changes to Offshore Engineer, AtComedia, PO Box 2126, Skokie, IL 60076-7826

One Stands for More in Subsea.

Introducing One Comprehensive Resource for Integrated Subsea Solutions.

Cameron & Schlumberger. Now together in OneSubsea™. From reservoir to subsea to surface, we apply more knowledge. More technologies. More services. We deliver premier processing, boosting and lifting. Unrivaled flow assurance. And world-class subsea production systems. Everything you need to optimize the life of your field. All in OneSubsea. **www.onesubsea.com**

- PRODUCTION SYSTEMS
- PROCESSING SYSTEMS
- CONTROL SYSTEMS
- SWIVEL & MARINE SYSTEMS
- INTEGRATED SOLUTIONS

AD00642OSS

OneSubsea
A Cameron & Schlumberger Company

Currently @

OEdigital.com

What's trending

Subsea facing escalating costs

The subsea industry is doing well, but it needs to reduce costs and invest more in technology development, according to Subsea 7 chairman Kristian Siem.

People

ABB announces CEO

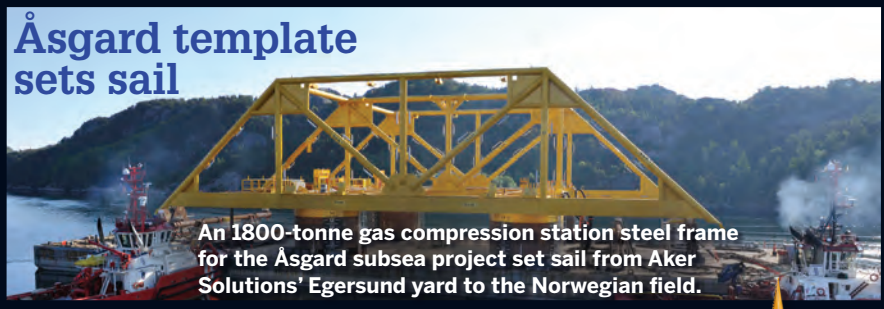
ABB selected Ulrich Spiesshofer as its new CEO, replacing Joe Hogan, effective September 15.

People

Marathon's Cazalot retires

Marathon CEO Clarence Cazalot Jr. will retire at the end of this year; Exxon Mobil Corp. executive, Lee Tillman will replace him on August 1.

Åsgard template sets sail



An 1800-tonne gas compression station steel frame for the Åsgard subsea project set sail from Aker Solutions' Egersund yard to the Norwegian field.

Expert Access

Organizing the weather off Sakhalin

Join us on 16 July 2013 at 11:00 CST as we host a live presentation and Q&A with marine meteorologists Eric Brozefski and Francis Kredensor, of Wilkens Weather Technologies LP, a Rockwell Collins Company. Brozefski and Kredensor will discuss their experiences off Sakhalin Island during the ice-free 2012 season, as onsite forecasters for Exxon Neftegas Limited (ENL), a subsidiary of Exxon Mobil Corp. and operator of the Sakhalin-1 project.

To register, go to www.oedigital.com

A WORK OF HEART

Discover a company where teamwork is more important than title. At Sembcorp Marine, it's not unusual to see top management in coveralls working with welders and pipefitters. That teamwork puts our best minds on each project and results in shorter production schedules and better solutions whether we're building rigs, converting vessels or repairing ships.

It's also why Sembcorp Marine is a leader in the global marine and offshore industry. We continue to expand, with an integrated new facility commencing operations in Singapore late in 2013 and a new yard opening in Brazil.

If you haven't discovered Sembcorp Marine, maybe it's time you gave us a call. You'll find a company that strives to make every project a masterpiece. Discover Sembcorp Marine. enquiries@sembcorpmarine.com.sg

sembcorp marine

50 YEARS BUILDING A REPUTATION. . . AND MORE.

Jurong Shipyard · Sembawang Shipyard · SMOE · PPL Shipyard · Jurong SML
Estaleiro Jurong Aracruz · Sembmarine Kakinada · Sembmarine SLP

INCEPTION

THE BEGINNING OF AN IDEA

SPE Offshore Europe

Since 1973, the SPE Offshore Europe conference has provided upstream oil and gas professionals with access to the projects, products, and people truly impacting and shaping the global industry. This event has been the catalyst precipitating many new ideas and strategic partnerships that have changed the industry. SPE Offshore Europe has effectively empowered people and companies to successfully compete in a technologically sophisticated and rapidly evolving business.

What idea will you take away from SPE Offshore Europe 2013?

Make sure to pick up your copy of ***OE*** while at the conference. Take a photo while reading for an opportunity to be featured in next month's Inception and receive a $100 American Express gift card. You can email editorial@atcomedia.com or post photos to our Facebook page.

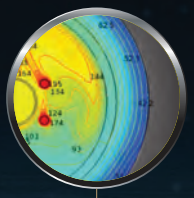
OE@OE 2013 Offshore Europe
SPE OFFSHORE EUROPE 3-6 SEPTEMBER, 2013

How do you know your offshore pipeline coatings will perform long term?

Here's one indication.

COMPLETE COATING ASSURANCE

SHAWCOR TO BE SURE

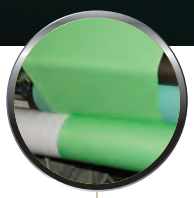


Engineering Services

Pipe and Joint Coating Design

Coating System Validation

Logistics Management



Pipe Coating Application

Field Joint Coating

Introducing the new model for offshore success.

When you control every detail of the coating system, you control your pipeline's longevity. And only one company makes it possible – Bredero Shaw. We offer *Complete Coating Assurance*, a new model that combines line pipe and field joint coating into a system of integrated services that ensures long-term performance.

Up front, our experts design a fully integrated interface between the pipe and field joint coatings. We pre-validate the solution in our state-of-the-art simulated service vessel. Then we handle every step of coating application, supply logistics and field joint installation, no matter how complex or remote the project. Plus, we take real responsibility for our work with a robust warranty.

Complete Coating Assurance. It's the only way to know that when your pipeline is lowered beneath the waves, your risk is being lowered with it. Let's talk.

BREDERO SHAW

A SHAWCOR COMPANY

brederoshaw.com

Voices

A few good recruits. The oil and gas industry is the one, rare sector still hiring, but vacancies remain. We reached out to companies to ask,

"Which is harder: recruitment or retention?"

They go hand-in-hand. Finding the right individual for a position is difficult enough, but when you have something everyone else wants, holding on to it can be just as difficult. With the shortage in skilled workers in the industry, competition is fierce and as the global market increases, the pool we "fish" from is getting smaller. We need to generate a wider, more sustainable pipeline of talent and our new initiative - Subsea Target - helps companies look for new talent from other sectors, allowing them to have a structured development program.

Neil Gordon, Chief Executive, Subsea UK

Heightened levels of activity within the oil and gas sector around the world mean that ensuring the right people are on the ground in the right place is one of the biggest challenges facing the industry. The global skills gap remains a hurdle which the sector as a whole needs to overcome, but in the first instance, it is vital for employers to be able to recruit high-quality, skilled personnel who meet the needs of their business.

Mark Guest, Managing Director, OilCareers.com

Retention would be the bigger problem for the industry because recruiting graduates is possible, it is quite easy. It is not a big risk because they have not yet built up knowledge – you have to train them. What is lost value is when you lose people that are experienced. That is the problem for companies. However, for the good of the industry as a whole, we need people to circulate a bit.

Jarand Rystad, Managing Partner, Rystad Energy

Recruitment is particularly challenging with high demand for various specialist disciplines that many businesses require. There is a need, therefore, to offer more in the psychological contract in order to attract and retain the best of the best. Businesses need to be careful with, and invest in, their reputation, their brand and the perception of them in the market.

Helen Stuart, HR Director, Taqa Bratani

Recruitment of experienced subsea engineers in the northeast of England is harder than retention. I can get graduates and train them, but for our new Discovery underwater CT pipeline scanning tool, we have an immediate need for people with a lot of subsea inspection experience.

Lee Robins, Head of Subsea Services, Tracerco

It is both, depending on skill sets! As the war for talent becomes fierce, experienced operational-level employees are targeted by both competitors and operators, plus there is an acute shortage of STEM college graduates entering the industry. In addition, diversity challenges within engineering disciplines makes it more challenging as far fewer female graduates enter the industry and when they do, they are highly sought after.

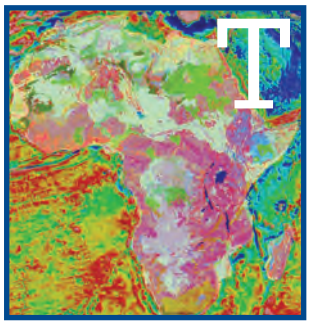
Mahesh Puducheri, Vice President, Human Resources, Halliburton

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

Nina Rach

Colloquy

Exploration Fabric of Africa



The American Association of Petroleum Geologists (AAPG) has developed a new African exploration GIS database, as the Edward G. Purdy Memorial Project, honoring the late geologist (b. 4 December 1931, d. 13 October 2009) who left a rich legacy of carbonate research and made significant contributions to the understanding of African geology.

In 1989, Purdy published maps of the "Exploration Fabric of Africa" and "African Basins," based on regional geology, tectonic framework and exploration-oriented information from a variety of sources, at scales of 1:5 million and 1:10 million. Since those maps were published, there have been major discoveries in deepwater West Africa, Nile Delta, transform margin, the East African Rift Valley, and East Africa offshore.

African Exploration GIS

In April this year, AAPG released the latest updates of Purdy's original maps within the context of modern GIS. The original Purdy data was fully vectorized and attributed, and two other geology datasets were added: USGS 1997 data and digital data derived from 1968 UNESCO maps, as well as faults and sediment thicknesses from the CGMW Tectonic map of Africa (2010) and image data showing the age of the seafloor around Africa, based on Dietmar Muller's work [EFA v. 3.2].

The ArcMap project has hyperlinks to relevant DSDP and ODP drill sites. The layers show the location of deepsea drilling sites and contain hyperlinks to archived data stored at NOAA and Texas A&M University. Final GIS version EFA v. 3.2 includes revised basin locations, ages, classification; revised sediment thickness; and revised depth-to-basement.

EFA is a joint industry project, sponsored by: AAPG, Afren, BHP, BP, CGG-Veritas, Chevron, Faroe Petroleum, Fugro, Hanno Resources, Hess, HRT Canada, ION, Lynx Information Systems, Maersk, Marathon, Moyes & Co., Murphy, Nexen, Nippon, Ophir Energy, PGS, Rift Energy, RWE, Sapetro, Sasol, Serica, Shell, Sipetrol, Statoil, Svenska, TGS, The Geological Society, Total, and Tullow Oil.

AAPG will publish the EFA Interactive Internet map, hardcopy maps and other digital output. EFA GIS data is only available to sponsors and to certain designated universities.

See: http://www.efafrica.com/

Who was Purdy?

Edward George Purdy was a carbonate and petroleum geologist who published widely. He earned a BSc. in agriculture from Rutgers University in 1956 and a Ph.D in geology from Columbia University in 1960. His doctoral studies in the Bahamas were funded by Humble Oil & Refining Co., Gulf Research & Development Co., Shell Development Co., and the American Petroleum Institute.

Beginning in 1959, he taught for 6 years at Rice University in Houston, first as Assistant, and then as Associate Professor of Geology, concentrating his research on British Honduras (now Belize).

In 1965, he joined Esso Exploration in Houston.

From 1979 to 1983, Purdy was the Geological Manager for Esso Exploration Europe-Africa Division. In 1986, after 21 years, he took early retirement from Esso and founded the international petroleum exploration consultancy, PetroQuest International Inc., based in Weybridge, Surrey. He continued to work for more than two decades, publishing the Africa maps in 1989.

From 1992-1995, Purdy was a visiting professor at Imperial College, and at Royal Holloway, University of London. From 2002-2004, he was a guest scientist and invited lecturer at Goethe-University in Frankfurt am Main, Germany.

In 1998, Purdy received a Special Commendation Award from the AAPG "for pioneering research on carbonate sediments and reefs, a seminal role in exploration worldwide, and for teaching and mentoring young geologists."

His self-described "last contribution to science" was a review and analysis of University of Chicago paleontologist Jack Sepkoski's taxonomic diversity database, which Purdy related to sea-level change and strontium isotope data throughout the Phanerozoic, published in 2008.

In April 2010, SEPM's carbonate research group started their annual meeting with a Memorial to Ed Purdy, "a phenomenal carbonate geologist and person." OE

Subsea services

improve uptime.

For the life of your field.

FMC Technologies is rapidly expanding its subsea services to provide the tools, vessels and technological expertise you need to maintain high production levels for the life of your field. That includes installation, asset management, production optimization, equipment intervention and well access. All the myriad, complex services you need to improve uptime, lower lifecycle costs, and increase recovery for the life of the field.

www.fmctechnologies.com

FMC Technologies

We put you first.
And keep you ahead.

ThoughtStream

Patrick O'Brien, ITF CEO

Collaboration key to technology development

In today's continually evolving oil and gas industry there are always emerging issues to address. Collaboration within the industry can be a vital cog to deliver new solutions to the most pertinent problems and plug technology gaps.

Oil and gas from unconventional reservoirs is one sector that has seen huge investment in recent years. ITF has been running an unconventional roadmap which is currently at the final technical clarification stage.

We've received about 25 very high quality proposals for joint industry projects (JIPs) from the small-to-medium enterprise (SME)and university community, both in the US and the UK.

This encompasses a wide variety of issues including rock matrix characterization, sweet spot identification, reservoir fracturing, prediction of fracture patterns and ingenious ways to monitor live reservoir fracturing behaviors using smart proppants.

Unlike conventional reservoirs, new ways of thinking are required to create methods that effectively drain these unconventional reservoirs of their hydrocarbon reserves through the fracks.

However, success here can be applied to all reservoirs, and plays into the general theme of enhanced oil recovery (EOR). Whether it's Norway, the UK or the Middle East, to my mind the topic of EOR continues to be high on the list of priorities for the industry as a whole.

Advanced materials are a common concern globally, though for many different reasons such as water depth, harsh environmental conditions, high pressure and high temperature (HPHT), and the perennial issue of corrosion. As we go into deeper water, we reach practical limits in the strength-to-weight ratio for steel, and here there are definite opportunities to use composite materials.

Materials for HPHT are high on the international agenda, but particularly in the Gulf of Mexico as evidenced by BP's recent announcement of its Project 20KTM, which will enable the company to produce from its deepwater Paleogene reservoirs .

> **"EOR continues to be high on the list of priorities for the industry."**

Current material limits for well completions and interventions, blowout preventors, drilling risers, and subsea equipment are typically at the 15,000psi pressure and 250°F temperature level, so a step up is required for 20,000-psi materials.

For mature oil provinces such as the North Sea, extending field life and ensuring the integrity of aging assets are key concerns, and materials play a major role. In particular, steel corrosion under insulation is a particular North Sea challenge at this time.

Another current exciting technology challenge is seismic-while-drilling. Being able to image the rock ahead of the drill bit will enable the driller to better control drilling operations and will radically improve safety while drilling into high pore pressure reservoirs, a major concern since the Macondo incident.

We are currently involved in developing two very specific technologies, now at the prototype stage. To test these tools and further develop these technologies, we will be using a drill test site in the US to compare seismic while drilling against conventional seismic tools.

On a broader note, to make our joint industry projects come to fruition more effectively and much quicker, ITF needs a robust relationship with the technology development community, and we are looking at ways to enhance that by collaborating with other industry and government bodies that promote innovative technology development businesses.

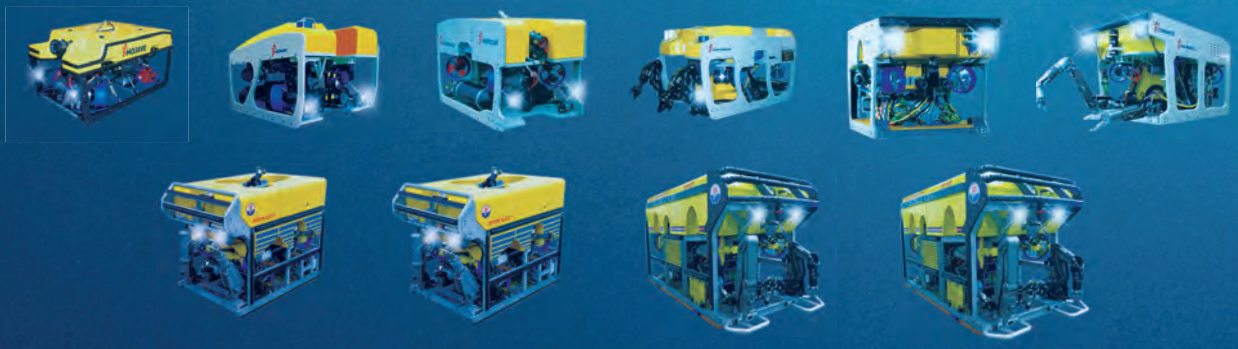
We need to find an effective mechanism that enables us to identify solutions from technology developers that closely meet our members' challenges. In this way, ITF can get industry, through our members, to invest in and speed up the development of technology to meet industry needs.

Patrick O'Brien *became CEO at ITF (Industry Technology Facilitator) in May after a 17-year career at MCS in London and Aberdeen, and then group director of strategic business and marketing at Wood Group Kenny. He earned a BE, MEngSc, and PhD in engineering at the National University of Ireland, Galway.*

2 REASONS WE BRING YOU EVERYTHING REMOTELY POSSIBLE:

Perry™

Sub-Atlantic™



Widest range of vehicles available in the industry

FORUM™

SUBSEA TECHNOLOGIES

everything remotely possible℠

To learn more about how Forum can help solve your next subsea challenge,
email us at subsea.sales@f-e-t.com or visit f-e-t.com/subsea

Global Briefs

A Exxon, Rosneft establish ARC

Rosneft and ExxonMobil signed agreements establishing a joint Arctic Research Center (ARC) in Russia and technology-sharing to support their joint ventures worldwide. ARC will provide research, development, and technical services, with a near-term focus on the Kara Sea. ARC staff will be in Moscow with the joint venture teams.

Initial activities include work on safety and environmental protection, ice, metocean and geotechnical surveys, sea ice management, design criteria, and evaluation and design of development concepts.

ExxonMobil will provide US$200 million for initial research. Rosneft and ExxonMobil will equally fund the next $250 million to continue their joint work at the ARC. Rosneft holds 66.67% and ExxonMobil holds 33.33%.

B Noble's Gunflint find

Noble Energy announced a non-commercial discovery at its second deepwater Gunflint appraisal well in the US Gulf of Mexico. The Mississippi Canyon 992 #1, located one mile west of the original discovery well, was drilled to 32,800ft TD in 6100ft of water and encountered 109 ft of net pay.

Reservoir data suggests an estimated gross resource of 65-90MMboe in the primary structure. The well will be suspended for future use. Noble Energy operates Gunflint with 31.14% WI. Its partners include Ecopetrol America Inc. (31.5%), Marathon Oil Co. (18.23%), and Samson Offshore, LLC (19.13%).

C Peru launches offshore round

Peru's international bid round will offer offshore blocks Z-56 and Z-57 (Cuenca Salaverry-Trujillo); Z-53, Z-54, and Z-55 (Lima-Pisco

Basins); and Z-58, Z-59, and Z-60 (Cuenca Mollendo). The blocks are within seven miles of the coast. Petroperú SA has the right to participate (up to 25% stake) in each concession after a discovery, though it will not participate in the exploration phase. Petroperú plans to award concession contracts on October 17.

The government estimates that the round could reap US$450 million, with companies investing a minimum of $50 million. Petroperú said that 20 companies from the US, Canada, France, and Russia expressed interest in the basins.

D CGG awarded Colombia survey

CGG has been awarded a contract by a subsidiary of Anadarko Petroleum Corp. and partner Ecopetrol to acquire and process a 5500sq km, 3D seismic survey on the Caribbean coast offshore Colombia. The *CGG Viking* will tow a 10m x 100m x 7050m spread.

The survey will cover portions of the Col 5; Ura 4, Fuerte Norte, Fuerte Sur, and Purple Angel blocks. It will begin in 3Q 2013 and is scheduled to be completed in four months.

E RWE in Suriname

RWE Dea signed a farm-in agreement with Petronas Suriname E&P BV, acquiring 40% interest in Block 52 off Suriname. The block is in the Guyana-Suriname Basin 120km off the north-east coast of South America

Contract Briefs

Technip wins Julia contract

ExxonMobil handed Technip a contract for Julia field, a US$4 billion project Exxon and partner Statoil announced last month. The contract covers project management, engineering, fabrication, installation, and pre-commissioning of more than 48km of 10.75-in. OD insulated flowlines, steel catenary risers, and flowline end terminations. Technip's operating center in Houston will perform project management, with detailed flowline design by Technip subsidiary, Genesis. The offshore installation is expected to be completed in 2015 by *Deep Blue*, aTechnip pipelay vessel.

Wood Group secures contract

Wood Group PSN (WGPSN) has secured its second North Sea duty-holder contract extension this year. Valued at about US$200 million (£140 million), the life-o-field contract from Ithaca Energy will see WGPSN operate and deliver managed services to the Beatrice offshore platforms and Nigg onshore terminal until the end of their operating life. This contract secures almost 200 UK jobs.

GE wins subsea deal

GE Oil & Gas and Pemex Exploration and Production have signed an US$84 million agreement for the supply and installation of subsea wellheads for Pemex's deepwater and ultra-deepwater drilling projects in the Gulf of Mexico. GE will supply SMS800 and DWHC 700 high capacity wellheads; similar GE technology has previously been installed at several other Mexican oil fields including Perdido, Lakach and Kunah.

Emerson wins Gorgon contract

Emerson Process Management (EPM) was awarded contracts by Chevron Australia Pty Ltd., valued at US$67 million, to provide natural gas valves, actuators, and valve controllers at the Gorgon Project.

The contracts include more than 1,000 control valves, actuators, and valve controllers. Emerson's Roxar subsea wet gas meters will also be used. EMC has support from facilities in Australia and is working with Perth-based Western Process Controls to train instrument and valve technicians.

GE tapped for propulsion

GE's Power Conversion business was awarded a contract by the Eastern Shipbuilding Group in Panama City, Fl. The contract entails GE supplying integrated diesel-electric power, propulsion and vessel control systems for two multipurpose supply vessels (MPSVs) with installed horsepower of 12,070 BHP (9,000 kW). Eastern will build the MPSVs for Hornbeck Offshore Services of Covington, La. The new contract is for the first of two multipurpose support vessels for the company. The systems include DO2, power management, alarm and monitoring, vessel control and an integrated bridge system.

Xodus wins pipeline contracts

Xodus Group secured two contracts from Abu Dhabi-based Valentine Maritime (Gulf) L.L.C. The first is for new subsea pipelines in the Arabian Gulf off Qatar's northeast coast. It involves design of a new 6.4km long, 24in. water injection pipeline, including risers and two J-tubes. The project is due for completion by the end of 2013.

The second is for the pipeline installations in Fateh field including: a 30in. by 6.7km subsea oil pipeline, a 30in. by 4km subsea oil pipeline, and a 16in. by 6km subsea water injection pipeline. All include new risers and tie-ins.

Sakhalin RMR win for AGR

AGR has been contracted to provide riserless mud recovery services for an operator working off Sakhalin. The US$3 million contract will see AGR Enhanced Drilling provide riserless mud recovery (RMR) services over this summer drilling season. In this area drilling operations have challenging top-hole conditions and stringent environmental regulations.

C-MAR wins FMEA contract

C-MAR Group announced that it won a contract, worth over $500,000, to carry out Failure Mode Effect Analysis (FMEA) surveys and trials on Maridive Group vessels for the next five years. The agreement covers 16 Maridive DP vessels to be serviced from C-MAR's Singapore, Dubai and Rio de Janeiro offices.

in 100-1,000m deep water and has potential in Upper Cretaceous strata. The work program includes a 3D seismic survey and one exploration well in the next three years. Petronas Suriname remains the operator.

F *Cidade de Paraty* in production

FPSO *Cidade de Paraty* went on stream, beginning production from the Lula Nordeste field in the Santos Basin presalt play. It is about 300km off Brazil, in the northeast corner of Block BM-S-11.

The FPSO can process up to 120,000bo/d and 5MMcm/d of gas. Petrobras, operator, said the first well (7-LL-11-RJS) to be connected to the platform has the potential to produce 25,000b/d, but it will be restricted to 13,000b/d during the first month as processing and reinjection systems are commissioned. Petrobras will connect another seven production wells and six injection wells. Peak production, 120,000 b/d, is expected for 2H 2014.

G FloaTEC mates P-61 modules

FloaTEC Singapore Pte Ltd. mated the topsides and hull of Petrobras P-61, Brazil's first tension-leg wellhead platform (TLWP) near the BrasFELS yard in Angra dos Reis, southern Rio de Janeiro state, Brazil. The P-61 TLWP will be installed later this year at the Papa Terra heavy oil field for Papa Terra BV- a joint venture company formed by Petrobras and Chevron.

H *Gryphon Alpha* FPSO

Maersk Oil's vessel, stationed about 280km northeast of Aberdeen in the North Sea, has undergone a major dry dock overhaul, while infield subsea infrastructure was removed and replaced. A 4D seismic survey and near-field drilling was also done over the area.

The project was necessary after the vessel was damaged in a storm on 4 February 2011. Maersk Oil

says that once all the associated fields are fully operational, production will ramp up to more than 20,000boe/d.

I Gina Krog gets FPSO

Statoil will build a floating production storage and offloading vessel for use on the Gina Krog field in the Norwegian sector of the North Sea. The FPSO will be converted from the shuttle tanker, *Randgrid*, currently 67% owned by Teekay Offshore. Teekay said the cost of the conversion and purchase of the remaining 33% would be about $220 million. Conversion completion is expected in the 1Q 2017.

