

# energize

energy. efficiency. engineering.

## oil & gas

# Focus on Safety

europa Signs of Improvement  
welding Fascinating Technique  
software Powerful Tools

**GL** Noble Denton



**trust. change. results.**

GL Noble Denton is the leading independent technical advisor to the oil and gas industry. With a presence in more than 80 countries, our experts are **trusted** by some of the sector's best known organisations to implement meaningful **change** and deliver exceptional **results** across the lifecycle of their assets.

From providing technical due diligence support to one of Germany's leading financial services providers, to delivering project management for ACS Cobra's new underground gas storage facility in Spain, we're committed to providing world-class service in everything that we do.

**Visit us at Offshore Europe 2011 – Hall 2, Stand E130**



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[glnobledenton@gl-group.com](mailto:glnobledenton@gl-group.com)

## To Our Readers



Pekka Paasivaara

**“Securing Safe, Smart, Sustainable Supply”** – the headline of the Offshore Europe conference and exhibition in Aberdeen could hardly be more relevant. Although the recent accident in the North Sea cannot be compared with the Deepwater Horizon incident 18 months ago, this episode shows just how necessary continuous quality assurance and reliable risk management is at the highest technical level.

**Regulatory demands on the oil and gas industry are increasing.** In Europe, for example, the European Union is planning new acts to improve the safety of offshore facilities. GL Noble Denton is taking this challenge seriously: with the Guidelines for the Certification of Blowout Preventers or in advising newcomers to the market, such as Ireland, in the implementation of a Petroleum Safety Framework (page 10).

**The largest discovery of oil in the North Sea** in thirty years has caused a sensation. As great as the rejoicing and hope for further sources of oil in the shelf sea may be, they only play a secondary role in supplying the world. The growing demand for energy means that the significance of deepwater offshore drilling is growing. This results in the necessity for technical risk-prevention solutions which must also increase operational efficiency and sustainability.

**Our Project Management Service** has made a name for itself in the industry for reaching the right decisions at the right time (page 44). The team has often shown that it can competently support its customers in each phase of a project, as exemplified by the Polvo project in the Brazilian offshore sectors.

**Innovative approaches are in demand.** The performance and safety of underwater welding operations on offshore structures, for instance, can be significantly improved. Fascinating technology from Australia has made this possible (page 24). Down Under, GL Noble Denton has a major involvement in the Queensland Curtis LNG project which is currently being executed by QGC (page 42). Our solid background in gas processing, production and transportation expertise, in particular, forms a stable basis for facing the challenges of a changing energy mix. This also involves developing city gas networks (page 38), an area where GL Noble Denton’s expertise is in great demand (page 48).

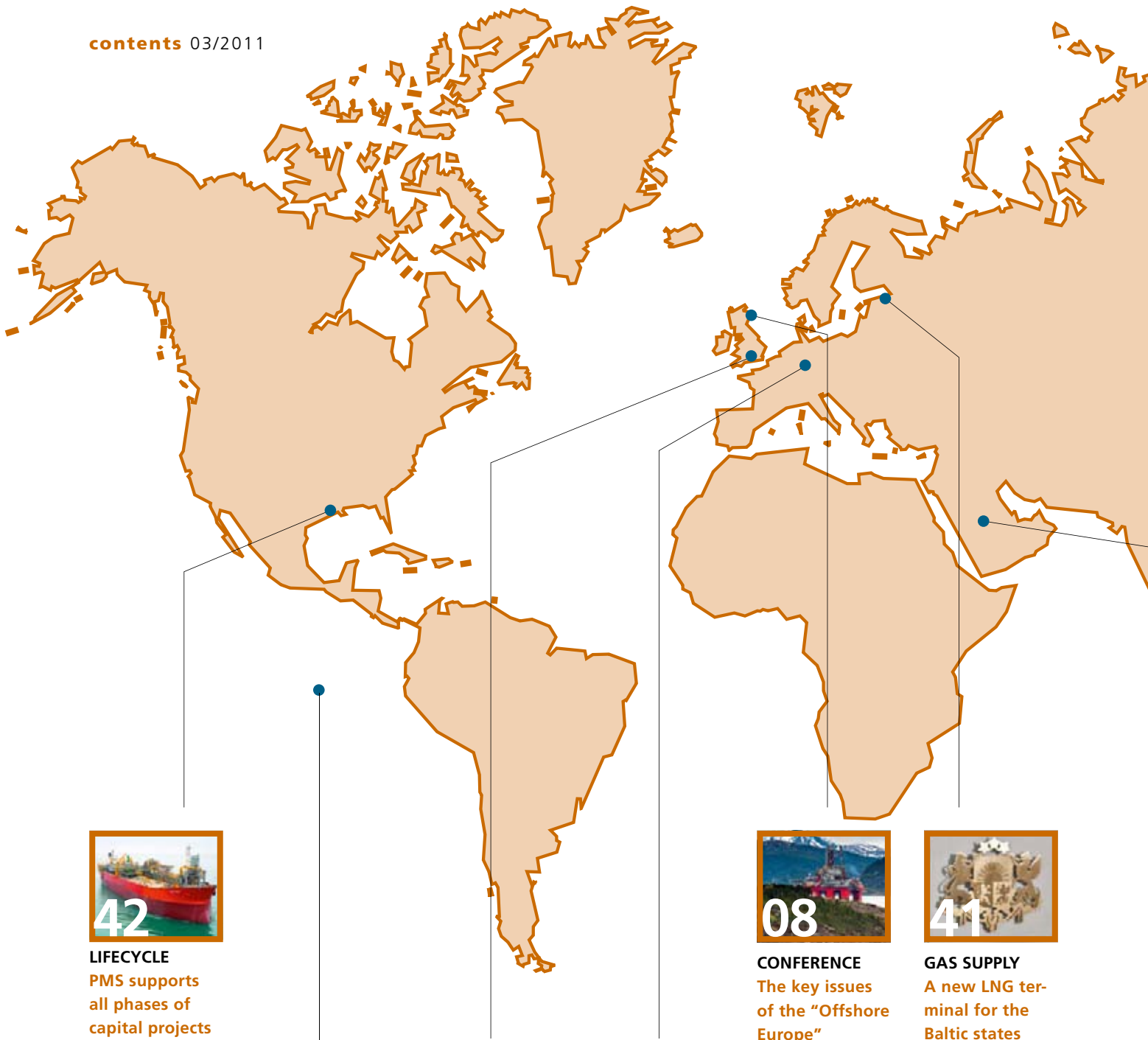
We look forward to providing you with the right solutions.

Yours sincerely,

A handwritten signature in blue ink, consisting of several loops and a horizontal line at the end, positioned above the printed name.

**Pekka Paasivaara**

Member of the Executive Board, GL Group



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PMS supports all phases of capital projects



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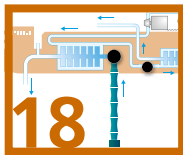
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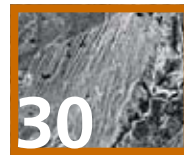
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## GL Noble Denton in Brief

- GL Noble Denton is a **TECHNICAL ADVISOR AND TRUSTED PARTNER** for the oil and gas industry.
- The oil and gas business segment of the GL Group helps to design, build, install and operate oil and gas onshore, maritime and offshore assets to ensure **SAFETY, SUSTAINABILITY AND SUPERIOR VALUE**.
- GL Noble Denton is the **MERGER BETWEEN GERMANISCHER LLOYD'S OIL & GAS BUSINESS AND NOBLE DENTON**, a premier provider of life-cycle marine and offshore engineering services. Since January 2010, they have been offering their services as GL Noble Denton.

GL Noble Denton is a full-service provider with broad upstream and midstream competence **FOR THE COMPLETE ASSET LIFECYCLE**.

GL Noble Denton combines excellent engineering and analytical skills with operational experience of offshore, maritime and onshore oil and gas assets. The oil and gas business segment of GL employs **MORE THAN 3,000 ENGINEERS AND EXPERTS IN 80 COUNTRIES**.

We have strong expertise in complex oil and gas assets such as MODUs, FPSOs, pipelines, subsea systems, OSVs – and assurance, asset integrity, safety and risk, marine operations, project management and software services to match. The scope of technical services includes safety, integrity, reliability and performance management.

GL Noble Denton is **A TRULY INDEPENDENT ADVISOR** without any vested interest in selling a design, installation, fabrication or equipment.

GL Noble Denton services oil and gas clients in onshore production, onshore pipelines, storage, import terminals, LNG, refineries and petrochemicals, distribution networks as well as mobile offshore drilling units, mobile offshore production units, fixed platforms, subsea, risers and flowlines, offshore support vessels, tankers and shipping and offshore pipelines. We oversee and support the full lifecycle of an asset from project concept to decommissioning. The business segment has **A GLOBAL REACH IN THE OIL AND GAS CENTRES** of the world.



**WELDING**  
A new technology for underwater tasks



**CITY GAS**  
A concept study for a new project in the Middle East



**VERIFICATION**  
Services for an Australian oil and gas project

**GL Noble Denton**  
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# europa

The oil and gas industry is to talk about safety as a key issue, deepwater offshore drilling and the growing importance of natural gas. As an important service provider GL Noble Denton presents lifecycle solutions to the whole industry.





The end of 2010 and the beginning of 2011 saw a period of recovery and increased confidence in the oil industry. Prices had started to rise and capital investment was growing.

The events of the last several months, with the prolonged wrangling over the debt ceiling in the U.S., the consequent downgrading of the US credit rating and the potential for recession combined with the continuing and spreading credit crisis in the EU seem set to challenge that confidence.

### Capital Expenditure Forecast to Improve

Relative price stability in the oil markets from the beginning of 2009 meant that 2010 and the beginning of 2011 saw a period of increased investment in Europe and globally, with a focus on offshore projects.

This investment was mainly driven by the national oil companies, with smaller players being more cautious in an environment where the resources open to them are more risky and capital intensive. In the Economist Intelligence Unit's survey of the sector in 2010, sponsored by GL Noble Denton, more than three quarters of the respondents had a positive outlook for the coming year and over half of the respondents expected increased investment in oil and gas projects.

### Tax Challenges in the UK

The continuing instability in the European credit markets sees governments scrambling to increase revenues. Positive results in the oil and gas industry attracted the attention of government authorities.

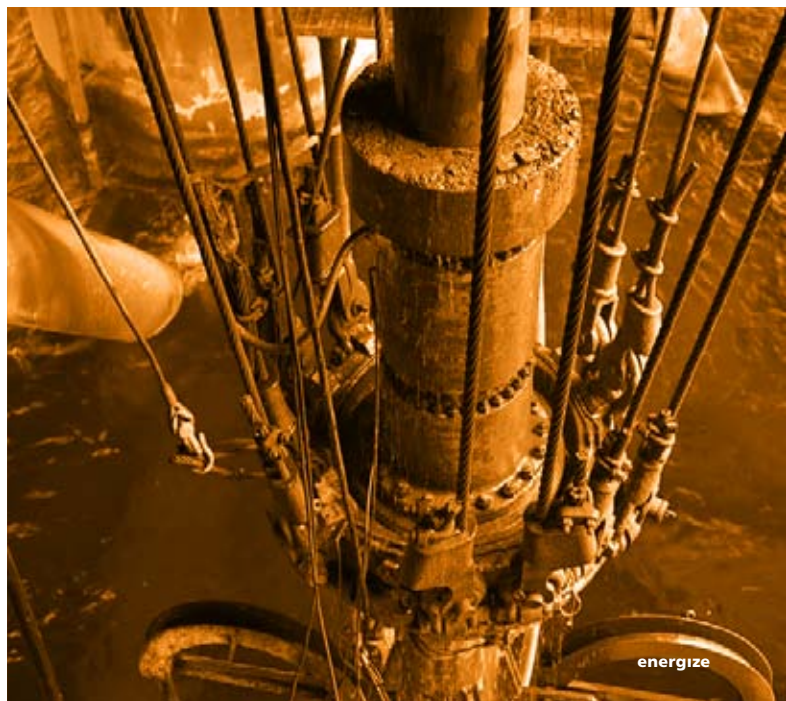
This can be seen in the UK, with an increase in the levy on oil from 20 per cent to 30 per cent. That may have an effect on investment and the development of resources in the North Sea which are reaching the end of their lifecycles. It will particularly affect the many smaller discoveries that



# Confidence Challenged



This year's Offshore Europe in Aberdeen is shaping up to be the biggest in the event's history. *energize* looks at the key issues





**Trend. Off-shore deep-water drilling projects represent the future of the oil and gas industry.**

have been in the course of development since the beginning of the year.

### Drive to Deeper Waters

As conventional supplies are depleted, deepwater offshore drilling grows in importance. As depth increases the challenges, risks and stresses on equipment increase. Alongside deepwater drilling, subsea systems provide the most commercially viable solution for developing these resources in ever more extreme conditions. The safety challenges associated with such projects are of course correspondingly magnified, yet with all this the increase in scheduled offshore deepwater drilling projects from 2010 to 2011 seems to signal that these projects represent the future of the industry.

### Safety Still an Area for Concern

Several recent incidents, none on the scale of the Macondo incident, highlight the continuing importance of safety on offshore platforms. Maintaining and improving systems and equipment to the highest levels is a constant process where no developer, administrator or auditor can afford to be complacent, even when safety records are good. Increasing diligence time loads not only in the US but in Europe suggest that the burden on industry to ensure that safety is maintained to the highest levels will continue to grow.

### EU Regulations

The ripples from the Macondo incident are still being felt, and not only in the legal area, as the impact of the disaster continues to be worked out. As the U.S. re-evaluates its safety and regulatory regimes and the future of offshore drilling in US continental waters faces uncertainty, the incident

has brought an increased level of scrutiny across the industry.

In particular the incident prompted the European Commission to announce its intention to look at the development of EU-wide safety rules. The communiqué from the Commission envisions an EU-wide standard approach to a whole raft of measures, from permitting and licensing, to safety equipment, emergency response and liability.

### Skills Shortages

Even with a willingness to invest, skills shortages persist, especially in the North Sea and UK. The industry in the UK expects to create 10,000 jobs over the next five years, according to oil and gas body OPITO.

With the demand for talent now a global issue, the North Sea and mainland Europe have become a training ground for workers who are then “exported” to projects all around the world. This skills drought means that potential resources which could offset some of the declining production in the North Sea go undeveloped. An industry-wide effort to attract and retain skilled workers will require a sustained programme to change the perception of the industry as one whose best days are over.

