LNG Journal supplement - the world's leading LNG publication

LNG shipping

REVIEW

- Confidence returns
- Plugging the gap
- Hoegh orders FSRUs
- Increased training needed
- CNG rules developed
- LNG as fuel gains ground

May 2011

Power Flexibility

for high-tech offshore vessels

Diesel-Mechanical Systems **Diesel-Electric Systems** **Propellers and Nozzles** **Gearboxes** **Propulsion Management Systems**

A wide range of MAN engines are deployed for highly specialised offshore vessels. Power availability, reliability and flexibility are key performance parameters, securing all operating modes from station-keeping to high transit speeds. MAN Diesel & Turbo's environmentally friendly engine technology means clean combustion, low consumptions and minimal emissions. Challenge our flexibility!
Find out more at www.mandieselturbo.com

Engineering the Future – since 1758.

MAN Diesel & Turbo

THE LNG journal

SHIPPING REVIEW 2011

An LNG Journal publication

CONTACTS

PUBLISHER
Stuart Fryer
Tel: +44 (0)20 7017 3400
Fax: +44 (0)20 7251 9179

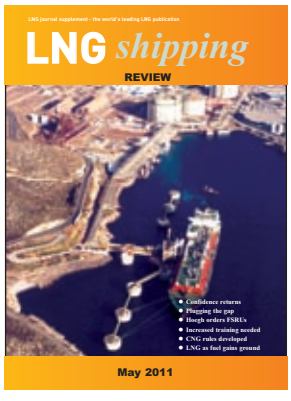
EDITOR
Ian Cochran
Tel: +44 (0)20 7017 3403
Fax: +44 (0)20 7251 9179
cochran@tankeroperator.com

ADVERTISING SALES
David Jeffries
ONLY MEDIA LTD
T: +44 (0) 20 8674 9444
F: +44 (0) 20 8674 2743
djeffries@lngjournal.com

PRODUCTION
Vivian Chee
Tel: +44 (0)20 8995 5540
chee@btconnect.com

Printed by Alya Print
ul. Siemianowicka 98
41-902 Bytom
Poland

CONTENTS



Scenes like this are expected to increase in the future as the prospects for gas shipments look much brighter than at anytime in the past couple of years, or so.

With projects coming to fruition in the Asia/Pacific rim and the situation in Japan necessitating extra LNG cargo imports, the LNG sector is definitely on the move again.

The only blot on the horizon is the US, where domestically produced shale gas has meant a fall off in natural gas imports. Much of the US shipping capacity has been switched to Europe, which is buying gas in increasing volumes.

For example, what was thought to be the first Q-Max to call at the UK's Isle of Grain receiving facility arrived recently and several Q-MAX and Q-Flex LNGCs have been seen at Milford Haven and Zeebrugge, while the new facility at Rotterdam (Maasvlakte) is due to open by the end of this year.

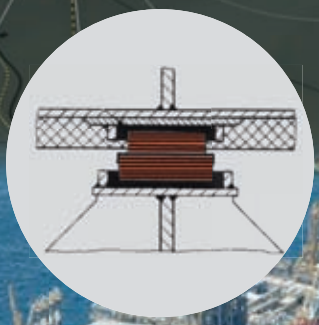
dehonit®

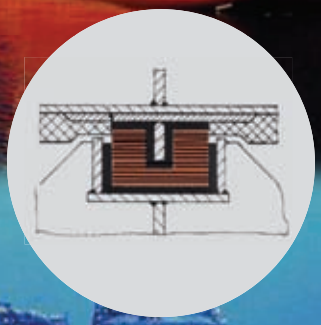
Leading in Cryogenic Support Engineering

Permali Compressed Wood

FPSO Tank Supports

Small Scale LNG and Ethylene Carrier Tank Supports





GBS Terminal

LNG Receiving Terminal

On land and at sea
60 years of experience
From the oldest to the newest
From the smallest to the largest
Why let anyone else support you?
Dehonit and Permali Pipe and Tank Supports
www.deho.de ++ info@deho.de ++ www.permalideho.co.uk
sales@permalideho.co.uk

Moving in the right direction again

Following a couple of years of all talk and no action, the LNGC shipping markets appear to be moving in the right direction again. Since the last *LNG Shipping Review*, a few orders have been confirmed on the back of long term contracts.

However, the days of the speculative LNGC order look to be well and truly over, unless your name happens to be Hoegh or Golar.

Commenting on a major order for new LNGCs recently, Golar LNG chairman John Fredriksen said; "The supply/demand balance for LNG shipping looks8 increasingly attractive. It is clear from the continued strong global LNG demand and supply growth that a significant amount of new infrastructure, including shipping, will be required over the coming years."

He is usually one step ahead of everybody else.

At the last count, there were about 366 LNGCs in service and another 30 or so on order. The latter figure could be enhanced by orders that have been around for some time and keep being deferred. The firm contracts include the hybrid small scale LNGCs, such as Anthony Veder's and IM Skaugen's multi-purpose gas carriers.

There are still many projects in the pipeline, many of which are in Western Australia, which will involve transporting gas to the Asian markets. However, the Russian Barents Sea gas producing facility - Shtokman - is still a long way away, possibly not coming on stream until 2018 at the earliest.

There is talk of more floating regasification (FSRUs) plants needed, which would suit companies, such as Golar with elderly tonnage to dispose of. Indeed, one of Golar's vessels recently left layup in Norway for Singapore to be converted into an FSRU. That leaves two of the company's vessels in layup – one in Norway and one in Malaysia – both no doubt awaiting news of floating storage projects in the pipeline.

Not stopping there, Golar has also confirmed an order for four 160,000 cu m regas LNGCs at Samsung with four more options in a deal worth $800 mill.

Samsung has claimed to have won $1.2 bill of LNGC orders amounting to six vessels. These include the four Golar LNGCs, plus two others from an unidentified owner.

In addition, Leif Hoegh has also signed a letter of intent for two sophisticated, plus at least two optional, 170,000 cu m capacity FSRUs with Hyundai. They have been designed to meet the requirements of new floating regas projects worldwide, the company said.

Meanwhile, the FLEX LNG initiative has come much closer as in April, InterOil Corp and Pacific LNG Operations, have signed a contract with Samsung Heavy Industries and FLEX LNG to construct a 2 mill tonne per annum FLNG.

This contract was still conditional upon Flex shareholder approval and final FID, the companies said.

The FLNG project is intended to be used to liquefy natural gas from the onshore Elk and Antelope gas fields in the Gulf Province of Papua New Guinea following preliminary arrangements with Energy World Corp and to link with InterOil's proposed condensate stripping plant (CSP) in a joint venture with the Mitsui Group and to accelerate the intended commercialisation of the Elk and Antelope fields.

Start-up of the FLNG vessel's operations is targeted for mid-2014.

AGEING FLEET

Out of the current fleet, there are nearly 40 vessels of 30 years of age or over. Although their containment systems can last for hundreds of years, the hulls and machinery need constant attention and the machinery will need upgrading to cope with the pending environmental legislation.

To cope with the age profile, there are several repair and service companies offering life-cycle type upgrades of LNGCs. It is obvious that a Q-Flex, or Q-Max, apart from their economies of scale due to their size, are far more economical to operate than a 1970s built steam turbine powered vessel, which has only half the carrying capacity.

There are receiving terminals due to come on stream in the near future, including several in China, one in Rotterdam and the continuing upgrade of the Isle of Grain plant.

In China, there are three receiving terminals in service, another three under construction and five planned.

One of the latest Chinese initiatives involves ongoing talks between CNOOC and the Tianjin port authority. If the talks are successful, Tianjin could build an LNG receiving terminal, capable of handling three million tonnes of LNG per year, imported from the Middle East. Tianjin is the nearest port to Beijing.

The one blot on the horizon is the slowdown in US imports, primarily due to the exploitation of domestic shale gas. We have even seen the US exporting imported gas and there is talk of exporting shale gas in the future, but this will still be some way off, as it will be used primarily for domestic consumption.

One result of this slowdown was the shutting of Excelerate Energy's Gulf Gateway LNG import facility in the Gulf of Mexico, which was deemed obsolete by this surging US domestic supply.