J Euroil, Shell farmin

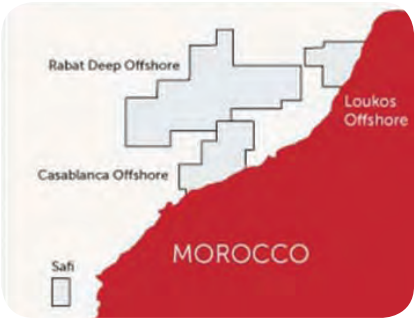
UK-based Ithaca Energy has agreed to farm-out deals with Euroil and Shell for several North Sea blocks. Euroil, a subsidiary of Edison International, will take a 25% interest in Ithaca's west of Shetland licenses P1631 and P1832. The licenses hold Handcross, a Palaeocene prospect in the Judd Basin. Ithaca retains 45% and operatorship with RWE Dea (20%) and Sussex Energy (10%).

Shell will take a 50% stake in production license P2048, covering blocks 29/24, 29/25, 29/29, and 29/30, leaving Ithaca with 50%. Commitments include gathering 500sq km of 3D seismic, which Shell will pay for as part of the farm-out agreement.

K DNO increases Tunisia acreage

DNO International is increasing its acreage offshore Tunisia and plans to drill next year. Its subsidiary DNO Tunisia AS has entered a farm-in agreement with Atlas Petroleum Exploration Worldwide and Eurogas International for 87.5% interest and operatorship in the Sfax offshore exploration permit and the Ras El Besh concession.

The Sfax offshore exploration permit and the Ras El Besh concession are in the Gulf of Gabes and cover 3296sq km, mostly offshore in shallow waters. An initial work plan includes drilling two exploration/appraisal wells in 2014, one on the Salloum discovery and the other on the Jawhara discovery.

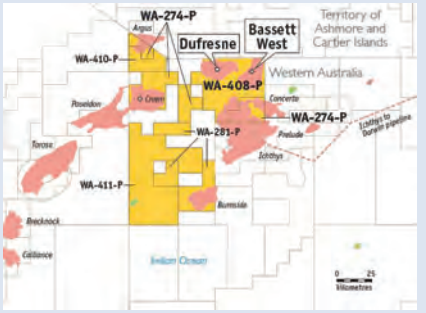


L Chariot extends Morocco licenses

Chariot Oil & Gas Ltd. and the Office

M Browse Basin gas discovery

Total E&P Australia discovered gas at the Bassett West-1 exploration well in WA-408-P in the Browse Basin off Western Australia state. The well is about 475km north-north-east of Broome and reached 5239m TD in 368m of water. Testing confirmed 7.5m of gas pay in Jurassic sandstones on the western flank of the large Bassett structure. Total operates with 50%; Santos holds 30% and Murphy Oil Corp. holds 20%.



National des Hydrocarbures et des Mines (ONHYM) agreed to a six-month extension for the first phase of exploration on the Loukos, Casablanca, and Safi licences, off Morocco. The licenses will now extend until 11 January 2014. Chariot is reprocessing and interpreting 11,000km of 2D seismic data. The licenses are 50km off Morocco in 5-165m water depths. The Loukos license covers 1,925sq km, while the Casablanca/Safi licenses cover 3,500 sq km. Chariot holds 75% interest and ONHYM holds 25%.

N Lukoil Farmin

African independent Taleveras agreed to farmout a 65% interest and operatorship in Ivory Coast Block CI-504 to Lukoil Overseas, a subsidiary of Russian oil firm Lukoil. Taleveras will retain 25% interest and Petroci, the Ivory Coast's national oil company, will hold 10%. Lukoil operates block CI-205 immediately south of CI-504. Block CI-504 is close to Baobab field, covering 399sq km in 800-2100m water depth.

O KrisEnergy spuds Tayum-1 well

KrisEnergy spudded the Tayum-1 exploration well in the Kutai PSC, offshore East Kalimantan, Indonesia, using the *Randolph Yost* jackup. The well is targeting multiple stacked deltaic sandstone reservoirs of Upper Miocene age and will be drilled to 2563m TVD subsea.

P Australian bid round

Australia's Department of Mines and Petroleum (DMP) announced a new lease sale off Western Australia state. Six licenses, four onshore and two offshore, are being placed on the auction block. The offshore areas are within the Northern Carnarvon Basin off the Pilbara coast.

The combined acreage for L13-1/T13-1 covers about 370sq km south of Barrow Island in the Barrow sub-basin. Area L13-1 is a prospective oil lease, while T13-1's sourthern portion has gas potential. Water depths are 10-50m. Block L12-1, covers about 878sq km within the Barrow sub-basin, less than 50km northeast of Onslow. Work program bids close 14 November 2013.

Analysis

Independents' frontier successes ramp wider offshore activity

By Julie Wilson

Independent oil companies have led the way opening new frontiers in recent years, but this may change as companies of all sizes have locked-up huge swathes of frontier acreage, creating opportunities for exploration-driven deals. Many new frontiers are offshore in deep waters, and a surge in frontier deepwater exploration will be facilitated by dramatic changes in rig supply. The risks of frontier exploration are high, but are even greater when opening a new country. Since 2006, nine countries have seen their first material discovery – Ghana, Sierra Leone, Liberia, Uganda, Kenya, Cyprus, Sri Lanka, French Guiana, and the Falkland Islands. All nine of the country-opening wildcats were operated by independent oil companies: Tullow Oil, Anadarko, Noble Energy, Cairn, Rockhopper, African Petroleum, and Kosmos. This is not to say the Majors have been absent from frontier exploration. They have opened a number of frontier plays in countries with established production, but they have not opened new countries as an operator.

The Majors' absence could be a reflection of cautious new ventures strategies that some have followed early in the past decade, when they were perhaps more focused on alternative growth avenues. It may also reflect onerous approval hurdles and materiality thresholds required for new country entry; exploration was centered on their large legacy positions in proven basins that offered lower-risk exploration opportunities. Meanwhile, the Independents could not gain access to those prolific basins and had to take more risks to grow. Many Majors reacted quickly to the new era of frontier exploration. Shell and Total farmed-in to French Guiana ahead of the discovery well. Others have moved to establish positions, once the potential of frontier countries had been confirmed.

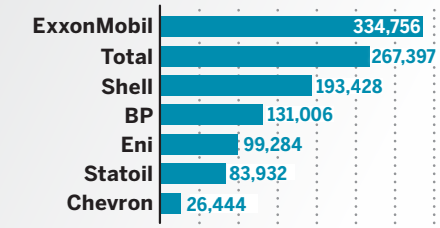
Total and Eni were fast-followers into Uganda and Ghana, respectively. In Liberia, Chevron farmed-in to operate three deepwater licences during 2010. In 2012, Shell announced a frontier exploration partnership with Tullow, covering the Atlantic basin. Further moves by the Majors to enter these emerging plays are likely to accelerate the discovery of new volumes. The results have been very rewarding for the companies involved. Over seven billion barrels of oil equivalent (Bboe) of reserves have been added to the participants' portfolios, creating over US$18 billion of value. However, in a global context the numbers are quite small. The volumes represent only 3% of total global volumes discovered since 2006, which are close to 250Bboe. Over US$350 billion of value has been created in the same timeframe, and new countries are 5% of the total.

The economics of frontier exploration have advantages and drawbacks when compared with the economics of exploring in more mature provinces. Resource discovery costs in frontier basins have been just US$1.20/boe since 2008 versus US$1.92/boe elsewhere. The competitive environment may also be easier. For Majors, the opportunity to get into basins early and achieve leadership in acreage, knowledge, and infrastructure, may be very attractive. Full-cycle returns are less enticing, averaging around 3% below emerging and mature basins since 2008. Four factors kept frontier returns down. Firstly, recent frontier discoveries have a high proportion of gas rather than oil, with lower revenues and longer field lives as a consequence. A related second factor is that frontier fields experience longer lead times, which can seriously erode

New acreage signed since start 2010

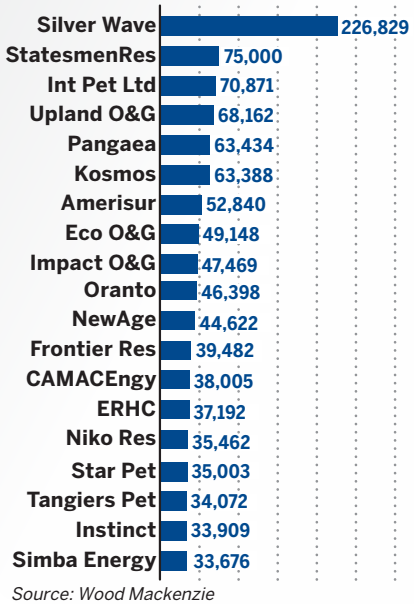
Majors

Net acreage signed since start 2010 (sq km)



Leading Small Cap

Net acreage signed since start 2010 (sq km)



Source: Wood Mackenzie

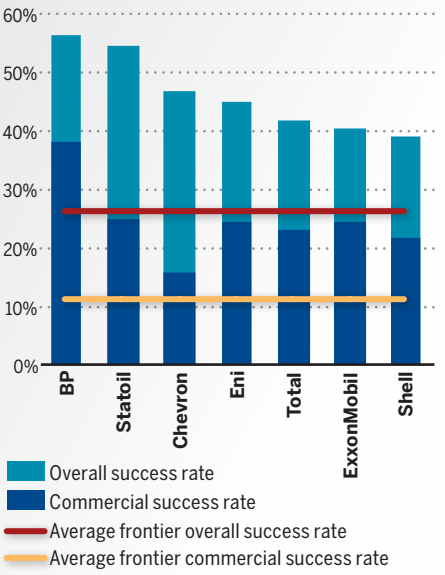
returns when up-front exploration costs are material. Third, the lack of existing infrastructure often results in high development costs. Lastly, companies investing in frontier basins generally have no existing production revenues for early recovery of exploration costs. Offsetting some of these negatives, fiscal terms are usually more attractive in frontier provinces. Average government take is 58% in frontier basins, a full 5% lower than in mature basins. Governments offer more attractive terms to entice investors and reward them for the high level of risk they are assuming. Once a basin is de-risked, there is often a rebalancing of the risk-reward equation, with terms becoming more onerous.

Although the economics of frontier exploration are more challenging, they are nonetheless positive, and we have seen a shift in the spending patterns of the most successful explorers toward frontier and emerging basins. That shift has come at a time of increasing exploration expenditure; more is being spent on frontier exploration than ever before. The Independents are, relative to their size, spending more on exploration than the Majors. Most Majors are spending US$2–3/bbl of production, while Independents typically spend two to three times that amount. Shell and Statoil have hiked their exploration spending over the past few years to reach levels above US$5/boe of production. If ExxonMobil, BP, and Chevron were to increase their expenditure to the $5/boe mark, an additional US$12 billion would be spent on exploration each year.

Many companies can expand their exploration spending and activity further, and they now have the opportunity set. There has been a huge land-grab over the past couple of years as companies scramble to reload their acreage portfolios. Of today's globally licensed acreage, around 30% has been acquired, since the beginning of 2010. Two groups have been particularly active in gaining acreage – the Majors, and a group of around 20 small cap companies, Figure 1. The Majors' acreage, acquired since 2010, totals 1.1 million sq km (439,000sq mi) and represents 45% of their combined acreage portfolio, although as individual companies the proportion ranges from 80% for ExxonMobil to 14% for Chevron. The leading small caps have taken on similarly large positions.

This amount of new frontier acreage would normally command extensive drilling programs. A conservative estimate suggests that the Majors' post-2010 acreage alone might merit some 200 high-impact wells with a total exploration investment of about US$40 billion.

Exploration well success rate (2002-2011)



Source: Wood Mackenzie

Clearly, neither the Majors nor the small caps have binding commitments to explore or invest at anything like these levels. We believe there will be a new wave of frontier exploration deals.

Some deals will be driven by the Majors. They have added more prospect acreage than can be realistically tested, and will farm-out selectively. High-impact exploration drilling in unproven basins carries more risk than drilling in established areas, taking success rates much lower. This will test their risk appetite and tenacity. The average commercial success rate of frontier wildcats, at around one well in ten, is much lower than the portfolio average for the Majors, Figure 2. While success rates have their shortcomings as a performance measure, they are often used as a key decision-making metric. Each Major that opts to increase its frontier drilling will need to accept diluted success rates. However, their limited appetite for very low chance of success drilling, coupled with rigorous process prior to drilling decisions, will result in prospect high-grading and divestment of weaker opportunities.

Other deals will be driven by the exploration minnows. The biggest hurdle for this group is always access to capital. Even when the capital markets are at their most supportive, many small cap explorers rely on promoted deals to carry them through a large part of their drilling costs. Their recent frontier land-grab has redoubled this issue. First, there are now an unusually large number of such companies seeking funding. Second, much of their new acreage includes plays that will be expensive to drill.

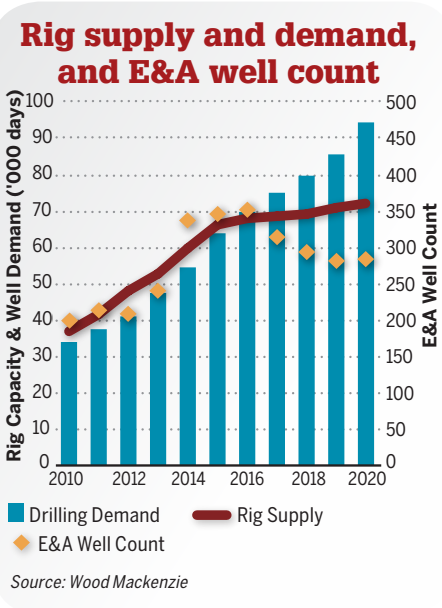
The expanded requirement for funding coincides with a period of market nervousness. Investors have a diminished appetite for the broader oil and gas sector, which has underperformed over the past year. Exposure to pure exploration risk is particularly out of market favor. It is clear that the small caps collectively hold far more acreage than they can reasonably explore. Those that have insufficient production revenue to be self-funding will seek larger partners, especially when looming drill-or-drop decisions move them to partially divest, rather than fully relinquish acreage.

Companies that continue to focus on high-impact conventional exploration will welcome the enhanced flow of frontier opportunities. Likely buyers include well-funded and technically-strong Independents. Many look well-positioned to enhance their portfolios. We may even see some divestments of predevelopment assets, as strong explorers reposition on wildcatting.

New acreage includes huge swathes of offshore frontiers, dominated by Africa and the Arctic. Since 2009, over 11.5 million sq mi of frontier offshore acreage have been licensed – representing 30 times the licensed area of the deepwater Gulf of Mexico (and 43 times the size of Texas). Around half of the deepwater frontiers are in the hands of mid- and small-cap companies, raising questions around how much of the acreage can be drilled before it expires. Some resource holders, who might be expecting drilling to follow licensing, will be disappointed.

An expected surge in deepwater frontier exploration will be facilitated by changes in the rig and services sector. Our analysis suggests that the number of global deepwater exploration

and appraisal (E&A) wells will climb to 240 in 2013, and above 350 by 2016, Figure 3. Growing levels of activity are supported by the ongoing renewal of the deepwater fleet with high-specification newbuild mobile offshore drilling units (MODUs). More than 100 new MODUs have been delivered to the market since 2008, with a further 90 expected by the end of the decade. This more than doubles the available capacity.



Source: Wood Mackenzie

Lest we forget, the strategic focus on deepwater has been driven by exploration successes many of which are now entering the development phase. So while the demand for exploration drilling grows, this is in conjunction with rising levels of development activity. An already tight rig market has been further constrained as demands on the technical specification of rigs have grown in line with increasingly stringent operating and HSE regulations, as well as moves into ever more challenging operating environments. While the current deepwater-rig, new-build phase may be unprecedented in scale and duration, the combination of growing levels of exploration and development drilling indicate that from 2016, we expect demand for deepwater rigs to outstrip supply, resulting in constrained E&A activity.

Over half the newbuild rigs have been contracted by Majors and large-cap companies. Rigs have been used as leverage to access exploration prospects, and with remote frontiers resulting in high rig mobilization costs, the first-mover to drill in a basin may have an advantage.

Companies of all sizes are experiencing a resurgence in frontier exploration. Although the challenges of exploring and developing frontiers can suppress value and returns, the rewards can be sizeable. Rigs are available in the near term to facilitate an upturn in frontier exploration activity. The coming transition from acreage capture to frontier drilling will trigger a phase of portfolio adjustment with farm-in opportunities. Much of this activity represents the normal risk-spreading process before drilling, as early entrants look to share well costs. These acreage deals will be essential to sustain an upward trend of frontier drilling. OE

***Julie Wilson**, Senior Analyst, joined Wood Mackenzie's Exploration Service team in January 2011, following 11 years in upstream consulting and research. Prior to Wood Mackenzie, she worked eight years for BP in the UK in political, commercial, and financial analysis, focusing on upstream assets. Wilson earned a BA Honours in Spanish and French from Heriot-Watt University, and an MSc in Marketing from University of Strathclyde.*

Quick stats

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

New discoveries announced

Depth range	2010	2011	2012	2013
Shallow (<500m)	93	102	72	14
Deep (500-1500m)	28	25	23	6
Ultradeep (>1500m)	29	20	34	9
Total	150	147	129	29

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

Reserves in the Golden Triangle

by water depth 2013-17

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Brazil			
Shallow	25	3,236.75	1,680.00
Deep	16	3,257.00	2,255.00
Ultradeep	40	12,428,45	17,340.00
United States			
Shallow	21	96.45	1,253.50
Deep	24	1,603.71	1824.87
Ultradeep	24	2,925.00	3,340.00
West Africa			
Shallow	150	3,378.60	18,217.81
Deep	47	5,574.00	6,420.00
Ultradeep	16	2,540.00	3,000.00
Total (last month)	363 (365)	35,039.96 (35,334.96)	55,331.18 (54,631.18)

Greenfield reserves

2013-17

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow (last month)	1,334 (1,349)	78,915.96 (78,930.66)	835,641.99 (837,296.39)
Deep (last month)	168 (171)	14,304.58 (14,524.58)	84,711.57 (87,046.57)
Ultradeep (last month)	99 (99)	18,322.45 (18,322.45)	65,907.00 (67,197.00)
Total	1,601	111,542.99	987,610.56

Pipelines

(operational and 2013 onwards)

	(km)	(last month)
<8in		
Operational/ installed	41,744	(42,633)
Planned/ possible	23,273	(23,170)
	65,017	(65,803)
8-16in		
Operational/ installed	77,255	(77,886)
Planned/ possible	47,029	(47,482)
	124,284	(125,368)
>16in		
Operational/ installed	87,825	(88,353)
Planned/ possible	48,217	(47,758)
	136,042	(135,670)

Production systems worldwide

(operational and 2013 onwards)

Floaters		(last month)
Operational	275	(274)
Under development	48	(46)
Planned/possible	316	(315)
	639	(635)
Fixed platforms		
Operational	9,637	(9,878)
Under development	144	(148)
Planned/possible	1,475	(1,467)
	11,256	(11,493)
Subsea wells		
Operational	4,411	(4,426)
Under development	393	(393)
Planned/possible	5,981	(5,981)
	10,765	(10,800)

Global offshore reserves (mmboe) onstream by water depth

	2011	2012	2013	2014	2015	2016	2017
Shallow (last month)	10,421.19 (10,429.53)	6,130.72 (6,125.23)	65,204.92 (65,466.32)	32,401.99 (34,157.68)	42,849.50 (41,087.23)	31,609.64 (31,629.57)	54,536.19 (54,574.12)
Deep (last month)	1,312.21 (1,316.73)	2,533.96 (2,533.96)	3,616.76 (3,652.02)	5,845.40 (5,830.40)	4,351.94 (3,968.34)	5,177.22 (5,424.56)	10,258.72 (10,996.57)
Ultradeep (last month)	199.94 (199.94)	737.15 (797.15)	3,090.44 (3,090.44)	3,075.06 (3,075.06)	1,789.91 (1,948.73)	6,108.56 (5,949.75)	16,114.35 (16,114.35)
Total	11,933.34	9,401.83	71,912.12	41,322.46	48,991.36	42,895.43	80,909.26

14 June 2013

G & G Notebook

Andrew McBarnet

Navigating the pitch and roll of broadband seismic

Last month's Annual Meeting of the European Association of Geoscientists and Engineers (EAGE) in London was by far the largest in the EAGE's history. Over 8000 delegates showed up at the conference and exhibition at the Excel Centre in London to create plenty of buzz, sales pitches and rumor. Andrew McBarnet offers this perspective.

Some of the big increase in attendance at the EAGE's event, nearly 2000 more than the previous record, can simply be put down to London being the venue, with its universal appeal and unique attractions. An opening speech by a royal – HH Prince Andrew, Duke of York – probably didn't do any harm. Also, it's hard to beat company evening events hosted in the Tower of London and the 19th Century *Cutty Sark* tea clipper anchored in the Thames, not to mention the official conference night for all delegates in the Natural History Museum, where the main band played to a packed audience massed around a very large dinosaur skeleton enhanced by state-of-the-art techno lighting.

The numbers also reflect the growing membership and international expansion of EAGE, which may, one day, have to drop "European" from its title and replace it with "International" or "Global." Half the membership, which has climbed to 17,000 from less than half that figure just a few years ago, comes from outside Europe. The association now has offices to serve its members in Moscow, Dubai, and Kuala Lumpur, is building a presence in South America, and is even staging regular events in North America, natural habitat of the US-based Society of Exploration Geophysicists (SEG).

The focus of the EAGE's Annual Meeting is always predominantly oil and gas E&P, so an obvious conclusion would also be that business in the geoscience field serving the oil industry is thriving. Not just geoscience, because the event has, for almost a decade, incorporated the SPE's EUROPEC conference and claims to be the largest multidisciplinary event combining geoscience and engineering.

Prince Andrew, Duke of York, made the meeting a royal occasion.

The fun at these meetings, where everyone is pitching something, is to determine how much of the talk is based on reality and to come to some conclusion on where this sector of the oil industry is heading. On the evidence present in London, this is probably as good as it's going to get.

There are a number of challenges on the horizon for the marine seismic business, not all of which have been fully acknowledged. The most fundamental is whether the main marine seismic contractors, of which there are only five left standing, can escape rampant commoditization.

This is always a sensitive issue, because companies naturally want to differentiate themselves for commercial advantage. Otherwise, if all the offerings look much the same, selling marine 3D surveys boils down to price, and that invariably ends in a low-balling fest, leading to economic misery.

Traditionally, the two ways that contractors can make a case for being superior to their competitors is by their vessels' quality and capacity and by the promised results from the technology being towed.

Taking vessels first, the global seismic fleet is pretty much up to date, following the modernization programs initiated by the leading players at

the end of the last decade. There are differences between the companies in terms of vessel size, power, and class. For example, not many are fully rated for Arctic operations, and not all have the capability to extend the weather window in northern Europe. CGG, which, since the acquisition of the Fugro fleet owns the largest number (22) of 3D vessels, does have a higher proportion of older stock, but is credited with spending $1 billion over the last three years in renovations and standardization.

For the oil company customer, the truth is that the vast majority of boats being offered for 3D seismic perform as advertised. In other words, the boat design is unlikely to be a deciding factor. Petroleum Geo-Services (PGS) might argue that its new Titan class is in a different league, which it is in terms of its enormous size and ability to tow up to 24-26 streamers. But many of the benefits, like being able to stay out of port for long periods with at-sea maintenance, exceptional crew comfort, etc., are about PGS making its operations cost-effective, i.e., not necessarily of direct interest to the client. The company has to be admired for the audacity of these monsters, the first of which, *Ramform Titan*, is now operational off the NW European continental shelf. It remains to be seen whether there is any marketable advantage. These vessels have to be costly to run, and many surveys do not require such a massive data harvester.

PGS' Ramform Titan: Will the monster make a difference?

If vessels are not the key differentiator, can we say that acquisition and processing technology is the key? In the past few years it has certainly looked that way. PGS, in particular, stole a march on the field with its GeoStreamer, launched in 2007. This was the first acquisition system to offer a "broadband" solution to improving subsurface imaging resolution in complex geological settings. The latest version, GeoStreamer GS, uses a time- and depth-distributed source technology (GeoSource) to avoid all source ghost effects on the emitted source signal spectrum. The complementary signals emitted by sub-sources in the array allow the "source ghost" effects to be removed, so much richer low- and high-frequency signal information is recovered. The system uses dual-sensor, solid streamers towed very deep to recover all of the seismic wavefield reflected from geological targets in the earth.

For a while, PGS was on its own with this technology, and even now, attributes its strong financial in 1Q 2013, with increased earnings and improved EBIT, primarily to the traction gained in the market for GeoStreamer. However, all the talk and displays at the EAGE meeting in London demonstrated just how far the playing field has been leveled, so much so that potential oil company customers can be forgiven for thinking that broadband seismic has become a standard service offered by all the main providers of marine seismic surveys. There is a wide range of broadband solutions out there now. They are not all dependent on expensively researched and developed acquisition technology, but are accessible through streamer-towing strategies and special processing, and an element of special pleading.