### Gas

Even as renewable energy grows in importance, with Scotland for example making an ambitious pledge to reach a 100 per cent renewable energy mix by 2020, gas looks set to grow in importance in energy generation to smooth the transition. Shifting from a fossil and nuclear-based energy generation model to a renewable one will require lower carbon inputs to keep up generation when unstable renewable supplies meet increasing demand. Gas as fuel, in particular in shipping, looks set to be one of the most important trends in areas where regulations are set to affect the fuels that vessels are allowed to use. **SA**

#### ABSTRACT

- The upcoming fear of a recession cuts confidence and growth in the oil industry
- Shifting from fossil and nuclear energy to a renewable mix means the importance of gas will increase



# The Market is Showing

**As the oil and gas industry gears up for Offshore Europe, *energize* spoke with Lutz Wittenberg, GL Noble Denton's Executive Vice President for Europe, about the trends and prospects for the year ahead**

**ENERGIZE: The Offshore Europe is being held in Aberdeen this year. What does it mean for GL to be attending the conference here this year?**

**WITTENBERG:** It is the first time that we are presenting GL Noble Denton's joint capabilities at the oil and gas show after we merged the companies. Heritage Noble Denton is surely a well-known player in the North Sea upstream market in particular with regard to the strengths in marine warranty, marine consulting and DP services, whereas our joint capabilities are less known to the market. The Aberdeen show gives us a chance to raise our group profile as an independent provider of technical consulting, design, assurance and project execution services. We want to show our clients that our joint group has even strengthened its capabilities in the assurance, marine consulting and warranty sector. We will also demonstrate that we are a well-placed partner for field development studies, design of mobile offshore productions as well as safety and gas process consulting.

**ENERGIZE: What are the important trends for the oil and gas market this year?**

**WITTENBERG:** The market is showing signs of improvement, investment is picking up again, and the number of sanctioned projects is increasing also in Europe. Europe has two large growth markets: Norway, and Russia/the Caspian Sea area. For both markets significant capital expenditure

growth for the coming three to five years is projected. That is, of course, provided macro-economic parameters remain as buoyant as they are right now. Beyond Europe, which will still remain a mature market, we see

new large oil and gas production areas evolving such as Australia, Brazil and West Africa, to name but a few. We have good chances of delivering services into these new markets but face the challenge to bring in resources and have the right delivery models for our clients. Hydrocarbon production is increasingly coming from deepwater, harsh environment acreage which is causing a boom in floating production and subsea completion systems as an important technological trend. We are developing our services to support such projects further. Currently, it's mainly our teams in Houston, the UK and Norway who serve as main competency bases for these projects.

**ENERGIZE: Safety is a key issue. Are you expecting stronger regulations, and what role does GL Noble Denton play?**

**WITTENBERG:** As regards Europe, I don't think there will be significant changes to existing regulations in the next couple of years. Existing standards are already very high in the main oil and gas producing countries. We will see more push towards better implementation, also triggered by a number of recent incidents in the North Sea that attracted public attention. Additionally, we are aware that the European Commission is driving an initiative to further harmonise regulations based on best practices. We expect this to create a lot of controversy and time effort until such a concept can be agreed. Prompted by the Macondo incident, other oil and gas producing countries are reviewing their regulatory regimes. In particular the US are implementing a tougher safety regime for drilling safety and well integrity. We are supporting operators with related certification services and have also issued blowout preventer design guidelines, which incorporate new technical aspects following the Macondo incident.

## ABSTRACT

- At the Offshore Europe in Aberdeen, GL Noble Denton will present their joint capability for the first time
- Environmental protection and safety are key issues for the industry

# Signs of Improvement



**Drilling.** The oil and gas market in Norway is enjoying an increasing number of investments.

Generally, we see a trend to base regulatory concepts on the safety case model that was successfully implemented in the UK. Newcomers to the oil and gas market in Europe and Ireland, for example, are now in the process of issuing licenses and implementing an information system. They are also developing regulatory systems based on this model. The GL Noble Denton team in Aberdeen is working with the Irish Commission for Energy Regulation (CER) to assist the development of Ireland's new Petroleum Safety Framework. They are looking at outlining how safety will be regulated at each stage of the lifecycle of Ireland's petroleum assets, from design, construction and operation to maintenance, modification and decommissioning.

**ENERGIZE: What are GL's major projects in Europe?**

**WITTENBERG:** GL Noble Denton is expanding its engineering resource at major oil and gas hubs around the world. At the same time, our European engineering teams, mainly from the UK, Germany and Norway continue to provide services to many international and European projects. Safety and risk consulting and gas process engineering services are main areas. We are supporting projects of oil and gas majors, NOCs and independents. Unconventional gas projects in Australia and studies for European gas transmission pipelines are surely highlights in this regard. There are also many floater projects that we are currently dealing with. I can mention conceptual design studies for storage and offload-ing in Brazil and design verification work for a new FPSO for

a Norwegian field. Our colleagues in Aberdeen are in high demand for their marine consulting competence. Another key activity area is the offshore renewables market in the North Sea and Baltic Sea. We are surely the leading service provider for MWS services for these projects and also provide project management for some projects. A pioneering project the whole group is our conceptual design for an emergency oil recovery vessel. The project is led by our Norwegian design competence centre.

**ENERGIZE: Natural gas is growing in importance, both as a fuel and for energy production. Do you see a shift taking place in the emphasis placed on gas in the industry?**

**WITTENBERG:** We know that the energy mix will be changing towards gas in the long term. New gas production and infrastructure projects are being initiated around the world. Surely Shell's decision to build the world's first floating LNG plant is a strong indicator for the industry's confidence in the gas markets. We are convinced that we are well positioned with our gas technology to participate in this trend. Our recent projects, such as a conceptual design study for an FLNG unit and gas process engineering services for an unconventional gas field in Australia, give proof of that. **SA**



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# Accolades for

**OilVLe**  
A powerful tool by GL Noble Denton for the complex mathematical operations needed in evaluating oil and gas reservoirs keeps finding new industry applications – and gaining awards

 OilVLe is GL Noble Denton's versatile oil and gas properties modelling application that sits quietly in Microsoft Excel's toolbar until you summon its powerful array of calculation options with a simple "click" from its drop-down menu.

The combination of the interaction between OilVLe's thermodynamic calculations and the flexibility of Excel's functionality means that anyone with imagination can paint truly imaginative solutions to complex problems on

one canvas. Conventional software usually assumes a linear and limited workflow and needs several platforms to achieve the same result. However, the versatility of OilVLe allows a much wider range of options which are finding many diverse applications in the petroleum industry. A simple new application is for the calculation of condensate yields for

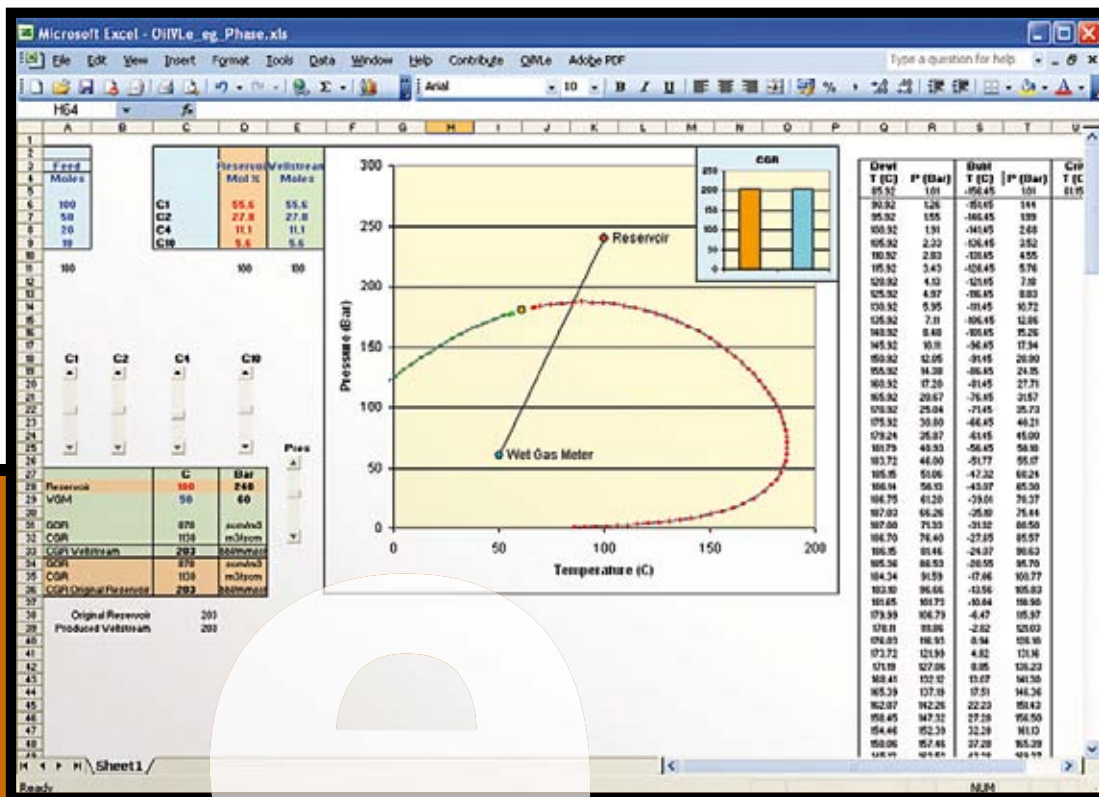
shale gases. Shale gas is providing an increasing share of gas reserves, particularly in the USA, Canada and Poland. With shale gases, OilVLe provides an ideal platform for rapid calculations where accurate gas properties and condensate yields can be quickly calculated and tabulated in spreadsheet format, providing both a useful reference table for properties such as calorific value as well as an audit trail for the multitude of different gases produced from numerous small-bore wells.

## Thermodynamic Wizardry

OilVLe scored a success for consultancy firm Petrophase in tackling the problem of defining wellstream compositions during well testing where the surface separators run very hot, typically over 90°C. This study focused on the commercial need to accurately define wellstream compositions in North Africa and the North Sea during exploration well tests. By reducing uncertainty in wellstream fluid composition, facilities can be sized and cost-assessed correctly and more accurate sales volumes can be forecast. OilVLe was

## ABSTRACT

- To assess the properties of deposits or determine wellstream fluid composition, complex mathematical operations must be carried out
- OilVLe by GL Noble Denton is a flexible software application that interfaces with MS Excel to model oil and reservoir conditions
- The comprehensive algorithms and rich functionalities of OilVLe enable engineers to create new applications for the tool



**Surface. OilVLe** is easy to use – with no reliance on mainframes. It can run from any Windows computer and is industry tested.

selected as the thermodynamic engine to drive the study across many different fluids.

The problem with hot separators is in analysing the separator gas. This gas is saturated with heavy hydrocarbons from the hot separator liquid and, as a result of the gas sits at its dew point temperature in the separator whilst the heavier components in the hot gas condense onto any surface that is cooler than the separator temperature. Unfortunately, these cooler surfaces include all the sampling equipment! Without understanding and correcting for this effect, the apparent export streams would be too lean in liquid sales. To solve the problem, OilVLe was used to “repair” reported separator gas composition data and combine this data with the condensate stream data to give the wellstream composition. From this wellstream composition, OilVLe calculated the correct export stream volumes.

The outcome of this study was not only extremely successful, it also gained Petrophase the 2010 BG Group’s Innovation Award. OilVLe had been previously used by Petrophase to model oil properties and phase equilibriums

of contaminants across the oil water contact in the Buzzard Reservoir. This novel approach helped explain the contaminant distribution across the field and allowed the planning of remedial facilities accordingly. This study had already earned Petrophase a BG Group Innovation Award in 2008.

### Predicting the Unpredictable

OilVLe is also being used to help account for the volumes of export liquid from the Armada Hub in the North Sea. By accurately modelling fluid properties from the reservoir through surface processing, this approach provides a flexible, fast and cheap method of calibrating an integrated asset model, the industry tool for modelling and optimising production from multi-well platforms. With high values of hydrocarbon liquids, the prediction of sales volumes is increasingly important. As gas condensate fields mature and the number of satellite fields that feed into a platform grows, the complexity of predicting the commingled export liquid rates grows too. ▶

### CONDENSATE.

Raw natural gas from many gas fields contains a mixture of hydrocarbons in the gaseous state that condense into liquid form once the temperature drops below the hydrocarbon dew point of the raw gas.

OilVLe



**Ceremony.** Petrophase was awarded the winning trophy at the BG Group's prestigious Chief Executive Innovation Award – from left to right: Martin Mentipty (Chief Petroleum Engineer, BG), Said Ladrouz (Miskar Team Leader, BG Tunisia), Brian Moffatt (Managing Director, Petrophase), Mike Fawcett (Technical Director, Petrophase) and Stephen Richards (Consultant Petroleum Engineer, BG).

OilVLe is also being used to help account for the volumes of export liquid from the Armada Hub.



▷ Errors are compounded when the process conditions change as new fields with different compositions at higher pressures are brought on stream. Liquid allocation is also important where different partner interests apply. Allocation based on the test separator condensate-to-gas ratio (CGR) is problematic because well test separator conditions are not representative of the production process through which the fiscally metered condensate passes. Well test CGRs may also become inaccurate as the liquid rates decline and fall below the meter design range.

Phase equilibrium effects can also affect environmental issues; if both condensed water and condensate are produced to surface, the so-called BTEX aromatic compounds of benzene, toluene, ethylbenzene and xylene will separate between the hydrocarbon and aqueous phases. The concentrations in water are important to ensure limits of these compounds are acceptable or for the fluid to be treated until the limits are acceptable. OilVLe can replicate these processes through reservoir depletion to predict wellstream and process stream concentration over the entire field life.

### When Pressure Gradients Get Kinky

Perhaps the most ambitious use of OilVLe was in forming a diagnostic tool to predict the presence of equilibrium gas gaps in reservoirs. The tool has been used to assess

early log data from exploration wells when the pressure gradient hints at oils sitting under a gas cap. Such systems show a kink in the pressure-versus-depth plot from the logging runs. The kink corresponds to the change in density between the lighter gas and heavier oil. From the rate of pressure increase with depth, the density of the reservoir fluids can be inferred.

However, coincidence of pressures at the pressure kink does not prove flow communication as there may be impermeable barriers implying separate gas and oil reservoirs. OilVLe was used to test this by iterating possible compositions of oil and gas that could be in thermodynamic equilibrium and that matched the phase densities. The software contained algorithms that constrained the hydrocarbon compositions to natural patterns. The method worked successfully and shows how many different aspects of problem solving, density prediction, multi-component phase equilibrium, distribution constraints and iterative calculation techniques can be combined on one platform.

When its enormous flexibility and powerful modelling features are combined with problem-solving imagination, it is no wonder OilVLe helps in winning awards! **BM**



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# Rewarding Investment

**Industrial companies could lower their energy costs by up to 30 per cent by introducing an energy management system. GL is a reliable partner**

According to studies conducted by Fraunhofer, Europe's largest applied sciences research organisation, and other research institutes, businesses could save substantial amounts of money by implementing specific optimisation and modernisation measures in terms of energy use and eliminating energy waste throughout their sites. A recent study concludes that the energy savings potential for German companies is as much as 30 per cent of current energy costs.

One-third of that could be reclaimed directly by implementing specific measures, such as running machines at optimal load, ensuring optimal machine calibration, running machines up to speed precisely at the time they are needed and switching off lights and equipment whenever they are not needed. The remaining savings potential can be realised by replacing outdated, inefficient machinery based on specific energy analyses.