Although LNG demand has increased recently driven by price and the power industry, the long term problem will be finding new supplies. The Iranian situation shows no sign of resolving itself, as although there are elections coming up this year, the giant South Pars gas field's exploitation seems as far off as ever. Much of Iran's current gas production is used domestically.

Indeed, at a recent meeting with NITC in Sharjah, *LNG Shipping Review* was told that

Time to weigh anchor.

there could be a need for up to 83 LNGCs once the field starts to produce gas. However, the company was adamant that no orders would be placed until long term contracts were signed to ship the gas.

LNG AS FUEL

Another outlet for LNG could come in the future in the shape of bunker fuel. DNV made a jaw-dropping statement late last year that some 50% of new orders from 2020 to 2050 could be fitted with propulsion plants powered by natural gas. BIMCO has also recently forecasted a similar percentage.

At least three of the major engine manufacturers – MAN Diesel, Rolls-Royce and Wärtsilä - have unveiled gas powered engine designs and some are already in service.

Initially designed for small ship operations, such of offshore support vessels and local Norwegian fjord ferries, the idea has grown to encompass conceptual designs of VLCCs and large containerships.

Norway is in the vanguard of research and in particular – DNV. The class society has been involved with most of the 10 or so installations seen thus far and is involved in projects for much larger vessels.

At the end of last year, DNV unveiled a conceptual design of a VLCC powered by LNG and is involved with MAN Diesel with a conversion and the project design of containerships. The class society claimed that the logistics of delivering the fuel would not be a problem as storage facilities could be set up near the gas receiving terminals. The building, or conversion, of bunker barges to transport LNG would also not be problematic, DNV claimed.

In the northern hemisphere, LNG is already transported in small LNGCs along the west coast of Norway to feed the local gas powered supply vessels and ferries. The gas is picked up from European storage and receiving terminals. There are similar plans for the Baltic region with a storage plant based in Gothenburg to supply the fuel.

Of course the driving force for all of these innovations is cleaner fuel to cope with the raft of national and international emission regulations that will come into place in the near future.

JAPANESE IMPORTS

In a double tragedy, Japan's nuclear energy programme was devastated by the earthquake and the resultant tsunami on 11th March. Several of the country's nuclear reactors were shut down following the double blow.

Nuclear power accounts for about 30% of Japan's power supply and the lost energy supplies will need to be replaced. One answer is to increase imports of LNG. Japan is already the world's largest importer of natural gas, but the receiving terminals are not running at full capacity.

Already QatarGas has said that it will send an extra 60 shipments representing an additional 4 mill tonnes of LNG over a 12-month period.

A loaded Russian LNGC also recently arrived at Futtsu, Chiba Prefecture.

The LNG, which Russia provided in addition to its normal LNG shipments to Japan, was to be transferred to Tokyo Electric Power Co's LNG storage base in the prefecture for a thermal power plant in the city.

The vessel *Grand Aniva,* loaded 65,000 tonnes of LNG in Sakhalin, before making the one-week voyage to Tokyo Bay. The gas will be used to supply electricity in Tokyo and its vicinity.

According to Reuters, although Japan's diplomatic relationship with Russia had been strained by a dispute over the Russian-held northern territories off Hokkaido, on 12th March, Russian Prime Minister Vladimir Putin directly ordered an increase in the supply of LNG and oil to Japan.

Gazprom, the Russian state-run natural gas company that arranged the LNG shipment, has indicated it could send more gas if needed. "Amid Japan's hardship, we'll offer more aid if requested," Gazprom said in a message, reported Reuters. ■

A truly unique expertise in high-integrity valves

Truflo Rona is a manufacturing centre of excellence specialising in the design and the production of dedicated valves for the oil, gas, chemical, petrochemical (PTA plants) industries, LNG ships and LNG terminals. Its products are designed for use in severe service applications where safety integrity and performance are critical.

Truflo Rona offers a full range of valve designs which include ball, gate, globe and check valves fully engineered to completely cover the customers' specifications in this quality driven market.

Truflo Rona

Truflo Rona Parc Industriel des Hauts Sarts 4040 Herstal Belgium
Tel +32 4240 6886 Fax +32 4248 0246 Email sales@truflorona.com

www.truflorona.com

Markets on the move after several years in the doldrums

Both the LNGC charter market and the newbuilding sector are experiencing a revival following three to four years of inactivity.

The cost of shipping liquefied natural gas may advance 67% to a five-year high as Japan replaces its crippled nuclear industry with power plants burning fossil fuels.

According to a report compiled by Bloomberg, LNGC charter rates will average $100,000 a day in the fourth quarter of this year from about $60,000 during the first quarter of 2011, said Oyvind Hagen, an analyst at ABG Sundal Collier in Oslo.

Responding to the resurgence of interest in LNG transportation, analysts covering Golar LNG , which operates 13 vessels, raised their 2011 earnings estimates by 24% in four weeks, according to data compiled by Bloomberg.

"There's no vessel available in the spot market," said Martin Korsvold, an analyst at Pareto Securities in Oslo who also forecasts rates of at least $100,000 a day in the fourth quarter. "In a shipping market where you have capacity utilisation of 100%, it's almost 'pick a number,'" for rates, said the analyst speaking towards the end of March.

Japan, already the world's biggest buyer of LNG, is facing power shortages after the magnitude-9 earthquake and 7 m tsunami damaged nuclear, coal, oil and gas-fired power plants, including Fukushima, which has become the world's worst atomic accident since Chernobyl a quarter century ago. The country generated about 34% of its electricity from nuclear in 2009, Credit Suisse Group said in a report 16th March, said Bloomberg.

LNG will probably be used to compensate for about half of the lost capacity, crude and fuel oil will make up another 30% and coal the remainder, Credit Suisse estimated. That would mean about 6.5 additional LNG cargoes a month. Russia, Qatar, Indonesia and South Korea have said they are willing to ship more, the bank said.

Shell, Europe's biggest oil company, diverted six LNG cargoes from Brunei, two from Russia and one from Nigeria to Japan, De La Rey Venter, the Hague-based company's head of LNG, said on 22nd March. He also said that more would follow in the next few weeks.

FOSSIL FUELS

Japan also relied on fossil fuels for extra power generation in 2007 when an earthquake shut the Kashiwazaki- Kariwa nuclear plant, with LNG making up 20% of the additional purchases, according to Credit Suisse. LNG's share will be higher this time as the fuel now costs about half as much as crude, compared with near-parity in 2007, Credit Suisse said.

Extra demand for gas may also come from nations shutting nuclear plants, or canceling orders for new ones. Germany suspended its seven oldest reactors and the European Union is planning safety checks on the region's 143 atomic stations.

Global LNG demand will increase 5.1% to the equivalent of 31.1 bill cu ft per day in 2011, according to Barclays Capital. Japan accounted for about 36% of demand in 2009, according to GIIGNL, a Levallois, France-based group with 54 full members drawn from the industry.

"With the increased supply of LNG into Japan you have to believe that an already tight shipping market will get tighter with a consequent increase in rates," said David Glendinning, president of Teekay Gas Services, talking to Bloomberg.

LNGC rates have risen for three consecutive quarters, the longest stretch in at least five years, according to data compiled by ABG Sundal. The scarcity of spot market vessels will not end soon, as there are just over 30 new orders, equal to more than 10% of existing capacity.

Most LNGCs are operating on long-term contracts. The market for single-voyage charters started about four years ago, as the fleet expanded at a time when LNG projects were delayed by financing, or construction restraints, according to Calum Kennedy, a London- based analyst at Clarkson.

Fleet growth has in part been hampered by vessel prices. A new gas carrier costs $210 mill, more than twice as much as VLCC.

CHINESE GOING FOR LNGCS

China's large shipbuilders, such as Hudong-Zhonghua Shipbuilding, Jiangsu Rongsheng Heavy Industries and New Century Shipbuilding, are actively pushing for LNGC orders, reported asiasis.

The country's shipbuilding industry, which is targeting high value added vessels, aims to engage in the LNGC market within the national policy - 'Chinese build Chinese ship'. However, it has proved difficult for Chinese yards to be competitive since LNGCs require highly-developed technology.