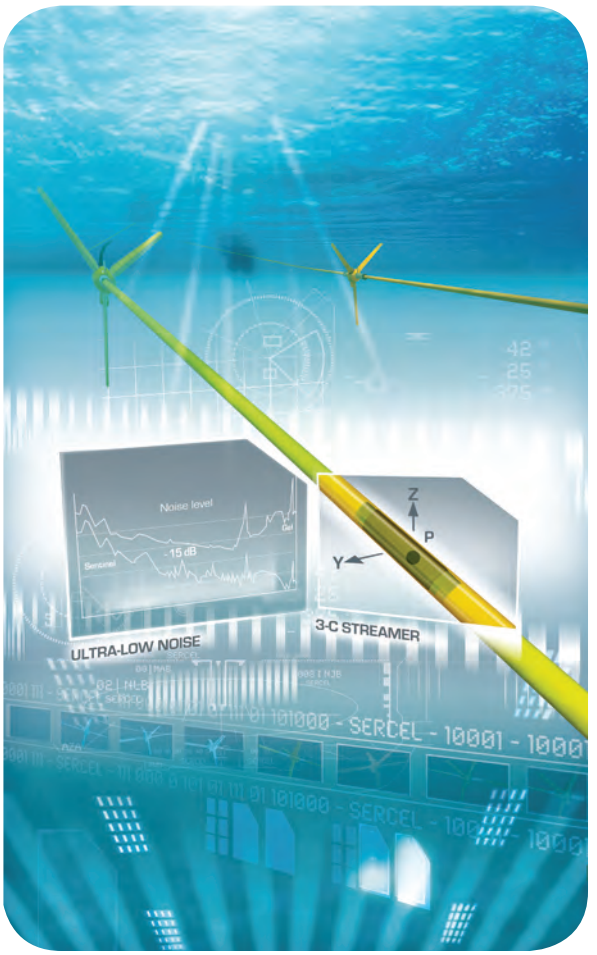
Increasingly, oil companies have been making broadband a prerequisite for marine seismic surveys. Until recently, the narrative was that PGS (GeoStreamer), CGG (BroadSeis) and WesternGeco (ObliQ and more) differentiated themselves from the rest of the herd because they had developed full acquisition and processing techniques to deliver broadband, which Dolphin Geophysical, Polarcus, and the multi-client specialists such as TGS and Spectrum could not match. As is so often the case in this technologically driven industry, that has all changed very rapidly.

Companies like Dolphin and Polarcus have come up with the rather ingenious argument, expressed to anyone who cared to listen in London, that broadband is actually a misnomer. They say that enhancement of low frequencies is what oil company clients are really looking for, rather than increasing the recorded bandwidth at both the high and low end. They contend that GeoStreamer and BroadSeis introduce unnecessary complexities into acquisition configurations, and complications into data processing requirements. Anecdotal evidence from a recent workshop on broadband technology in Kuala Lumpur suggests that they be winning the argument.

Broadband experts reportedly now concede that most of the bases for so-called broadband can be covered by the less-elaborate solutions advocated by Dolphin, Polarcus, and others.

Dolphin rather cheekily takes a shot at the big guns when it refers to its SHarp broadband combination of acquisition and processing as "fleet ready, no new equipment required." In common with the Polarcus RightBAND technique, SHarp is predicated on towing streamers deeply to record the low frequencies, plus some fancy processing to do deghosting, etc. Polarcus emphasizes an intelligent application of geophysical principles, involving each component of the seismic workflow. It customizes the source arrays for each project to generate the necessary broadband signals. Solid Sercel Sentinel streamers, deep-towed and recording in the quiet environment created as a result, enable the company to deliver data that it suggests have the lowest possible noise content across the entire frequency spectrum. Sercel claims its broadband results are as good or better than those achieved by the Big Three. For its data processing train, Polarcus uses the ION Geophysical subsidiary GXT, which, with WiBand offers an answer to the source and receiver notches in the frequency spectrum resulting from the free surface reflections (ghosts) that limit data resolution in the marine environment. Significantly, it is applicable to conventional "flat" (cf. sloping) streamer data acquisition configurations, which make up the vast majority of legacy data and the majority of new data.

As a high-profile acquirer of data through its multi-client projects, TGS has introduced its Clari-Fi, three-step ,processing solution that allows broadband data to be generated from conventionally acquired seismic data.



Sercel's MS Sentinel challenges WesternGeco's Isometrix.

Clari-Fi Totus addresses the source and receiver ghosts, while Clari-Fi Amplio broadens the spectrum to a desired shape, up to the first ghost notch frequency. The company says the solution is flexible enough to be used on a variety of marine data types (2D, 3D, narrow, and wide azimuth), both new and legacy data, and on either pre-stack or post-stack data sets. Soon, there will be plenty of other companies providing broadband-enabling products. The clear implication is that marine seismic companies will be searching for some further technology advance that can distance themselves from their competitors. A year ago, at the EAGE Annual Meeting in Vienna, WesternGeco launched IsoMetrix as the ultimate seismic acquisition technology, able to record data measuring wavefield pressure and gradient vertically and cross-line. If it works, that would be impressive, was the word. Geophysicists were talking as if it would put everyone else out of business, particularly since Schlumberger has an aggressive patent protection department to prevent copying.

A year later, IsoMetrix has yet to prove commercially successful amid rumors of streamer problems. Some have mischievously connected the recent abrupt replacement of the company CEO with the technology's muted appearance.

In London, CGG's equipment manufacturing subsidiary, Sercel, fired what can only be described as a shot across WesternGeco's bow when it announced MS Sentinel. Lo and behold, in addition to the high-quality pressure measurement provided by its hydrophone sensor, the system features two additional acceleration components, based on its Sentinel solid streamer technology. Sercel claims directional measurements for both cross-line and vertical wave fronts that deliver multi-sensor data sets for enhanced broadband imaging. Sercel stated it would be 2014 before the MS Sentinel will be available, but it appears as though WesternGeco won't have this particular differentiator all to itself.

Doubtless, PGS and other contractors will be considering their response to the cross-line measurement possibility, which will clearly provide more information about the subsurface. This always assumes that acquisition bugs and processing issues of the much larger data sets can be sorted out.

The overall message is clear: no one is going to get a jump on the opposition for long. That being said, contractors begin to look very much like operators of "boats for rent" with not much to differentiate them, i.e., the commodity scenario that they dread. With a buoyant market and negligible slack in the global vessel capacity to meet demand, marine contractors were able to leave London without too much to worry about. But a clutch of new high streamer-count vessels are due out in 2014–15. This could affect the supply-demand equation, unless there are some vessel retirements. Also companies can't count on oil companies' upstream spending continuing at its current rate. Don't be surprised, therefore, if a survey price war breaks out in the not too distant future. OE

Transport Containers | Drum Racks | Pipe Slings

Tool Baskets | Bottle Racks | Reefer Units

INEFFICIENCY

A ready, hassle-free source for CCUs. That's the mark of Tiger.

Helping you get CCUs efficiently and cost-effectively is pure instinct to Tiger Offshore Rentals. We carry the broadest range of units, so you can carry virtually any cargo to your offshore installations. We have fully stocked locations in key ports in North America, South America and East Africa, allowing us to dispatch exactly the CCUs you need, 24/7/365. You get faster response times and less freight charge on returns. In fact, you can return units to any of our locations, with no back-haul fees. With Tiger ordering is simple and invoicing is clean with no hidden fees. Everything you want and need, all from a single source. That's efficiency at its best. That's Tiger. Call us.

TIGER OFFSHORE
OFFSHORE RENTAL, LTD.

Make it happen.

24/7 Dispatch
1.877.844.3791
tigeroffshorerentals.com

EOR: A core topic

Industry and government bodies think there is still a strong future in the UK North Sea, but they are not complacent about the challenges the basin faces.

By Elaine Maslin

After more than 40 years of production from the North Sea, with declining output and an ever-more complex and costly operating environment, it would be easy to view the basin with a "glass half empty" attitude.

Industry and authorities are taking the opposite view. Investment is high, driven by a number of mega-projects and sustained high oil prices. To ensure the longer term health of the basin, increasing focus is falling on the prize that could be had from eking-out the mostly smaller pockets of remaining resources and increasing production from mature fields.

A number of fiscal and technological initiatives are underway on the UK Continental Shelf (UKCS). The role of independent oil companies in stimulating regional exploration activity and how players evolve from explorers to developers and producers will be discussed at the Offshore Europe conference in Aberdeen this September.

The UK Department of Energy and Climate Change (DECC) is leading a PILOT group that has been looking at the lack of funding for development activities accessible to smaller players, as banks remain unwilling to lend.

New tax allowances were introduced last year, aimed at improving the commerciality of small fields, ultra heavy oil, shallow-water gas fields and brown field investment. This mitigated a tax increase on oil and gas producers made by the UK Treasury in 2011.

Most new fields approved since 2012 have benefited from the small field allowance, says Simon O'Toole, head of exploration, licensing, and development at DECC. The brown-field allowance has also encouraged investment in facilities to extend field life and unlock otherwise stranded fields, with 15 projects totaling about £3billion of Capex either agreed or soon to be agreed.

Projects involving technology, such as enhancing oil recovery (EOR) and increasing production efficiency, are not as well promoted.

"We have kicked off, in PILOT, a project to see if industry as a whole can up its game in production efficiency," O'Toole said at the SPE London annual conference in May.

"We are trying to get engineers to work on existing fields to increase production efficiency. It is a real problem offshore at the moment. We are losing a great deal of production simply through unplanned stoppages and unplanned maintenance."

Another effort to prolong field life and increase production is a PILOT project to encourage EOR technologies. The UKCS has produced just over 41billion boe. The recovery rate averages 40% and is on track to reach 46%, says ConocoPhillips' Ian Walker, who recently finished a secondment to DECC.

"With a global average of 30%, it could be easy to say it is expensive to go further in the offshore environment with high well costs," he says. "We have done a good job using water flood; it went in when it was required. But at the same time, it is asked 'Why are we leaving so much behind?' There is more that can be done in EOR."

An EOR work group screened North Sea fields to see which technologies could be applied most effectively.

The group looked at miscible hydrocarbon flood, nitrogen and flue gas, miscible CO_2, surfactant with polymer, polymer, in situ combustion, steam drive, bright water ("strong gel"), low-salinity water, and colloid dispersal gel (CDG, weak gel).

"When you look at it, and look at the geographies technologies might apply to, there are a few technologies that come to the fore," says Walker. These were miscible hydrocarbon flood, miscible CO_2, surfactant with polymer, polymer, and low salinity.

"Low-salinity (water injection) lends itself to early adoption; chemical EOR would come a bit later because it is less easy to implement; and miscible gas would be later too," he said. "But in the North Sea there are examples of all these technologies at work."

BP, a leading proponent of low-salinity EOR technology, is planning the first offshore, full-field deployment of its LoSal EOR technology on the West of Shetland Clair Ridge development. This will be a secondary waterflood, expected in 2016. BP may try it next in the Gulf of Mexico, for Mad Dog Phase 2. Shell and Statoil have also been looking at low-salinity water in other areas of the world.

The group identified North Sea cluster areas deemed optimal for EOR, around Taqa Bratani's northern North Sea assets, near BP's central North Sea assets, and around Nexen's facilities in the Moray Firth. The research so far, despite being "a bit coarse,"showed the prize could be 6 billion bbl, says Walker, a significant sum when the estimated remaining recoverable resource has been put at 10-20 billion bbl.

Industry workshops have been held with 12 operators, and Walker sees "an appetite" for low-salinity technology. However, there are still uncertainties and a need to share information, provide guidelines, and encourage cooperation.

"It is low cost and there is scope for standardization and scope for shared projects," he says. "But there is also nervousness."

EOR chemistry isn't fully understood and mixed core results may unnerve investors.

The work group is developing

in the North Sea

guidelines for core testing and participants are being encouraged to share data, and consider joint facilities in cluster areas.

"Creating a common core flood protocol and building a larger database of results would help tie down screening parameters," says Walker. "Sharing lab results within clusters would encourage other operators."

One operator involved in the work is Taqa Bratani. Peter Brand, asset development manager at Taqa, told DEVEX: "There is a need for speed if we are going to get anything done using these technologies, which is why sharing information, which is not a habit in the past, is going to be key to faster progress in future.

"We have done core experiments in Pelican and Tern so far with low-salinity flooding. The results have not been spectacular but we do feel it has potential."

He said it was considered that a green-field approach would be needed to "kick-start" implementation of low-salinity EOR in the northern North Sea, offering lower costs and having the added benefit of avoiding scale and H_2S, which would encourage its use even when the incremental increase in production is fairly low.

At the DEVEX 2013 conference (Aberdeen, May), Walker warned that the industry is running out of time, with production declining (at 1.5mm boe/d in 2012), threatening the life of "core pieces of infrastructure."

Speaking at the SPE conference, Mark Tandy, commercial and exploration director at Taqa, says: "We believe [that] in the northern North Sea alone, there are over 20 billion bbl—something in the order of three quarters of a billion of that will be stranded as infrastructure pulls back."

O'Toole says: "We are going to lose some infrastructure in the next 10-15 years. In the southern North Sea we can expect there will be fewer infrastructure systems in 2025. There will not be a complete dearth of infrastructure, most areas will have some, but most of it will not be full. We need the right assessment of rewards and risks so people who own infrastructure are willing to take production across at a reasonable rate."

Together, with the efforts being made to improve or strengthen fiscal and regulatory incentives alongside technology development and use, the industry and government are both hoping the North Sea will continue to be a glass half full basin. OE

Core experiments with low salinity flooding have been carried out on Taqa's Tern (platform pictured) and Pelican fields.

Remote caisson inspection gets a hand

Caisson inspection can be crucial for long term integrity, especially of firewater systems.

Graham Marshall,
subsea project manager,
Sonomatic

The deterioration and failure of caissons, and associated supports, is a core industry concern for several reasons. Key is the impact such deterioration can have on production. Should the firewater pumps be adversely affected or out of action, the platform is required to shutdown.

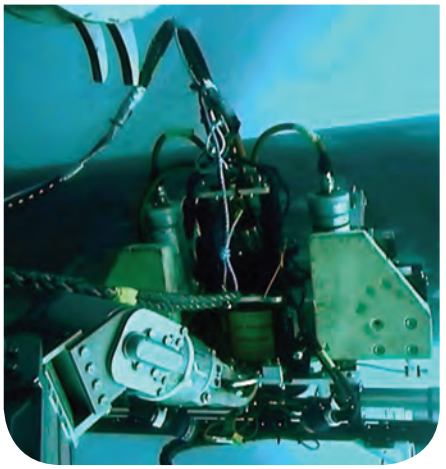
Caissons can suffer degradation that can lead to catastrophic failure if left unchecked, with potentially severe health, safety, and environmental consequences. Given the number of aging structures in operation, there is a growing focus on caisson integrity.

Repairs are costly and operators have indicated that they require effective inspection programs to identify and address deterioration before the structural integrity of a caisson is compromised. This involves regular inspection to assess the condition of caissons so that maintenance decisions can be made.

Inspection

Before an inspection, it is difficult to assess the condition of a caisson visually, as one of the main degradation mechanisms in caissons is internal. This makes external visual inspection a relatively ineffective method of determining the extent of deterioration. Internal inspection is often not possible for pump caissons without a shutdown to remove the pumps.

External ultrasonic inspection is an option that has many benefits, though it too is challenged by the position of the caisson, which spans subsea, splash zone and topside boundaries. As a result, the inspection equipment involved must be capable of both subsea and topside inspections. ROV (remotely operated vehicle) deployment subsea is now the industry's preferred method, as diver deployment has inherent safety risks and is also costly due to the requirement for a dive support vessel.



MAG-Rover deployed for caisson inspection.

The MAG-Rover

Sonomatic has recently carried out several caisson inspections using its MAG-Rover, a tethered crawler system capable of topside and subsea deployment.

The standard MAG-Rover unit is a steerable crawler driven by two magnetic drive wheels, which allow the scanner to attach to any magnetic surface. At the front is the ultrasonic transducer, which gimbals to follow the contour of the surface being inspected.

It was originally designed for the inspection of monopiles using time of flight diffraction (TOFD). This involved mounting the tool on the internal surface of the monopole whilst topside, and driving it down the monopole to the subsea environment. A straight line weld inspection probe ensured the collection of consistent data for analysis. Adapting this process to carry out caisson inspections was relatively simple.

To use the MAG-Rover for caisson inspection, the tool was required to attach to the external surface of the caisson. The original design of the tool included capability for TOFD weld and pulse echo inspection.

This capability was unchanged, but additional functionality was added to enable corrosion mapping. This involved the adding a corrosion mapping third axis to fully quantify the thickness profile of the caisson. For caissons, the MAG-Rover is attached by an ROV and controlled remotely topside. It is fully deployed by ROV with no diver intervention. Once

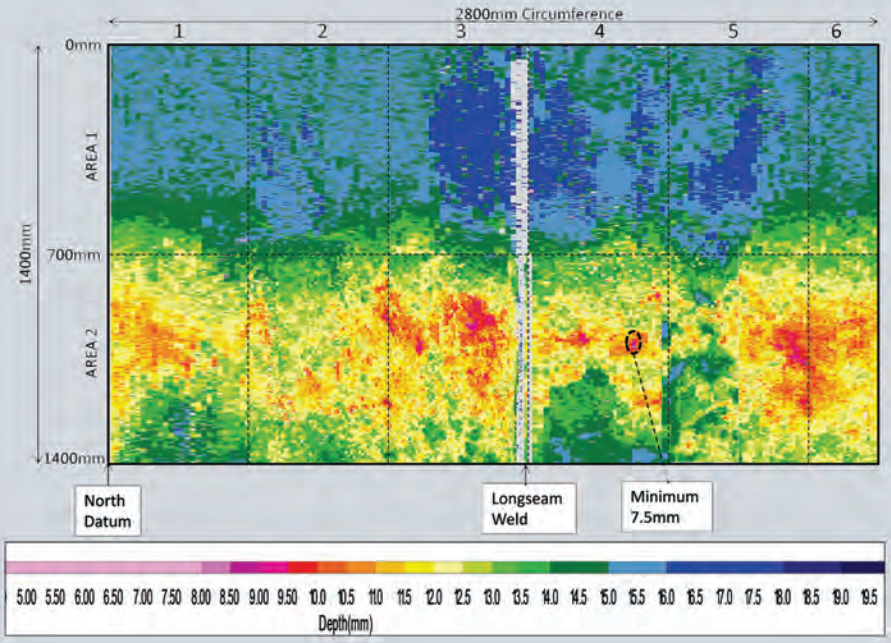


Fig. 3: Corrosion map

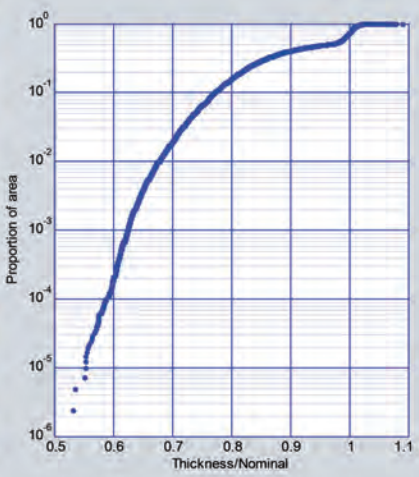


Fig. 4: Wall thickness Distribution

Case study: ROV-deployed inspection of firewater pumps on a North Sea platform

Firewater pumps are crucial to the safe operation of platforms. Caissons protect the pumps from the harsh offshore environment and provide the transport route for firewater. Degradation of the caisson can render pumps ineffective; so it is necessary to demonstrate caisson integrity for the safe platform operation. This relies on inspection to determine caisson condition.

A recent inspection of a firewater caisson by the MAG-Rover found degradation. The inspection included 0° corrosion mapping to quantify the condition of the material. Degradation was found on the internal surface of the caisson, therefore the damage was not visible to external inspection.

This corrosion map defines the nature, depth and extent of the wall loss. A further representation of the condition of the material is provided in the wall thickness distribution shown in Figure 4.

This distribution shows the proportion of the area inspected as a function of thickness. It shows that about 60% of the area is below nominal thickness and is clearly suffering wall loss. About 10% of the area is below 76% of nominal and about 1% of the area is below 68% of nominal. About 0.2% of the area is below 60% of nominal and the minimum thickness is near 52% of nominal. The detailed information obtained provided the basis for understanding caisson integrity of the and ensured sound decisions.

mounted on the caisson, it is steerable and can be positioned in the area of interest.

This enables the accurate mapping of wall loss, so that the inspection team can identify early stage degradation.

The MAG-Rover and corrosion mapping software provide of full scan data, which allows for comparative analysis on subsequent inspections. The data collected can also be used to carry out fitness-for-service and remaining life assessments, which consider the effects of deterioration and enable operational decisions.

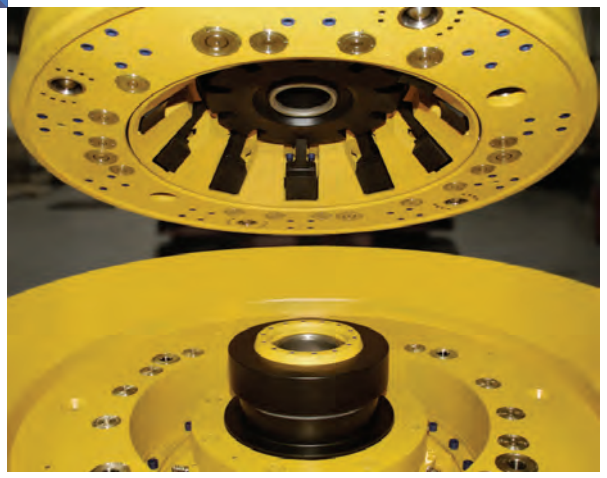
Corrosion engineering assessments, to validate the type of corrosion present, can also be carried out along with statistical analysis of the inspection data to provide a basis for definition of future inspection requirements. This stage is particularly crucial for caisson inspections, where corrosion is found, to ensure repairs can be performed before the damage impacts integrity, thereby reducing the risk of a major incident.

The program of inspection outlined above demonstrates how new technologies can work alongside existing systems and assessment methods to tackle important industry issues. It also shows how remote ultrasonic technologies can be developed and used for difficult to access and hazardous inspection locations. Not only does the MAG-Rover capture more detailed and accurate data than external visual inspection, it also captures the information in a way that ensures informed decisions can be made for the long-term maintenance of caissons.

Graham Marshall *is Sonomatic's subsea project manager. He joined the organisation in 2009. His role is focused on projects utilising ROV deployed inspection systems using advanced ultrasonic technology.*

Marshall was previously a towed array sonar specialist in the Royal Navy and since joining Sonomatic has become TOFD level ll qualified.

Emergency Release Connectors designed for high bending moment



View of face-to-face interface ensuring reliable release.

By Drummond Lawson, managing director of Subsea Technologies Ltd.

In the wake of the Macondo incident, the drilling industry has focused on making improvements to offshore safety and developing methods to recover from similar incidents.

However, emergency release connector (ERC) technologies, which might prevent or significantly reduce the impact of such disasters, are yet to benefit from this innovative process.

While incremental developments to existing connectors might provide some benefits, their design contains a fundamental flaw.

Based on the traditional male-to-female engagement, existing ERCs have operational limits, because of their geometry, and the connector may to fail to separate if unlocked with a high bending moment applied.

Failure to disconnect from the well head in this situation can lead to a major accident. The consequences of such incidents, as seen in the aftermath of Macondo and other disasters, including the 1988 blow-out on the *Ocean Odyssey*, are far-reaching.

Furthermore, there is no official record of the number of times that connectors fail to release on demand due to excessive rig offset. though unofficial figures suggest that such events could be occurring 15 to 20 times globally each year.

Additionally, when existing ERCs are disconnected with an offset, but within their design limitations, they still tend to become damaged by the disconnect process, leading to rig downtime and repair costs. It is therefore imperative that these issues are addressed by the industry.

The resulting emergency disconnect package (EDP), the XR connector, broke with several design conventions associated with existing connectors and solves its essential problems.

Using a face-to-face engagement, instead of the traditional male to female configuration, the XR connector is capable of releasing safely with 100% maximum bending moment applied.

It has no maximum disconnect angle and thus will not get stuck or fail to release when it is required to act.

Most importantly, the XR connector continues to provide options beyond normal operating limits and remains operational even after a complete riser failure.

This is especially problematic for floating vessels, on which an error in the dynamic positioning system or loss of position due to particularly bad weather can quickly precipitate a crisis, causing vessel and environmental damage and, potentially, casualties.

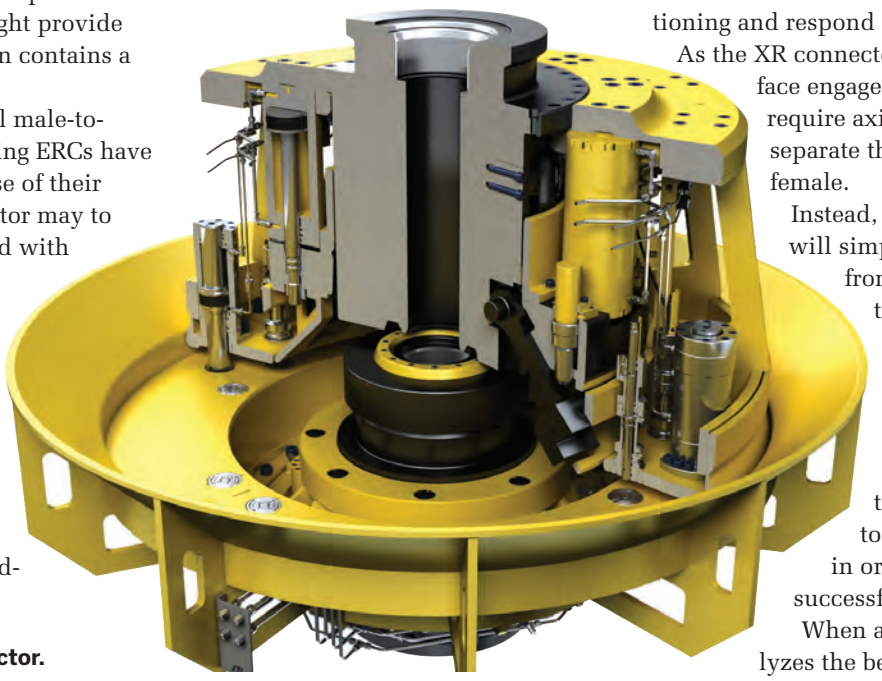
Conventional connectors have a geometry-limited maximum disconnect angle to prevent them from "locking up."