## ABSTRACT

- Energy management integrates energy efficiency into management and manufacturing practises
- GL has been accredited to offer certification of energy management systems to the new ISO 50001 or EN 16001 standard

With the expected rise of energy costs over the coming years due to the realisation of worldwide climate goals and growing worldwide demand for energy, energy management is moving into focus as an effective means not only of cutting energy costs but also of helping to achieve CO<sub>2</sub> reduction targets. A certified energy management system ensures that the steps a company takes to improve its energy balance are structured, systematic, effective and consistent with established standards, such as ISO 50001 or EN 16001. In addition, it helps enterprises prepare for new regulations requiring the introduction of certified energy management systems. It also demonstrates the company's commitment to energy efficiency and to reduce emissions, improving brand perception and consumer approval.



Photo: iStockphoto/RS\_RoNaludO

**Efficiency. GL helps companies to cut costs and CO<sub>2</sub> emissions.**

And finally, it enables companies to benefit from government subsidies granted to energy-efficient businesses.

## GL Certification Now Available

Recently, GL announced a new service offering: companies can have their energy management systems certified to the ISO 50001 or EN 16001 standard by GL Systems Certification, the accredited management systems certification unit of GL. GL can either certify an individual energy management system or provide combined certification for several integrated management systems (e.g. integrated environmental and energy management systems according to ISO 14001 and ISO 50001), saving the client both time and money. Specific energy management training courses and seminars are planned to be provided by the GL Academy. □ **AMO**



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# offshore

The demand for engineering services, technical assurance and consulting in the offshore sector is rising. GL Noble Denton supports oil and gas companies with its high-performance spectrum.






Photo: iStockphoto/Ms.LightBox

# Cold and Abundant

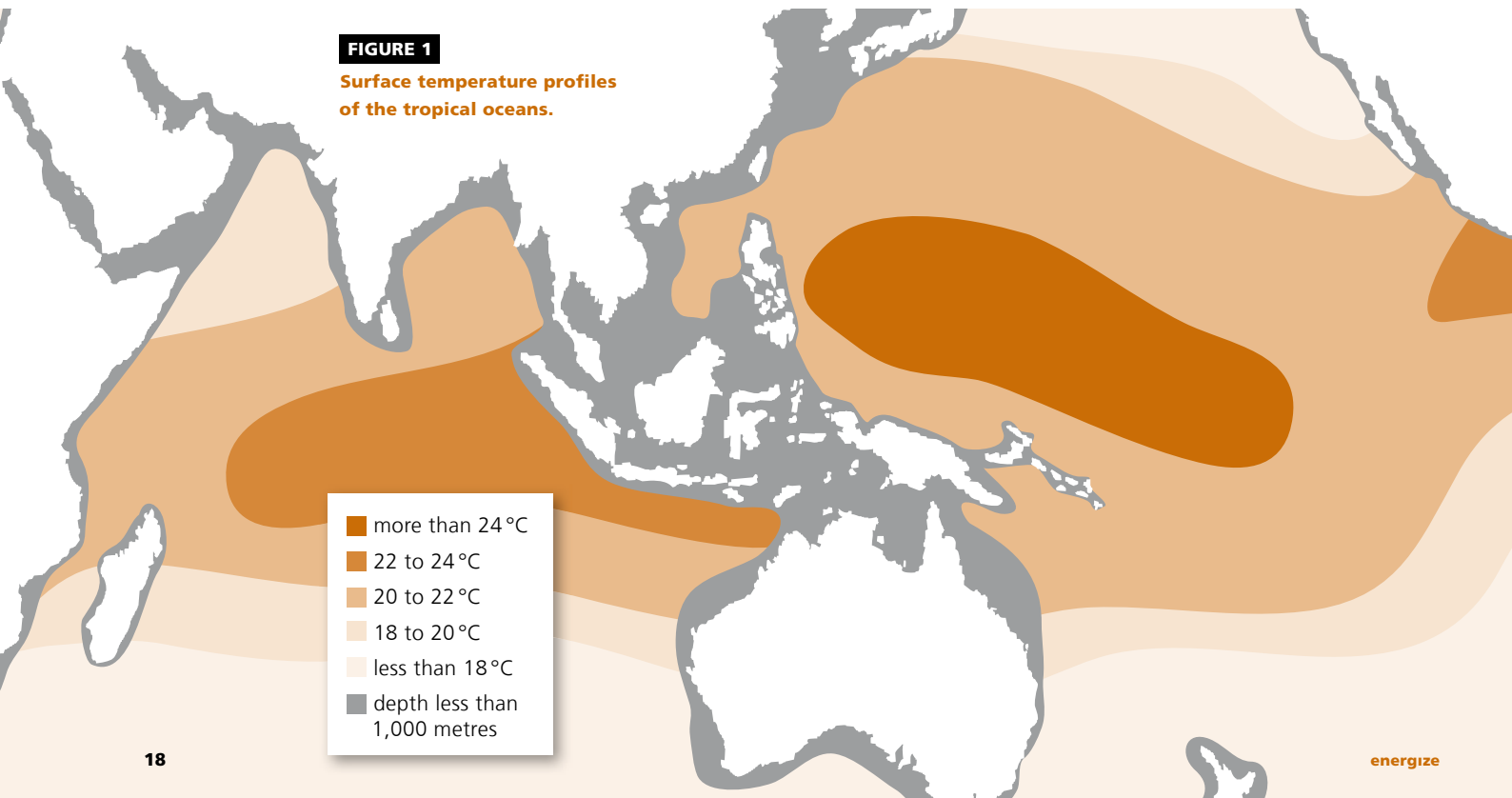
**In the quest for renewable energy sources, technologies for exploiting the heat and cold of tropical ocean water are moving into focus again. Ocean thermal energy conversion (OTEC) offers great promise to deliver clean power, fresh water, low-cost air conditioning and aquacultural products**

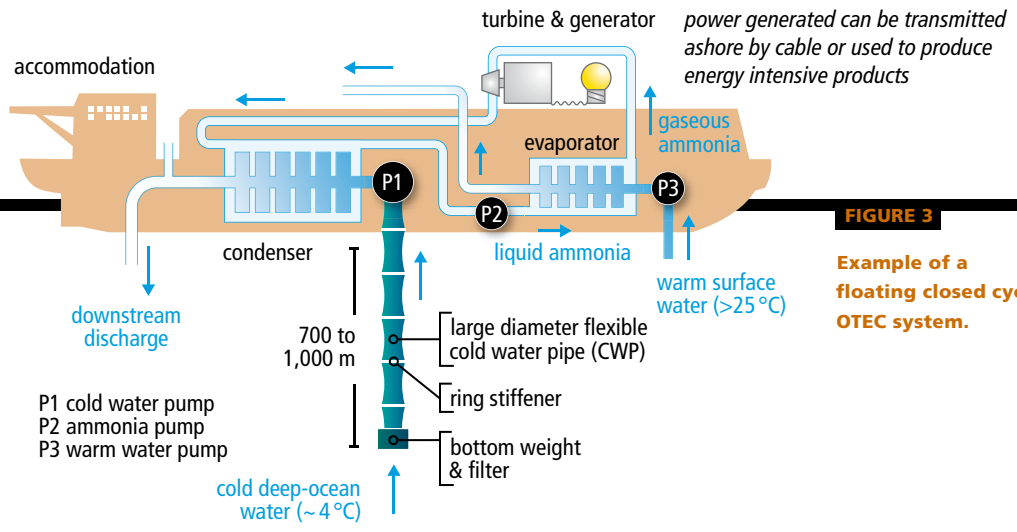
 The world's tropical oceans effectively act as a gigantic solar collector with surface temperatures in the range of 22 to 25 °C (see Figure 1). However, due to the presence of a thermocline, seawater temperature decreases with depth such that at about 1,000 metres below the surface the temperature has dropped to about 4 °C (Figure 2). Although there are some seasonal variations, this approximate temperature difference is preserved all year round. In addition, the deep ocean water is high in nutrients due to the organic matter which, over

time, drops down through the water column and is largely free of disease-bearing organisms.

There are several possibilities to exploit this surface/sub-surface temperature variation. One approach is known as ocean thermal energy conversion (OTEC). A simple closed cycle OTEC system is shown in Figure 3. As can be seen from the schematic diagram, the warm surface water is pumped into the floating production facility where it is passed through a heat exchanger. On the other side of the heat exchanger membrane is a working fluid, such as am-

**FIGURE 1**  
Surface temperature profiles of the tropical oceans.

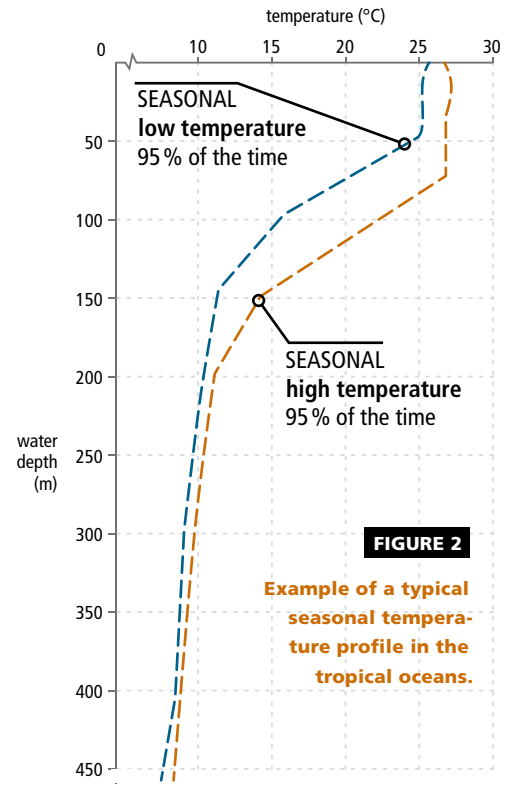
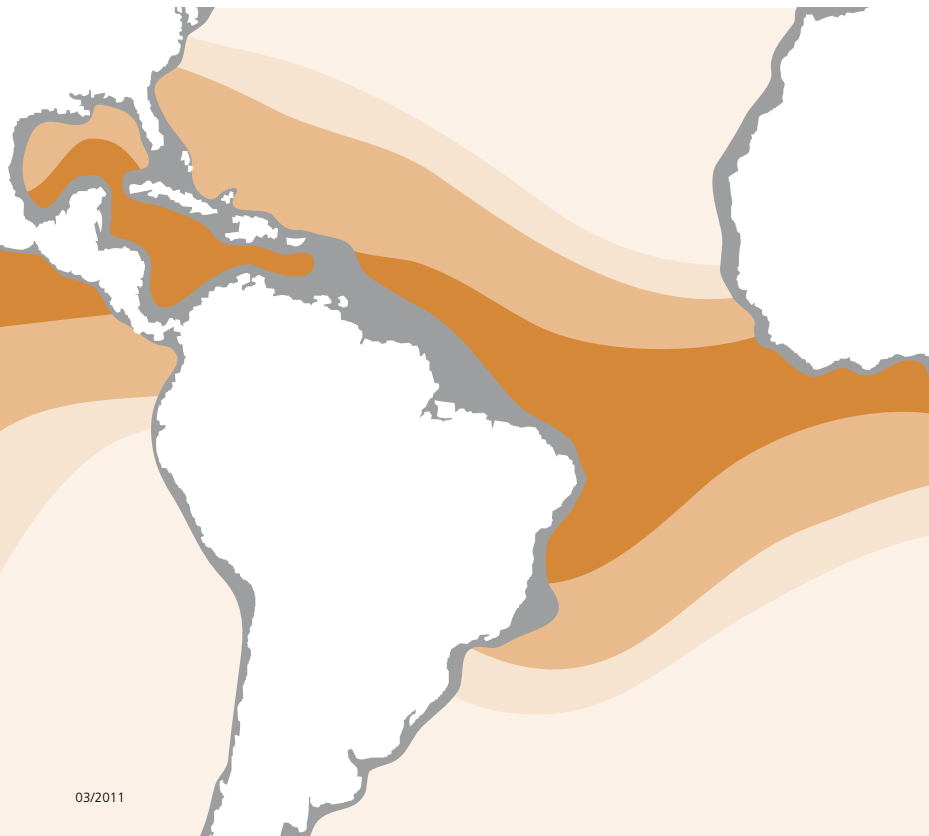




**FIGURE 3**  
**Example of a floating closed cycle OTEC system.**

monia, which vaporises at low temperatures. The gaseous ammonia is then used to drive a turbine to generate electricity. After passing through the turbine, the ammonia is condensed back to a liquid using a second heat exchanger, cooled by cold deep-ocean water. The now liquid ammonia is pumped back to the warm water heat exchanger and the whole process is repeated again.

Because the temperature difference is relatively small, the thermal efficiency of the OTEC process is inevitably low. However, since the thermal resource is enormous it is possible to process very large quantities of warm and cold water. Thus the potential power output is significant and floating OTEC power stations of 400-megawatt capacity and above have been proposed. While OTEC technology ➤



**FIGURE 2**  
**Example of a typical seasonal temperature profile in the tropical oceans.**



**FIGURE 4**

Photo: NELH

**Aerial view of NELH showing seawater intakes and aquacultural pens.**

▷ is not well known in Europe, considerable research has been carried out in the United States.

**OTEC Benefits**

A major advantage of OTEC, compared to many other renewable energy sources, is that OTEC power generation is not intermittent. Baseload electricity generation is achievable 24 hours a day, 365 days a year. The technology itself is relatively unsophisticated; hence process uptime should be high and major breakdowns rare.

Although true large-scale OTEC systems will be floating, the technology also has potential for locations in the tropical oceans where deep water can be found within a few kilometres of the shore. One location is Hawaii where deep ocean water has been pumped up from the depths since 1979 at the Natural Energy Laboratory Hawaii (NELH) (Figure 4). NELH is a world-leading centre for OTEC and deep ocean water applications, including reduced-cost, large-scale air conditioning and aquaculture. Aquaculture makes use of the nutrient-rich and relatively pure deep ocean water.

Open-cycle OTEC is another way of making use of the temperature difference. In such a system warm sea water serves as the working fluid. The advantage of open-cycle

**OTEC IMPRESSIONS FROM THE PAST**

**Figure 5. Claude’s cold water pipe prior to deployment in Cuba.**

**Figure 6. Cold water pipe deployment at Matanzas Bay, Cuba (1930).**

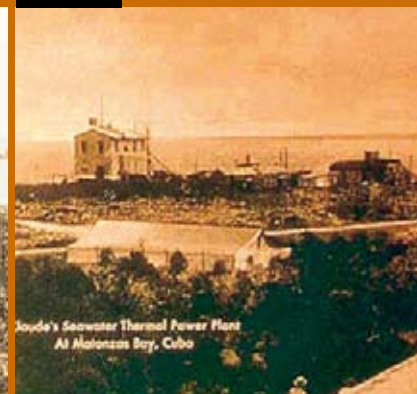
**Figure 7. “Mini OTEC” floating demonstration barge off Hawaii (1979).**

**Figure 8. “OTEC-1” cold water pipe prior to deployment offshore Hawaii.**

**FIGURE 5**



**FIGURE 6**



OTEC is that fresh water can be generated as part of the power production process. Fresh water is a valuable commodity in many tropical locations, where rainfall is limited. However, a large-diameter, low-pressure turbine is required for open-cycle OTEC, which is more complicated and hence more expensive than the equivalent higher-pressure closed-cycle turbine. Hybrid cycles have also been proposed, which attempt to reap the respective benefits of both open and closed-cycle systems.