For instance, Hudong-Zhonghua signed a

> "With the increased supply of LNG into Japan ... an already tight shipping market will get tighter with a consequent increase in rates"
>
> **- David Glendinning, president, Teekay Gas Services**

newbuilding contract in January this year with Japan's MOL to build four 170,000 cu m LNGCs for $220 mill each - the first Chinese shipyard to conclude an LNGC export contract.

Another Chinese shipbuilding giant, Rongsheng, is also working on breaking into the LNGC and offshore markets. The yard has been participating in a number of energy-related project bidding in the hope of winning new orders in these sectors.

Moreover, the yard has recently signed a license contract with France's GTT, which holds a patent for membrane-type LNG tank systems. The yard's engineering team were sent to GTT early this year for training in the preparation of containment systems and on mock-up installations.

STX France has become another co-operative partner of Rongsheng to share LNG shipbuilding technology. The yard, which has been working at entering the LNGC newbuilding market from the second half of 2009, is now trying to secure the designs for 170,000 to 200,000 cu m LNGCs.

In addition, asiais said that New Century Shipbuilding, which emerged as the number one shipyard in China last year with newbuilding output of 29 ships totaling 3.6 mill dwt, has set its delivery target for this year at 34 vessels of 4.5 mill dwt. The yard has also announced plans to break into LNGC shipbuilding this year.

The yard has also embarked upon a similar strategy to attack the LNGC market by inviting Japanese technicians specialising in LNGC building and design.

South Korean shipbuilders have said that the technological barrier to build LNGCs is so high that Chinese yards cannot expect to make a profit in a short time despite their efforts to win new orders.

This is seen to be just one step for the Chinese yards to increase their market share by expanding the newbuidling output of LNGCs ships, the South Koreans claim, according to asiasis.

Leading player Golar LNG Energy has entered into agreements to timecharter its four modern LNGCs - *Golar Grand, Golar Viking, Golar Arctic* and *Golar Maria* - for periods of between 12 and 18 months to various charterers. Total charter coverage amounts to 57 months. The commencement of the fixtures ranged from February to April 2011.

The combined annualised EBITDA contribution of all four vessels derived from these timecharters is approximately $80 mill based on assumed levels of operating costs. This represents attractive rates above the current spot market rate for LNGCs, Golar said.

The LNGC spot market over the last decade has been highly volatile resulting in difficulties maintaining reasonable utilisation rates. Total operating costs for LNGCs while off-hire are significantly higher than in other shipping sectors; due to high fuel consumption during idling, cool down requirements and repositioning costs. This fact, along with current attractive charter rates, is a contributing factor with regards to the decision to fix out the vessels for the near term.

At the time of the charters, Golar Energy's CEO, Oscar Spieler said in a comment: "The LNG shipping market has recently tightened and these four timecharters, together with the recent success on the Nusantara Regas Project in West Java, puts the company in a strong position for further growth.

The Chinese will be a key player in both building and operating LNGCs.

"The charter coverage will strengthen the company's liquidity position and create liquidity for developing additional FSRU projects without raising additional equity. We believe that the market will strengthen further in the years to come due to a relatively small newbuilding orderbook, strong increases in LNG production, and changing trading patterns," he said.

NEW ORDERS

Last December, Korea Gas Corp was reported as saying that it might order four LNGCs from a South Korean shipyard in 2011 to transport gas under new contracts.

The vessels are earmarked to transport LNG from Australia's Gladstone project. The Santos Ltd-led Gladstone development will supply 3.5 mill tonnes of the fuel per year to Korea Gas starting in 2015.

As mentioned above, MOL has ordered four 98,000 dwt, 170,000 cu m LNGCs at Hudong-Zhonghua for delivery 2014-2018. This represents China's first overseas order, which was concluded on the back of ExxonMobil's PNG project. Hudong delivered the first Chinese built LNGC – the 147,000 cu m *Daepeng Sun* in 2008.

Golar LNG Limited said that it had entered into a firm contract to build six 160,000 cu m LNGCs at Samsung Heavy Industries.

The company said that newbuilding contracts were originally entered into by companies affiliated with Golar's largest shareholder World Shipholding. Golar has acquired the newbuilding contracts from the affiliated party based on the original contracting terms.

Four vessels are to be delivered in 2013 and two the following year. The total cost of the six newbuildings is around $1.2 bill. In addition, Golar said that it had options to acquire further vessels for delivery in 2013 onwards.

Golar has options to include ice strengthening/winterisation of the vessels, as well as regasification equipment.

The vessels will be delivered with dual-fuel diesel-electric main engines, which will be significantly more efficient than steam turbines thereby reducing fuel costs materially. The company claimed that the new engines will also have lower emission levels of pollutants and CO2,

Golar said that it saw further opportunities in the newbuilding markets and was actively pursuing several other projects with the target to increase the newbuilding programme for early deliveries further.

Given the likely strengthening of the shipping market in the coming years, Golar will spend some time in evaluating employment alternatives for the vessels. These opportunities include spot trading, employment within Golar Commodities for its own cargo trading activities, joint venture structures with LNG suppliers and possible long-term timecharters to third parties. Commitment within the FSRU segment for several of the ships seems also like a very realistic and attractive opportunity, the company said.

The equity financing of the newbuildings has been secured through the proceeds received from the initial public offering of Golar LNG Partners.

Another order is close to firming up. This is InterOil Corp's and Pacific LNG Operations agreements, conditional upon Flex shareholder approval and final FID, with Samsung and FLEX LNG for the construction and operation of a 2 mill tonne per annum FLNG.

The FLNG project is intended to integrate with the proposed infrastructure to liquefy natural gas from the onshore Elk and Antelope gas fields in Papua New Guinea in accordance with preliminary arrangements with Energy World Corporation. It will also link with InterOil's proposed condensate stripping plant (CSP) being arranged in joint venture with the Mitsui Group and to accelerate the intended commercialisation of the Elk and Antelope fields.

Commencement of the FLNG's operations is targeted for mid-2014.

Meanwhile, Höegh LNG has entered into a firm 'letter of intent' (LOI) with Hyundai to build two 170,000 cu m FSRUs.

In addition to the delivery of two firm vessels, the LOI with HHI includes two plus two optional vessels.

The new built FSRU's are based on Höegh's in-house design, 'Höegh FSRU™'. This is a generic FSRU with 170,000 cu m storage capacity and flexible regas capacity, aimed at meeting the technical requirements for the long list of new floating regas projects around the world, the company said.

There is also an unconfirmed rumour that Maran Tankers Management has changed a VLCC order into an LNGC to be managed by Maran Gas. ■

PLUG - the affordable shore power solution

In this paper, the terms 'shore power', 'cold ironing', 'high voltage shore connection' (HVSC) are described for the maritime industry - that is, connecting ships to onshore power networks when they are in port thus allowing them to cease running their generators**.

Such practice is routinely used for naval vessels and is starting to be implemented for commercial vessels, mostly for environmental reasons. Historically, 'cold ironing' is a US Navy term stemming from the fact that once the on board gensets have been stopped, the whole iron/steel mass of the whole engine room gets cold.

Shore power has attracted a lot of attention recently as a way to reduce emissions at two levels:

1) Local diesel engines emissions, which are increasingly considered as a public health issues for the populations located around port areas (see Ref 5).
2) Global shipping industry CO2 emissions, as part of the numerous corrective actions identified to reduce climate change risks.

Ideally, as illustrated in Figure 1, shore power could become a fully optimised extension of the shore power network towards the vessels at berth, both in economical and environmental terms, by allowing ships to get connected to lower emissions, lower costs power sources.

Taking advantages of present day IT technologies and that efficient power exchange trade markets are already in place in many countries to allow to trade power just one quarter of an hour ahead, shore power could become a real time optimisation of the balance between supply and demand.