This means that, to operate within the limited angle, the vessel is limited in the distance it can move from its central position, giving the crew little reaction time to identify a loss in positioning and respond accordingly.

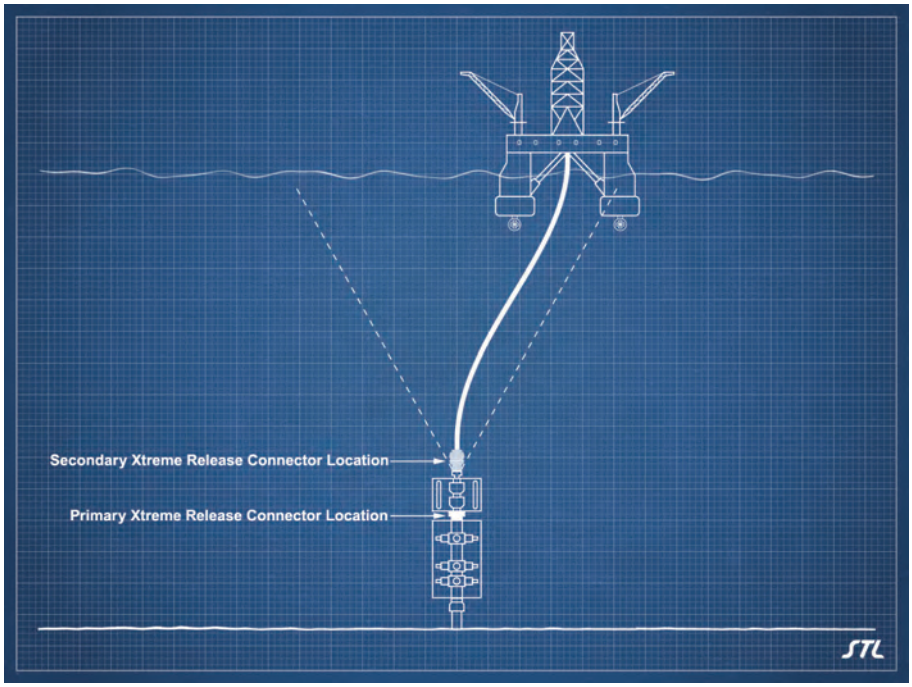
As the XR connector uses a face-to-face engagement, it does not require axial movement to separate the male from the female.

Instead, the female face will simply roll away from the male face, if triggered to release with full bending load applied. As a result, it does not even require the topside riser tensioning system to be operational in order to disconnect successfully.

When an operator analyzes the bending capacity



Section view of XR Connector.



Primary and secondary options for locating the XR connector in a drilling BOP stack.

(strength) of the riser system, the weakest point (in bending) will never be the XR connector. Even after the riser has been bent beyond the limit of its weakest point and has become damaged, the XR will still disconnect from the well.

What this means for those onboard a vessel encountering positioning problems, is that the risk to life and of damage to the vessel is greatly reduced.

Even in the event of a complete riser failure, the XR can be released to provide a competent and undamaged structural and sealing interface compatible with a capping stack.

Side view of complete 7⅜-in., 10kpsi XR connector.

In the event that it is unsafe or not possible to disconnect from onboard the vessel, the XR can be released using a remote acoustic trigger or ROV (though this is dependent on which control system it has been configured with).

When designing the system, the team at STL was keenly aware that, in an emergency situation, having time to plan a response and put that response into action is crucial to limiting damage and preventing fatalities.

The events of the Macondo incident in April 2010 were sobering for the international oil and gas industry, which prides itself on its high standards of HSEQ.

Though the XR was originally designed for use on intervention risers, plans are now in place to develop it for drilling purposes.

Had this process already occurred and the Macondo well been fitted with an XR connector, there may have been more options for the crew onboard the Deepwater Horizon and the first responders to make decisions on how to proceed. According to Ian Fitzsimmons, the XR connector, had it been configured to fit a drilling riser, would have "passed the Macondo test."

Unfortunately, in 2010 the XR connector had only been designed and manufactured for well intervention applications which only require an ERC with a relatively small bore of 7⅜-in.

However, STL plans to develop the XR, making it compatible with 18¾-in. drilling risers. This scaled-up version of the XR would offer operators the same benefits as those offered by the smaller XR, ensuring drilling crew are given options when faced with a well control emergency.

The XR connector would be particularly useful for drilling operations because it also increases productivity. Its ability to release at up to 100% maximum bending capacity means there is less need to shut down in poor weather conditions, increasing the operating window and reducing precautionary disconnects.

The STL team has completed a preliminary feasibility study for the 18¾-in. XR connector and is now looking to raise sponsorship or grant funding in order to undertake front end engineering design work. This is an ideal time to invest in the development of well control safety, as the industry adjusts to new challenges, such as drilling in deep water.

Once developed for drilling purposes, the XR connector will provide an important buffer during operations, giving crew members the time and options required to make the best decisions during an incident. OE

Drummond Lawson *began his career with Expro Group, Aberdeen, as a subsea design engineer. He has gone on to work Schlumberger IPM, working in Shell and Ramco Energy, and founded Lewis Limited before co-founding STL in 2010. He has a BEng in Manufacturing Engineering & Management from the University of Dundee and is a chartered engineer.*

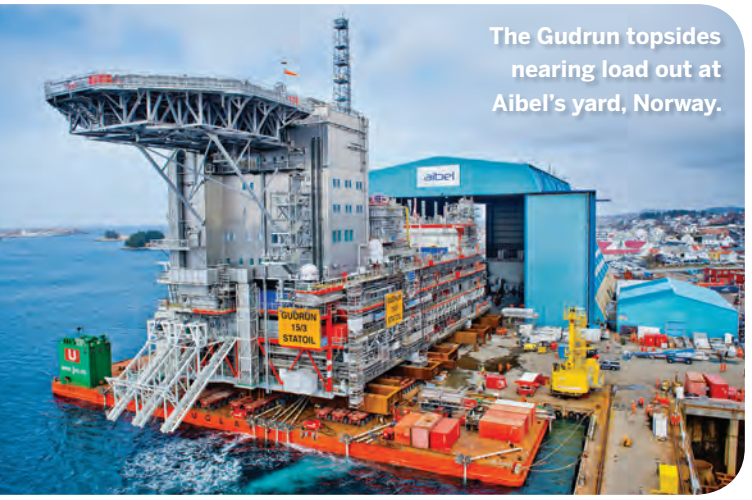
North Sea fabrication **filling order books**

A high level of fabrication activity in and around the North Sea is attracting new players. Elaine Maslin reports.

Platform fabrication for new installations in North Sea will reach fever pitch this year as a historically high number of facilities are completed for load out.

Yards around Europe, including Norway, the UK, Italy, The Netherlands, Spain, and Sardinia, are all busy completing jackets and topsides for North Sea projects.

The work is also spilling out worldwide; South Korea, home to Samsung Heavy Industries, Hyundai Heavy Industries, and Daewoo Shipbuilding and Marine, are all also busy with work for the UK sector, as well as Dubai's Lamprell and SMOE in Singapore.



The Gudrun topsides nearing load out at Aibel's yard, Norway.

Floating production features highly in the new projects coming out of South Korea in the next few years. ENI's floating production unit Goliat, based on a Sevan Marine Sevan 1000 design, is due to be installed next year in the Barents Sea, followed by BP's 270m-long *Schiehallion* FPSO a year later and Chevron's 292m-long *Rosebank* FPSO after that, both west of Shetland.

In addition, and in construction more locally, there is a growing amount of brownfield work, including new compression or accommodation modules or satellite platforms to extend life or increase capacity on fields.

IHS Petrodata, based in Aberdeen, says: "While the North West Europe region is undoubtedly dominated by subsea tieback projects, feeding so-called hungry hosts, the last couple of years have seen a higher level of activity for platform-based projects."

Data from IHS Petrodata's FieldsBase shows that 10 platforms are currently under construction and due to be installed in the NW Europe region this year. ConocoPhillips' Jasmine quarters, has already been installed, and Apache's Forties Alpha Satellite platform is nearing completion.

Looking ahead to 2014, 11 platforms are currently under construction and due for installation in that year, with a further five platforms due to be loaded out and installed in 2015. These figures compare well with historical trends, as only five new platforms were installed in 2010, seven in 2011 and seven installed last year, says IHS.

Catherine MacFarlane, IHS Petrodata's field development analyst, says: "These figures, do not, of course include future projects still in the planning stage. If all platforms with a status of possible, planned, or tendering come to fruition between this year and the end of 2017, then that is an additional 53 fixed platforms. In fact, in 2015 alone, there are 13 platforms in the planning stage and a further seven possible platforms. Of course, some of these projects will fall by the wayside, or fall victim to development delays but overall, the project pipeline remains fairly strong."

According to engineering consultancy AMEC's projections the UKCS market alone will see 32 new fixed structures (with average 6-7000 tonne topsides) built in the next five to seven years by 16 operators, exceeding historic capex spending. However, it says "considerable market constraints" are visible, for major equipment, fabrication capacity, and lift vessel/accommodation.

The buoyancy in the fabrication market follows a period of some instability, particularly in the UK, after a slump in activity in the 1990s. Last year, the McNulty Offshore yard was sold after it went into administration.

Norway's Kvearner has built a strong order book since it was spun out into a standalone company from Aker Solutions. But, the company says it needs to focus on addressing cost challenges, optimizing capacity, and increasing competitiveness.

Further afield, Dubai ship, rig and platform builder Lamprell has been regaining control of its business after a string of profit warnings throughout 2012.

There have also been projects cancelled. BG Group recently dropped its plans for a bridge-linked platform on its UK North Sea Lomond installation, after it went out to tender

to platform fabricators. The project would have unlocked the nearby Dana Petroleum Arran fields and Serica Energy's Columbus field. Dana and Serica are now looking for alternative export routes for their fields.

Two floating projects have also been cancelled. Shell is reassessing its plans for the Fram field, for which SBM Offshore had been designing a floating unit, after seeing drilling results on the field. Antrim Energy also cancelled plans for an FPSO on the Fyne field, saying the economics no longer worked.

There is still work, however. Lowestoft-based SLP Engineering, now owned by Singapore's Sembcorp Marine, is back building after being in administration in 2009 and then again in 2011 when the firm which had bought it also went into administration.

It also recently gained an exclusive license with Seahorse Platform Partners to use its Seaharvester and SeaHorse minimum facilities technology for platforms in UK waters.

OGN Group, based on the Tyne near Newcastle, saw the float out and installation of its first major project, the Forties Alpha satellite platform—the largest central North Sea platform built in the UK in 25 years—last month (May 31).

HSM Offshore, in The Netherlands, is working on its largest platform project, the southern North Sea Leman compression platform for Shell. Heerema Fabrication Group, at Vlissingen, also in The Netherlands, says the jacket for Gina Krog offshore Norway will be the largest launched jacket it has built.

The market is also about to see some new competition. With a number of significant UK North Sea projects already completed, including three jackets and a gas sweetening module for ConocoPhillips' Jasmine development, and integrated decks for Total's Elgin B and West Franklin platforms, Italy's Rosetti Marino Group is looking to build a presence in the UK.

Marco Deserti, Rosetti general manager, says to be more competitive in the North Sea the firm is looking to work in partnership with a yard in the UK.

By building projects in the UK, it could be more cost competitive by removing transport costs, he says. It has already started recruiting, having recently advertised for an Aberdeen-based branch manager, and has set up a UK-registered company, Rosetti Marino UK.

Rosetti, which more traditionally works for the Mediterranean and West African markets, has already shown it can work overseas; it opened a yard in Kazakhstan in 2008, which now accounts for 30% of the firm's turnover, says Deserti.

It is currently also working on a four-legged jacket and for the Ivory Coast Marlin project for Foxtrot International, with sail-away 2014-25; two integrated decks for ENI for the Fauzia and Elettra platforms in the Adriatic Sea, and a deck for the IKA JZ platform project off Croatia.

Meanwhile, large North Sea investments will continue, says Mark Wallace, Maersk Oil's Danish unit's managing director, after announcing $800million of investment in a new platform to be built by Denmark's Bladt Industries for Tyra Southeast in the Danish Sea, following a competitive tender.

"The Danish North Sea still contains significant oil and gas resources," he says. "However, the remaining oil and gas is becoming progressively more difficult to extract requiring efficient development, new technology, and continued large investments. The Tyra Southeast development is an example and represents an important part of the next chapter in the Danish oil production."

Engineering consultancy AMEC agrees. ''We are continuing to see a huge demand from our customers operating in the North Sea" says Sandy Clark, AMEC's strategy and growth director. "For those businesses like AMEC who are able to meet the challenges and complexities, it is an exciting time." OE

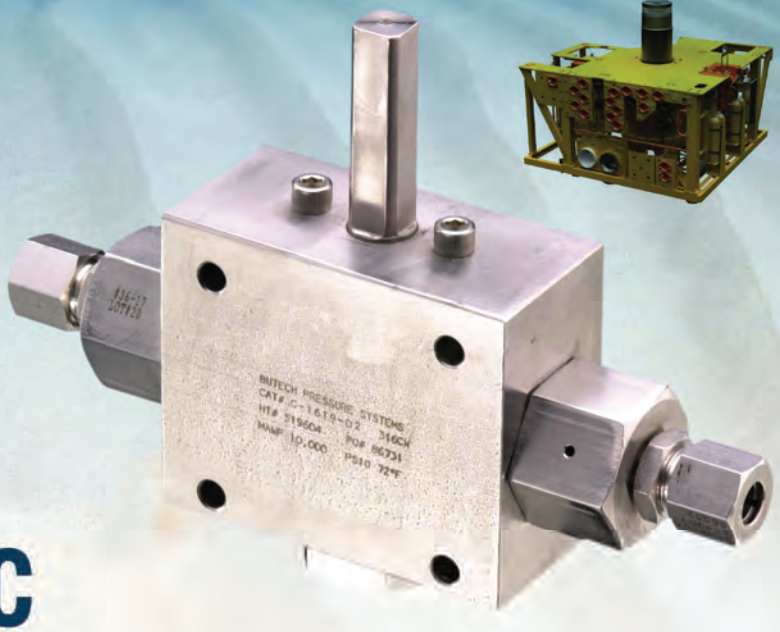
Left: Apache's Forties Alpha Satellite platform (FASP) in the Hadrian Yard. Inset top and center: Apache's Forties Alpha Satellite platform being towed out to sea. Inset bottom: Heerema's heavy lift vessel *Thialf* lifting the FASP into place, image courtesy of Apache.

North Sea platform projects

Project / shelf	Operator	Topsides	Jacket	Notes
UK Continental Shelf				
Cygnus (gas)	GDF Suez E&P	Process and utilities module, two wellhead modules, compression module with bridges and other structures, Heerema Fabrication Group, Hartlepool. Due March 2014-2015.	Four jackets and piles (total weight 8000-tonne), BiFab, Methil, Scotland.	Cygnus Alpha (three platforms) and Cygnus Bravo (one platform)
Leman	Shell	New 3000-tonne compression platform. HSM Offshore, Netherlands, Quarters and utility platform, Bifab, Methil. due out 2014.	Jacket, HSM Offshore, 2013.	HSM's largest platform project to date.
Clipper	Shell	84-person accommodation module, Rosetti, Italy.	Jacket, Rosetti.	
Golden Eagle	Nexen	Wellhead and production, utility and quarters deck, Lamprell, Jebel Ali yard, Dubai, completion due 2013 and 2014. 140-person accommodation module and flare stack and bridge, Sembcorp SLP (formerly SLP Engineering), Lowestoft, UK, sailaway May 2014.	Two 6000-tonne jackets, HFG, Vlissingen, Netherlands.	
Solan	Premier Oil	3500-tonne topside, BiFab, Methil and Arnish yards, Scotland, due for float out April 2014.	8000-tonne jacket, Bifab, Methil.	
Mariner	Statoil	Production, drilling and quarters platform with 50 well slots, Daewoo Shipbuilding and Marine (DSME), South Korea.	21,000-tonne jacket, Dragados Offshore, Puerto Real, Sardinia, due out June 2015.	Largest jacket to be built by Dragados.
Bressay	Statoil	Contracts yet to be announced – SNC Lavalin doing FEED as it did for Mariner.		
Rosebank	Chevron	292m long, 99,750-tonne FPSO, Hyundai Heavy Industries (HHI).	n/a	
Clair Ridge	BP	Drilling and production platform and quarters and utility platform, HHI, due to be installed 2015.	Two jackets (22,300 and 9000-tonne respectively), Aker Solutions, Verdal, Norway. Due to be installed mid-late July, going to print.	
Montrose Arbroath Redevelopment	Talisman Sinopec Energy UK	8500-ton topsides, Heerema Fabrication Group, Zwinjdrecht, Netherlands, due out April 2015.	5400-tonne jacket, OGN, Tyneside, due out March/ April 2014.	
Forties Alpha	Apache	Satellite platform, OGN, Tyneside, had been due out 2012. Sailed out May 31.	Jacket, OGN, sailed away August 2012.	
Britannia	ConocoPhillips	Long term compression module, Wilton Engineering, Teesside. Due to complete summer 2013.	n/a	
Elgin B and West Franklin	Total	Production topsides for the Elgin B and West Franklin platforms, Rosetti, Italy. Installation due in July and August.	Saipem, already installed.	
Fram	Shell	Shell had approval for an FPSO development but said in January it was reassessing options after drilling results.	SBM Offshore had been working on plans for a unit.	
Claymore	Talisman	1200-tonne compression module, HSM Offshore, due out in August.	n/a	
Schiehallion	BP	FPSO, HHI, South Korea, to be delivered early 2015.	n/a	
Lomond	BG Group	BG put out to tender for a satellite platform, but then cancelled the project.	It leaves Dana Petroleum and Serica Energy looking for alternative export solutions for their Arran fields and Columbus development, respectively.	

SUBSEA. NOT SUBSTANDARD.

WE CAN HANDLE THE PRESSURE!



pneumatic AND hydraulic COMPANY, LLC

Lafayette, LA
1338 Petroleum Pkwy.
Broussard, LA 70518

Houston, TX
15811 Tuckerton Rd.
Houston, TX 77095

1-877-836-1999

pneumaticandhydraulic.com

PHC offers a full line of subsea valves designed for the harshest environments. We provide an extensive line of BuTech needle valves, ball valves, and check valves for all of your subsea applications, including but not limited to chemical injection, well control, and process valving. Our subsea valves are able to withstand hydrogen sulfides, paraffin thinners, and corrosion inhibitors to ensure reliable and easy operation in your application. Numerous fittings and configurations are available to custom fit each and every application.

Let PHC supply all your subsea valve requirements in this progressing Industry.

"Service Beyond all Expectations"

3rd Annual

emerging FPSO forum

REGISTER EARLY & SAVE

The Emerging FPSO Forum brings together industry experts from around the globe with real-world FPSO experience. Join these industry thought-leaders as they discuss the latest FPSO business developments.

September 24-26th

Galveston Island
Convention Center at
the San Luis Resort

NEW THIS YEAR!

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

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

PRESENTED BY: OE

HOSTED BY: BW Offshore, Shell

SUPPORTED BY: MTS

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

SPE Offshore Europe Conference and Exhibition

3rd-6th September 2013
Aberdeen, UK

Offshore Europe 2013

LEARN

CONNECT

EXPLORE

DISCOVER

SPE OFFSHORE EUROPE THE NEXT 50 YEARS

SPE Offshore Europe is where the E&P community meets to find the solutions required to keep up with an accelerating technology race, and understand the demands of a changing industry committed to ensuring security of supply in an increasingly complex world.

REGISTER NOW
WWW.OFFSHORE-EUROPE.CO.UK

3rd–6th September 2013
AECC, Aberdeen, UK

REGISTER FOR THE FREE CONFERENCE & EXHIBITION: WWW.OFFSHORE-EUROPE.CO.UK

The Offshore Europe Partnership,
a joint venture between:

SPE International
Society of Petroleum Engineers

Reed Exhibitions
Energy & Marine

Image credits: Ole Jørgen Bratland (COSL Pioneer) and Statoil ASA (Vega field)

Fabricating an 8-leg launch jacket in record time

Using multiple work centers and close project management, L&T delivered the MNP jacket on schedule.

By C. S. Kole, Larsen & Toubro MFY LLC, Sohar, Oman
Kumar Rudra, Larsen & Toubro, Mumbai, India

Larsen & Toubro (L&T), India was awarded the Mumbai High North (MHN) process platform, living quarters, and process gas compressor module project by ONGC, on 31 July 2009. The demanding, 33-month schedule included EPCI of an 8-leg launch jacket weighing in excess of 13,500 metric tonnes (mt) with jacket delivery in 12 months.

The project management team decided to execute the MNP Jacket project from multiple work centers with independent task forces: engineering at L&T Valdel (LTV) Bangalore, fabrication at L&T Modular Fabrication Yard (MFY) Sohar, Oman, and project management and installation at Mumbai.

The MNP jacket (60m x 82m x 81m) and its piles were completed ahead of schedule, in ten months. This was achieved by meticulous planning and coordination between teams, and "imagineering" unique fabrication sequences. The MNP Jacket sailed away in November 2010.

Preliminary calculations indicated a substantial increase in jacket weight when compared to the client's FEED calculations, due to an increase in topsides area and load. Vendor inputs for equipment, packages, and installation constraints had cascading effects on jacket weight.

Due to time constraints, the project team decided to start fabrication based on drawings submitted to the client for approval. Construction engineers were available for real-time inputs on drawings.

The steel required was ordered from Korean mills, based on the preliminary material take-off (MTO). Since the dimensions were preliminary, tubulars with standard length of 11.8m and can length with extra 0.3 m were procured.

Mudmat fabrication in process.

The MNP jacket sailed out from L&T's Modular Fabrication Yard in Oman.

Schedule optimization:

The jacket was intricate, including 20 skirt legs with skirt pile guides, and 23 internal risers (over top and bottom row instead of side panel). Jacket dimensions required the outside panels to be fabricated elsewhere, and to be moved to the final roll-up location after roll-up of the inside panels. Self-propelled, modular trailers were used for transportation of panels. The fabrication sequence was altered four times to optimize activities and timing.

Fabrication

Client representatives at LTV during engineering reduced cycle time and speeded document approval. Client's consultants were authorized to expedite the work. Difference in time zone and work week between Oman and India was effectively utilized for query resolution. The fabrication sequence optimized use of resources during fabrication cycles. Its flexibility motivated the construction team to innovate and try possible options. Special tools and welding processes (automatic FCAW) were used for launch cradle welding and internal stiffener insertion inside the main leg.

The jacket's outside legs had double batter, whereas the inside (launch frame) had single batter. The main jacket was to be supported on the seabed with 20 skirt piles and guides. The dimension between the two launch legs was 20m.

This jacket was divided into multiple components including: launch cradle (two per launch leg), launch truss (Row 2 & 3), side panels (Row 1 & 4), Row A and B side panels, Five horizontal

frames, mud-mat (steel), pile guide and sleeves, buoyancy tanks (on Rows 1 & 4 for controlled upending), and 23 risers (10 on top, 13 on bottom); sump caisson, fire, water, and utility caisson.

The launch cradle had transverse and longitudinal webs that were welded to the launch leg. The cradle was supported by timber along the bottom and the mating surface was timber over a stainless steel (SS) skid beam with wax and grease in between.

The launch cradle was fabricated in 3 or 4 pieces, kept on the skid beam, and joined. Care was taken during welding to minimize distortion and to provide saddle supports. Launch trusses were fabricated on the saddle supports, which were designed for jacking down.

The launch truss members were designed to withstand normal wave forces as well as load-out forces during skidding. The launch leg had internal/external stiffener rings at nodal locations to resist pinching stresses. The launch leg was made of 63mm-thick, 2z (50ksi) material. Launch trusses were fabricated in parallel position 85mm higher than required to avoid contact between rolling members, during the roll-up process. Legs were placed on cup/saddle support and cross bracings were added.

Once the panels were fabricated, the horizontal framings were erected. Cross bracings of Row A were installed. Row 2 was rolled-up first against the horizontal framings, guyed in position, and horizontal framings fit-up with the leg was completed. After welding, the cranes were positioned to roll-up Row 3. The panels, weighing around 1450mt, were rolled-up using four cranes. Once Row 2 & 3 panels were in position, Row B cross bracings were installed and welded.

Jacking down

It was decided to jack down the entire jacket instead of individual panels of Rows 2 & 3, considering safety and the following advantages, the inside jacket structure as a whole is sturdier, connected panels eliminate misalignment, and the members between Legs 2 & 3 could be erected and welded.

The roll-up saddles were inserted between the launch cradle and launch panel; Rows 2 & 3 were supported on these saddles. Individual panels were rolled up; the inside jacket was completed and jacked down to the required height.

Side panels

Leg-pots were designed to accommodate ground elevation change from initial to final side panel location. Side panels were transported with leg-pots and placed on final location, after which skirt sleeves and guides were completed. Plates provided easy maneuverability for offloading the panels. The flooding and grouting line for leg was completed prior to roll-up. The panel was then rolled-up against the inside jacket using four cranes.

Horizontal panels

The inside horizontal panels were fabricated as "K" and positioned using temporary steel before roll-up of Rows 2 & 3. These panels were guyed with wires and roll-up was done against them. This avoided the necessity of a pup piece and girth weld, for which 100% radiography is required, thereby saving time. Erecting 13 risers (top row B) with synchronized cranes was time

Launch cradle fabrication in progress.

Lay-out of side panels for fabrication and assembly.

consuming and had an adverse impact on the project schedule. During brainstorming sessions several options were evaluated. The project management team decided to build temporary "riser racks" and erect them after completing the frame of Row B.