### The History of OTEC

The potential to use the oceans' thermal gradients was first proposed by a French physicist, Jacques-Arsène D'Arsonval, in 1881. In the 1930s a major step forward occurred when the inventor of the liquid oxygen process (Georges Claude) invested some 10 million pounds sterling of his own money

(a huge expenditure for the time) in a land-based test plant in Cuba and a later floating system off Rio de Janeiro.

Claude's plant in Cuba worked for a short period of time until his cold water pipe (CWP) (Figure 5 and Figure 6)

was destroyed by a hurricane. He also had deployment problems with a vertical steel CWP on his floating system off Rio de Janeiro. Looking back, it is clear that Claude was ahead of his time with respect to the materials and offshore technology available to him.

The next major development in OTEC research came in the 1970s following the oil crisis. President Jimmy Carter selected OTEC as a serious renewable energy contender due to its major baseload power generation capability. Over 200 million US dollars were spent on OTEC, which included the floating demonstration units "Mini-OTEC" and "OTEC-1" (see Figures 7 and 8, respectively). But when the oil price dropped in the 1980s and Ronald Regan came to power, the existing OTEC budget was drastically cut. This was at a devastating time for OTEC developments, since vital long-term in-field operational data was in the process of being obtained.

### Catch-22 Situation

Since the 1980s OTEC research has continued at a relatively low level with the main work carried out in Japan, Taiwan, India and Hawaii. Unfortunately, the technology has been caught up in a catch-22 situation. To be commercially viable and benefit from economies of scale, a

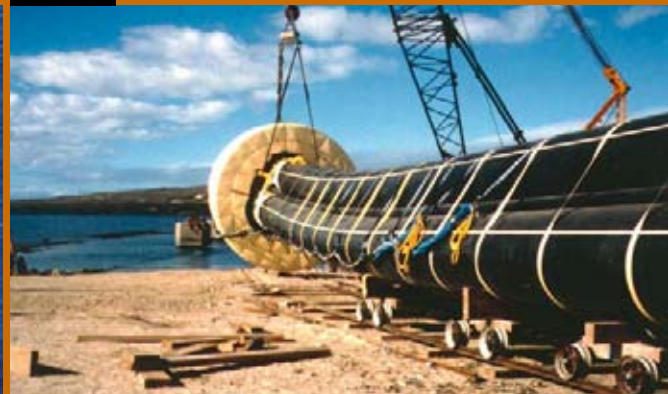
#### ABSTRACT

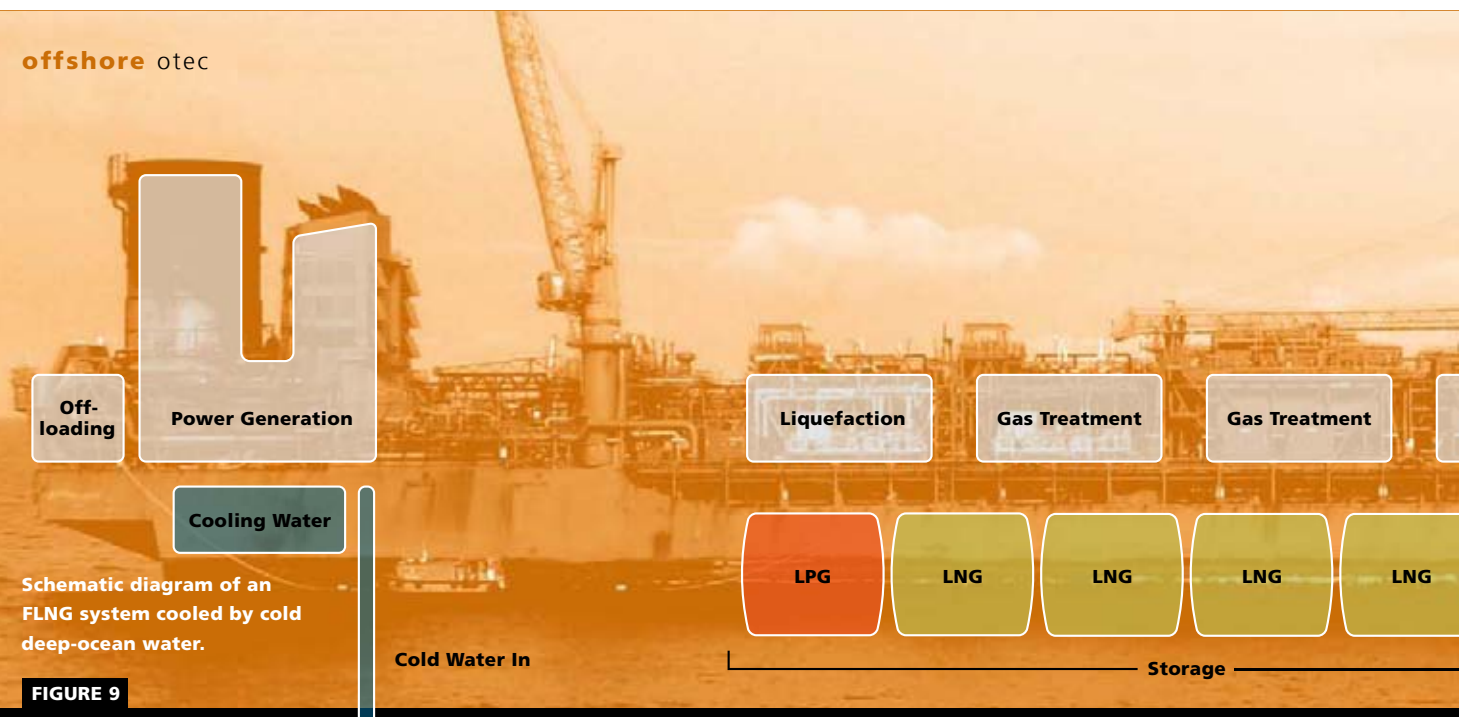
- The temperature variation between water layers in tropical oceans is a largely untapped energy resource
- Cold deep-ocean water can also be used for fresh water production, aquaculture, reduced-cost air conditioning and efficiency-enhanced FLNG production

FIGURE 7



FIGURE 8





Schematic diagram of an FLNG system cooled by cold deep-ocean water.

FIGURE 9

➤ reasonably large unit is required, say 50 megawatts. For large-scale OTEC developments financed by the investment community, operational performance from a reasonably sized prototype unit (say 5 megawatts) is required. But a 5 megawatt prototype floating unit is unlikely to be commercially viable, hence no such unit has yet been built.

**PERSPECTIVES.**

Renewed interest in ocean thermal energy as a renewable energy source may encourage potential investors.

Such an impasse is not untypical for promising new technologies and is typically overcome by government or government/private-sector funding.

**Future Forecast**

Over the last few years the prospects for OTEC have improved considerably. Key factors include:

- significant oil and gas price rises making renewable energy much more competitive
- development and maturity of floating deepwater oil and gas production technology
- increasing concern over global warming
- public opposition to nuclear power following the Fukushima disaster
- rapid industrialisation of countries such as India and China, which do have access to cold deep-ocean water

- concerns about the safety of deep water drilling following the Macondo blow-out
- new U.S. and European Union funding for renewable energy technologies.

Some of the above factors have led to plans for a 10-megawatt floating system for the island Réunion in the Indian Ocean by the major French defence contracting group DCNS. This facility is planned for installation in 2015 and is likely to receive significant European Union NER 300 support (“Finance for installations of innovative renewable energy technology and CCS in the EU”). Lockheed Martin in the US is also developing critical OTEC system components, supported by the US Navy.

**FLNG as a Stepping Stone to OTEC**

At times, commercial support can bring a technology to the market more quickly than government assistance, particularly if it is basically an extension to an existing technology. A number of different floating liquefied natural gas (FLNG) plants (see Figure 9) have been proposed by various organisations, e.g. Shell, FlexLNG, Bluewater, Teekay, etc.

FLNG provides a means of exploiting remote or stranded gas fields which are too far from an existing market for the gas to be transported economically by pipeline. Large-



Photos: Dreamstime/Davispics



Drawing: Ian Whitby

## GL Noble Denton Expertise for Cold Deep-Ocean Water Projects

**GL NOBLE DENTON IS EXTREMELY WELL POSITIONED TO ASSIST PROJECTS USING COLD DEEP-OCEAN WATER.**

The company has a unique pool of skills covering the following key areas:

- Floating Production System (FPS) hull and process system design capability
  - Design and integrity of deep-water moorings
  - Transportation and installation of floating structures
  - Design of seawater intake riser systems
  - Extensive gas processing expertise including FLNG FEED studies
- This integrated service is available to tackle either a complete project or individual aspects.

**FIGURE 10**  
Example of how a FLNG system could act as a stepping stone to OTEC.

scale flaring of gas is no longer an environmentally acceptable solution for the extraction of crude oil. Therefore, FLNG systems are receiving significant attention from both energy companies and contractors.

The actual process of cooling and liquefying natural gas is very energy intensive. The overall production rate can be increased by approximately seven per cent by using 10 °C cold ocean water for cooling, as opposed to warm surface seawater. Such a significant increase in output has a very significant environmental and economic value. Still, from an OTEC point of view what is exciting is that FLNG provides a mechanism to provide vital operational performance data on the cold water delivery system. Figure 10 shows

that FLNG systems could act as a vital stepping stone in the development of large-scale floating OTEC systems.

Cold deep-ocean water can also enhance the efficiency of a conventional FPSO based in tropical waters. Overall, therefore, it is highly desirable to make optimum use of the cold deep water under the keels of tropical FPSO and FLNG systems. **□ MB**



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Custom made. A welder accesses the welding habitat with the electrode using the "welding socks".

# Underwater Welding

Offshore structures are exposed to a hostile environment. The steel elements must be carefully maintained to avoid premature failure. A look at a fascinating welding technique





Increasing numbers of offshore assets require repair, maintenance work and modification.

For steel structures immersed in water, from oil platforms and wind turbines to ships, that often means underwater welding. Considering the stringent requirements these structures must meet, it is easy to imagine how difficult it must be to create welded joints that stand the test: the molten consumable must fuse inseparably with the material of the structure. In addition, the welding work should not affect ongoing operations on the structure, and it must be safe and cost-efficient. Conventional underwater welding techniques cannot easily meet these requirements.

How can you achieve underwater welding results equivalent to dry-welding standards without taking the structure out of the water? Neptune Marine Services of Perth, Australia, knows the answer: "Instead of taking damaged areas to a dry environment, we take a dry environment to the damage, wherever it is located," explains Nino Amato, Group Welding Manager at Neptune. The company introduced a patented technology called Nepsys that is capable of producing consistently high weld quality below the waterline while being both cost-efficient and safe.

### Quenching Prohibited

Neptune establishes a customised "welding habitat" around the underwater area to be welded. This protective zone is secured in place using adjustable seals, suction cups, magnets or straps. The result is a fully enclosed, controlled environment isolating the welding zone from its aqueous surrounding. Continuous delivery of argon gas to the habitat purges out the water and creates a hydrogen-free environment to prevent quenching and ensure even heat distribution. „Quenching is one of the main critical factors for underwater welding," explains Nino Amato. "Welds can become porous due to rapid quenching when working

directly in the water. With Nepsys, we have no quenching effects because the weld cools down more slowly." With Nepsys the company consistently achieves class A quality welds compliant with all applicable codes such as AWS D3.6 Class A and ISO 15614-10.

Qualified Nepsys welders wear standard commercial diving equipment. They communicate by intercom with their supervisor above the surface who monitors and adjusts the welding temperature and gas pressure on a control panel. Welders use pre-defined communication codes

such as "go hot" or "go cool" to tell their partner to switch the arc on or off. To access the welding habitat with the proprietary electrode the welder uses a so-called "welding sock". The electrodes are similar to those used onshore but are coated with a special wax for water protection.

Contrary to other underwater dry welding concepts, the Nepsys welders remain outside the dry environment of the habitat. In case of an emergency, the welder gets away from the working surface quickly and safely. "Safety is a big issue in underwater welding," ▶

#### ABSTRACT

- Nepsys technology delivers underwater welding results equivalent to dry-welding standards
- GL guidelines help to avoid mistakes and flaws in welding

## Neptune Marine Services

**NEPTUNE MARINE SERVICES IS A PROVIDER OF ENGINEERING SOLUTIONS TO THE OIL AND GAS, MARINE AND RENEWABLE ENERGY INDUSTRIES** and is headquartered in Perth, Western Australia. The company offers dry underwater welding solutions; subsea and pipeline engineering; offshore asset integrity management; ROV services; hydrographic surveying, positioning and geophysical services; commercial diving; specialist fabrication; pipeline stabilisation and grouting; rope access and platform IRM; and end-to-end project management.

▶ Nino Amato points out. "The diver has to cope with a huge amount of welding cables, poor visibility, rough sea conditions and limited communication possibilities. It is essential that the welder is not covered by a habitat that would limit his mobility."

**NEPSYS.**

The Neptune dry underwater welding system is a class approved technology to improve conventional methods of offshore maintenance and repair.

"Nepsys offers an alternative to existing methods such as wet and Hypobaric welding," explains Nino Amato. "Whilst Hypobaric welding has longer offshore production times that incur greater costs than Nepsys, wet welding has weldability issues as a permanent welded solution." It has been proven that the company's technology achieves class A welded joints

that is equal or better than welding performed in dry workshop conditions.

**Quality Standards**

GL's welding experts are intimately familiar with the intricacies of welding technology. What is complex ashore be-

comes even more challenging under water. While the result of welding is visible immediately, the quality of a weld is not so obvious. "This is why it is so crucial to know exactly what you are doing," stresses GL welding specialist Marcus von Busch. GL has issued procedural guidelines within the scope of its technical rules to establish welding quality standards. These guidelines explain how to avoid mistakes and flaws in welding.

Neptune's dry underwater welding technology has been tested and certified by Germanischer Lloyd. This allows the company to carry out certain types of underwater welding work using Nepsys on GL-classed ships. The GL certification confirms that the Australian company has adequate equipment, qualified welding supervisors and welders certified for the required processes.

According to the GL procedural rules, prior to starting a new job Neptune must clarify the following questions: What kinds of materials are we going to weld, what kind of equipment and filler material will we need, and what is the best method of joining the pieces? Before beginning the actual assembly process, the selected combination is tested. This welding procedure test, which is monitored and certified by technical experts from GL, scrutinises the processes to be applied by Neptune.