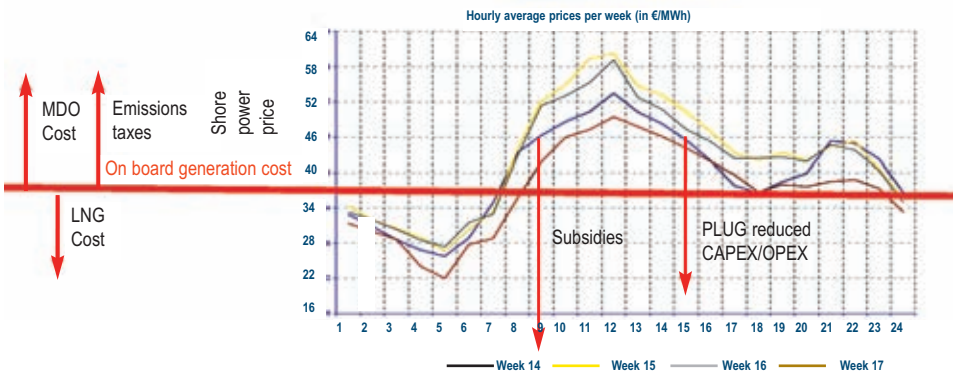


Figure 2: Typical shore power/on board generation economical benchmarking.

SPECIFIC REQUIREMENTS AND CONSTRAINTS

Figure 2 illustrates the possible strategies shipowners could have on this market, taking into account the typical, intrinsically, hour-by-hour, week-by-week, fluctuating price of the onshore power market.

Compared to shore power market price, on board generation cost is remarkably stable on a daily basis, as it is mostly driven by the cost of the fuel and maintenance of the on board gensets (although this may vary depending on the power load and the corresponding engine efficiency), and has been illustrated by a flat line in this figure.

As an example, we have set this on board generation cost line in the middle of the typical hourly shore power market price. This means that during the day peak hours, when demand by other (shore based) consumers is high, shore power price is significantly higher than on board generation and that a shipowner's interest is to keep the gensets running.

Taking the opposite situation, during a low demand period, typically at night, the interest is to switch to shore power to get access to lower cost sources of energy.

In this case, a shore power connection becomes an attractive option and most importantly, beat the shore power market, by getting connected only when it is profitable. Some vessels, such as the new generation diesel electric powered LNGCs, could even play the market both ways, using their main propulsion gensets to sell power to the shore during peak hours, see Ref 1.

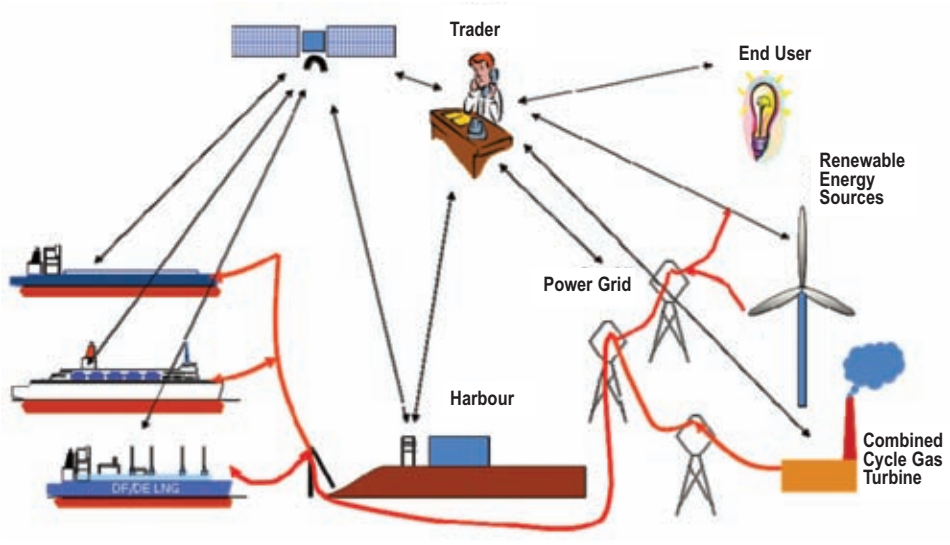


Figure 1: The shore power concept.

Figure 3: The Shore power challenge: certainly green and good for emissions, but what about profitability?

Unfortunately, the reality is currently quite different, and you do not need much encouragement to a shipowner (or, alternatively, a terminal operator) to have him, or her, tell you that shore power is just one of these fancy gimmicks invented by some greenish bureaucrat from the Californian Air Resource Board (or even worse the European Commission) to kill its profits, see Figure 3.

Such a statement should not be neglected by any shore power promoter, as it reflects the truth. In most cases, shore power is not profitable for shipowners and out of the present world 60,000 plus merchant vessels* in operation, hardly a couple of hundred are using it during their normal operations, a clear indication that this is not a profitable operation.

In fact, while reviewing CO2 emissions (and fuel consumption) reduction strategies Det Norske Veritas recently ranked shore power as one of the least efficient CO2 emissions abatement technologies, behind no less than 20 others. (See Figure 4, taken from Reference 2)

Nevertheless, several factors, beyond mandatory requirements, may change shore power use, as identified in Figure 2:

- On board (diesel) generation fuel costs may rise sharply compared to shore generation resources in the coming years, both if oil barrel price rises and if, as it is already the case in some areas, use of low sulphur fuels becomes mandatory (see Ref 3).
- Conversely, as identified in Figure 4, the development of LNG as a fuel for the shipping industry could become a very attractive solution against shore power both to meet global CO2 and local (Californian) emissions abatement requirements.
- In the same way, implementation of diesel exhaust scrubbers to reduce common air contaminants (CACs) emissions could be as well very competitive to meet the local (Californian) requirements.
- On board generation price may as well increase if local or global emissions taxes are implemented and this could be a long term solution.
- Subsidies, especially to cover the shipowner's and terminal' s expenses may be implemented (and has been in most present cases for capex, but for example, Sweden is considering delivering shore power tax free to make it competitive on the long term), mostly due to a local emission concerns, but cannot be considered as a long term, widespread, solution.
- And last, and by no means least in the long term, the shore power industry can increase its competitiveness by reducing, through innovation and other cost abatement measures, its capex and opex, as NG2 is proposing with its PLUG connector solution.

PLUG (an acronym for Power Generation during Loading & Unloading) is an innovative solution to drastically increase shore power competitiveness, both in terms of economical and environmental benefits.

PLUG is to be benchmarked with at least these three existing solutions (see Ref 4):

- For small power exchange requirements (<1 MW) all manual operations for cable and connector handling, such as in the Baltic Sea.
- For large cruise ship with large power requirements (<12 MW) mechanised supports and handling of the cable on the connectors up to the vessel power sockets, with final manual connection, such as in Alaska.
- For Container Carriers (2 to 12 MW) the Port of Long Beach is actively promoting a solution, called 'AMP' (alternative maritime power) based on one or two on board mechanised cable reels with manual connection and this solution is considered by IEC as a standard.

Compared to these solutions, PLUG proposes game changing technology based on a very innovative connector system, leading to much easier and efficient operations.

As soon as the vessel is secured alongside the quay, the crew just slides out above the quay a beam to which is attached the ship side power socket and drop a chain toward the quay side connector.

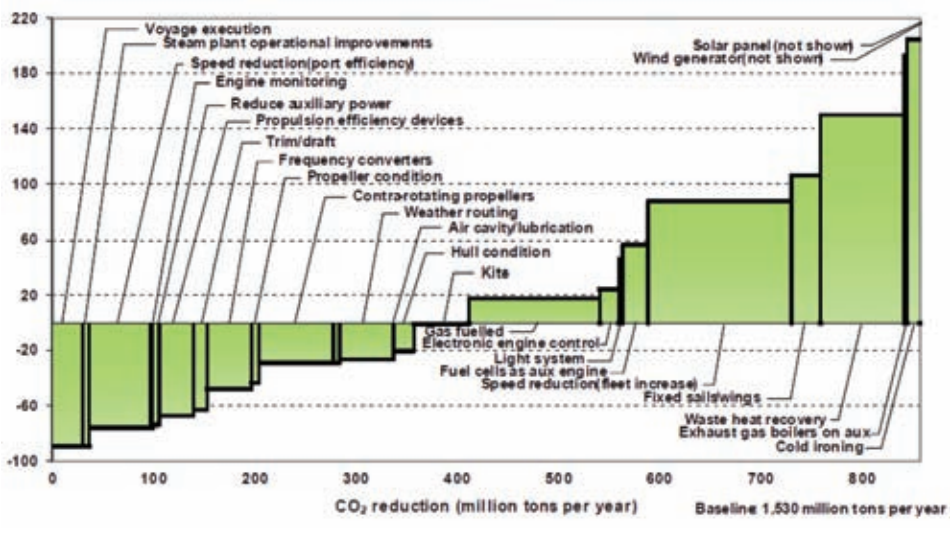


Figure 4: Benchmarking between CO2 emissions abatement solutions from a report issued by DNV (Ref 2).