This procedure had cost and schedule advantages, was safe, fast, and required much less steel. Care was taken to avoid damage to concrete-coated risers.

The horizontal panels between Rows 1 & 2 and Rows 3 & 4 were used as "riser racks" to temporarily keep the Row B risers. These inclined braces were checked in STAAD Pro for deflection against the risers' load. Temporary stoppers were provided to prevent risers from slipping. Riser clamps were pre-assembled and welding was completed after alignment of all riser clamps. Once the risers were stored in racks, the top panel with riser clamps was erected; welded, and then individual risers were lifted and clamped.

Features of the MNP Jacket

JACKET STRUCTURE	MNP JACKET
Legs	8
Load out weight (mt)	13500
Jacket buoyancy (mt)	15200
Reserve buoyancy (to gross)	12.87%
Top dimension (m)	60.5 x 25.5
Bottom dimension (m)	80.4 x 45.4
Water depth (m)	72
Top elevation (m)	EL(+) 7.6 (walkway level)
Bottom elevation (m)	EL(-)71.5
Total Height (m)	83.32
Leg diameter (m)	2.5
Horizontal levels	5
Corner leg batter	Double (1:8)
Installation method	Launch
Risers	23 (CTE and concrete coated)
Caissons	3
Foundation piles	20 skirt piles (1981mm OD)
Pile location	3 on corner legs, 2 on inner legs
Pile weight (mt)	8000
Pile length (m)	144
Pile penetration (m)	115
Design period	Sept. 2009 – Sept. 2010
Fabrication period	Feb. – Nov 2010
Cranes used	2 x 600mt, 2 x 450mt, 4 x 250mt, 1 tower crane
Manpower	+1200

Buoyancy tanks under construction.

Mud mat, pile guide, and sleeves

The mud mat was made of 4mm corrugated steel plate, seam-welded over the rolled part of the frame. The mud mat with frames was lifted in sections and installed.

The piles (20) were parallel to the legs. Each corner leg had three piles and the central leg had two piles. The main leg did not have any piles, and internal stiffeners were provided to resist against bending load and pre-punching load. Piles were provided with pile guide to facilitate welding during driving. Pile sleeve was joined to the leg with a combination of tubular section and yoke plate.

Buoyancy tanks

Buoyancy tank design and connection details were very complicated and required approval from the installation contractor. The two buoyancy tanks weighed 600mt each, including 150mt connection details for each tank,

The required resources were mobilized and three separate teams were formed for fabrication and installation. Buoyancy tanks were positioned using four cranes and rolled on inclined support using two cranes. The roll-up was more critical due to inclined cup supports and probability of slippage of the whole structure.

Load-out

A special skid-way was created at MFY on which the MNP was assembled. Load-bearing capacity of the skid beam was calculated at 150mt/m and involved 600mt of fabrication. Due to time constraints, outsourcing fabrication or bought-out skid beam was feasible, however, considering quality, it was decided to procure a suitable skid beam.

The ground was leveled and compacted, and workers placed sleepers to prepare the skidding track. The vertical load on skid beam / sleepers was 1500 kN/m. Traction load along skid beam and sway load perpendicular

CONNECTING You to the OIL AND GAS INDUSTRY

People. Industry. Connect

Visit Oilonline.com today and connect with oil and gas professionals throughout the world. In addition to networking, expand your professional profile by uploading your resume, accessing and engaging in resources and training, and staying up to date on industry news.

Create your profile today @ oilonline.com and be a part of the global oil and gas community.

OILONLINE
Advancing the Industry

to the track were max 15% and 5%, respectively.

The skid beam top surface was leveled within 6mm using shim plates between the skid beam and sleeper surface and then welded together. This weld provided locking against the traction pull required during skidding operation. The skid beam top was SS plate, stitch-welded over CS material and the mating surface was SS plates with timber. FC grease with slip coat was used as lubricant. During load-out, break-out was achieved with only 270mt (2% of jacket weight).

Load-out operation required four-strand jacks (900mt each), 34 strand wires (18mm) with SWL 15mt in each strand jack, power packs for strand-jack operation, motorized ballast pumps, 24 No's (1000mt/hr) and 16 No's (250mt/hr), ballast line pipes, mooring wires, mooring winches, etc.

The barge was made stern on, moored by lines and winches. Strand wires were then pulled from strand jack to anchor frame mounted on the barge. A temporary platform was fabricated on the skid beam to facilitate strand-wire pulling operation. These innovations saved two days. The jacket was ready for load-out, once all the strand wires were laid down. A pushing bracket with 450mt push jack was welded to the skid beam. Strand wire pre-tensioning began jacket movement. The jacket was moved at 10m/hr and the barge level was monitored continuously. Barge level was within 25mm throughout the operation.

The jacket reached the final load-out location as it touched the stopper plate. Once sea fastening activities were completed, the jacket was ready for sail out.

The MNP jacket was successfully launched in Mumbai High field on 20 January 2011. Successful completion of the launch jacket in record time of 10 months demonstrated that new benchmarks can be established with proper coordination among teams, client's support, calculated risks, proper risk mitigation plans, and out-of-the-box thinking. Some innovative concepts that could not be implemented in this project can be implemented in future projects. OE

MNP jacket ready for load-out.

Launch of MNP jacket in Mumbai High Field.

Acknowledgement

The authors wish to acknowledge the contribution of co-authors Mssrs. S. P. Kulkarni, Dibyendu Das, Prabhas Tripathi, Sandeep Badhe, Shardul Samant, and Devendra Awadhiya during execution of the project and their assistance in the development of this article.

Mr. C.S. Kole *is Chief Executive of L&T Modular Fabrication Yard, Sohar, Oman and has been responsible for planning and execution of fabrication projects for L&T's Hydrocarbon Business at Sohar yard. He has 32 years of experience and has successfully completed more than 30 major onshore and offshore projects. Kole is a Civil Engineering graduate and gold medalist from University of North Bengal.*

Mr. Kumar Rudra *is Head – Projects and is responsible for L&T's Upstream Domestic Oil & Gas Operations. He has more than 22 years of experience and has successfully completed more than 12 major EPC projects. Rudra is a Chemical Engineering graduate from Jadavpur University Kolkata.*

EXCLUSIVE RESEARCH

Deepwater Intervention

Technology Needs Assessment 2013

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

Available only @ OILONLINE Advancing the Industry

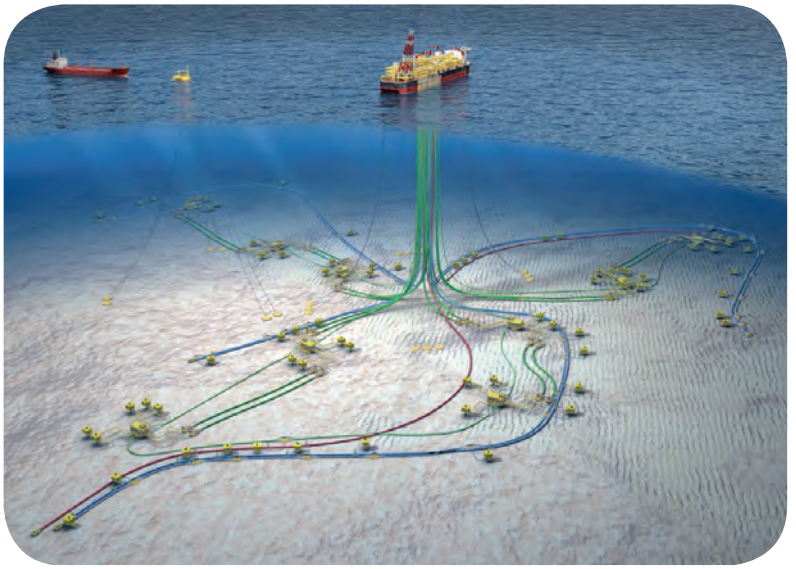
www.oilonline.com/store

OE ATCOmedia PUBLICATION

Gelb An Endeavor Management Company

Mooring line failures attract industry attention

Mooring lines on floating production systems continue to fail, costing the industry lost time and production—why and what is being done? Elaine Maslin reports.



The *Dalia* FPSO had a chain failure near the anchor and another failure in the same area two years later.

The use of floating production systems in the offshore oil and gas industry has been predicted to grow at a significant rate between now and 2017.

The number of newbuild units coming onto the market—on top of conversions—is expected to peak in 2016 and 2017 (*OE* April 2013).

However, the number of mooring-related incidents involving floating production units continues to raise concerns in the industry.

Kai-Tung Ma, of Chevron Energy Technology Co., says between 2001 and 2011, there were 21 mooring failures—an average of more than two per year (OTC.13, paper OTC-24025-MS). Nine were multiple-line failures.

Research by Granherne, a KBR company, (OTC.13, OTC-24181), lists 23 permanent mooring failures since 2000, and four of those were categorized as catastrophic, with riser failure and extended field shut-down.

In addition, at least 20 floating production systems (FPS) had integrity issues requiring intervention and 150 mooring lines were repaired or replaced across 33 FPS, says Sai Majhi, of Granherne.

"We are having too many [repeated] mooring failures," says Ma. "In 2011, we had four and when preparing this paper, there were another two chain failures and one wire rope failure, so it is ongoing."

The consequences of multiple mooring line failure can be high, says Ma. It is not just the mooring lines that break—risers and other subsea equipment can be damaged, making reinstatement costly.

The *Gryphon Alpha*, which saw four of ten lines parted when it came off station in a storm in the UK North Sea in early 2011, cost an estimated US$1.8billion to reinstate, says Ma. *Banff*, with five of 10 lines parted when it came off station in the same sector later in 2011, will cost an estimated $0.3billion.

"*Nan Hai Fa Xian* (moored south east of Hong Kong), had four of eight lines broken," says Ma. "Plant [equipment] was flipped upside down, pipe ruptured and all the risers broken. The message here is that the consequences of failure are high."

However, when it comes to assessing the cause of mooring line failures, results have not been clear.

Research presented by Ma showed mooring chain accounted for the majority (47%) of all incidents followed by wire rope and then polyester rope. By number of breaks, mooring chain was still the primary cause.

Due to the high variety of root causes, from knotted chain, to fatigue and corrosion, finding trends is "challenging." Worse, more than half of the root causes were surprises—unexpected issues, hard to pre-empt.

But when failures do occur, Ma says they are often then repeated in a similar area on the same installation.

"*Dalia* had two chain failures near the anchor; [the second break two years after the first] almost exactly in the same location. There are more examples of multiple breaks in the same place. In your design, you are going to have a weak point and that weak point is going to be in your mooring lines and you are likely going to have similar failures in other lines."

Another trend is early-life failure. "There is a clear trend of 'infant mortality'," says Ma. "So many incidents happen in the first five years (12 of the 23 assessed)."

Majhi's research showed a similar trend, with the replacement rate of mooring lines peaking in the first two years (about 50 of those assessed since 2000), falling to just under 30 in the fifth year, before slowing increasing towards the 20-year life of the system.

There has been work on improving mooring integrity in the past decade, including the SCORCH (seawater

corrosion of rope and chain) joint industry project, says Majhi. However, there is still a lot of room for improvement, from the design phase through procurement, installation and operation and having technically competent oversight. Mooring system inspection, for example, varies widely, from annually to every five years.

"During mooring design, handling and installation, there is very little interface and if it does happen, it is late in the game. If companies try to have a feed-back loop, you find there are gaps in manufacturing, gaps in installation." Closing these gaps would take the industry in the right direction, he says.

"One of the big challenges is interface, ensuring early and efficient engagement," says Majhi. It's also important to ensure that design methodology assumptions are correct, reflecting worse-case scenarios. He says adequate modeling should be carried out, and that once installed, systems should be re-analyzed. "One of the biggest gaps is re-analysis of as-built systems; if information is captured, it is not put back into to mooring analysis," says Majhi. The procurement and manufacturing phase needs to be closely managed, to make sure design specifications are followed-through and that strength, fatigue and corrosion protection verification is carried out, he says, as compliance "varies widely" and there are often multi-layered contracts. In addition, materials used should be traceable for future testing.

He said there is a reliance on Class designations for quality assurance and control of hardware manufacture, but a lack of detailed oversight of it. Dedicated, technically competent inspectors are needed to oversee compliance, he says. This includes during testing of materials, such as heat treatment, where control of the process can directly impact test results, and non-destructive testing (NDT) beyond Class requirements.

During installation, mooring hardware, deck equipment, and monitoring equipment needs to be correctly specified and in-situ maintenance and replacement of deck equipment planned in. "Having spare equipment is one of the big savers when offshore, you need to expect there is going to be damage of some critical component," says Majhi. "You also need to have a good deck-handling protocol so you do not damage sheathing before you put it in the water."

Once installed, there is a risk the mooring system is "out of sight and out of mind," instead of being subject to a good inspection protocol and condition assessment with data fed back for future projects and code enhancement, says Majhi. During one failure investigation, it was discovered that the crew on the vessel did not have any kind of monitoring system and they did not realize they had a mooring failure until they saw a fixed platform nearby moving away from them, says Ma.

On an industry level, Ma says that engineering standards should be updated and developed to "raise the bar" industry-wide. Work is being carried out based on API standards to agree on new codes, he says, adding that the move to deeper waters will bring an increased need to understand the "novelty" of going in to deep water.

"The tension is higher and we are going in to high-pressure environments and using longer mooring components," says Ma. "We should encourage joint industry projects and share lessons learned openly, without identifying facilities."

Majhi's conclusion is a little more pragmatic: "It is prudent to anticipate failure and be prepared." OE

Eight major incidents

known to the authors of paper OTC-24025-MS in the 10 year period from 2001 to 2011:

2011 *Banff* – 5 of 10 lines parted.

2011 *Volve* – 2 of 9 lines parted, no damage to riser.

2011 *Gryphon Alpha* – 4 of 10 lines parted, vessel drifted a distance, riser broken.

2010 *Jubarte* – 3 lines parted between 2008 and 2010.

2009 *Nan Hai Fa Xian* – 4 of 8 lines parted; vessel drifted a distance, riser broken.

2009 *Hai Yang Shi You* – Entire yoke mooring column collapsed; vessel adrift, riser broken.

2006 *Liuhua* (N.H.S.L.) – 7 of 10 lines parted; vessel drifted a distance, riser broken.

2002 *Girassol* buoy – 3 (+2) of 9 lines parted, no damage to offloading lines (2 later).

PRESENTED BY:

OE

Follow us!

DEEPWATER INTERVENTION FORUM

Be a part of the conversation.

Sharing Technology, Bridging Resource Gaps and Improving Competencies

AUGUST 13-15, 2013
Galveston Island Convention Center
@ the San Luis Resort

deepwaterintervention.com

Hosted By:

bp

subsea 7

Supported By:

SUT Society for Underwater Technology

IC TA Intervention & Coiled Tubing Association

2013 Sponsors

HALLIBURTON

OCEANEERING

FORUM ENERGY TECHNOLOGIES

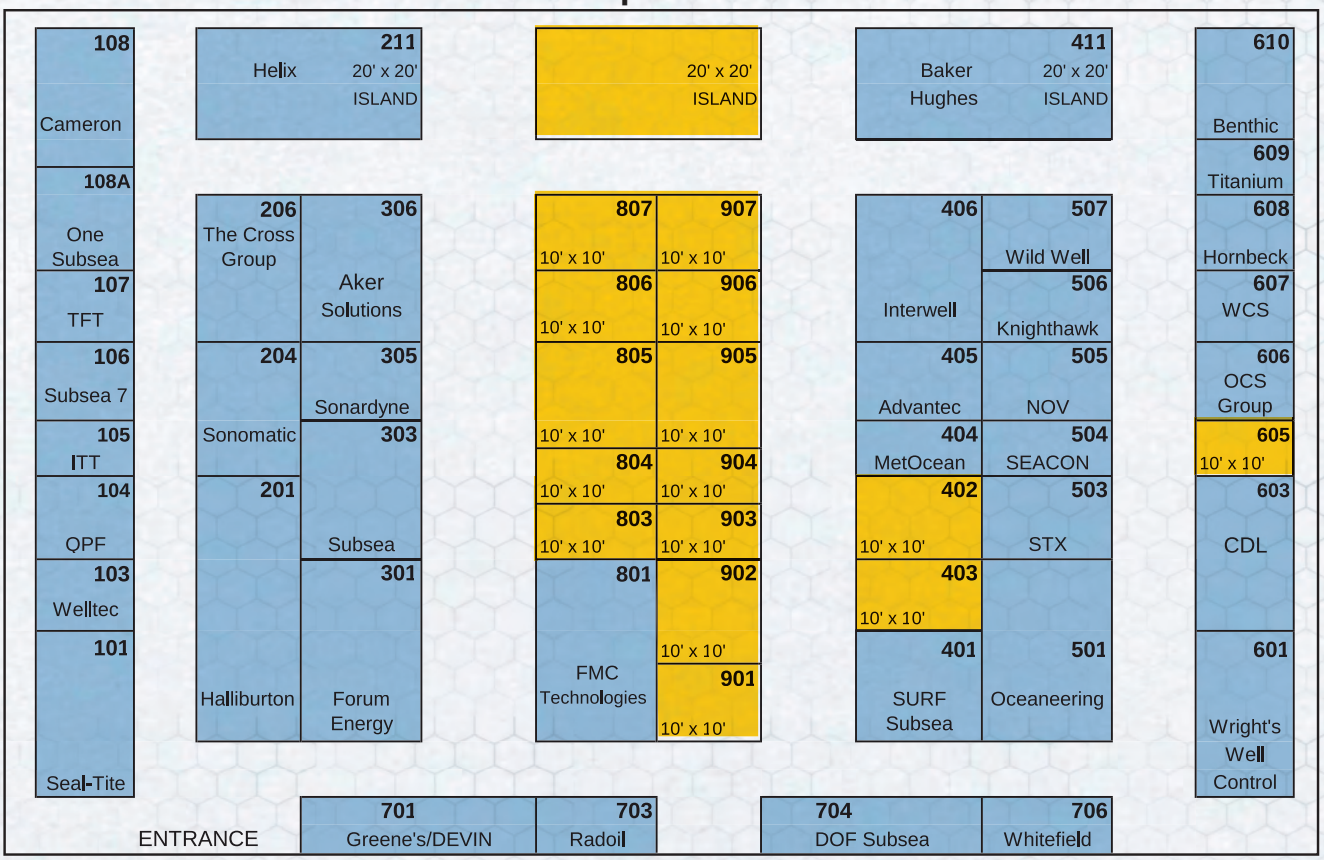
DCF Subsea

OCEAN SUB SEA SERVICES

DEEPWATER INTERVENTION FORUM

Exhibit Hall Sold Out! More Rows Added!

Exhibit Space Floor Plan



List of Exhibitors

	BOOTH
ADVANTEC	405
AKER Solutions	306
BAKER HUGHES	411
BENTHIC	610
CAMERON	108
CDL INC.	603
DOF SUBSEA	704
FMC TECHNOLOGIES	402
FORUM ENERGY TECHNOLOGIES	801
GREENE'S ENERGY GROUP / DEVIN INT.	701
HALLIBURTON	201
HELIX	211
HORNBECK OFFSHORE	608
INTERWELL	406
ITT ENIDINE	105
KNIGHTHAWK ENGINEERING	506
METOCEAN	404
NOV - TEXAS OIL TOOLS	505
OCEANEERING	501
OCS Group	606

	BOOTH
ONE SUBSEA	108A
QUALITY PRODUCT FINISHING, INC.	104
RADOIL	703
SEACON	504
SEAL-TITE INTERNATIONAL	101
SONARDYNE, INC.	305
SONOMATIC	204
STX MARINE	503
SUBSEA 7	106
SURF SUBSEA, INC.	401
TFT - PNEUMATIC, LLC	107
THE CROSS GROUP	206
TITANIUM ENGINEERS, INC	609
WACHS SUBSEA	303
WELL CONTROL SCHOOL	607
WELLTEC	103
WHITEFIELD PLASTICS	706
WILD WELL CONTROL	507
WRIGHTS WELL CONTROL SERVICES	601

For exhibit or sponsorship opportunities contact:

John Lauletta

E: jlauletta@atcomedia.com

P: 713. 874. 2220

For more information visit www.deepwaterintervention.com

Join us for the 9th Annual Deepwater Intervention Forum

The premier subsea-technology conference

This year, in addition to case histories and new technologies sessions, we will address our theme with a panel discussion about bridging resource gaps. Operators and Engineering Schools will discuss one of the key challenges facing the industry: how to attract and retain young talent in the subsea technology segment.

Preliminary Agenda

DEEPWATER INTERVENTION FORUM

DAY 1 Tuesday, August 13th

WORKSHOP
1:00-5:00pm
Planning, Preparation and Execution of Well Intervention

Opening Night Reception In Exhibit Hall 5:00-7:00pm
Sponsored By: HALLIBURTON

Hospitality Lounge @ San Luis 7:00-9:00pm
Sponsored By: HELIX ENERGY SOLUTIONS

DAY 2 Wednesday, August 14th

KEYNOTE 1

FMC Technologies

8:00-8:30am
Designing to Reduce Training Time
Tyler Schilling,
President/General Manager
FMC Schilling Robotics

KEYNOTE 2

8:30-9:00am
Developing Competency in Well Control
Kevin Cary,
General Manager
Chevron

Session I
CASE HISTORIES
9:00-10:15am

Session II
NEW TECHNOLOGIES
10:45am-12:00pm

Subsea Riserless Light Well Intervention to Install Wireline Retrievable SSSV
Steve Ascroft,
Anadarko

Deepwater Riserless Well Intervention
Ian Still,
Blue Ocean Technologies

Skandi Aker, the First Deepwater Intervention Vessel
Sebastien Bourgin,
Total

Riserless Light Well Intervention
Ole Eddie Karlsen,
Welltec

Neutral Buoyancy Lab
Frank Sager,
Oceaneering

Fiber Bragg Grating (FBG) Sensors
Aaron Barr,
Transocean

Session III
CASE HISTORIES
1:30-3:00pm

Deepwater Subsea Well Decommissioning
Darian Hilton,
Well Ops

Session IV
Panel: Bridging Human Resource Gaps
3:30-5:00pm

Advanced Well Capping Operation Using a Unique Offset Deployment Method
John B. Garner, John Reese & Bud Curtis,
Boots & Coots

Heave-Compensated Tower Enables Cost Effective Subsea Well Intervention
Trey Miller,
Devin International

Well Flow Impacted by Paraffin Deposition
Nathan Goodman,
Anadarko

Chevron
Shell
A&M Galveston
University of Houston
Oceaneering
Baker Hughes

Reception In Exhibit Hall
5:00-7:00pm

For more information visit
www.deepwaterintervention.com

DEEPWATER INTERVENTION FORUM

DAY 3 Thursday, August 15th

KEYNOTE

8:00-8:30am
Jones Act
Robert Alario,
Previous Charman and President of Offshore Marine Service Association (OMSA)

Session V
NEW TECHNOLOGIES
8:30-9:45am

Enabling Technology for Well Intervention to Extend Field Life
Carl AJ Roemmele,
GE Oil & Gas

Session VI
Well Intervention Systems, Design, and Operations Panel
10:15-11:45am

Joe Scranton
Schlumberger

Mitchell Dziekonski,
Titanium Engineers

Mirick Cox,
ExxonMobil

Brian Skeels,
FMC

Mike Hess,
Shell

Designing a Completion Workover Riser System Today for Operation Use Tomorrow
Justin Vaughan,
FMC

New Development for Deep Water Open Water Wireline Intervention
Frankie Calder,
Well Ops

Session VII
STANDARDS & REGULATORY UPDATE
1:00-2:15pm

Advancing Well Containment Technology and Readiness Efforts: How MWCC Enhances Industry's Response Capabilities
Charlie Miller,
MWCC

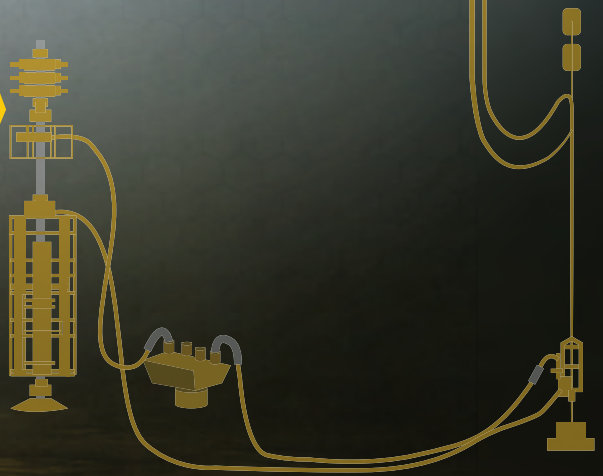
Session VIII
CLOSING SESSION
2:15-3:15pm

Jodie Connor
J. Connor Consulting, Inc.

New Sheriff In Town-BSEE's Expanding Role and Its Impact on Risk Allocation
Glenn Legge,
Legge Farrow

Workshop Summary
ARS Electronic Survey Presentation
Day Two Wrap-Up

Register Today! @
deepwaterintervention.com



For more information about the conference contact:
Lisa Zadok
P: 713. 874. 2215
E: lzadok@atcomedia.com

Quad 204 takes shape subsea

BP's Quad 204 redevelopment will be one of the largest subsea developments in the UKCS.

The subsea architecture on the Quad204 redevelopment.

By Andrew Train, BP's project director, offshore program and Wood Group Kenny director, Bob MacDonald

Quad 204 is one of the world's biggest subsea redevelopment projects, and one of the most complex engineering challenges BP and its project partners have ever undertaken.

It involves redevelopment of the Schiehallion and Loyal fields, to the west of Shetland on the UK Continental Shelf (UKCS). Wood Group Kenny is responsible for engineering the subsea, umbilical, riser and flowline (SURF) system, from the subsea trees to the connections within the new *Schiehallion* floating production, storage and offloading (FPSO) vessel.