In the welding procedure test, Germanischer Lloyd examines whether the existing welding instructions are sufficient to enable the Neptune welders to produce high-quality welds. During the test, a sample is welded up in the presence of a GL surveyor. The sample is then expedited to a GL-approved, accredited laboratory for non-destructive and destructive testing. These tests deliver solid data on the quality of the workmanship. This procedure intends to identify a welding technique that will minimise negative effects on material properties. □ MD

# GL offering

**WORKSHOP APPROVALS**

**ACCORDING TO:**

- GL Rules, EN ISO 3834-2 to -4, DIN 2303, DIN 18800-7, EN 1090-1, EN 15085-2, EN 17660, AD 2000 HP 0

**WELDERS AND OPERATORS**

**QUALIFICATION ACCORDING TO:**

- DIN EN 287, EN ISO 9606, EN 1418, ISO 14732, AWS D1.1, AWS D3.6M, AD 2000 HP 3, EN ISO 14555,

- EN ISO 15618-1 and -2, ASME Sec. IX, EN 13133 (brazer)

**WELDING PROCEDURE TESTS**

**ACCORDING TO:**

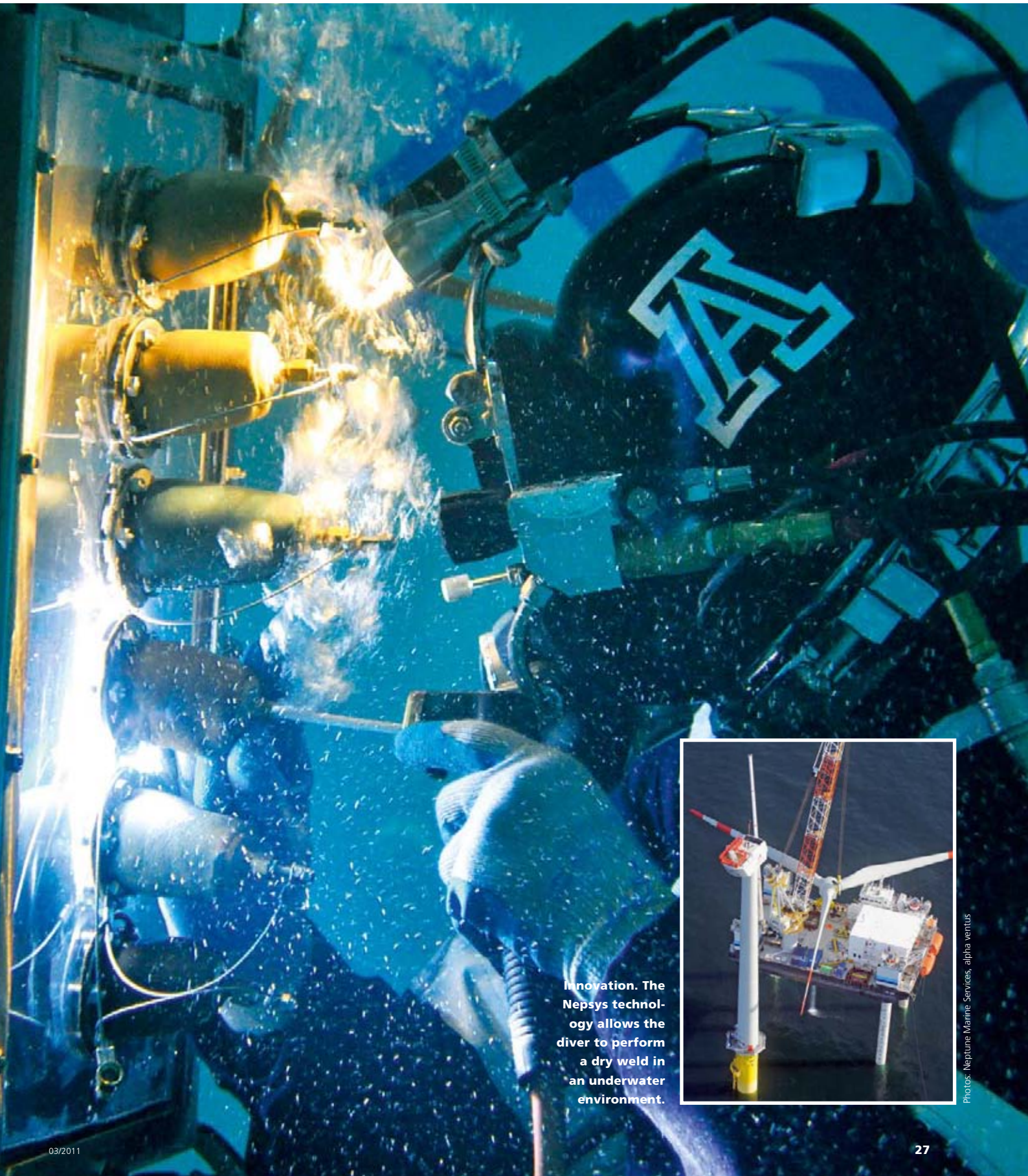
- GL Rules for Welding, EN ISO 15614-1 to -13, EN ISO 14555 (stud welding)
- EN 13134 (brazing), AD 2000 HP 2/1

**APPROVAL OF NDT WORKSHOPS**



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Innovation. The Nepsys technology allows the diver to perform a dry weld in an underwater environment.



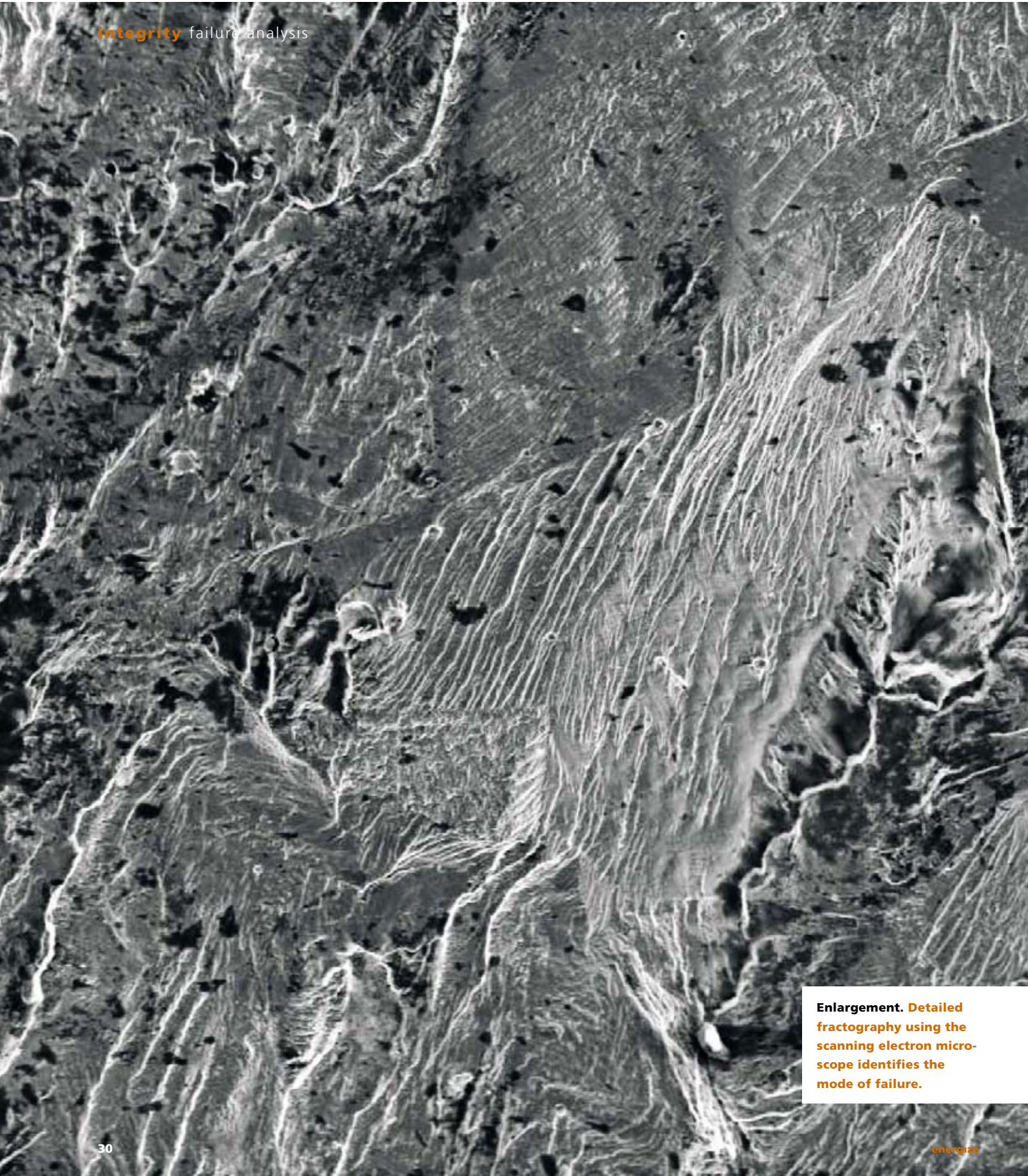
Photos: Neptune Marine Services, alpha ventus



# integrity



**GL Noble Denton offers a holistic asset integrity management capability that spans from the wellhead to transmission systems, production and processing facilities to substructures and the point of delivery on shore.**



**Enlargement.** Detailed fractography using the scanning electron microscope identifies the mode of failure.

# Turning Failure to Advantage

**Identifying the root causes of technical failures can be laborious – but it is well worth the effort: it will highlight hidden equipment or process weaknesses that should be eliminated to avoid repeated or more severe and costly problems**

So, if a failure occurs, why should it be investigated? What are the benefits of investigating a failure? There are many reasons for asset operators to investigate failures. Some common themes are:

- to determine the mode and mechanism of failure, i.e. to understand the immediate cause(s)
- to determine the root cause(s) of the failure, and in so doing to identify and implement remedial measures to prevent

further failures

- to provide an early indication of wider problems developing with potential to present a serious future threat to the operator's assets, personnel or the environment

- to prevent future similar

failures by applying the lessons learnt throughout all the operator's assets, and also sharing lessons learnt with other operators

- to provide expert witness support should the failure investigation have the potential for litigation
- to protect the operator's business from future financial and reputational damage.

In addition, operators will have a legal obligation to report incidents and dangerous occurrences to the relevant regulatory authorities.

Items of primary concern for owners and operators of process plant and pipeline assets are material defects, such as crack-like flaws and unexpected metal loss, as well as failures of pressurised components and equipment that have the potential to cause harm to personnel and the environment or wider damage to the operator's asset and business and, where relevant, to cause consequential damage to other operators' assets.

It is important to recognise that detecting a defect or experiencing a component failure, however unwelcome, often presents a valuable opportunity to identify a much more serious problem that, if allowed to develop or continue, could represent a serious threat to the integrity of the process or the asset concerned.

## Scope of Failure Investigation

There are many reasons why a material defect or failure may arise, for example:

- incorrect or inadequate material selection
- material quality issues
- fabrication issues
- operation outside original design parameters
- environmental factors
- maintenance and protection issues
- contamination
- human and procedural factors
- third party damage.

## ABSTRACT

- Investigating failures is crucial for understanding and eliminating system weaknesses
- A successful failure investigation requires a multi-disciplinary approach
- GL Noble Denton specialises in investigating material defects and component failures in the oil and gas sector

► The scope of a failure investigation will depend to a large extent upon the nature of the failure. Often this means that the investigation will be somewhat fluid, evolving and unfolding as the investigation proceeds and as information and results become available. Investigations may range from relatively straight-forward laboratory analysis involving a few days' effort to complex multi-disciplinary programmes taking many months or even years to complete, particularly for high profile incidents. A complex failure investigation may involve several overlapping activities carried out concurrently, which will require careful management to keep on track. For plant and pipeline assets, where a material defect is discovered, such as a crack-like flaw, it is important to identify the degradation mechanism. This is an essential element of fitness-for-purpose assessments. Where a component failure occurs it is important to determine the root cause. This is an essential element of modern asset management themes.

**NDE METHODS.**

The analysis typically includes magnetic particle inspection, dye penetrant resting, manual ultrasonic testing and alternating current potential drop.

**Site Visit**

An important first step in any failure investigation is to ensure the failure is preserved for future examination. For

plant and pipeline assets this generally involves a visit to site to identify and collect all relevant material as well as to stabilise and protect as necessary for onward transport to the laboratory. In the event of a dynamic failure, such as an explosion resulting in extensive damage, this may be a difficult and arduous task as the majority of the failures and damage evident will be "effect" and not necessarily directly relevant to identifying the cause.

In these circumstances detailed photography is essential to record the condition and location of ejected parts and debris, with as many items as possible tagged, before any material is removed from the site of the failure. During the site visit it is important to interview site personnel to establish the circumstances surrounding the failure and operating conditions at the time. It is also generally useful to identify and obtain copies of all relevant documents and certificates.

Where the failure involves a defect in a component or structure, the extent of the failure and associated damage should be determined by non-destructive examination (NDE) methods prior to extraction for detailed analysis. Typically, site NDE methods include magnetic particle inspection (MPI), dye penetrant (DP) testing, manual ultrasonic

## Experience and Multi-Disciplinary Approach

**INVESTIGATING A FAILURE, HOWEVER UNWELCOME, IS AN OPPORTUNITY TO OBTAIN PREVIOUSLY UNKNOWN INFORMATION ABOUT THE ASSET THAT MIGHT PROVE CRITICAL TO THE FUTURE OF THE BUSINESS. FAILURE INVESTIGATION THUS DELIVERS TRUE, TANGIBLE VALUE.**

GL Noble Denton's expert knowledge and facilities have been applied to investigating failures for more than three decades. GL Noble Denton specialises in investigating material defects and component failures in assets in the oil and gas sector, such as offshore and onshore oil and gas processing plants, oil and gas transmission

pipelines and distribution networks, as well as energy-related plants and appliances. More recently the GL Group has broadened its activities to include water, electric and other industrial sectors. A successful failure investigation requires a multi-disciplinary approach. GL Noble Denton's breadth of knowledge in non-

destructive examination (NDE), metallurgy and welding, corrosion, coatings, chemistry, process engineering and engineering analysis combined with extensive laboratory facilities offers a comprehensive and independent capability for investigating plant and pipeline failures that is trusted by our clients worldwide.





**Damage.** The examination of the components helps to identify the root cause.

## CASE STUDY #1

# Industrial Gas Turbine

**GL NOBLE DENTON INVESTIGATED THE FAILURE OF AN INDUSTRIAL GAS TURBINE ENGINE FOR A MAJOR GAS NETWORK OPERATOR.**

The malfunction had resulted in the failure of the compressor section casing and the ejection of numerous stator and turbine blades and associated components, which in turn had caused extensive impact damage to the material of the engine cab. Collecting the components proved vital to the investigation; through careful examination of these components and analysis of material samples collected from the turbine section it was possible to re-construct the events leading to the failure and to identify the root cause.