Figure 5: PLUG connector patented guiding technology.

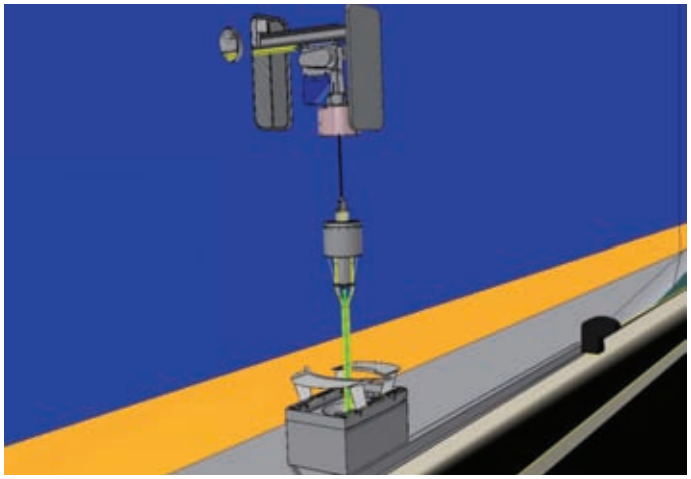


Figure 6: PLUG operations.

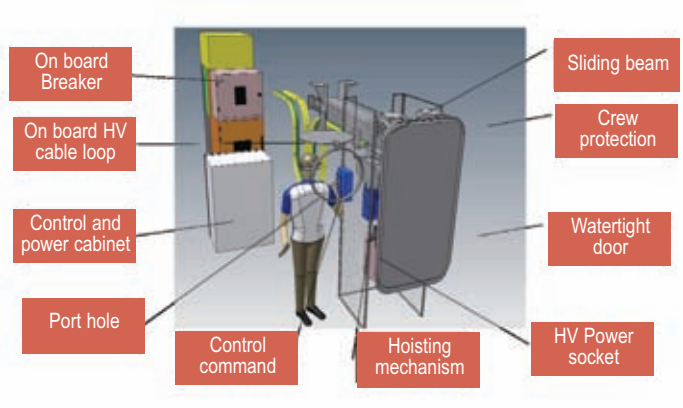


Figure 8 : Typical ship side PLUG deliverables.

The chain is equipped (see Figure 5) at its end with a triangular cross section 'shuttle bar', which as soon as it is within reach, is grabbed by a diaphragm system, which guides it towards the quay side connector. Further down, inside the connector, the shuttle bar comes into contact with a set of three rollers, which force it to rotate and get indexed with the connector electrical contacts. Even further down, the shuttle bar meets a mechanism, which locks it with the connector.

The diaphragm can then be re-opened and the crew can hoist it up towards the ship side socket the quay side connector and the power cables attached to it (see Figure 6 or watch/download videos on NG2 website).

When it gets into the ship side socket, the shuttle bar is guided by another set of three rollers and rotates again to align in front of each others the connector and socket electrical contacts.

As the connector gets further up, the socket electrical contacts push open the quayside connector contacts and the connection is established

These unique features, make PLUG the world first solution to perform a safe, multi-mega watt, high voltage, connection in less than a minute.

Another feature is that PLUG fully mechanised operations are insensitive to the mass and (lack of) flexibility of the connectors and cables: the power exchange capability can be optimised to meet with the same design, and a single PLUG unit, most of the world's fleet requirements, under up to 11,000 volts, as illustrated in Figure 7.

Figure 8 shows the typical ship side shore power PLUG deliverables, which consists mainly of:

- A watertight door , which when fully closed, protects the whole system from the marine environment, reducing the corresponding maintenance costs.
- A sliding beam to which is attached the watertight door, the hoisting system and the HV socket; it should be noted that this beam can fit easily between two existing deck beams, reducing the on board system footprint, allowing an easy retrofit on existing vessels.
- An HV socket which protects the contacts from the marine environment during the power exchange.
- A hoisting mechanism, which allows to establish not only the connection, but as well, provides a built in emergency release capability, just by releasing the chain until its last link gets out of the chain grab.
- A control command cabinet , including a radio link which allows a single crew member to perform the whole operations, including the remote control of the quay side PLUG interface.
- An on board set of HV cables between the HV socket and the on board breaker arranged as festoon to follow the mechanism when it is slid out.
- Crew protection, which will protect the crew from any mechanical and electrical part, suppressing the need to rely on an a

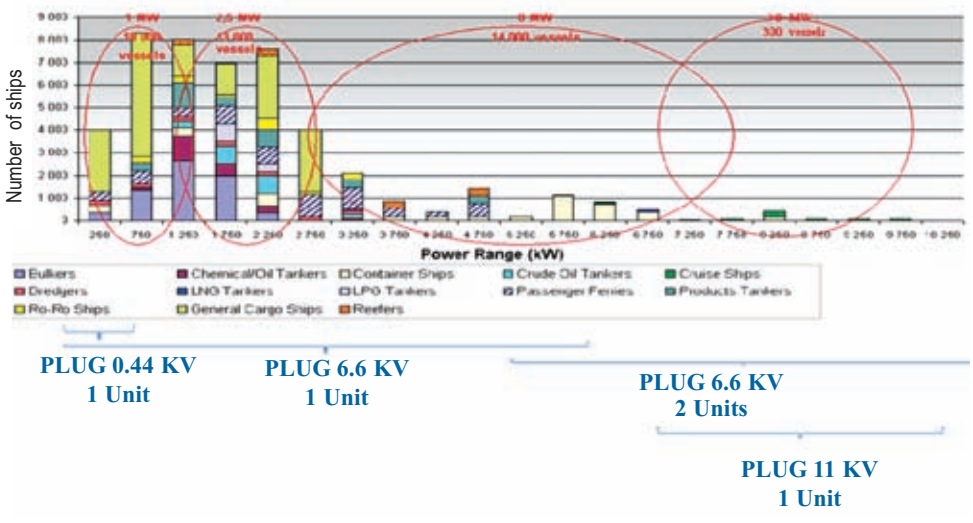


Figure 7 : PLUG typical power range compared to various ships shore power requirements.

Figure 10: PLUG operation demonstrations at SMM.

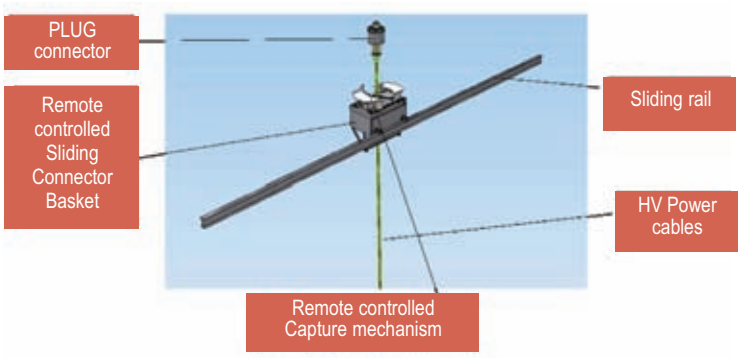


Figure 9: Typical quay side PLUG deliverables.

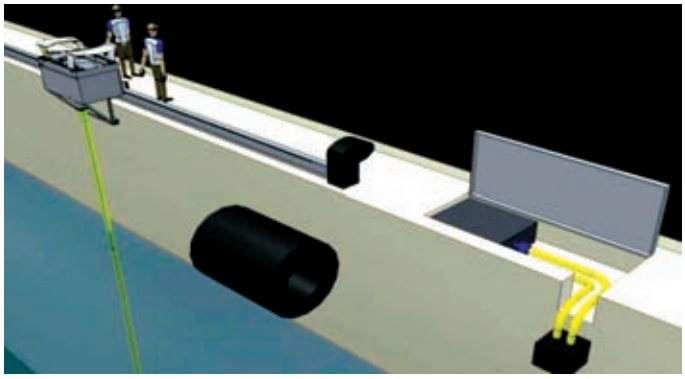


Figure 11 : PLUG/AMP adaptor.

qualified electrical engineer to perform PLUG operations.