Wood Group Kenny will also support BP through the delivery, testing, installation and commissioning of these systems, which represent approximately US$1 billion worth of subsea production systems, umbilicals, pipeline and risers infrastructure.

As the project reaches a key milestone, with preparations nearing completion for the *Schiehallion* FPSO tow away, Andrew Train, BP's project director, offshore program and Wood Group Kenny director, Bob MacDonald look at some of the challenges involved in a subsea project of this scale and discuss how they think it could benefit the subsea industry as a whole.

The *Schiehallion* FPSO has been moored in 400m of water, 281km (175 miles) west of the Shetland Isles, producing oil from the Schiehallion and Loyal fields since 1998. The reservoir sits 2000m below the seabed, covering an area of approximately 194sq km (75sq mi.) As a result of new exploration activity and the technological developments that have occurred since it was discovered 20 years ago, recoverable reserves are now known to be more than double the original estimates.

Accessing these reserves has required a major expansion of what was already a sizeable subsea development and one of the largest oil producing fields on the UKCS. The original development has already expanded to comprise 51 wells in five subsea drill centers, and the Quad 204 redevelopment project is adding 25 more wells.

The addition of the new wells will significantly extend the life of the field,

with potential production estimated to reach a billion barrels or more of oil equivalent by the end of its new anticipated design life in 2035.

There were a number of possible approaches to such a major redevelopment and Wood Group Kenny assisted BP in the evaluation of a wide range of concept options. The design being taken forward is replacing the existing vessel with a newbuild state-of-the-art FPSO on the same location and reusing the existing subsea infrastructure, where practicable without compromising safety or quality, replacing it only where required and extending it as required to support additional wells.

While there is a strong emphasis on reuse of existing equipment and infrastructure, the magnitude of the Quad 204 project means that although it is a redevelopment project, it effectively includes as much "new development" as many greenfield projects.

At the same time, the fact that this is a redevelopment creates a number of challenges. For example, BP has not taken an FPSO off-station before, and all the new subsea structures will have to be installed in an already congested seabed that contains a lot of equipment that will be reused.

In addition, subsea technology has developed rapidly since the field was first discovered, and although many aspects of the original development were ground-breaking at the time, the existing equipment is not aligned with the state-of-the art technology that is deployed on subsea developments today. These factors all come together to create a highly complex and exciting project.

One of the biggest overall challenges for the Quad 204 subsea project team has been with respect to managing the total size of the development and the quantity of subsea structures involved. For ex-ample, in addition to the 25 new wells, there will be 38km of replacement flowlines, 17km of new flowlines and eight new manifolds; changes to the umbilical system include replacing two dynamic umbilicals, installing three new static umbilicals and 26 associated structures.

Water depth is another key issue. With a depth range of 395m-470m, all the tasks relating to the removal of existing equipment and installation of new equipment, such as valve operations and connection of flowlines, have to be undertaken using diverless techniques in hostile conditions, as will changing parts in the future so this is something that has to be factored into the design and development.

In fact, there are significant issues to be tackled in all aspects of the development, concerning the architecture, the controls system, and the umbilical distribution system, each presenting their own difficulties. Assessment of the existing infrastructure for reuse and the integration of existing and new parts of the development are also complex tasks.

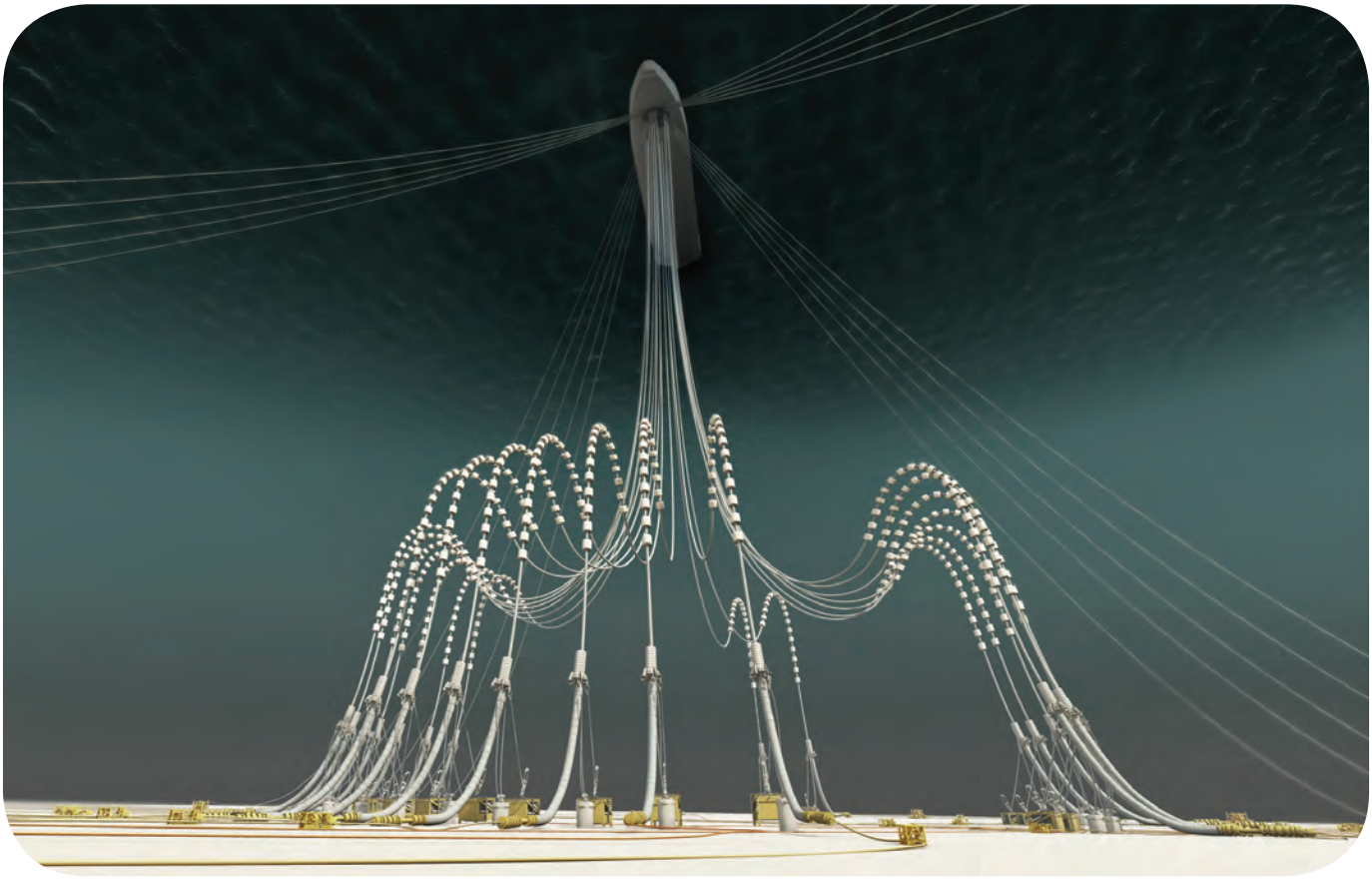
In line with the overall project approach, the original intention was to reuse as many of the existing 15 risers as possible, and there was a significant scope of work in this regard, including an assessment of their general condition which used historic integrity assessments as the starting point. However, there were a number of other factors in addition to the condition of the risers that had to be taken in to account in determining their suitability for reuse- critically whether they were compatible with the new FPSO and the revised metocean conditions.

To reuse the risers it also had to be possible to carry out a lay-down and abandonment procedure that involved leaving the risers on the seabed for about two years before the new FPSO came on-station. As this was not something that the risers were originally designed to do, careful consideration of the procedure was required to ascertain its feasibility.

As part of this process, a trial of the lay-down procedure was undertaken with a single riser, which was left in the abandoned condition for 18 days, prior to dissection and examination of three sections from it.

This examination not only allowed the project team to determine whether any damage had occurred as a result of the procedure but also provided an opportunity for a general inspection of the riser condition. Much was learned from this including the condition of the layers within the flexible riser, and the whole process enabled a very well-informed judgment to be made on

An artist's illustration of the new Quad204 FPSO.



A new riser system has been developed for the Quad204 redevelopment.

the overall suitability of the risers for reuse.

Although the lay-down trial itself did not damage the riser, the data gathered from it did tie in with previous analysis that indicated over-bending of the riser could be expected to occur if it was left on the seabed for two years.

When all the available information was taken into account, it became apparent that only two of the risers were suitable for reuse from all perspectives, and ultimately the decision was made to introduce an all-new riser system.

Another significant element of the QUAD 204 project, and a "technology first," is the design of the bend stiffener. Bend stiffeners are conical polyurethane moldings designed to control the curvature of the riser under dynamic conditions, and prevent over-bending at the interface of the riser with a more rigid structure, in this case the vessel turret.

More onerous conditions lead to larger stiffeners, and as the west of Shetland area is a harsh water environment, bend stiffeners used there are generally larger than they might be in other, less-hostile locations.

The motion characteristics of the new FPSO are more onerous than the outgoing FPSO and these characteristics combined with the harsh water environment have resulted in the need for the design of a new bend stiffener that is around twice the volume of what was used on the original *Schiehallion* FPSO.

The key challenges here were that the existing design methodologies could not be assumed to be relevant for something so much larger than what had previously been considered. It was therefore necessary to conduct a much more thorough design process than is typical, and a qualification program is underway to ensure that the larger stiffener can be designed, manufactured and installed as well as provide 20 years of service.

Wood Group Kenny has defined the requirements for the qualification program to be consistent with BP practices, and actively involved in ensuring the activities are carried out correctly and that the aims of the program are met. Up to 28 of these large bend stiffeners, which are about 8m long and 1.8m wide at the base, will be required for the redevelopment.

In total, 21 new flexible risers will be installed, which will allow the flow of 320m bbl/d of fluid a day to travel up to the FPSO for processing. Each of the risers will be about 800m long and will be tethered to an anchor, suction-piled to the seabed, giving them enough strength to withstand a 100-year wave as well as the upward force generated by the midline buoyancy modules.

A key area with respect to integrating the existing and new elements of the development is the determination and mitigation of flow-induced pulsations in structures piping. The interaction of a number of factors can cause surges in fluid flow that in turn can cause fatigue damage or cracking in subsea structures.

Addition of the new wells will result in a change of flow regime that may potentially cause changes with respect to flow-induced pulsation in the existing structures and so an important element of the Quad 204 design work is to ensure that structural support is in place to protect against this kind of damage.

REGISTER
EARLY
& SAVE

emerging FPSO forum

The Emerging FPSO Forum brings together industry experts from around the globe with real-world FPSO experience. Join these industry thought-leaders as they discuss the latest FPSO business developments.

September 24-26

Galveston Island
Convention Center at
the San Luis Resort

AGENDA TOPICS

- Mooring Integrity and Station Keeping
- The World of FPSOs: Trends Today and Outlook for Tomorrow
- Own or Lease in Today's Business World
- Redeployment Realities
- Industry Outlook: Active Projects in the Pipeline Decision Processes
- Growing Recognition of Project Management as Critical Discipline
- Concept into Practical GTL Plant for FPSOs
- Realities in Building for the FPSO for GoM
- Latest at BSEE & USCG: The Focus on Standards
- And much more

Interested in speaking at this event?
Contact Lisa Zadok at 713.874.2215 or email: lzadok@atcomedia.com

For sponsorship and exhibit opportunities,
Contact John Lauletta at 713.874.2220 or email: jlauletta@atcomedia.com

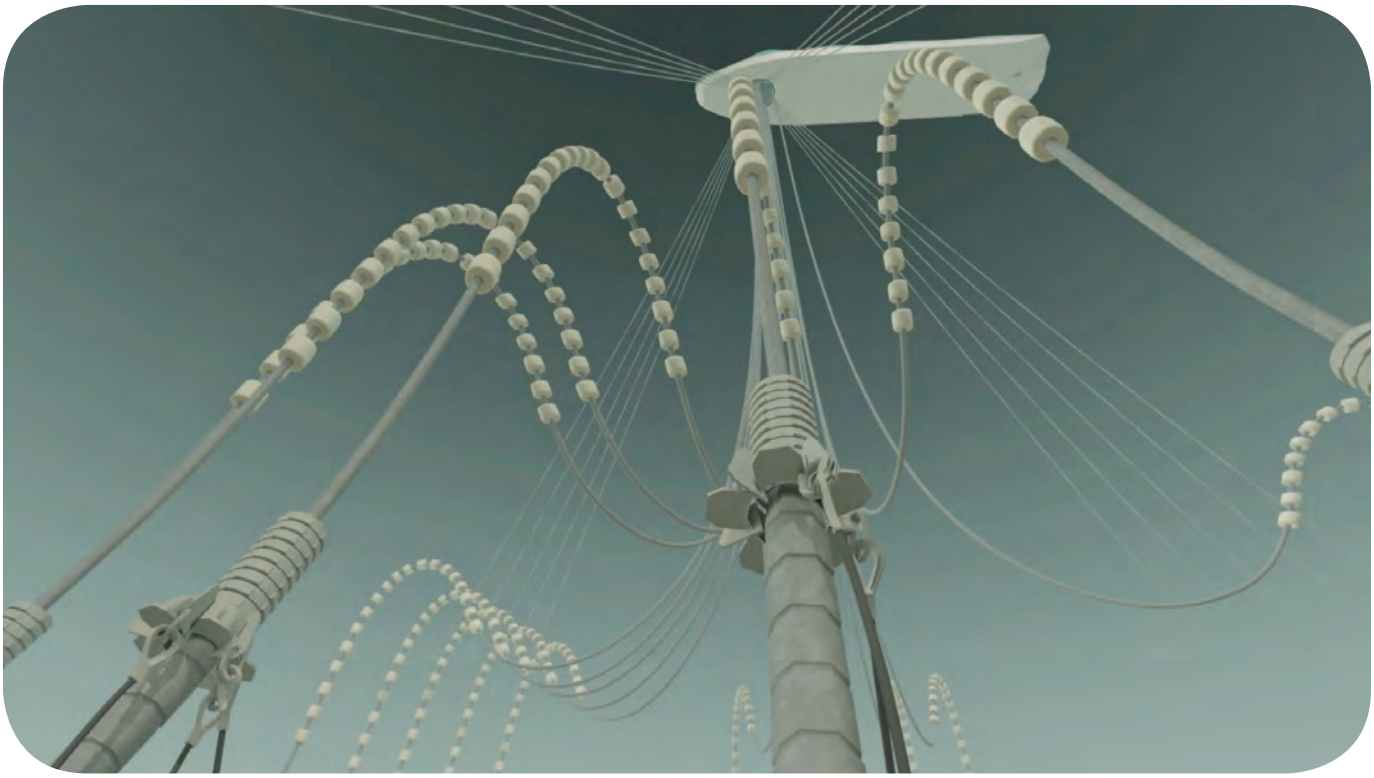
www.emergingfpso.com

PRESENTED BY: OE

HOSTED BY: BW Offshore

SUPPORTED BY: MTS marine technology society — Opportunity runs deep

OEADV-38-REVB



New bend stiffeners will be deployed on the Quad204 project.

A study was undertaken to predict the frequency of flow-induced pulsations within the development and give an understanding of the susceptibility of the existing structures to fatigue failure. Work is now underway to determine how suitable supports can be installed by ROV onto the existing structures while they are in place on the seabed: this will be a challenging process.

With respect to the new equipment it is comparatively straightforward to tackle this—additional bracing can be designed alongside the new equipment, onshore and prior to installation: this is still a complex task but achievable when considered early enough in the design process.

It should be noted, however, that the fact that this is a redevelopment has not only brought challenges but also some benefits in so much as it has been possible to factor in valuable information, lessons learned and experience gained from the existing development into the design of the new facilities.

For example, five new flowlines are being added to the development, and 10 of the existing production flowlines needed to be replaced as a result of corrosion. The experience and assessment of corrosion in the existing flowlines led to the decision to clad all the new flowlines with corrosion resistant alloy in order to mitigate this problem in the future.

When work was first starting on the Schiehallion development, the west of Shetland area was frequently referred to within the oil and gas industry as the Atlantic frontier.

In the early 1990s, Schiehallion was pioneering, not just for BP but for the industry as a whole, and it was instrumental in helping to develop a great deal of deeper water capability, which in turn enabled other deep water developments around the world to be undertaken.

It is hoped that Quad 204 will have a similar impact today, in terms of pushing forward the frontiers of what is possible, and how things are done with respect to field life extension and subsea redevelopment.

The oil and gas industry is being called on to apply increasing levels of ingenuity to tackle increasingly complex developments: Quad 204 has brought together a world-class team in terms of subsea knowledge and expertise and should go some way towards building a capability that can be applied to other projects around the world. OE

Andrew Train *is the project director for the offshore program element of the BP Quad 204 project. He has worked with BP for 23 years in various roles, including project engineering, commercial management and project management. He has a degree in Civil Engineering from the University of Strathclyde and an MBA from the University of Warwick.*

Bob MacDonald*, regional director, Wood Group Kenny (North Sea), started his career in the subsea industry 20 years ago. He holds a degree in engineering technology and a masters in offshore engineering, both from Robert Gordon University, Aberdeen. He has held a wide variety of roles within the subsea sector, working extensively offshore and latterly on overseas assignments in Europe, North and South America and in the Middle East.*

Deepwater production gets high-pressure boost

Petrobras leads subsea pumping development to overcome deepwater production problems

By Victor Schmidt

Subsea boosting has evolved since the first subsea multiphase pump was installed, in 1994, by Shell at Draugen field in the Norwegian Sea. That pump was installed in 270m (885ft) water depth and sent production 6km (3.7mi.) from Rogn South field to the gravity-based platform at Block 6407/9, Figure 1. Adding the pump increased output by 5000b/d and proved the concept of developing satellite fields with extended tiebacks with a pump on the seabed.

That one-pump/one-spare system was modest compared with today's installations. It was rated at 1MW and could handle differential pressures up to 53bar (768psi). By comparison, Total's Pazflor field that was installed in 2011, in 800m of water, has six pumps with two spares, is rated at 13.8 MW and can handle differential pressures up to 105bar.

Subsea pumps have seen continual and incremental development as the industry has stepped into deeper water and discovered reservoirs with increasingly challenging production characteristics. Recently, Petrobras has moved to the forefront with its R&D efforts to overcome production challenges in deepwater developments off Brazil. Many of the company's fields produce heavy oil with gravities less than 20°API, with high flow rates, and with high gas- and water-cuts. Petrobras is finding more fields, but in deeper water with attendant production problems.

These developments have led Petrobras to seek technologies through its PROCAP Technology-Future Vision program that can extend the operational envelope of subsea boosting and develop equipment for subsea processing. Among the projects are gas compression systems, compact oil-water separation, compact gas-liquid separation, and high differential pressure multiphase pumps. The pumping projects are bearing fruit and Petrobras shared a few of their developments in a subsea session at the recent Offshore Technology Conference in Houston.

Mudline ESP

One of Petrobras' goals is to reduce capital and operational expenditures (capex, opex) in its deepwater operations. For fields that have low gas-oil ratios (GOR), the company normally installs gas-lift equipment in addition to electric submersible pumps (ESP) within wells to minimize production downtime if a pump fails. At Jubarte and Golfinho fields in the Campos basin off Espirito Santo state, booster pumps were installed in dummy wells in the seabed. By moving the ESPs out of the producing well and onto the seabed, an intervention rig can install and service equipment. The operation is simpler, easier, and less expensive than using a semisubmersible rig.

The company has taken the next step by creating a seabed pump skid, using off-the-shelf components. The seabed unit has two modules: a pump module containing a pair of ESPs, set in series at a 5° angle to the seabed, and a flow-base module that fits underneath the pump module to support the ESPs and their flowline connections. The pumps use 600hp electric motors and each has 24 stages.

In December 2011, the prototype system was used in the Campos basin at Espadarte field, in water 1300m deep, to produce 24°API crude oil. The system sent crude to the FPSO *Rio das Ostras*, about 11km from the wellhead at 2,000cu m/d (12,580b/d) with no water and a 60:1 GOR, using 100bar pressure differential at the pumphead.

The test was successful, increasing the flow rate by 600cu m/d compared to natural flow from the wells. Petrobras intends to apply the mudline ESP concept next in the Gulf of Mexico at its Chinook and Cascade fields. These fields have high pressures (12,500psi) and temperatures (236°F, 113°C), and produce 20-27°API crude oil.

Raw water injection

Petrobras has developed what it calls the subsea raw water injection (SWRI) system - a way to use subsea pumping, coupled with in-water filtration of raw seawater, to maintain reservoir pressure. Maturing fields with declining pressures often require water injection to maintain production, but this can be problematic for deepwater fields that are developed early in the opening of a new basin.

Many early fields are developed without adequate plans for reservoir support because future water-injection needs are estimates. This means that the topside facilities (ship-shaped FPSO or semisubmersible FPS) do not have space or weight capacity to add more water treatment, processing, and injection equipment to prepare and send water into the reservoir. So, a

retrofit solution is required to maintain reservoir pressure and stabilize crude oil production.

Petrobras' Albacora field in the Campos basin had this problem. As a mature, giant field in water depths of 250-1100m, it has seen much development. The original FPSO, *P. P. Morales*, was installed in 1987, followed by FPS semisubmersible *P-24* in 1993 in a second development phase. In 1996, the *P-24* was replaced by two units: the FPS semi *P-25* was installed first, followed two years later by the FPSO *P-31* in 1998. Field production peaked in 1999, and the reservoir required more pressure support than the existing water injection system could deliver.

The company created a research project to solve the problem, facing the issues of water properties, reservoir compatibility, equipment reliability, power delivery, corrosion, and biologic control. In addition, new infill drilling was planned for the field, which would increase the need for water injection at higher flow rates. SWRI was the most economic solution, rather than adding conventional topside capacity, replacing the existing FPS, or adding a new FPS.

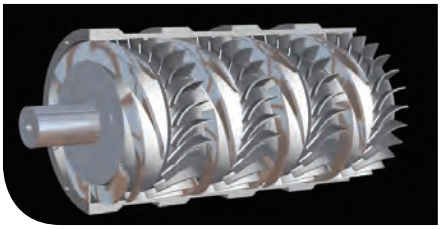
The SWRI system includes a buoy to support water intake at about 100m above the seabed, where water quality is best; a skid with variable-speed controllers, filtration, and pumps that sits on the seabed; and related power cable, flowlines, jumpers, etc. The subsea system is connected to the *P-25* topside facility for delivery of biocide and related chemicals.

The system began operating October 2012. Water injection will ramp up as needed to a maximum 16,500cu m/d into seven injection wells.

Helico-axial multiphase pump

Petrobras has had difficulty finding helico-axial multiphase pumps (HMPP) to meet its need for high differential pressure to move viscous crudes. The gas-lift systems it uses can handle pressures around 45 bar (652psi), which is similar to the limit on many HMPPs. However, the company has fields that require stronger equipment. The company initiated a research program in cooperation with FRAMO,

The first subsea multiphase pump was installed by Shell at Draugen field in Block 6407/9 in the Norwegian Sea.



Helico-axial multiphase pumps (HMPP) use a series of rotating impellers and diffusers to increase flow pressure.

FRAMO, a Schlumberger company, to produce an HMPP that can withstand differential pressures up to 60bar.

HMPPs use a series of rotating impellers, separated by diffusers, which together increase flow pressure to move produced fluids. The design overcomes gas-locking by keeping gas and liquids mixed as they move through the pump, Figure 2. A new high-boost HMPP was designed by modifying the impeller and diffuser geometries, as well as the pump speed and flow rate, taking into account the field's gas fraction and 20cP crude oil viscosity. The final HMPP had 13 stages for a 14cP fluid with an intake of 177cu m/hr, and could operate at a maximum differential pressure of 70bar.

Barracuda field was chosen to test the prototype pump. The Campos basin project tied-back Barracuda to Caratinga field, whose FPSO *P-48* had sufficient capacity to handle the flow from Barracuda. The fields are in water 600-1300m deep and are about 10km (6.2mi.) apart. The HMPP is positioned on the seabed in water 1040m deep, 330m from the producing well.

The HMPP was installed and began operations 14 July 2012. The initial fluid flow was 3000cu m/d with a pressure differential of 60bar and a gas volume fraction of 45%. The pump worked as expected and raised production by 1000cu m/d (6290b/d), a 40% increase compared to natural flow from the well. Reliability has been 100%, despite 11 shutdowns during commissioning and personnel training, with no need for hydrate treatments.

The extension of HMPPs operational envelope opens many new applications for this technology. Petrobras continues to press forward to solve its deepwater operational problems and thereby help the industry extend its production capability into ever deeper water, deeper reservoirs, and more challenging production scenarios. OE

FURTHER READING

OTC 24263, Evolution of Subsea Boosting, A Review of Pas and Present Projects; P. Luce, J. Michaelson and N. Solvik.

OTC 24161, Subsea Processing Systems: Future Vision; F. Albuquerque,etal.

OTC 24201, Mudline ESP: Electrical Submersible pump installed in a Seabed Skid; M. Roberto, P. Oliveira, and B. Pyramo.

OTC 24167, Albacora Subsea Raww Water Injection Systems; L. Bulk etal.

OTC 24217, Barracuda Subsea Helico-aAxial Multiphase Pump Project; C. Kuchpil etal.

OE, Draugen: Exceeding Expectations, Odin Estensen; June 2013, pp. 35-37.