A metallurgical investigation would typically include:

- ▣ visual examination and using a stereo optical microscope
- ▣ detailed fractography using the scanning electron microscope (SEM)
- ▣ semi-quantitative energy dispersive X-ray microanalysis
- ▣ preparation of weld sections for macro-examination and hardness surveys
- ▣ preparation of mounted and polished sections for microstructural analysis and to confirm the crack path.

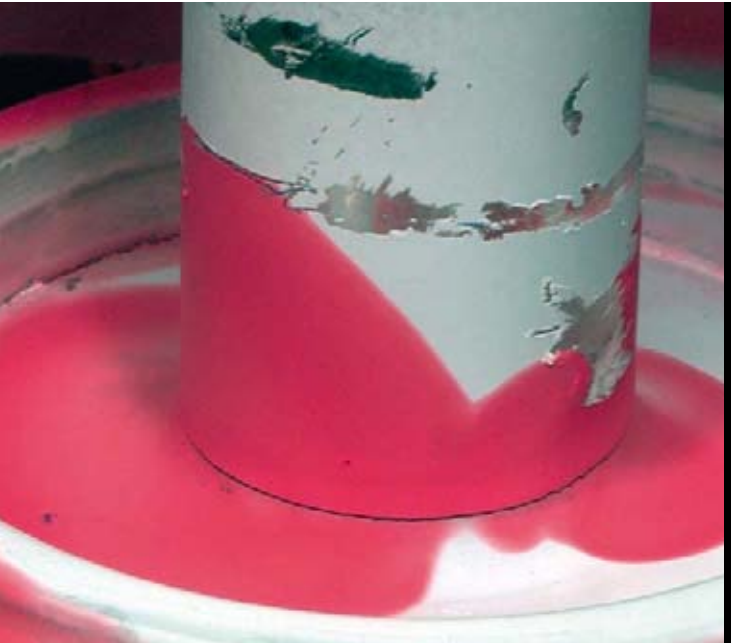
Microstructural analysis can be a very useful tool to confirm the identity of the material and to identify degradation mechanisms. For example, metallic gas distribution networks were traditionally constructed from cast pipes manufactured by different methods, for example pit-cast and metal-spun and sand-spun grey cast iron pipe, and metal-spun ductile iron pipe. For these pipe materials, microstructural characterisation remains a simple and conclusive means of identifying the material and manufacturing method. Further, sub-critical crack growth and metal wastage and degradation mechanisms often have ▶

testing (MUT), alternating current potential drop (ACPD), in addition to dimensional measurements. An initial opinion on the mode of failure is often useful at this stage, to inform the inspection team of similar components considered to be at risk of failure, whilst inspection personnel are onsite.

### **Metallurgical Analysis and Materials Testing**

Once the failure is extracted the laboratory analysis to characterise the failure can commence. Characterising a defect or component failure typically involves a metallurgical examination and complementary materials testing programme.

**Crack. The fracture was caused by flow-induced vibration produced by vortex shedding around the thermowell.**



▷ characteristic features evident on microstructural examination that aid in diagnosis. SEM/EDX analysis is also particularly useful for investigating corrosion and metallic coating failures.

Materials testing is a common element of failure investigations; two main reasons being the need to establish that the material in question complies with the requirements of relevant standards, and to generate accurate mechanical property data for supporting engineering analysis assessments. The latter is particularly important where mechanical properties do not comply or have been degraded in service, or where supplementary data is required for weld and heat-affected-zone material. Materials testing often includes:

- chemical composition
- tensile property determination (for example yield strength, tensile strength, elongation, etc. and specific component tests for threaded fasteners)
- hardness determination
- toughness properties, for example Charpy impact testing, drop weight testing (nil-ductility temperature/fracture

#### CASE STUDY #2

## Steel Thermowell

**GL NOBLE DENTON INVESTIGATED THE FAILURE OF A STAINLESS STEEL THERMOWELL THAT HAD BEEN LOCATED IN A DRY GAS TRANSMISSION PIPELINE.**

A circumferential crack was found at the base of the thermowell. Metallurgical analysis determined that the crack was consistent with low stress, high cycle fatigue crack propagation. An assessment of the process conditions indicated that the fracture was caused by flow-induced vibration produced by vortex shedding around the thermowell. As a result of this failure the client reviewed the use of thermowells across its whole network. GL Noble Denton provided further assistance with additional guidance on the susceptibility of thermowells to vortex shedding, and by identifying appropriate alternatives to prevent future failures.

# High Pressure Pipe Fittings

**GL NOBLE DENTON INVESTIGATED POOR TOUGHNESS IN MANUFACTURED HIGH-PRESSURE PIPE FITTINGS ON BEHALF OF A MAJOR OIL AND GAS OPERATOR.**

The issue only became apparent once the asset had been constructed. Extensive mechanical property testing was carried out, including tensile testing, hardness testing and Charpy testing to characterise the extent of the problem.

CTOD fracture mechanics data was generated to support an engineering analysis assessment to develop pressure and temperature operating limits for the safe operation of the pipe system prior to future replacement of the fittings during scheduled shut-down.

analysis diagram), drop weight tear testing (for transmission line pipe), and fracture mechanics testing, such as CTOD and J-integral.

Manufactured components and fittings with material properties that do not meet the minimum levels specified in the relevant standard are becoming increasingly common, and in itself may be classed as a failure in that the component or fitting fails to perform its expected function. The issue is particularly critical for pressure systems, such as pipelines and process plants, where the relevant design codes assume the materials of construction comply with the referenced standards.

## Engineering Analysis

The output from the metallurgical analysis and materials testing programme offers an opinion on the mode and likely cause of failure, and an understanding of the contribution of material-related factors. To understand the

contribution of mechanical factors it is usual to complement the metallurgical examination and materials testing programme with an engineering analysis. Depending on the nature and scope of the failure investigation, further analysis may be carried out to understand the wider implications of the failure and to ensure that recommendations for preventing further failures are implemented, for example:

- detailed fracture mechanics analysis to determine safe operating parameters
- fitness for purpose assessments
- remaining life analyses
- review and update of operating procedures
- review of asset integrity and inspection programmes (such as RBI).

## Reporting

In any failure investigation, regular updates are essential to inform the operator and other sponsors about all developments and progress, particularly where the information is shared with other interested parties, such as regulatory authorities. Where there is potential for litigation it is often necessary for legal reasons to carry out the failure investigation under instructions from the operator's legal advisers. For this reason it is advisable that the operator considers obtaining legal advice at an early stage so that the necessary instructions may be given. Where the report is prepared with a view to litigation, the report will need to comply with legal procedures.

The benefits of investigating failures are proven, and failure investigation is an integral element of modern asset integrity management. □ GM



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During the last decade, GL Noble Denton has been working to develop an alternative solution which removes the need for welding to a live pipeline, and is both rapid and safe. Over 240 of its trademarked Grouted Tees have now been installed on a range of both high-and low-pressure pipelines of varying diameters, and this solution has provided many advantages over other techniques.

The Grouted Tee was originally developed to overcome issues of welding connections onto gas transmission pipe-

application, the tee piece is custom-manufactured to the appropriate size as half shells that are clamped by bolts around the host pipe. The tee can be set at any position around the host pipe to suit the configuration of the pipework.

A special hydrogenated butadiene nitrile rubber (HNBR) seal is installed at the position where the branch line will meet the host pipeline, and is retained in position by a steel containment ring inside the half shell within the tee piece. Opposite the branch in the other half shell, spreader plates are located to allow seal compression during tightening of



## Teeing off with Live Pipeline Intervention

GL Noble Denton's Grouted Tee is an innovative technology to connect an off-take or tee to an existing flow line

lines. Since then, GL Noble Denton has worked with a number of pipeline operators to develop the technology further to accommodate thin-wall pipelines, high flow rates and numerous pipeline products.

The Grouted technology does not require any site welding, and full pressure and flow can be maintained during installation and hot tapping. The tee's half-shell construction is simple, and GL Noble Denton says that it can also accommodate much larger ovality in the main pipeline than other alternatives. Installation is carried out with minimal pipe preparation; all that is required is for the existing coating to be removed and the pipe surface grit-blasted to ensure it is both clean and has a suitable

"key" to which the subsequently injected grout can adhere. The tee is made up of several equally important components. For each

the bolts and subsequent compressive load to be spread over the pipe and not to act as a point load (for which the host pipe would not have been designed).

### Teeing up Projects

Once the half shells have been clamped around the host pipe and the bolts tightened to the predesigned load, the gaps between the ends of the half shells and the host pipe are filled with a rapid-setting epoxy putty which – within approximately 60 minutes – provides a seal to prevent escape of the epoxy grout that is injected as the next part of the operation.

The three-part epoxy grout is injected to fill the space between the inside of the tee piece and the host pipe, and has the effect of both adhering to both surfaces to keep the tee securely in place and of transferring the load from the main pipe to the newly-installed outer shell. Tests have shown that even without the bolts to hold the two halves

### ABSTRACT

- Installing a tee on a live pipeline cannot always be accomplished by welding
- GL Noble Denton's Grouted Tee method offers an alternative that is rapid, economical and safe

of the Grouted Tee in place, the epoxy grout's adhesive properties ensure that the pressure-bearing capacity is retained. The liquid grout is pumped into the space between the tee piece and the host pipe from the bottom. A number of "tell-tale" points are used, both to allow the air in the annulus to exit and to ensure an even progress of the injected grout as it fills the space. These points are subsequently sealed with set screws. The grout is then left to harden, which usually takes 24 hours, after which the tee is pressure-tested to line pressure, and released for service.

ing pipeline, the Grouted Tee has a further advantage over other methods, as it requires only a very small team to complete its installation.

While welding a tee onto a high-pressure pipeline can require upwards of eight to ten welders and support staff, a Grouted Tee can be installed at any size by a team of only five. GL Noble Denton says that a total elapsed time onsite of two days is normally required, much of which is required solely for the curing of the epoxy grout. Ordering and manufacturing time for pipeline sizes from 4 to 12 inches is be-



II



III



IV

- I. An angled Grouted Tee installed on an 18" diameter flare line.
- II. Installation of a double branch Grouted Tee.
- III. Hot tapping using a Grouted Tee connection.
- IV. Low pressure 24" diameter pipeline diversion.

UK high-pressure gas pipeline operator National Grid has installed many of the 240 Grouted Tees that have been used to date; GL Noble Denton also has licensing agreements with both Furmanite and Subsea 7 to use the technology onshore and offshore respectively. The tees have also been successfully installed in Brazil, Norway and Kazakhstan. The components, designed by GL Noble Denton, are not manufactured by the firm, so suitable third-party engineering companies are used for this purpose. The special HNBR seals are supplied by FTL Technology and are imported from a specialist manufacturer in Italy. RotaBolts are specified for the half-shell bolts because of their simplicity and ease of installation, and most importantly to ensure accurate tensioning is applied.

### Suitable for Numerous Fluids

Apart from providing a straightforward and elegant solution to the problem of attaching a tee piece to an operat-

ing pipeline, the Grouted Tee has a further advantage over other methods, as it requires only a very small team to complete its installation.

While welding a tee onto a high-pressure pipeline can require upwards of eight to ten welders and support staff, a Grouted Tee can be installed at any size by a team of only five. GL Noble Denton has developed solutions using this technique for installing two tees of similar or different sizes, and for diver-installed use of the technology subsea. A clever double-Y branch fitting has also been developed, for which could be used to provide a pig launcher or receiver, for example. The Grouted Tee is suitable for operations with numerous pipeline fluids and gases in the temperature range -50 °C to +125 °C, and can be manufactured to suit a host pipe diameter range of 2 to 56 inches and diameter-to-wall-thickness ratios of 120 or less. □

Abbreviated version of an article in the June 2011 edition of Pipelines International magazine: [www.pipelinesinternational.com](http://www.pipelinesinternational.com)



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# City Gas in the Middle East

**GL Noble Denton was awarded a contract to undertake a concept study for a new city gas distribution project in the Middle East**

The development of city gas networks, using natural gas as a replacement for liquefied petroleum gas (LPG) and other traditional fuels, offers economic and social advancement. Especially countries in the Middle East are looking to invest in the installation of city natural gas supply infrastructures. The driving forces behind these initiatives are numerous and include enhanced safety, environmental improvement and the availability of natural gas.

## ABSTRACT

- A client in the Middle East charged GL Noble Denton with a concept study for a city gas project
- A multi-disciplinary team of GL Noble Denton consultants delivered a successful outcome for the client

Driven by the desire to significantly reduce the transportation of LPG cylinders around the country's capital city by truck or road tanker and thereby achieving improved social, environmental and safety benefits for the city's population, a client in the Middle East asked GL Noble Denton to undertake a concept study. An additional objective was to make available increased volumes of LPG to international markets

that would be "released" through the use of natural gas via a piped gas distribution network. The extent of the piped network is in the region of 2,500 kilometres with in excess of 100,000 connected properties.

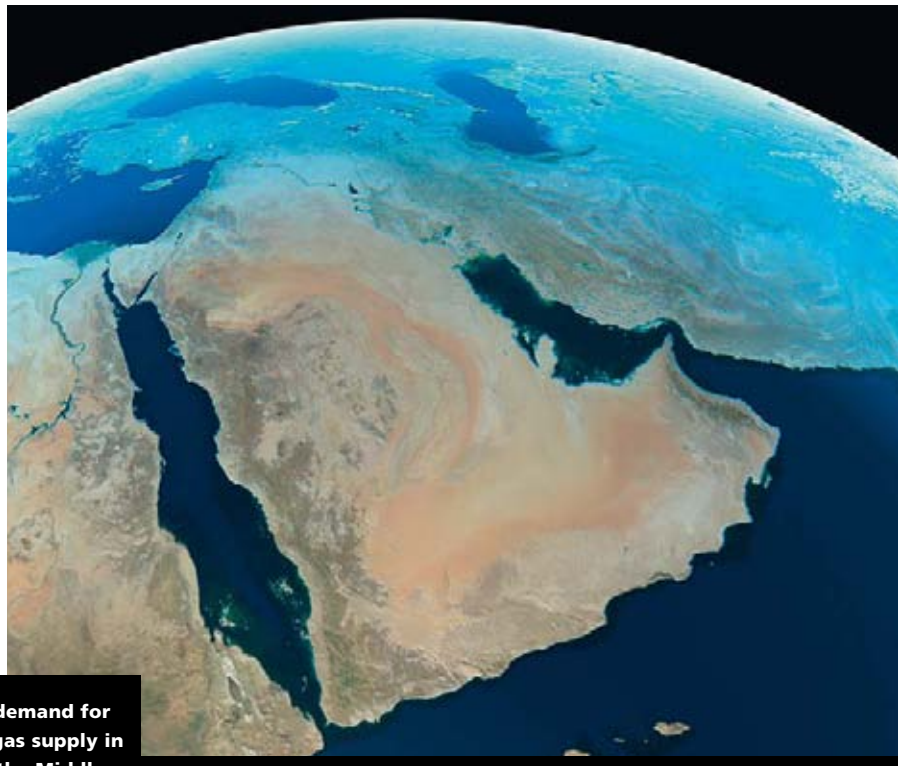
## Identifying Requirements

The concept study commenced in early October 2010 and was undertaken by a multi-disciplinary team of GL Noble Denton consultants from locations in Loughborough, London, Hamburg and include the local GL Noble Denton consultancy team. To support the study and to impart know how to the client, two of the client's engineers were based in the Loughborough office for a period of six months, working closely with the GL Noble Denton team and liaising with the client's senior management throughout the duration of the study.