Figure 9 shows the typical quay side shore power PLUG deliverables, which consists mainly of:

- A watertight HV connector which is hoisted towards the vessel to establish the connection.
- A remote control connector basket, which is used to store and protect the connector when not in use, and is equipped with a capture mechanism to grab the vessel hoisting chain; this baskets slides along the quay, just above water so that it can be located right below the ship PLUG interface.
- A sliding rail which is attached to the quay.
- A set of HV power cables, which link the connector to the quayside HV breaker. These cables form a festoon in the water along the quay to provide some flexibility and adjustment capability with regard to the vessel longitudinal position, tide variations, etc.

PROJECT STATUS

PLUG was officially released on the market at the September 2010 SMM technology expo in Hamburg, where a full size PLUG was on display, see Figure 10 on the previous page, demonstrating , among other features, its one minute connection/disconnection capability.

Following this exhibition, this PLUG unit is going to be used to perform high voltage and other qualification tests, in order to get class and owner's approval for an implementation on several projects in 2011.

In parallel:

1) A PLUG/AMP adaptor is being developed to propose PLUG for California terminals already equipped with AMP, see Figure 11. Due to the gains in brings in terms of speed of operations and reduction of man power costs, such adaptor is expected to require a pay back period of a one, or two years for the terminal operator.
2) A floating PLUG connector version is being developed to meet tankers shore power requirements as well as a 11 kV version for cruise ships.

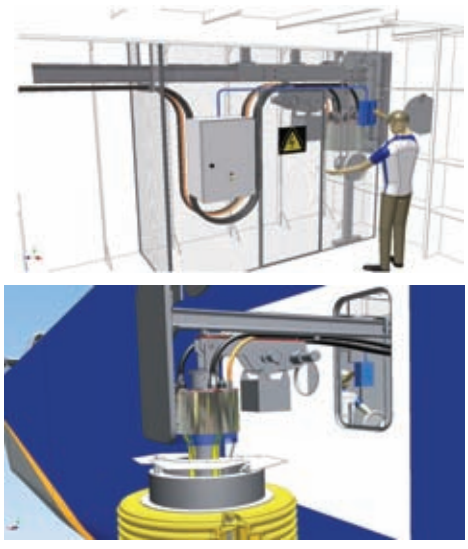


Figure 12: PLUG typical implementation on a cruise ship or a tanker.

CONCLUSION

Like most other emissions abatement strategies, shore power is facing an economical challenge, but in many cases, it may bring the opportunity to tap in not only greener, but most importantly, lower cost, sources of energy, such as hydro, nuclear, gas, or although on a longer term wind or solar.

The possibility to develop the corresponding business case with a satisfactory added value for all the stakeholders involved will, therefore, first depend on the availability of such lower cost and greener power.

If this is available, the next item would be to provide shore power at the appropriate frequency, and this may require, in countries like Singapore, to build up a dedicated power infrastructure. This, combined with the use of PLUG technologies, which drastically reduce shipowners and terminal operators expenses, while increasing the whole operation return on investment should make shore power economically attractive, in particular in Singapore by taking advantage of the implementation of a new LNG receiving terminal. ■

** 'Vessels are considered to be at least 100 m long, floating, more or less, upright above the water.*

*** This is an extract from a paper given by Damien Féger, vice president, New Generation, Natural Gas, 174 Boulevard Haussmann, 75008 Paris, France at the International Maritime – Port Technology and Development Conference (MTEC) in Singapore. He can be contacted at Damien@ng-two.com www.newgeneration-natural gas.com*

REFERENCES

1. 'PLUG in for profit and environment' - An innovative solution to exchange electric power between LNG carriers and terminals, Damien Féger, Ian harper - Gastech 2008 conference paper.
2. 'Pathway to low carbon shipping : abatement potential towards 2030', Det Norske Veritas Report, 15th December 2009.
3. 'Consequences of Low Sulphur Fuel Requirements'. A report commissioned by European Community Shipowners' Associations (ECSA), Prof Dr Theo Notteboom, ITMMA – University of Antwerp and Dr Eef Delhaye, Kris Vanherle, Transport & Mobility Leuven, January 2010.
4. www.onshorepowersupply.org
5. 'Initial statement of reasons for the proposed rule making regulations to reduce emissions from diesel auxiliary engines on ocean going vessels while at berth at California ports.' California Air Resource Board, October 2007.

DYWIDAG *LNG Technology*

Member of **STRABAG** Group

Engineering Design
FEED
Basic Design
Detailed Design
Research and Development

LNG Tank
Design & Construction
since 1968

Construction
Consultancy Services
Construction
Posttensioning
Cryogenic Material Testing

Nynashamn - Sweden's First Liquified Natural Gas Receiving Terminal

The combination of highly specialised know-how and the strength of a leading market player benefits to your advantage.
DYWIDAG LNG Technology is now part of the STRABAG Group.
The group is experienced in jetty works, road works and all kind of civil construction works within the terminal needs. As an experienced EPC contractor we will be the ideal partner not only for concrete works and full containment tanks but could also arrange the coordination of the steel and plant erection.

DYWIDAG LNG Technology, Klausenburger Strasse 9, 81677 Munich, Germany
Phone: +49 89 921048 2594, www.dywidag-international.com

Ships agency designed for LNG carriers

The last 10 years has seen a dramatic increase in LNG trade around the world. However, there has been little change in the way most ship agents operate, and few concessions to cater for the demands of LNGCs.

Claiming to be the exception to the rule is Wilhelmsen Ships Service (WSS), a company operating in 2,200 ports worldwide, which handled over 1,500 LNGC port calls in 2010.

The company has completely re-structured its ships agency business, and in 2010 launched a concept called 'Ships Agency Re-Defined', an offer which deals specifically with the different needs of the LNG industry.

Unlike traditional oil tankers, which are involved with a high proportion of spot trading, the majority of LNGCs still operate on fixed schedules governed by long term supply contracts. Also LNG is a technically demanding cargo that requires sophisticated vessels manned and operated by qualified, experienced staff.

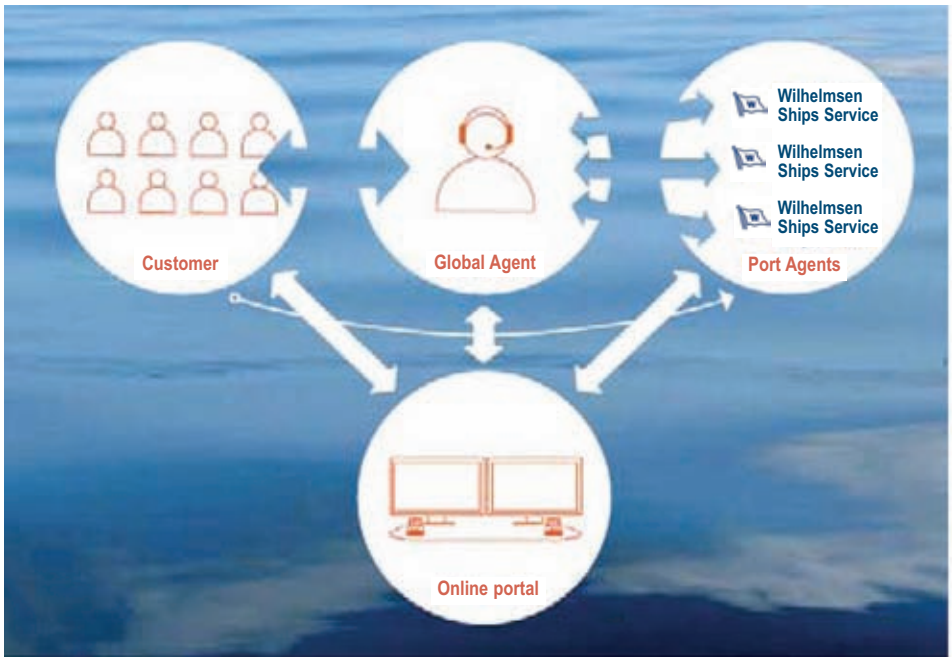
Furthermore, expensive terminal operations require these vessels to stick to tight deadlines, and there is very little margin for delays or inefficiencies. Maintaining operational excellence therefore demands high levels of knowledge, co-operation and partnership between ships' staff and those onshore.