PECOM

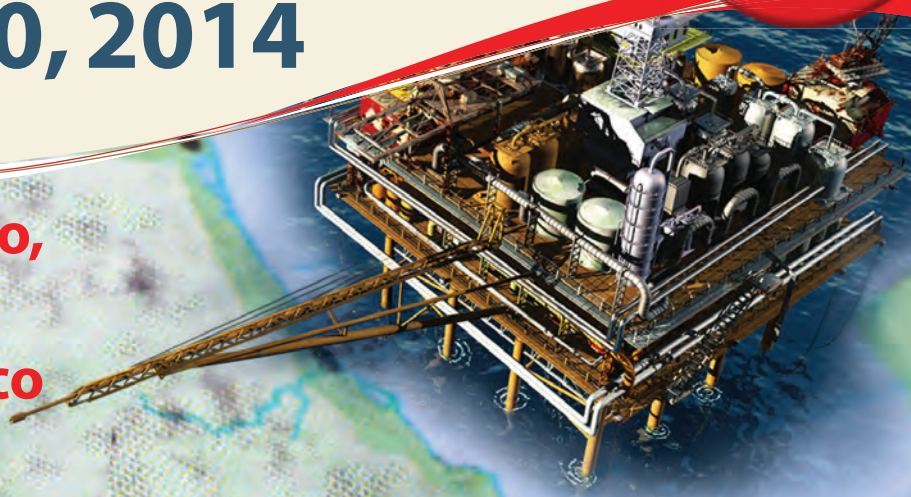
since 1994

Petroleum Exhibition & Conference of Mexico

April 8-10, 2014

NOW ACCEPTING ABSTRACTS

Parque Tabasco, Villahermosa, Tabasco, Mexico



Celebrating 20 Years as *the* International Gathering for Mexico's Oil Industry

Plan your participation at PECOM 2013 and be a part of Mexico's growing oil and gas industry.

2013 Supporters

PEMEX Exploración y Producción · IMP Instituto Mexicano del Petróleo · Tabasco cambia contigo · Centro cambia contigo · SENER · CNH Comisión Nacional de Hidrocarburos · OCV Tabasco

Speaking Opportunities
Sandy Basler
VP, Strategic
Business Development
713.285.5075
sbasler@atcomedia.com

Exhibition and Sponsorship Opportunities:
Hortensia "Tish" Barroso
Sales Director- Latin America & Mexico
713.285.5070
tbarroso@atcomedia.com

Presented by: OE

www.pecomexpo.com

Mozambique rising

All eyes are on Mozambique as significant natural gas finds are set to turn the East African country into a major LNG player, but are oil riches on the horizon?

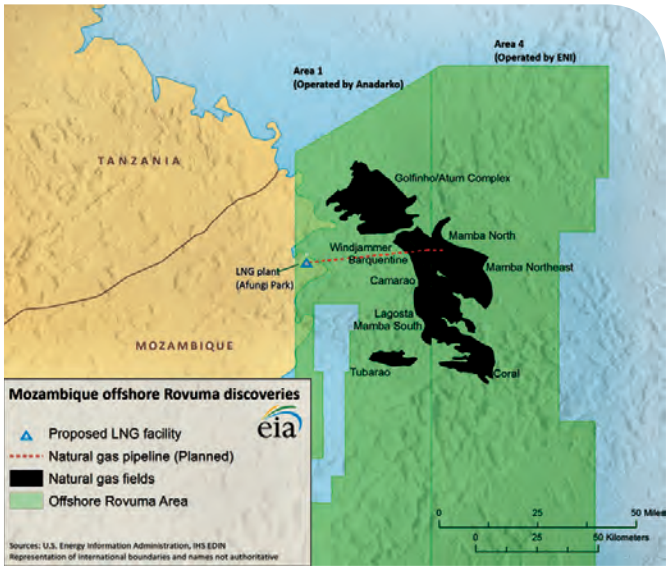
By Audrey Leon

Mozambique's prolific Rovuma basin holds 12 offshore discoveries within a 50km radius. Rovuma's deepwater basin covers 12,500 sq km and includes the Anadarko- and Eni-operated fields Area 1 and Area 4, in which the companies have found a combined 170 Tcf of natural gas. Norway's Statoil and Malaysia's Petronas took stakes in Area 2 and 5, and 3 and 6, respectively, during past licensing rounds.

All four companies have maintained a presence in Mozambique since the country's second licensing round in 2006, and have spent billions in the process.

For other companies interested in Mozambique, claiming a stake now can be pricy. In April, China National Petroleum Corp. (CNPC) purchased a 28.57% at Eni's subsidiary – Eni East Africa – for US$4.2 billion, giving it a foothold in Mozambique's Area 4, where 75 Tcf of gas has been discovered.

In 2012, a bidding war escalated between Royal Dutch Shell and Thailand's PTT Exploration & Production over Dublin-based Cove Energy, which held 8.5% participating interest in Anadarko's Rovuma Offshore Area 1. PTTEP eventually took over the East Africa-focused explorer for US$1.9 billion.



Japan's Inpex announced in April that it would farm into 25% of Statoil's share (reducing Statoil to 40%) in Areas 2 and 5. The price of the farm-in was not announced by either party, but JOGMEC said in May that it would provide equity financing of US$89.3 million (JPY 8.5 billion) to Inpex to carry out the transaction, with JOGMEC becoming a shareholder of Inpex's subsidiary Inpex Mozambique Ltd.

While natural gas has proved abundant in Mozambique, three companies are also seeking to produce oil. Currently, executives at Statoil and UK-based Tullow Oil espect to prove commercial oil deposits at their Cachalote well, in Area 2, south of Mozambique's current gas finds. Tullow Oil's Angus McCoss told Bloomberg last month that finding oil off Mozambique is an attractive prospect. "The value lies in oil," he says. "Cachalote is certainly worth doing as a potentially needle-moving prospect."

Eni has similar plans to explore for oil off Mozambique. The Italian firm will drill its first oil exploration well this month in Area 4, where it has already discovered 80 Tcf of natural gas in the Mamba Complex and Coral prospects. Eni plans to drill the Agulha-1 prospect later this year, to test the hydrocarbon potential of Area 4's deeper plays.

With all eyes now on Mozambique, the country's National Petroleum Institute (Instituto de Petroleo/INP) used its spot at this year's Offshore Technology Conference in Houston to advocate for investing in the country's infrastructure including new rail and ports. A new airport in the capital, Maputo, opened in February.

INP's exploration manager Carlos Zacarias, who spoke at OTC, touted Mozambique's new "Gas Master Plan," which offers revisions to the country's petroleum laws, regulations, and fiscal packages, including new royalty rates for its abundance resources.

According to a study by ICF International, Mozambique could earn US$5.2 billion annually from its gas resources by 2026. Reforms to its current petroleum laws are certainly

The US Energy Information Administration (EIA) plots recent discoveries in Mozambique's Rovuma basin. Also listed: Anadarko and Eni's Mozambique LNG facility on the Afungi peninsula in Cabo Delgado province.

attractive to both the government and the oil and gas companies operating there.

"There's 170 Tcf in Area 1 and Area 4, but they are not fully explored," Zacarias told OTC delegates. "We hope the companies operating in Mozambique will continue to unlock more resources."

Anadarko's Mozambique playbook

Last year, at IHS CERAWeek, Anadarko's CEO and Chairman James Hackett told Daniel Yergin that the company 'doubled' down on Mozambique out of desperation. Hackett was being facetious, but he went on to say that the company needed to invest in a place that "wasn't already picked over by the majors." These are exciting times for Anadarko; R.A. "Al" Walker replaced Hackett as President and CEO last May and Chairman this year.

"Not everyone gets to open a new gas resource in their lifetime," says President of Anadarko Mozambique, John Peffer, of the country's 2.56 billion boe in proved reserves. Two decades ago when he started, Anadarko had no international division. "It's been an incredible ride."

Anadarko has big plans for Mozambique. Walker wants to see the country become a major LNG player. Anadarko and Eni formed a joint partnership to develop and bring on stream a US$15 billion, two-train offshore LNG facility at Palma by 2018. The facility, Mozambique LNG, will eventually have the capacity to produce up to 50MMTPA.

But the road to becoming an LNG exporter is a long one, as Peffer acknowledged at OTC. Much like the companies that are flocking to Brazil (another predominantly Portuguese-speaking country with coveted resources), those in Mozambique are finding that they must work around infrastructure and workforce difficulties.

Anadarko set up training centers last year (See: "Jubilee points way for Prosperidade" - *OE* September 2012) to teach local workers construction skills for the LNG facility, road and dock improvements.

"Labor is quite restricted," Peffer said to OTC delegates. "It can be a challenge for whoever comes into the country." Peffer said Anadarko worked with INP to get its foreign workers into the country, but urged companies who follow in their footsteps to do so with their eyes open.

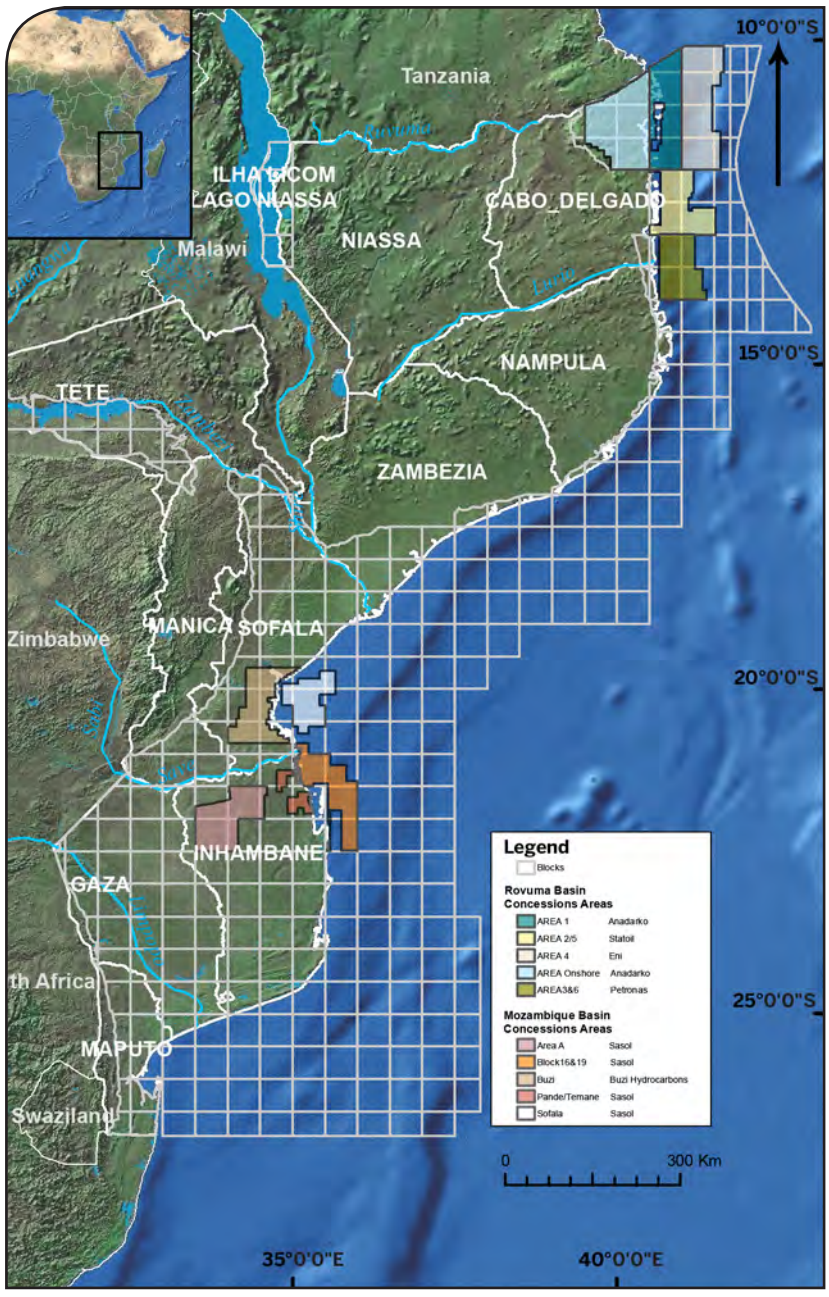
Peffer highlighted some of Anadarko's infrastructure developments. The company set up a camp at Mocimboa da Praia and built a heliport. At Pemba, Anadarko built a base to manage its northern operations and supply chain logistics. The Pemba port has a 180m quay, which Peffer says Anadarko jockeys for space alongside container vessels and partner Eni. Currently, a floating dock system has taken some pressure off the main dock. "Before the dock you could only have three rigs," he says.

Anadarko is focused on developing its large-scale Mozambique LNG project at Palma and plans are in the works to build an air strip there. Anadarko will need to route flowlines around surface faults and deep channels.

Infrastructure difficulties aside, Peffer said there are many other challenges in Mozambique, including managing expectations of local citizens and government. He says Mozambique's government seemed to be most focused on capacity building – making sure that its citizens have good jobs and training. Another challenge: the distance from Anadarko's northern discoveries and the capital in the South, where most of the schools, educated workforce, consulates, and government officials reside.

It's not all bad news. The coastline may be long, but so far the discoveries are close enough to the shore to give them a

Mozambique Acreage Map



cost-competitive advantage over many other projects worldwide, Peffer says. Another bonus is a good working relationship with the local government.

"A lot of changes are needed, but the government is open and we do get our input. Although we don't always get it, we do get our say," he said. "That's very different from other countries."

Mozambique: rising LNG star?

Mike Haney of Douglas Westwood believes Mozambique has serious potential as an LNG exporter.

"Mozambique is well-positioned to play an important role in natural gas supply later this decade," Haney said in advance of the OTC panel discussion on Mozambique.

"From a relatively minor player only a few years ago, the waters offshore Mozambique have been found to contain some of the world's largest natural gas reserves. Some industry experts foresee ten or more LNG trains being built to bring this gas to market, which would transform Mozambique into the world's third largest LNG exporter after Qatar and Australia."

However, Haney warned that Mozambique could face some hardship in the LNG sector due to Australia's numerous LNG projects, which are slated to come on stream during the same time frame, and a US entrance into the market. "Mozambique will face a tough challenge getting into the Asian markets because of Australian LNG, which is closer to that market," he says.

For that reason, Peffer believes Mozambique LNG could potentially export its wares to the Atlantic. "We have to clear a path to get here."

But for now, Anadarko can't argue with the numbers. Mozambique's Golfino-Atum complex holds 15-35 Tcf of recoverable natural gas resources. The Prosperidade discovery, located to the north of Golfino-Atum, find boasts 17-30 Tcf, and those numbers are more than enough to keep the company motivated to work toward LNG exports.

'There's a lot of hard work to do before we get there," Peffer says of exports. OE

Recent Discoveries

April 2013 - Anadarko's Orca-1 discovery well encountered approximately 58m of net gas pay in a Paleocene fan system at Offshore Area 1 in the Rovuma basin.

April 2013 - Eni's Mamba South 3 found 214m of gas pay in high-quality Oligocene and Eocene reservoirs in Area 4. The well is located 6km north of Mamba South 1 and 2, 50km off the coast of Cabo Delgado.

February 2013 - Eni's Coral 3 delineation well encountered 117m of gas pay in high-quality Eocene, increasing the potential of the Coral discovery to 13 Tcf in place. The find confirmed the potential of the Mamba complex inside Area 4 at 75 Tcf of gas in place.

June 2012 - Anadarko's Atum exploration well encountered 92m of gas pay in two high-quality Oligocene fan systems, 16.5km southeast of the Golfinho discovery.

May 2012 - Anadarko's Golfinho, 32km northwest of Prosperidade, proved 59m of net gas pay in two high-quality Oligocene fan systems inside Offshore Area 1.

March 2012 - Eni's Mamba North East 1 well met 240m of gas pay in several high-quality Oligocene and Eocene sands inside Area 4. The find increased the resource base by 10 Tcf, raising the Mamba complex's resource potential to 40 Tcf.

Anadarko Petroleum conducts flow tests off Mozambique with Transocean's fifth generation drillship *Deepwater Millennium*. Flow tests in the Prosperidade and Golfinho/Atum complexes yielded facility-constrained rates of 90-100 MMcf/d. (Photo courtesy of Anadarko)

IT'S HERE

Purchase the Houston/Texas Oil Directory and own an extensive list of companies and contacts throughout the oil and gas industry.

Buy Today @ oilonline.com
or call 713. 529. 1616

From the Publishers of

OE

GULF COAST OIL DIRECTORY

HOUSTON/TEXAS OIL DIRECTORY

OEADV-41

Tanzanian investment to continue

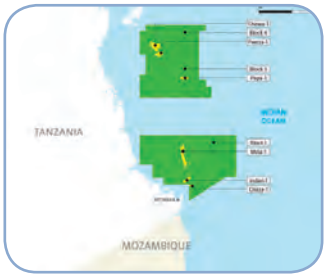
Tanzania has become hot property, with BG Group and Statoil eying LNG export from the gas-rich offshore region.

Tanzania's recent rise up the resource rankings has been fast, despite it having taken a long time to reveal its potential reserves.

While drilling offshore started in the 1950s, the first production did not happen until 2004, from the 1974-discovered Songa Songa gas field.

Nearly 10 years on, Songa Songa, operated by Orca Exploration, a subsidiary of Toronto-listed PanAfrican Energy, is one of only two fields producing. The Mnazi Bay development, gas from the Mnazi and Msimbiti fields, is the second. Mnazi Bay production currently supplies the local Mtwara Power Plant but the Tanzanian government recently received Chinese bank support to fund a 532km pipeline to the capital Dar-es-Salaam.

Historically, lack of infrastructure, along with little 2D data, has hindered further development in the country, which ranks 152 out of 185 in the lower quartile of the Human Development Index.



BG's licenses offshore Tanzania

However, recent gas finds have changed Tanzania's fortunes. BG and partner Ophir have made six consecutive discoveries in deepwater Blocks 1, 3, and 4, while Statoil and partner ExxonMobil have made three discoveries in Block 2.

Early design studies are now being worked on for the country's first LNG processing trains, with plans to reach a final investment decision by 2016-17.

Tanzania's government estimates there are 41.7Tcf of recoverable natural gas reserves in the East African Rift Valley and in deep water offshore. The country is working on new policies for the upstream sector, including restructuring the state-run Tanzanian Petroleum Development Corporation (TPDC), which sets exploration and production policies, making operators list on a local stock exchange, and creating a gas revenue fund.

The country's delayed 4th licensing round is expected to launch in October, with seven deep offshore blocks to be offered.

Early days

More than 102,000 sq km of deepwater offshore acreage has been awarded off Tanzania in total, most since 2000.

Shell was awarded Blocks 9-12 in 2003, but it is still waiting to agree a production sharing agreement to allow it to start exploration activities.

During 2005-06, Ophir was awarded Blocks 1, 3 and 4, covering 20,850sq km of the Deep Mafia Offshore basin and northern portion of the Rovuma basin, Statoil was awarded Block 2, with partner Exxon, and Petrobras, as operator in a 50% owned joint venture with Shell, Block 5. In 2006, the Petrobras-led JV with Shell added Block 6 to its acreage, followed by Block 8.

Tanzania's first deepwater drilling campaign was operated by Ophir, in Blocks 1 and 4 in 2010, partnered by BG Group.

However, before deepwater exploration could start, the country needed investment in port and logistics infrastructure, as well as agreements on commercial contracts with government.

Over two years, Ophir negotiated terms for an LNG gas commercial project for Blocks 1, 3 and 4 withTPDC. Ophir Energy and Petrobras also agreed in 2009 to join forces and

initially invest $9million upgrading Mtwara Port to create a joint base of operations for the Mnazi Bay gas development—now also shared by BG Group and Statoil and undergoing further investment.

The Mnazi Bay project brought power and light to Mtwara, paving the way for future development.

However, by 2009, while Mtwara had electricity, it was intermittent. Just 58 ships passed through during a two-year time frame. The airport had no road connection to Dar-es-Salaam and there were fewer than six flights per week.

It opened in July 2010, coinciding with $500,000 of investment by Ophir in the airport. The airport now handles 14 flights per week and the port could handle up to four drilling rigs and the supply vessels and marine security to support them.

Exploration to date

Between October 2010 and April 2011, Ophir and BG Group drilled three deepwater discovery wells with Odfjell's new semisubmersible, Deepsea Stavanger. In Block 4, the Pweza-1 well was drilled in water 1400m deep, and the Chewa-1 well was in water 1300m deep. In Block 1, the Chaza-1 well was drilled in 950m water depth.

In 2012, BG Group, now operator in the partnership, then went on to make further discoveries; Jodari-1 and Mzia in Block 1, and Papa-1, the first discovery in Block 3 about 100km offshore, in 2180m deep water. At the end of 2012, BG drilled another discovery, the Jodari North-1 well, the seventh consecutive find.

In March this year, a drill stem test on the Jodari-1 well flowed at a maximum rate of 70MM scf/d, constrained by testing equipment. In May, a drill stem test on the Mzia-2 appraisal well, saw a maximum flow rate of 57MM scf/d, also constrained by testing equipment. Both drill stem tests exceeded expectations, says BG. Mzia was BG's first Cretaceous discovery in Tanzania; Papa-1 was second.

Petrobras started drilling in 2011, using the *Ocean Rig Poseidon* on Zeta-1 in Block 5, with a second well in 2012. However, no results have been announced in the Shell-partnered block.

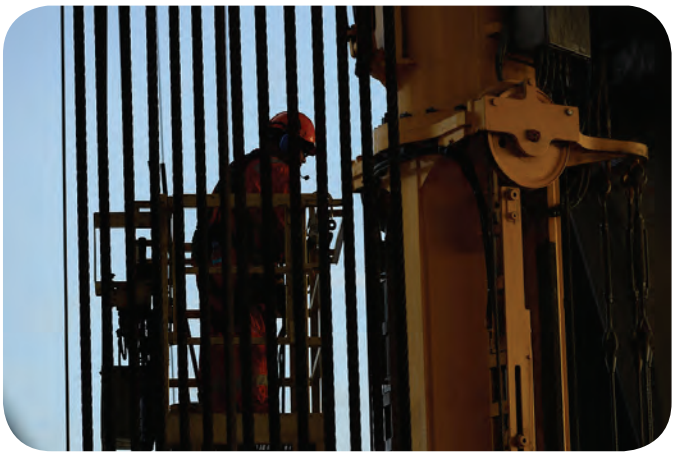
In 2012 and 2013, Statoil and partner ExxonMobil made a string of discoveries, also using the *Ocean Rig Poseidon*. These were the Zafarani, Lavani and Tangawizi discoveries in Block 2, covering about 5500 sq km in water 1500-3000m

The *Deepsea Metro-1* is contracted to BG Group for drilling offshore Tanzania.

deep. Statoil has a 65% working interest and Exxon 35%. The Lavani-2 well tested the deeper Saffron target, described as a "promising new discovery" by Statoil. Together, Statoil says the finds add up to 10-13 Tcf of recoverable gas resources.

In May this year, Statoil acquired 12% WI in Block 6 from Petrobras. The block covers 5549 sq km in the Mafia basin, about 170km north of Block 2. Petrobras retains 38% WI, Shell has 50%.

Ophir has also added Block 7 to its licenses, operated in partnership with Dominion Petroleum.



Operations offshore on the *Deepsea Metro-1* for BG Group.

Planning for LNG

BG, with Ophir, are planning for the country's first LNG facilities, with final investment decision planned for 2016/7.

Statoil said its finds have added "robustness" to a future decision on a potential LNG project. Statoil may recommend an LNG site this year and says planning to recommend a site in 2Q this year and says there is potential for at least two trains to handle production from existing finds on Block 2, including BG's.

Exploration continues

London-listed Afren is currently processing 620sq km of 3D seismic shot over the Tanga block, to the north of Tanzania, earlier in 2013, with a view to pin-pointing exploration targets.

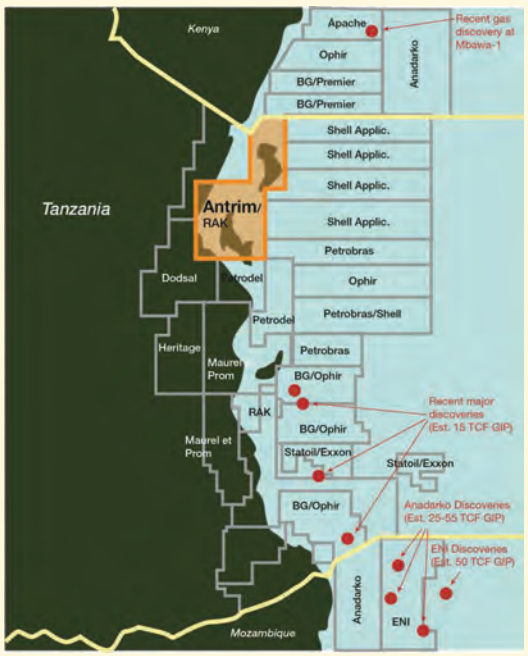
Earlier this year, Afren said it signed a letter of intent to use a rig to drill the Calliope prospect with partner Petrodel Resources Ltd., a privately held company based on the Isle of Man.

Mnazi Bay gas looks bright

Recent finds by BG Group, Statoil, Eni, and Ophir Energy are changing Tanzania's fortunes. Now a number of these operators, along with ExxonMobil, are working on early design studies for the country's first LNG processing trains. The operators expect to reach a final investment decision by 2016 and begin exports in 2020.

London-based independent Ophir Energy plc has been involved in Tanzanian gas exploration since it was founded in 2004. Stephanie Prior, its senior commercial manager, says driving the renewed interest off Tanzania has been the award of more than 1.7million sq mi of acreage offshore since 2000, 25% in deep water, dramatically changing the color of the Tanzanian licensing map.

During 2005/6, Ophir acquired 2D seismic over 4300sq km, with a more 2D over an additional 3800sq km in 2008. It also shot Tanzania's first 3D survey in the same year. It then acquired more 2D and 3D in 2009, moving toward Tanzania's first deepwater exploration program. Partnering with BG Group, Ophir drilled a three-well campaign in Blocks 1 and 4 during 2010.