Senior Project Manager Mark Saunders, based in Loughborough, undertook the project management and coordination of the various aspects of the concept study,



Photos: Dreamstime/Joao Vinissimo, iStockphoto/Fabio Filzi



**Project. The demand for an efficient gas supply in the cities of the Middle East is strong.**

which involved establishing a core project team to undertake the city gas conceptual study, including an energy market study, initial network design and options for an LPG-supplied network. “Furthermore, we needed to identify the organisational requirements to support a city gas distribution business, and the areas where business preparedness is required to operate the asset on an ongoing basis.” GL Country Manager Sherif EL Sayed and his team supported the project with documentation, external stakeholder liaison and data gathering.

By utilising GL Noble Denton’s SynerGEE® network modelling software and costing the proposed gas distribution network, the experts were able to develop the concept design for the gas distribution network. This also included working with the client to assess the connection point capacity for the pre-existing transmission pipeline system.

Another essential part was to carry out a quantified risk assessment (QRA) of the proposed infrastructure using GL Noble Denton’s FROST® software. “We had to ensure that

the proposed design was in accordance with internationally accepted levels of individual and societal risk,” says Mark Saunders. Additional reliability, availability and maintainability (RAM) Assessment of the proposed infrastructure facilities was then carried out with GL Noble Denton’s OPTAGON® software.

### Potential Impacts

In order to identify the potential positive and negative impacts that the construction of a city gas distribution network would have on the local community and residents, a social impact analysis (SIA) was undertaken. The short term disruptive impacts of constructing a buried gas distribution network were assessed against the longer-term benefits of a safe, secure and environmentally-friendly source of fuel for domestic, commercial and industrial properties.

“Equally important is the environmental impact analysis (EIA) of the impacts associated with the construction ▶

### SIA.

A social impact analysis shows the potential positive and negative impacts of a city gas distribution network on the local community.



Photos: Dreamstime/Anthony Villalon, iStockphoto/Fabio Filzi

**Scheduling. To verify the technical viability of the project, a design concept workshop was held.**

**MONTE CARLO.** Monte Carlo methods are especially useful for simulating systems with many coupled degrees of freedom, such as fluids.

of the gas distribution network on the local community and surrounding environment,” explains Mark Saunders. This involves weighing the potential short-term negative impacts of the network construction, which can be significantly mitigated by means of a well-coordinated environmental management programme, against the reduced requirement for a fleet of LPG trucks and road tankers delivering LPG cylinders to homes and businesses around the city.

### Verifying Viability

Eventually, a fully integrated financial model was developed including all aspects of customer demand and conversion to natural gas, capital and operational expenditure, economic and macro-effects and other key financial parameters to make an assessment of the financial viability of the investment over a 30-year project life.

Throughout the concept study, there were a series of milestone workshops to verify the technical and financial

viability of the project via a design concept workshop and a financial workshop held in January 2011 and March 2011, respectively. Finally, the outcomes of the concept study were presented to the clients’ Board of Directors in March 2011. Senior Project Manager Mark Saunders commented: “This concept study clearly demonstrates how the significant consultancy skills, experience and software resources of GL Noble Denton from the Group can be brought together to deliver a successful outcome for the client on what is a strategically significant project for the country as a whole. GL Noble Denton will now work with our client to take this project into its next phase and we will continue to develop and strengthen our close working relationship.” **CB**



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# Advantage Riga

**Lowest costs and shortest time needed for the implementation are persuasive reasons to build a liquefied gas terminal for the Baltic states in Latvia**

In order to ensure competitiveness in the natural gas market of the Baltic states, thus achieving the lowest price for the consumers, it is economically viable to build only one regional liquefied gas terminal. Taking into account geographical and economical considerations, Latvia and particularly Riga is the most advantageous location for the terminal to be built. These are the main conclusions drawn from the prefeasibility study carried out by GL Noble Denton and The Energy Contract Company, who are in charge of evaluating the viability of erecting an LNG terminal in the Baltic region. The experts used set criteria to analyse 22 possible options for the terminal in Latvia.

## ABSTRACT

- A prefeasibility study analysed 22 options for an LNG terminal in Latvia
- Dependence of Baltic states on one gas supplier will be significantly reduced

## Dependence Will Be Reduced

If the LNG project were to be implemented by 2016, it would become an important hub in Europe, would improve the safety of the infrastructure in the Baltic region, reduce risks of natural gas supply prices and ensure competitive natural gas prices for consumers.

The dependence of the Baltic states on one gas supplier will be reduced at least by 25 per cent. "Building the terminal is an important issue for the energy sector development of the whole Baltic region," says Mr Artis Kampars, Minister for Economic Affairs of the Republic of Latvia.

The GL Noble Denton study mentions several advantages of building the LNG terminal in Latvia: the most convenient geographical location, already existing and appropriate infrastructure, as well as the gas interconnections with Lithuania and Estonia that are already in place. Very important is the existence of the Inčukalns underground gas storage (UGS) that, if necessary, could be extended up to 3.2



Photo: Anrijs Požarskis

***Building the terminal is an important issue for the energy sector development of the whole Baltic region.***

**ARTIS KAMPARS, MINISTER FOR ECONOMIC AFFAIRS, REPUBLIC OF LATVIA**

billion cubic metres and ensures that LNG can be pumped directly into the storage. The advantages mentioned above mean that the costs of adapting the existing infrastructure could be kept to a minimum. □




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# Added Value for Australia

**One of Australia’s most important oil and gas projects has been launched on Queensland’s coast. GL Noble Denton is providing various services and studies**

 Australian coal seam gas explorer and producer QGC has selected GL Noble Denton to provide verification services and RAM studies for the development of one of the country’s largest capital infrastructure projects, Queensland Curtis Liquefied Natural Gas (QCLNG). The venture will supply more than 8.5 million tonnes of LNG per annum through the development of two LNG trains, and GL Noble Denton’s experts will oversee the pipeline construction portion of the project over a two-year period. The company will also supply inspection services for the installation of the 540 km underground line

between the natural gas fields in Australia’s Surat Basin and a natural gas liquefaction plant on Curtis Island.

The contract was awarded to GL Noble Denton following the successful completion of an in-depth study into the production capacity of the LNG plant design that will be built on Curtis Island. GL Noble Denton used its simulation software, OPTAGON, to provide a holistic assessment of the ability of the LNG plant to meet its intended use. The model also identifies equipment criticality and the resulting contributions to unplanned downtime. The results provided have added significant strategic and operational value to the project.

“The Queensland Curtis LNG project is one of the Australian oil and gas industry’s most exciting developments to

## ABSTRACT

- QGC has selected GL Noble Denton for a major assurance contract and RAM studies
- Demand for services has increased in Australia

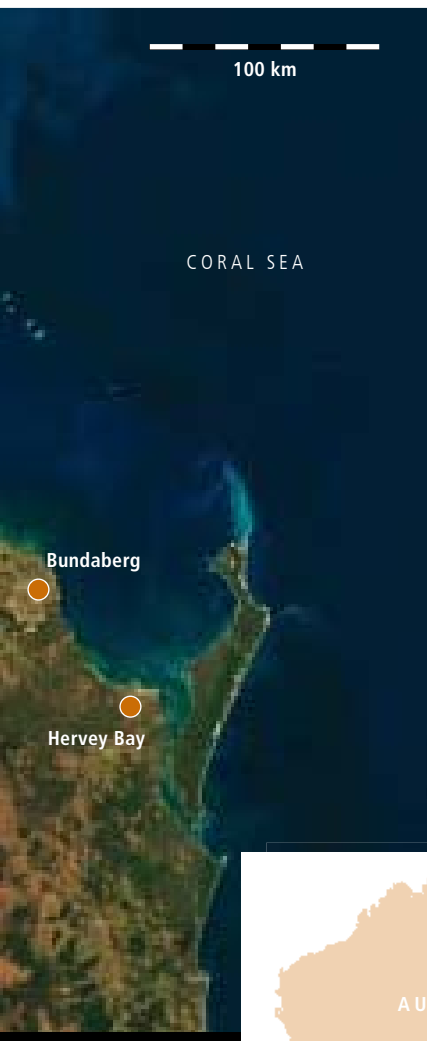


Photo: NASA



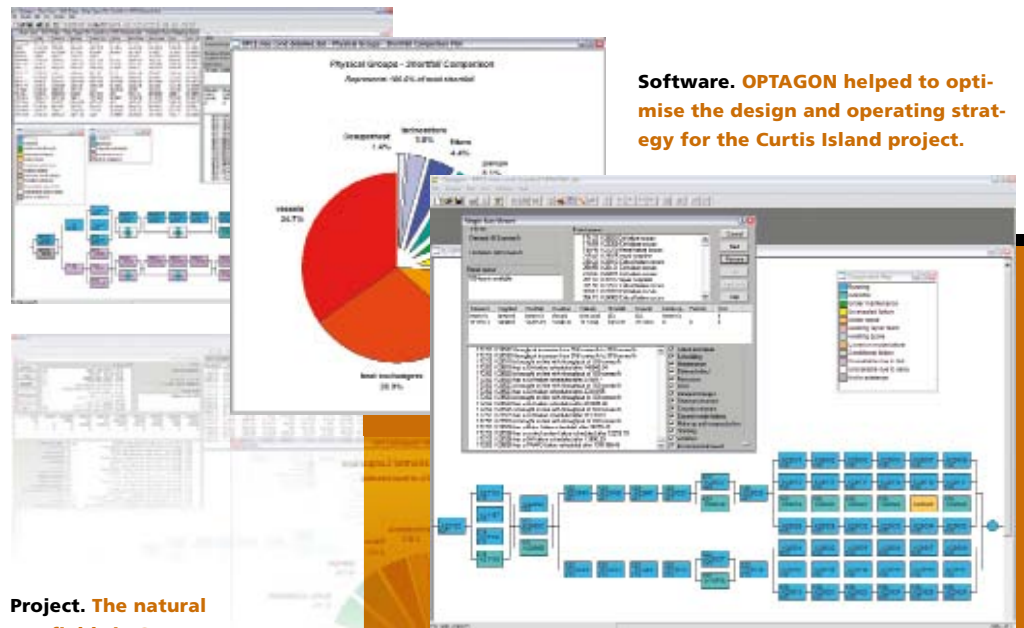
**Project.** The natural gas fields in Surat Basin will be connected to the new LNG plant on Curtis Island, near Gladstone on Queensland's coast.

date. It will help define the country as a leading producer and exporter of natural gas, and we are delighted to play a role in its development," says Richard Bailey, GL Noble Denton's Executive Vice President Asia Pacific. "Demand for GL Noble Denton's services has increased considerably in Australia over the past year, as operators continue to unlock the significant potential of the natural resources available on- and offshore the country." □ RC



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**Software.** OPTAGON helped to optimise the design and operating strategy for the Curtis Island project.

# Simulation – the OPTAGON Way


**RESULTS FROM GL NOBLE DENTON'S OPTAGON SIMULATION SOFTWARE HAVE ADDED SIGNIFICANT COMMERCIAL VALUE TO THE QUEENSLAND CURTIS LNG PROJECT,** allowing QGC to make informed decisions on how to optimise the design and operating strategy for the Curtis Island LNG plant during the development phase of the project.

OPTAGON allows the reliability, availability and maintainability (RAM) of clients' complex process systems to be accurately simulated, helping to quantify the likelihood and commercial impact of both planned and unplanned production outages. The functionality of OPTAGON is extensive and its Monte Carlo simulation method enables complex system behaviours to be incorporated within the system model.

When run for the proposed Curtis Island LNG plant, OPTAGON provided results that have helped QGC ensure that the LNG plant will deliver its targeted annual throughput, quantify the impact of potential production loss in all areas of the LNG supply chain, and identify key production-critical systems for targeting CAPEX and OPEX investment.

# Pivot of the Project

**GL Noble Denton's Project Management Services team has made a name for itself in supporting the different phases of a capital project from concept identification all the way through to abandonment**

 If there were a hierarchy of services within GL Noble Denton, then Project Management Services would sit somewhere near the top.

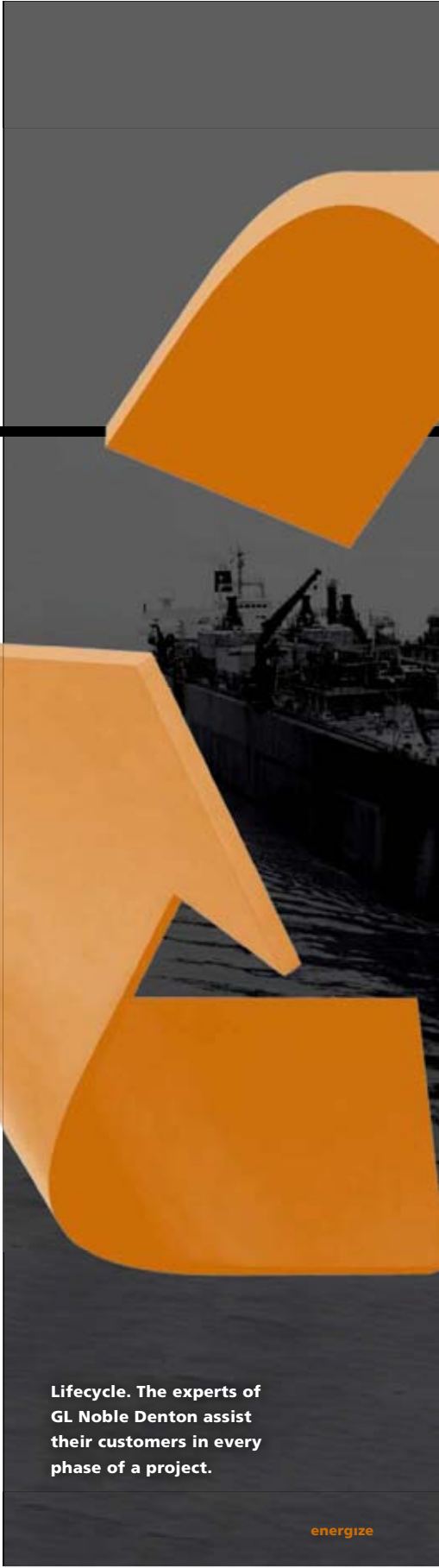
The unit, headquartered in Houston, Texas, and run by Vice President Dick Porter, was absorbed into GL Noble Denton in 2007 with the acquisition of Lowe Offshore International Ltd, a US provider of project management services to the oil and gas industry.

Project Management Services cover every stage in the life of a project from inception to completion. Porter's team brings robust project management methodology into the definition, design, specification, construction monitoring, procurement, regulatory interfacing, quality control and assurance of onshore, offshore and marine oil and gas assets.