The excellent safety record for the LNG process chain is a result of the LNG industry's stringent design practices and diligent operating standards, enhanced and supported by strong regulatory oversight.

Port agents dealing with LNGCs therefore need to have excellent relations with terminal operations to build up a good understanding of terminal specific load/discharge operational aspects with cryogenic cargoes.

For LNG sellers (producers), in particular, control of shipping is a core issue to ensure loading schedules are tuned to production. Because most LNGCs operate on fixed schedules between ports, having the same procedures in place at both ends of a voyage helps to streamline the process.

Traditionally, most operators in the LNG industry deal with different agents in every port, resulting in time-consuming administration and unpredictability due to varying performances from port to port.



The customer notifies Wilhelmsen Ships Service Global Agent of expected port calls, who handles the pre-arrival and post-departure phases. The Global Agent can also assist during port operations, but the customer is also free to deal directly with the port agent. All parties can monitor the operation through an online portal.

The operator's instructions need to be repeated for each port call, disbursement accounts and reports come in different formats, there is little transparency in cost and agency fees, and there is little, or no cross-port co-operation. All of this results in costly and time-consuming administration for LNGCs.

For instance, it is not unusual for six months to pass and many emails to be exchanged between agent and customer from the first enquiry until the settlement of the final disbursement account. Multiplied by the number of vessels an operator handles per year, the inefficiencies of this business structure become even more apparent.

RE-DEFINING THE OPERATIONS

In an attempt to deal with these challenges, WSS consulted with its customers, other LNG operators and operators of LNG terminals. The company set up a specific 'Oil and Gas' market segment, which draws together the expertise of their own specialists who have many years experience in maritime transportation industry.

Most importantly, the company re-examined the whole way that ships agency services were delivered around the world and in 2010 launched its 'Ships Agency Re-Defined' concept.

Two key elements of this concept are of direct interest to LNG operators. First, WSS standardised all the operations of its agents throughout the world. To do this, they took advantage of the company's worldwide network and customised software to ensure that all customers receive the same services wherever they operate.

They realised that customers need agency support in two locations: where their head offices are located and where their vessels call. Wilhelmsen Ships Service has professionally driven customer services in all major shipowning and operating locations, and experienced ships agents in 2,200 ports worldwide.

Second, the company introduced the role of the 'Global Agent' – an experienced agent based in the same time zone where the LNG operators have their head offices, but able to co-ordinate both ends of an LNG operation through their own agents in port.

LNG CUSTOMER BENEFITS

The benefits to LNG customers are obvious. They can issue one set of instructions to WSS, which will then apply to all their vessels in every port around the world where they operate. Port agents around the world are constantly building up the 'Global Agent's' knowledge about the requirements of a specific customer. The knowledge that agents gain at the loading port can easily be applied at the discharge port.

Improved cost control through predictable pricing is another benefit of WSS' 'Ships Agency Re-Defined' offer. While the market norm is to charge a highly fluctuating lump sum agency fee, resulting in limited cost control, WSS has created a standardised price list for its ships' agency services, meaning that LNG operators know exactly what the price will be and what they are charged for.

To simplify matters still further, all charges for the customer around the world can be consolidated on one invoice and payments, up-front deposits, reimbursements, etc can all be channelled through one bank account.

Through an online portal, the customer can have a real-time view of operations and can get an immediate overview of times, dates and costs. It gives easy access to operational details and electronic disbursement accounts.

> The company set up a specific 'Oil and Gas' market segment, which draws together the expertise of their own specialists who have many years experience in maritime transportation industry.

GLOBAL AGENTS

LNG operators can have all their port calls managed by an experienced 'Global Agent' working in the customer's location and co-ordinating all the port calls for that customer. This gives customers the benefits of someone who speaks their language and works in the same time zone.

By being involved in all port calls globally, the 'Global Agent' develops a closer relation with the customer and a better understanding of their special needs and preferences, than what is possible from a local perspective.

The 'Global Agent' also has access to the team of oil and gas specialists based in major LNG markets. The customer's recurring operational requirements are also mapped and integrated into WSS' operational system. As a result, LNG operators experience a consistent high-quality service, even in new and unfamiliar ports.

"The market has welcomed our new approach to ships agency," commented Frederic Fontarosa, WSS' business director ships agency and bunkers. "We believe this approach will considerably simplify port call operations for LNG operators in the future." ■

Hoegh LNG reinvests in tonnage

Last month's news that Höegh LNG (HLNG) has entered into a firm 'Letter of Intent' (LOI) with Hyundai Heavy Industries (HHI) for the delivery of two 170,000 cu m floating storage and regasification units (FSRUs), brings the Oslo-based concern firmly back into focus in the LNGC sector.

In addition to the delivery of two firm vessels, the LOI with HHI includes two, plus a further two optional vessels, which if firmed, would bring the total to six newbuilding FSRUs.

HLNG said that the newbuilding FSRUs are based on an in-house design -Höegh FSRU™ - which is a generic FSRU with 170,000 cu m storage capacity and flexible regas capacity. It has been designed to meet the technical requirements for a long list of new floating regas projects worldwide, the company said.

Through the design, development and construction of the two Neptune shuttle and regasification vessels (SRVs) delivered in 2009 and 2010; HLNG established itself as one of three companies that has a proven track record in the provision of floating regasification solutions to the LNG market – the others being Exmar/Excelerate Energy and Golar.

The company explained that today, the floating regas market is in rapid growth. There are currently 13 units in operation, three under construction, and around 25 in various stages of development. The market has only been explored for the past two years or so, HLNG said.

STRONG GROWTH

HLNG believed this regas carrier sector will be the strongest growth in the medium term, in particular in the Asia/Pacific region, but also for a number of fast growing economies in the Atlantic markets.

This is simply because the FSRU is the most cost efficient and shortest way for a country to import LNG, which is the fuel of choice in particular for power generation, HLNG said.

"Given the very strong LNG market with an expected growth of 6-7% on annual basis next few years and our qualification to bid for all new FSRU projects, we have with this agreement with HHI put HLNG in the position to compete for such projects based on our newbuilt FSRU's, which offer our customers the earliest possible delivery positions, a purpose built design, in addition to the most energy and cost efficient solution for their market, even compared to conversion solutions or first generation regas vessels.

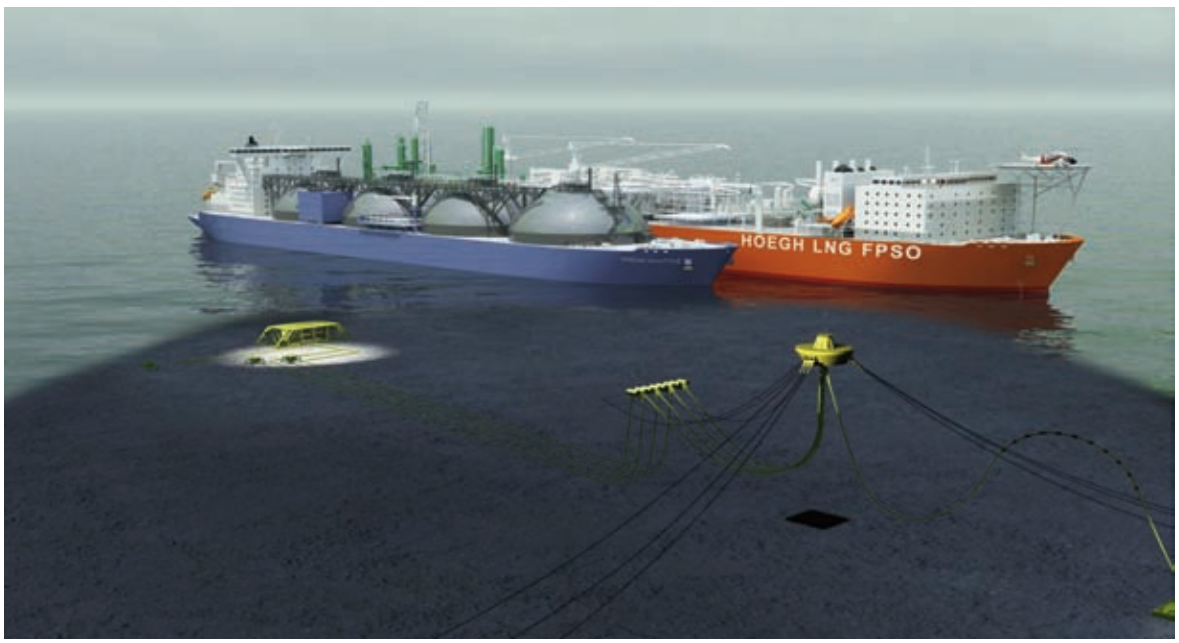
"Finally, I would add that we are very pleased to have reached this agreement with HHI, being a world class shipyard with a strong track record in the LNG and offshore segment and shipbuilding in general. We know their capability to deliver quality vessels on time and on budget," explained Sveinung Støhle, president and CEO of HLNG.