Illustrated map of blocks awarded off Tanzania. Photo: Antrim Energy

However, Prior says, before the first well could be drilled, investment in port and logistics infrastructure was required, as well as negotiations with the government.

"A huge amount of the work for the team was working to agree [to] a production sharing agreement and [on] the terms of a gas commercial project with the Tanzanian government," Prior told SPE London's annual conference in London in May.

Commercial project terms for natural gas took two years to negotiate, leading up to 2010. "We realized if it was going to work, if there were large amounts of gas offshore, it would be destined for LNG markets," Prior says. "So before investing in drilling,

Statoil and ExxonMobil are working on additional prospects in Block 2 and have recently acquired 3D seismic data in areas covered only by 2D seismic. Planning is also underway for an appraisal well on Zafarani.

Petrobras is still assessing data from the Block 5 Zeta-1 well, alongside 3D seismic interpretation work on Block 6.

Shell says it is in conversation with the TPDC with a view to finalizing a production sharing agreement on Blocks 9-12, which would allow it to start exploration activities.

The BG/Ophir partnership completed drilling of an exploration well, Ngisi-1, using the *Deepsea Metro-1*, operated by Odfjell, last month [June]. It is also planning further drilling after an agreement signed in May extended use of the *Deepsea Metro-1* for a further 18 months, from June.

Exploration targets will be sought using 3D seismic acquired on Block 1 earlier this year, with an intention to explore the potential continuation of the Tertiary basin floor fan prospectivity in the Rovuma basin found in Mozambique.

Ophir will also have access to the rig to drill exploration wells on Mlinzi in Block 7 and Maembe, in the East Pande block, closer to shore.

The Mlinzi subsurface is thought to have analogues to ENI's giant Mamba discovery offshore Mozambique with Ophir estimating gross mean resources of 25.6Tcf. **OE**

we needed to sit around a table with the Tanzanian government for fast-track LNG development for Blocks 1, 3, and 4, and agree [on] domestic market obligations. It means we are clear along the value chain.

"They are struggling with these in Mozambique. In fact, other assets in Tanzania will have to go through this [process] too, including some of ours.

"From a logistics standpoint, in order to kick off [a] deepwater drilling campaign, we also needed to identify how to supply these campaigns, where supply vessels were going to be located, where pipe was going to come in and, in addition, marine security needed to be considered, as we are operating near the Indian Ocean.

"Early on, we also decided we wanted to leave a long-lasting set of assets in Tanzania, so we worked to [make some improvements at] Mtwara Port, one of three deepwater ports in Tanzania."

Tanzania Ports Authority manages the ports at Mtwara, Dar es Salaam, and Tanga. In 2004, Mtwara became the base for the Mnazi Bay gas field.

By 2009, Mtwara had intermittent electricity from a power station powered by Mnazi Bay gas. However, Prior says, infrastructure in the country needed vast improvements.

"If we were to run an exploration campaign successfully, we needed a functioning airport, heliport, accommodation and canteen, clinic and ambulance services, an offshore supply port, and reliable power supply and drinking water—some of the most basic elements were

Aerial view of Mtwara Port.

required."

Early 2009, Ophir and Petrobras decided to join forces to set up Mtwara as a base of operations. "With $50-100million cost per well, $9million to refurbish a port (split 50:50 between Petrobras and Ophir) isn't that much," says Prior.

Regent Tanzania Ltd. was appointed in 2009 to run the supply base for gas exploration out of Mtwara Port.

However, there has been recent unrest over the investments proposed in the country. In late May, 80 people were arrested in Mtwara, over fears that the town would miss out on benefits from the gas, if it is piped to the capital.

By the end of the BG-Ophir 2012 drilling campaign, the partnership had acquired more 3D seismic and grown a resource base of more than 10Tcf recoverable gas reserves, with further discoveries—Jodari and Mzia - made in Block 1, and Papa-1, the first Block 3 discovery.

Planning for LNG facilities is "well under way, to understand what we need to do for front end engineering and design, and final investment decision for 2016 with first export of gas in 2020," Prior says.

"In three years, we've gone from creating jobs and transforming the port in a small community to potentially having a big impact on the whole country."

The pace is unlikely to slacken. This year BG and Ophir may drill as many as six wells off Tanzania, using the drillship *Deepsea Metro-1*. The work includes drill stem tests on Jodari and Mzia, exploration on Ngisi prospect in Block 4, Well 1C in Block 1, drilling in Block 7 (operated) on Mlinzi and Maembe, and in East Pande, closer to shore. BG is also acquiring more 3D seismic.

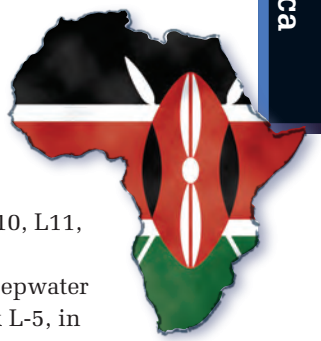
The Mlinzi subsurface is thought to have analogues to Eni's giant Mamba discovery offshore Mozambique. Ophir estimates gross mean resources of 25.6Tcf.

"We are moving our exploration up [north] towards Dar es Salaam, where massive prospects could support more trains, and into deeper water," says Prior.

"East Africa has a long way to go and I guarantee this presentation will look quite different in two years. The rest of the industry has woken up and we are expecting a number of (corporate) transactions in coming years." OE

Kenya forges ahead

Recent offshore drilling by Apache and Anadarko help gauge the potential of the Lamu basin.



By Nina Rach

Vision 2030 is Kenya's development strategy which aims to transform the economy and "create a globally competitive and prosperous nation with a high quality of life by 2030." The government is committed to continued institutional reforms in the energy sector, and stresses public-private partnership.

NOCK

The National Oil Corporation of Kenya (NOCK) was incorporated in 1981, and began to oversee exploration activities delegated from the Ministry of Energy, in 1984. The Petroleum (Exploration & Production) Act, Cap 308, (1986) provides legal framework and regulates the negotiation of production-sharing contracts with potential investors. PSCs are also governed by the Environmental Management & Coordination Act (2000; NEMA).

In 2010, NOCK launched a program to digitize all of Kenya's oil and gas exploration data. In February 2013, CEO Sumayya Hassan-Athmani announced in the company's "Energized Bulletin" that the project was complete, data would soon be uploaded, and available to the public online.

Exploration history

The first wells drilled in Kenya were onshore, in the Lamu embayment, beginning in 1960.

The earliest offshore exploration activities were 2D seismic data acquisition programs, beginning in 1970. The first three offshore wells were drilled in the Lamu basin. Total drilled the Simba-1 well (Block L-9) in 1978, to 3604m (11,824ft) TD. In 1982, Cities Services drilled the Maridadi-1B well in Block L-6, to 4,198m TD. In 1985, Union drilled the Kofia well in Block L-7, to 3,629m TD.

After an in-house study in 1991, NOC Kenya subdivided the Lamu embayment (both onshore and offshore) into 10 exploration blocks, created 2 more blocks in 2001, and several more in the last decade. Kenya signed seven production-sharing agreements (PSC) in 2000-2002.

In August-October 2003, Woodside acquired 7884km of 2D seismic data in the offshore Lamu basin, over Blocks L5, L6, L7, L8, L9, L10, L11, and L12.

In 2006, Woodside drilled the first deepwater well off Kenya, the Pomboo-1, on Block L-5, in water 2193m (7195ft) deep.

NOCK acquired offshore Block 14T in Magadi in November 2010, and in 2012, signed an agreement with Japan national oil company, Japan Oil, Gas and Metals National Corp. (JOGMEC) for joint exploration. Full-tensor gravity gradiometry (FTG), 2D seismic, magneto telluric, and time-domain electromagnetic studies began in June 2012.

Recent offshore wells

In 3Q 2012, Apache Corp. drilled its Mbawa South well in Block 8, in water 864m deep. The well encountered 53m net gas pay, making it the first hydrocarbon discovery offshore Kenya. Apache operates the block with 50% interest.

Anadarko has working interests in five blocks off Kenya: L5, L7, L12, L11A, and L11B. It began work offshore in December 2012 with Transocean's *Deepwater Millenium* drillship. In April 2013, the company announced that it had completed the Kubwa well in the L-07 Block, which it operates (50% WI) on behalf of partners Total E&P Kenya B.V. (40%) and PTT Exploration & Production Plc (10%). The well had non-commercial oil shows.

"We are very encouraged with our first test of Kenya's previously unexplored deepwater basin, in which mud-log and well-site evaluation of core data indicates the presence of a working petroleum system with reservoir-quality sands," said Anadarko Sr. Vice President, Worldwide Exploration Bob Daniels. "The Kubwa well tested multiple play concepts and provided useful data regarding the prospectivity of our six-million-acre position offshore Kenya. The rig will now mobilize south to drill the Kiboko well."

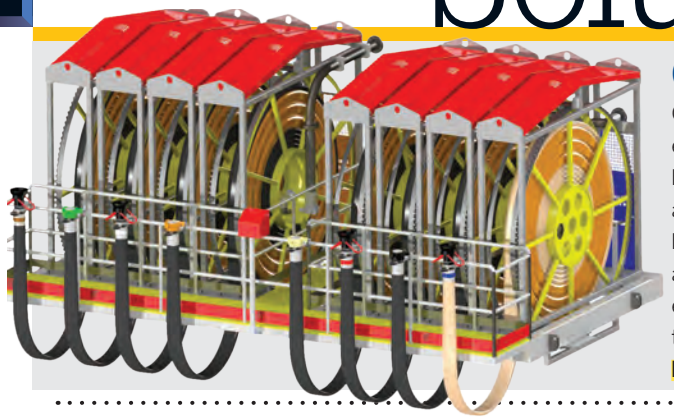
Anadarko is drilling the Kiboko prospect on Block L-11B. Anadarko said the Kiboko well is testing both Upper and Lower Cretaceous sands, just above the thick Jurassic carbonate section. So we're just getting started in Kenya, and we're pretty excited about what we see." OE

Early 2D seismic acquired offshore Lamu basin

Operator	Years	Km acquired, 2D
BP, Shell	1970	1080
Shell	1972-1973	2103
Total	1973	3652
Oceanic	1975	451
Wainoco & Anchutz	1975	350
Sun Oil	1975	1099
GSI (African Marine)	1975	690
Seagap	1976	820
Cities Services	1980	1251
Lamont Doherty	1980	2400
Woodside Petroleum	2003	7881
PGS/NOCK	2008	3400
	Total	**25,352**

Data from National Oil Corporation of Kenya.

Solutions



Compact loading stations

Oklahoma-based Tulsa Power's offshore loading stations are designed to eliminate hoses being laid on deck and dangling from saddles – avoiding trip hazards; reducing UV exposure, hose kinks and fatigue/breakage failures, and reducing the chance of spills. The stations offer up to four-times-longer hose life when compared to laying on deck or saddles. Powered deployment and retrieval of hoses minimizes manpower and operator exposure, greatly enhancing personnel safety. This system also weighs 30% less than competitor's reels and offers a neat and safe way to store the hoses.

http://www.tulsapower.com

New gyro compass launched

Germany's Raytheon Anschütz launched a new generation, maintenance-free gyro compass. The Horizon MF is a strap-down compass system that uses hemispherical resonator gyros (HRG) to measure angular rates for heading calculation. The system provides the same advanced functions as standard gyro compasses, such as heading selection and monitoring, automatic switch-over functions, an independent transmitting magnetic compass and individual speed error correction, with a MTBF value of more than 100,000 hours.

http://www.raytheon-anschuetz.com/

NASDrill upgraded

Aberdeen-based Nautronix enhanced the functionality of the Nautronix NASDrill USBL acoustic positioning systems by incorporating a new transducer design. The company used its acoustic digital spread spectrum (ADS^2) signaling technology to house the hydrophone within a ruggedized, non-corrosive, pvc material. This eliminates most water corrosion issues. The hydrophone is also more compact and lighter in weight, and employs an identical mounting flange so it can directly replace existing hydrophone models on existing deployment poles and methods.

http://www.nautronix.com

Wireless monitoring

WFS Technologies and Stork Technical Services unveiled their Seatooth Smart CP, a subsea wireless cathodic protection (CP) monitoring system designed for retrofit to existing fields. The system monitors the effects of corrosion by measuring anode current wirelessly in "real-time" using a Seatooth S100 device and a wireless enabled ROV.

It also enables wireless monitoring of the condition of the anode to verify that it is functioning and the rate of depletion. The CP Engineer can extrapolate what weight of anode material is required to optimize levels of protection based on actual conditions on the structure.

http://www.wfs-tech.com/

Remote intregity monitoring

Aberdeen-based Flexlife deployed its new integrity monitoring technology, FlexGuard, at Chevron's Captain field in the UK North Sea. The new monitoring tool provides the operator with instant, continuous monitoring of any subsea riser. This information can be acquired remotely from any location in the world – ensuring a failsafe early warning system, providing major cost and safety benefits. The system can be installed either during installation or by retrofit to risers already in operation in the field.

http://www.flexlife.co.uk

Spotlight

By Audrey Leon

Back to Basics with Offshore Installation Services President Mike Earlam

Mike Earlam joined Aberdeen-based Offshore Installation Services (OIS), an Aceton company, as president in April. OIS specializes in providing support for construction, maintenance, installation and decommissioning projects.

As leader of OIS, Earlam says his immediate focus is on growing the business in 2014. These efforts will include further expansion of OIS' suspended well abandonment tool (SWAT) – designed by fellow Aceton company Claxton Engineering – and also moving OIS' abandonment services into the Malaysian market.

Earlam says he's also keen to pursue opportunities to partner with other Acteon companies, encouraged by past pair ups with Aquatic and 2H Offshore in Brazil. "We're looking at synergies," he says. "We have some core skills internally within Acteon Group and we want to see how to work together to execute future contracts."

Since joining OIS, Earlam hit the ground running, learning more about the business from not only his management team, but his customer base as well. During his first few weeks on the job, he scheduled meetings with numerous clients in order to discover what Acteon and OIS can do to better serve them.

"It's about getting back to basics," Earlam says. "First, you have to listen to your team and what they tell you, and then you have to get out in front of clients and figure out what you can do for them.

"Safety is key. It has to be a part of our ethos," he says. "If you can't manage safety, you can't manage anything."

"You can have a very short-sighted view of the world until you've chatted with your client and seen what his expectations are; (until you've done that) you're probably barking up the wrong tree."

Earlam comes to OIS from Fugro Salt Subsea where he worked in the company's subsea construction and trenching businesses in the North Sea and Europe. From his experience at Fugro, Earlam took with him a commitment to safety culture. "Safety is key. It has to be a part of our ethos," he says. "If you can't manage safety, you can't manage anything.

"We always start all our meetings with a safety moment this way safety stays and the forefront of everybody's mind."

Prior to Fugro, Earlam worked with Subsea 7 as its global chartering manager, helping to develop the company's fleet. In addition, he spent 10 years with ASCO managing its marine operations and logistics. OE

Entrance and Egress

ABB appointed **Ulrich Spiesshofer**, the head of its Discrete Automation and Motion (DM) division, to succeed Joe Hogan as CEO, effective September 15.

Marcio Rocha Mello, founder and CEO of Brazilian E&P firm HRT, has resigned his position. He will retain his place on the board.

Clarence Cazalot Jr. will step down as Marathon Oil Corp.'s CEO. He will be replaced by ExxonMobil Development Co.'s Vice President of Engineering **Lee Tillman** on August 1. Marathon also picked up **Bruce A. McCullough**, who succeeded Thomas K. Sneed as vice president and CIO.

Jeff Shellebarger succeeds Gary Luquette as Chevron's new president of North American Exploration and Production, effective August 1.

James J. Kleckner has been promoted to executive vice president, International and Deepwater Operations at Anadarko following Robert Douglas Lawler's jump to Chesapeake Energy last month.

Peter Voser will retire as Shell CEO by 1H 2014.

Arshad Matin joined Paradigm as president and CEO.

David Kemp succeeds Duncan Skinner as CFO of Wood Group PSN.

Ken Borda succeeded Peter Coates as Chairman of Australia's Santos. Borda has been a non-executive director at the company since 2007.

Activity

Subsea 7 opened its Global Pipeline Welding Development Centre (GPWDC), the result of a US$15.6 million investment in its operations base at Clydebank, Glasgow. The center will develop welding technology for global deployment. The GPWDC is located in two buildings—Pipeline Development Centre (PDC) 1, a welding and inspection center and PDC2, housing R&D and screened radiographic and ultrasound NDT testing facilities. (Pictured: Scottish Government First Minister Alex Salmond)

Royal Boskalis Westminster and **Royal Volker Wessels Stevin** (VolkerWessels) will establish a joint venture (JV) for carrying out offshore cable installation. Boskalis and VolkerWessels will each hold a 50% stake in Visser & Smit Marine Contracting—currently a 100% subsidiary of VolkerWessels—which will continue its activities under the name VSMC. The JV will focus on installing offshore power cables, such as for wind farms, and both infield and export cables. Through the JV, VSMC will have access to two cable-laying vessels, the *Stemat Spirit* and the *Ndurance*, a new-build vessel due to be delivered this year. These vessels are fitted with DP class 2 equipment with a cable turntable capacity of around 5000 tonnes and are wholly owned by the two parent companies.

Foster Wheeler AG has acquired Monterrey, Mexico-based **NorthAm Engineering**. NorthAm is one of the largest Mexican engineering and project management companies, specializing in upstream, offshore and onshore, downstream, and power projects. "The acquisition of NorthAm is part of our stated strategy to grow our upstream capabilities and the geographic footprint of our global engineering and construction group," said Kent Masters, CEO Foster Wheeler AG.

Dassault Systèmes, moved to acquire manufacturing software solutions provider **Apriso**, for about US$205 million. The acquisition of California-based Apriso deepens the global manufacturing operations management capabilities of the 3DEXPERIENCE platform. Dassault Systèmes' acquisition of Apriso will expand the 3DEXPERIENCE footprint across multiple industries, such as consumer goods, packaged goods, high tech, life sciences, transportation & mobility, aerospace & defense and industrial equipment.

After closing its US$2.5 billion acquisition of well-drilling equipment parts provider **Robbins & Myers**, Houston-based **National Oilwell Varco (NOV)** adds three more businesses to its NOV Mono division: Moyno Inc., Chemineer Inc., and Tarby Inc. The three additions make NOV the largest designer and manufacturer of progressing cavity pumps. NOV Mono Senior VP, Santosh Mathilakath, said that the acquisition of these companies represents a new force in the industrial pump arena, creating growth opportunities and faster response times for consumers.

Teekay Offshore Partners L.P. has agreed to acquire a 50% interest in the *Cidade de Itajai* FPSO from Teekay Corporation (Teekay) for about US $204 million. The *Cidade de Itajai* FPSO is operating on the Baúna and Piracaba fields in the Santos basin off Brazil under a nine-year, fixed-rate, time-charter contract with Petrobras. Odebrecht Oil and Gas S.A. holds the remaining 50% interest in the FPSO.

TAM International, Inc., an inflatable and swellable packers

Zilift is developing systems to form the next generation of artificial lift. (Pictured: Iain Maclean, CEO, Zilift)

Saudi Aramco Energy Ventures LLC (SAEV) closed on an equity investment in Zi-Lift AS, developer of through-tubing-deployed artificial lift systems using permanent magnet motors and transmissions. "Reliable and easily deployable artificial-lift systems are a priority area of technology development for Saudi Aramco," said Ibrahim Buainain, SAEV CEO. "Zilift's technologies offer potential for time and cost savings in artificial lift deployment and for enhancing the output from large numbers of producing wells."

provider, opened a new office in Dubai to support the company's growth in the Middle East. The office offers state-of-the-art technology and is in a centralized area, enabling customers to visit staff members and attend lunch-and-learn sessions, presentations, and in-house training. "We want to be the industry-leading supplier of inflatable and swellable packers in the region and this expansion will help us accomplish that goal," said Colin Graham, Middle East regional manager.

Praxair Offshore Services Ltd. acquired Scotland-based **Dominion Technology Gases Investment Ltd.**, supplier of diving, welding, industrial, laboratory and calibration gases, and associated equipment to the offshore oil and gas industry. Through its acquisition, Praxair will be able to provide products and services to an expanded base of high-value customers in the global market. Dominion is expected to generate sales in 2013 of about US$55 million.

Howco Group PLC, has invested over US$4.6 million in new equipment and machinery at three of its UK plants, with $2 million spent at its facility in Sheffield. The company's two aerospace-standard heat treatment furnaces offer precise temperature control throughout the operating range, and a dedicated rapid charger for loading and unloading products. Howco also purchased the Hyundia Wia KBN 135 boring machine to provide additional capacity and capability to finish machine components with a maximum component weight of 10 tons. OE

Editorial Index

Advertiser Index

Advertising sales

NORTH AMERICA
Bill Krull
Phone: 713-535-1521
bkrull@atcomedia.com

Amy Vallance
Phone: 281-758-5733
avallance@atcomedia.com

John Lauletta
Phone: 713-874-2220
jlauletta@atcomedia.com

Rhonda Warren
Phone: 713-285-5072
rwarren@atcomedia.com

UNITED KINGDOM
Neil Levett, Mike Cramp
Alad Ltd
Ph: +44 01732 459683
Fax: +44 01732 455837
neil@aladltd.co.uk
mike@aladltd.co.uk

NORWAY/DENMARK/ SWEDEN/FINLAND
Brenda Homewood, Alad Ltd
Ph: +44 01732 459683
Fax: +44 01732 455837
brenda@aladltd.co.uk

ITALY
Fabio Potesta,
Media Point & Communications
Ph: +39 010 570-4948
Fax: +39 010 553-00885
info@mediapointsrl.it

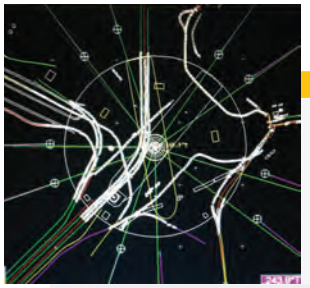
NETHERLANDS/AUSTRIA/GERMANY
Arthur Schavemaker, Kenter & Co. BV
Ph: +31 547-275 005
Fax: +31 547-271 831
arthur@kenter.nl

FRANCE/SPAIN
Paul Thornhill
Ph: 01732 459683
paul@aladltd.co.ukk

MALAYSIA
Koh Earn Soo,
Market Intelligence (M) Sdn Bhd
Ph: +60 12 389 0675
Fax: (603) - 6274 7660
kes.marketintelligence@gmail.com

SINGAPORE AND AUSTRALIA
June Jonet, The Silverback
Ph: +(65) 8112 6844
junejonet@thesilverback.com

Numerology



4 Of the ten anchor lines parted on the *Gryphon Alpha* FPSO during a storm in early 2011. ▶ See Production, page 46.

US$25 billion The amount Iran plans to invest for its development, exploratory and seismic operations until March 2014. *(Source: National Iranian Oil Company)*

20 The number of exploration licenses Greenland has issued to date. *(Source: Government of Greenland)*

Revised end-of-life date of the Quad 204 development. ▶ See Production, page 52.

13,500 The weight, in metric tonnes, of the eight-legged MNP jacket built for ONGC. ▶ EPIC-India, page 40.

58 Anadarko's Orca-1 discovery off Mozambique encountered approximately 58m of net gas pay. ▶ See Mozambique, page 62.

1800

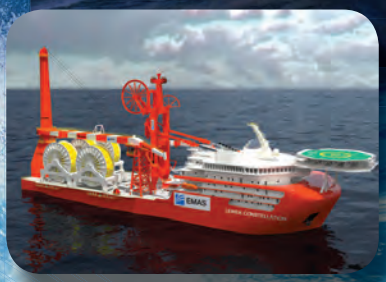
The weight, in tonnes, of the subsea template for the Åsgard compression project. *(Source: Statoil)*

32,800 The total depth, in feet, that Noble Energy's Gulf of Mexico prospect Gunflint was drilled. ▶ See Global Briefs, page 16.

878 sq. km The size of one offshore block up for grabs in Western Australia's bid round. *(Source: Australia's Department of Mines and Petroleum)*

Right People. Right Solutions. Right Now.

Together We Deliver



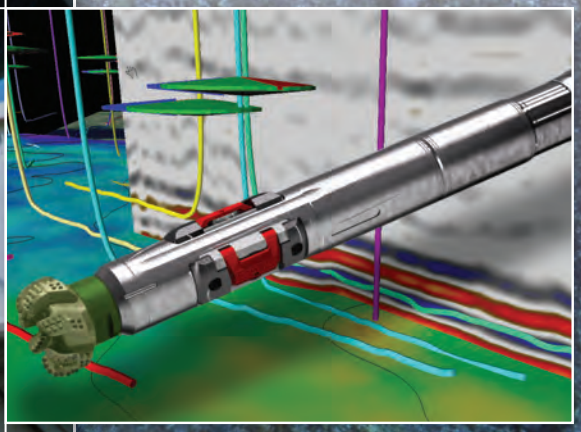
The **EMAS** Group comprises over 5,000 employees with assets and services across five continents. With a combined fleet of over 65 offshore construction and marine support vessels and strategically located offices and facilities worldwide, **EMAS** delivers subsea construction, offshore installation, floating production, well services and marine support to the global offshore energy industry.

EMAS

Together We Deliver

AMC Energy Marine Production

www.emas.com



PowerDrive vorteX

POWERED ROTARY STEERABLE SYSTEM

Drill hard formations with maximum downhole control.

The PowerDrive vorteX powered RSS gives the performance boost to drill hard and abrasive formations while maintaining control in deep land wells. The integrated power section has a high torque capability to optimize ROP and fully rotates to reduce stick/slip.

PowerDrive vorteX RSS saved the operator 12 drilling days and USD 14.1 million by optimizing ROP in the hard Santos formation of Brazil.

Find out more at

slb.com/vorteX

Schlumberger