One of the core capabilities is to provide its clients with the management skills that many of them – being small to medium-sized operators – tend to lack. The smaller operators prefer to keep their cash for what they do best – exploration and drilling – and hire in the project management company to provide the services that they are unable to carry out.

## ABSTRACT

- Project Management Services (PMS) cover every stage in the lifecycle of a project from inception to completion
- GL Noble Denton provides different teams to best suit the needs of the project at each phase



**Lifecycle. The experts of GL Noble Denton assist their customers in every phase of a project.**




Photos: Dreamstime/Valdum, PROSAFE

Many clients look for strong project managers to lead their team, especially those companies that may have a large physical footprint but don't have the large staff numbers to back that up. This is where GL Noble Denton comes in. "The clients have a small amount of cash and haven't yet matured as a company to the point where they have a large cadre of project staff in house. And that's what we bring on board," says Porter.

The project manager is often the pivot of any large project, so experience counts. GL Noble Denton has among its ranks a cadre of seasoned project managers who have worked for major engineering houses and marine fabrication yards, and are well versed in completing turnkey jobs for clients of all shapes and sizes.

### **Seven Phases in Life**

"The buzzword here is the project lifecycle," says Porter. "Most of our project managers are experienced and have been through the entire project lifecycle numerous times, so they understand the process from conception through to commissioning and start-up and handing the keys over to the customer."

One of the advantages of GL Noble Denton's Project Management division is that it can support the different phases of a capital project from concept identification all the way through to abandonment. Bob Laing, Vice President of Business Development, explains: "A capital project typically has six or seven phases throughout its life, and we can provide a project team with different managers and key personnel transferring in and out to best suit the 

► needs of the project at each phase. Project involvement can range from a few months to several years depending on the scope of the project.”

**POLVO.**  
Experts estimate the capacity of the oil field off the Brazilian coast at about 15 million barrels.

Furthermore, with a strong project team on board, the wider services of GL Noble Denton can be called upon whenever necessary. Laing notes, “You can pull in other group services, not just project management. For example, in the early stages we can mobilise our field development expertise, and in later stages provide ongoing asset integrity skills.”

GL Noble Denton’s deep technical resource pool provides a strong additional capability for the client. “We have the skills to manage the project but we can also provide

the technical know-how and all the support functions, the cost monitoring, forecasting, and scheduling,” says Porter.

### Cost-effective Consultancy

It can also add value where it really matters – on the bottom line. One client managed to obtain some significant cost savings by deploying GL Noble Denton’s project management services.

Porter takes up the story: “The client was going to buy a floating production, storage and offloading (FPSO) unit. We scratched around and found out about the tax ramifications and told the client he could lease the FPSO which would be a cheaper option as he wouldn’t have to pay any import tax. Somebody else built it and leased it to them.”

## Polvo – a Case Study

When Noble Denton was contracted to provide the overall project management services for **DEVON ENERGY AND SK CORPORATION** for their Polvo project in Brazil’s offshore in 2005, it posed a considerable challenge for the Project Management Services team.

The complex project included a drilling wellhead fix platform connected to a FPSO facility connected by two infield pipelines, and a power and telecommunications umbilical in 100 meters of water. The client

was faced with a multitude of challenges in the development of this first project in Brazil, including local content requirements, budget based on similar projects in the Gulf of Mexico, and local market suppliers mainly accustomed to performing work for the local national oil company.

GL Noble Denton’s international team prepared the project management plan with particular consideration given to the local project requirements, global vendor selection, budget and time constraints,

and Brazilian specific rules and regulations. It managed to fast-track a complex project, enabling the clients to start oil exploration in less than two years from project initiation. The typical cycle time for a project of that scope in Brazil is at least four or five years.

“A lot of that was due to project management input. We did some good work and like all successful projects, we had a lot of good people putting in long hours that enabled us to pull it off,” says Porter.



Photo: PROSAFE

**FPSO Polvo.**

**GL Noble Denton provided project management services for a complex project that included building a floating production, storage and offloading unit that connects to a fixed drilling/wellhead platform at the Polvo oilfield off the Brazilian coast.**

One of the key value add-ins is interface management – the links in the chain where the “handoff” takes place between different parts of the organisation, or between different companies involved in a project. “Typically, engineering houses know their business pretty well, vendors know their product lines pretty well, fabricators know how to fabricate – all the specialists know their craft, but it’s the interface or the handoff where things fall apart, or where

the schedule disconnects. The interface is a typical failure point,” says Porter. With its strengths across the value chain, Project Management Services can step in to smooth over any cracks at these interface points.

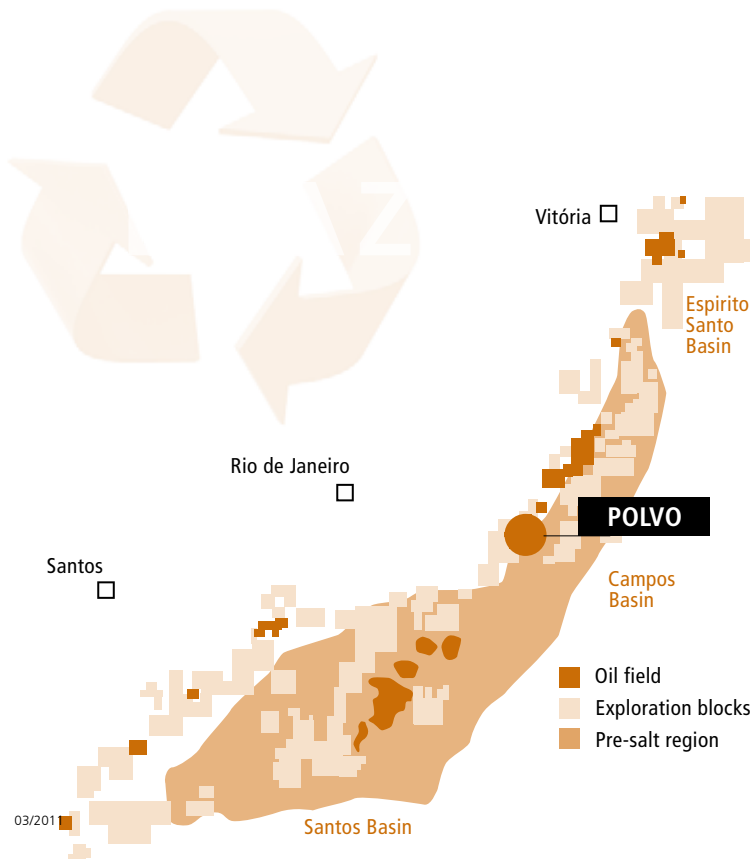
**Upcoming Challenges**

As the oil and gas market evolves, Porter’s team will have to respond to a growing list of challenges. One of these is the chronic manpower shortage facing the industry. The oil and gas “patch” has failed to attract sufficiently skilled people to the business in the last few years. The generation that built the North Sea, expanded the Middle East and developed the US, Brazilian and Angolan deep waters, is nearing retirement age.

There’s a void of longer-term experience that will need to be filled, particularly with projects becoming more technically challenging, or located in deeper water and in more hostile environments like the Arctic.

As the scale of the challenge grows, Project Management Services will remain in strong demand as clients look to GL Noble Denton to provide a seamless service that minimises project dependencies and reduces potential risks.

“As the physical and financial scale of projects steps up, we will need to have more sophisticated management tools,” says Porter. “We also have to be flexible, and adapt. We’ve gained experience from projects all over the world, and we’re pretty flexible. There’s no ‘one-size fits all’ approach. We apply the size that each individual job needs.” **JG**



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# projects in brief

## **Debate** Shale Gas Production to Increase Demand for Carbon Capture and Storage

**uk** GL Noble Denton has forecast that the development of shale gas production in Britain will increase the energy sector's dependence on carbon capture and storage as a method for reaching UK's targets of reducing carbon emissions by 80 per cent by 2050 and decarbonisation of the power sector by 2030.

Talking at a debate on the future of unconventional gas in London, GL Noble Denton's Managing Director for the UK, Arthur Stoddart, said that because Britain is

already heavily reliant on gas, the cleanest of all fossil fuels, the increased use of unconventional energy resources such as shale gas would be unlikely to reduce emissions in line with UK targets.

To meet emission reduction targets, a greater focus would need to be placed on capturing and storing the carbon emitted by the energy industry. "The UK oil and gas industry has an increasing need to develop innovative solutions for capturing carbon, if we are going

to get anywhere near meeting the emission targets," said Mr Stoddart during "An Unconventional Future", a panel debate hosted by industry journal "Petroleum Economist" and sponsored by GL Noble Denton.

An Unconventional Future attracted more than 40 of the gas sector's commercial and academic leaders and addressed a range of key issues on the role of unconventional gas as a potential solution to the world's increasing energy demands.

**Exploration. Shale gas production is to become a solution to increasing energy demands.**

Photo: devenergy

## **Trelleborg** Reducing Cost of Installing Platforms

**singapore** New technology from Trelleborg Singapore Ltd. for installing offshore production platforms provides a welcome reduction in costs. Leg mating units (LMUs) make a valuable contribution to the float-over method of installing the topsides of offshore oil and gas platforms from a barge. But the crucial challenge, according to JP Chia, Engineering Manager at Trelleborg Singapore, is transferring the load from the barge to the jacket.

The company participated in two float-over projects last year and performed full custom design, engineering, fabrication and testing. Trelleborg worked with GL Noble Denton. "In this project,

Trelleborg supplied twelve LMUs, which showed good performance and reliability during the topside float-over installation," says GL Noble Denton Project Engineering Manager Andy Wang.



Photo: Trelleborg

**Float-over. The LMUs are placed inside steel cans.**

## **IQPC** Experience in City Gas Network Planning

**kuala lumpur** Andy Cummings, Senior Consultant at GL Noble Denton, the global independent technical advisor to the oil and gas industry, chaired the renowned IQPC City Gas Asia conference in Kuala Lumpur this year. At the event, for which GL Noble Denton was the primary sponsor, a wide range of issues facing the sector were discussed, including best practice in pipeline integrity management, metering and billing, and distribution network maintenance.

Cummings was invited to chair the IQPC in recognition of his in-depth experience in city



**Chair. GL Noble Denton's Andy Cummings.**

gas network planning, particularly in Asia. He also presented a paper on the complexities of developing a city gas business, and facilitated a discussion on ensuring the safety of city gas distribution operations.



## **GL Noble Denton** Specialists Win Innovation Award



**Ceremony.** Dave Gregory, GL Noble Denton, receives the award alongside representatives from National Grid and ALH.

**London** GL Noble Denton won the coveted Innovation Award at the 2011 Gas Industry Awards in London last May. The accolade was received jointly with the company's largest client, National Grid, and gas network maintenance specialist ALH Ltd. for a collaborative project to design a new method for securing drilling valves into gas mains, known as beam drilling system.

The awarded system challenges more than three decades of traditional drilling practice, and saves considerable amounts of time and resources by removing the need to dig large holes in the ground to secure drilling bases to gas pipelines. It uses specially designed beams placed over reduced excavations to carry out drilling work, and allows a wide range of tasks without having to enter the excavation they are working on.

The beam drilling system was developed by GL Noble Denton's Transmission and Distribution Services team in Loughborough, alongside specialists from National Grid and ALH. It forms part of an Innovation Funding Initiative from UK gas and electricity regulator, Ofgem. The system was specifically recognised by the Gas Awards judging panel for its contribution to improving the safety of working practices and reducing road traffic disruption.

## **EPSRC** Offshore Engineers to Benefit from Wave Modelling Tool Developed at City University London

**London** Designers of offshore structures are set to benefit from a software tool under development at the City University London that can model the behaviour of extreme ocean waves more accurately, efficiently and consistently than current technology.

The University has received 103,000 GBP from the Engineering and Physical Sciences Research Council (EPSRC) and Finance South East to commercialise research by its Hydrodynamic Engineering Group through a new collaboration with GL Noble Denton which will also contribute 50,000 GBP to the work. The new funding was secured with support from the City University London's Research and Enterprise team.

The twelve-month project will deliver an application to predict the wave force that offshore structures – whether oil rigs, wind turbines or floating tidal power stations – are subjected to. The modelling is based on parameters such as weather conditions, wave height and wave spectrum, and will enable engineers to create optimised designs with a reduced risk of failure. The project is being led by Qingwei Ma,

**Dr RV Ahilan.**  
Managing Director of Advanced Engineering Consulting at GL Noble Denton.



Professor of Hydrodynamics at City, who says: "Interest in building offshore structures is growing rapidly, as oil and gas exploration moves to deeper waters and marine renewable projects take off. Ensuring that structures are resilient to the harsh ocean environment is key and we hope that our software will make this process more reliable."

Dr RV Ahilan, Managing Director of Advanced Engineering Consulting at GL Noble Denton, adds: "Our engineers are engaged in developing offshore assets the world over, which must be safe, sustainable and affordable. The research at City will aid this by enabling us to generate designs with a much better understanding of the forces that they must stand up to under extreme conditions."



**University.** The Hydrodynamic Engineering Group is developing a software tool to predict the wave force that offshore structures are subjected to.

# dates

## Conferences & Fairs

### SEPTEMBER

**12.09.2011**

**IMCA Vessel Assurance Workshop**

Aberdeen, UK



**Discussion. Vessel integrity management.**

**14. – 15.09.2011**

**Fire and Blast Information Group – Recent accidents and related research update**

Aberdeen, UK



**Accident. Knowledge on fires and explosions.**

**19. – 22.09.2011**

**12th Annual FPSO Forum**

Singapore



**FPSO. Asset integrity management system in focus.**

**27. – 28.09.2011**

**Integrated Asset Integrity Management**

London, UK



**Workshop. Health and safety management.**

### OCTOBER

**03. – 05.10.2011**

**Middle East Workboats 2011**

Abu Dhabi, UAE



**MEWB. Technical and environmental challenges.**

**11. – 12.10.2011**

**Dynamic Positioning (DP) Conference**

Houston, USA



**Houston. The DP conference was established in 1996.**

**13.10.2011**

**Gas 2011**

Loughborough, UK



**Gas production. Asset life extension.**

**25. – 27.10.2011**

**Louisiana Gulf Coast Oil Exposition (LAGCOE)**

Lafayette, USA



**LAGCOE. Petroleum conference in the US.**

### IMPRINT

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# Exciting Career and Development Opportunities at GL Noble Denton

To support our ambitious growth and development plans we are currently looking for talented individuals, who share our passion for technical excellence.

To be successful in our business you'll be self motivated with the flexibility and desire to work at client offices in various locations around the world.

In return we offer real opportunities for progression and personal development within our global organisation, along with attractive remuneration packages and the opportunity to work alongside other industry experts on an exciting range of projects.

To apply, please forward your CV along with covering letter to [recruitment@gl-group.com](mailto:recruitment@gl-group.com) or alternatively visit our careers website [www.gl-nobledenton.com/careers](http://www.gl-nobledenton.com/careers) for details of our opportunities.

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