He told *LNG Shipping Review* last March that the company was a fully integrated shipping and LNG service provider offering long-term floating production, transportation, regasification and terminal solutions for LNG.

Today, the company operates a fleet of seven LNGCs, including two shuttle and re-gasification vessels (SRVs). In addition to transporting natural gas, these two vessels act as floating terminals while delivering the natural gas to the market.

In addition to the head office in Oslo, HLNG has established outlets in Singapore, London and Tampa (Florida).

"We operate our own vessels and conduct



The LNGFPSO market is likely to take off shortly.

fleet technical management in-house. We will never be the cheapest, but will offer the best quality," Støhle said.

He explained that rival Golar's policy was usually to convert existing older LNGCs into regas units. However, this statement was made before the news broke of Golar's recent four ship order of 160,000 cu m LNGCs, which the company claimed could be converted for regas operations.

CONVERSIONS V NEWBUILDINGS

Comparing costs, Støhle thought that the average cost of a conversion of an older unit was $200 mill, compared with a newbuilding priced at $300 mill.

The world's existing regas terminals consist of three in the US; three, plus one planned in South America; one, plus one planned in Europe and two, plus another one planned in Asia. Both the Asian regas units are located in the Middle East Gulf.

HLNG still has two regas projects on the go – one in Florida (Port Dolphin) and one in Morecambe Bay, UK (Port Meridian). There are four or five other projects being talked of in Europe alone, while others are under consideration in South America and the Caribbean.

Støhle said that the company also had big ambitions in Asia, which has led to the opening of a subsidiary office in Singapore - Höegh LNG Asia Pte Ltd. The Singapore office will initially be staffed with experienced personnel from other parts of the company with a view to employ local staff and regional representatives as the need arises.

Støhle said at the time of the announcement: "Höegh LNG Asia has been set up to increase the ability to successfully win new business for regasification terminals, traditional LNG transportation and FPSO projects in the Asian region.

"Working together with our partners and customers in this important region we hope to increase our ability to serve the growing demand for the services we offer to the market. There is strong economic growth in Asia, and stable and secure energy supply is an important element in sustaining the growth. We are currently pursuing a number of floating regas and floating production projects in the region, of which one is in the tender stage, and we are very hopeful of a successful outcome for at least one of the projects this year," he concluded.

Speaking before the announcement of the new orders, Støhle said that at least one new regas project would be firmed up this year, possibly in Indonesia. He said that a floating regas vessel costs around 33% of a shore-based facility and had a shorter delivery time.

One of the two sophisticated shuttle and regas LNGCs, managed by HLNG.

He also confirmed that the LNGC charter market was back with a bang saying that rates had shot up to $70,000 per day from $30,000 per day in just two months starting late last year. These rates were mainly being paid for short term fixtures as longer term charters were still not an attractive option. In addition, shipyard prices had fallen, making newbuildings an attractive option again, he said.

Last June, HLNG chartered in the 150,000 cu m *STX Frontier* from Pan Ocean and immediately sublet her to Repsol (Stream). The charter periods are for three years each. Both the recently built regas vessels were chartered to GDF SUEZ.

FPSOS COMING CLOSER

Floating production units is another area under investigation by HLNG. Since Shell has taken the plunge and ordered the world's first LNGFPSO, the market will open up, the company believed.

For example, he thought that Daewoo was capable of putting together a very complicated FPSO-type package. Last year, HLNG teamed up with Kellogg Brown & Root [KBR] leading to long term co-operation within the LNGFPSO segment. Under the agreement KBR will be Höegh LNG's topside engineering partner for HLNG's LNGFPSO projects.

The first phase of the co-operation will see KBR undertake studies and basic engineering or Front End Engineering and Design (FEED), as instructed by HLNG. The scope of the second phase to be undertaken by KBR will include execution of topsides detailed engineering and procurement services, project management services, construction management as well as integration and commissioning supervision as may be required for each specific project.

An operational agreement was also signed with Prosafe, now part of BW Offshore. This co-operation will use as its basis the FEED work already developed by HLNG. For each specific project, HLNG will be responsible for design, project execution, completion, operation and funding, while Prosafe will, in co-operation with HLNG, be responsible for the operation and maintenance of the LNGFPSO's and will assist Höegh LNG during project execution and completion.

An agreement is in place to supply an LNGFPSO for a Petromin project in Papua New Guinea. The platform will be built in South Korea, most probably at Daewoo, which has already undertaken much preparatory work on the project. A commercial agreement to sell the gas to local energy suppliers on the island was possible this year, HLNG said. An environmental impact survey will also be carried out before the final go ahead is given.

Brazil was also looking at the LNGFPSO solution with at least three studies underway as are West African and Australian interests.

All will be newbuildings and the cost is roughly split between one third for the hull and two thirds for the topsides, HLNG explained. The company also explained that the hull needed to be of Q-Max/Q-Flex size for flexibility.

As for CNG, HLNG is talking with Seatech on tank solutions, but these are very much longer term projects, the company explained .■

GREENS POWER

www.greenspower.co.uk

Marine Products

- Spanner boilers
- ESD boilers
- Diesecons and economisers
- Shell and composite boilers
- Waste heat boilers
- WHRUs

Service & Repairs

- Boiler & associated equipment spares
- Boiler Repairs
- Replacement and retubing
- Boiler Inspections
- Low Sulphur MGO conversion
- Performance improvement
- Life extension studies

Greens Power Limited
Raines House, Denby Dale Road,
Wakefield, West Yorkshire,
England, WF1 1HR

Tel: +44 (0) 1924 203970
Fax: +44 (0) 1924 387320

Spares: Melissa Healy
Email: melissahealy@greenspower.co.uk

Repairs & Service: John Sewell
Email: johnsewell@greenspower.co.uk

1960-2010 Greens Steel H Finned Tubes
50 years
50th Anniversary

Celebrating half a century of supplying Greens Steel H finned tubes

LNG market expansion increases the pressure to perform

Similar to so many other shipping sectors, the dynamics of the global LNG industry saw significant changes in the last 12 months or so*.

In the past, LNG has typically been transported between the same production and importation terminals for the life of the supply contract, averaging 20 years. However, increasing quantities of LNG are now being supplied into the spot market on short-term contracts – often securing premiums above the typical market price.

The tragic situation in Japan is an example of how the LNG spot market is able to instantly respond to an unexpected demand, where a large percentage of the lost power generation is being made up with significant increased importation of LNG.

In addition, the market came under pressure to expand and with the DNV's recent study, which concluded that LNG was the most efficient and economical method for operators to meet the air emissions requirements in the North American ECA, this pressure looks set to intensify this year in the run up to the ECA's enforcement in August 2012.

DNV's study shows that despite adding $3.6 mill to the cost of a typical domestic cargo ship, LNG as a marine fuel saves $12 mill over 20 years, compared to the use of scrubbers or low-sulphur fuel. It is therefore no surprise that the LNG sector has continued to grow with new production plants coming online, terminals being built and vessels coming into service - belying market trends in other commodities. The LNG market is high cost but delivers high value and the hardware involved represents a significant asset.

For example, an exportation LNG terminal that costs $3 bill to build, with a ship alongside valued at $250 mill discharging a cargo of LNG valued at $20 mill carries significant financial risk, as well as the safety, security, environmental risks associated with the LNG product. The LNG market exemplifies the importance of effectively protecting a vessel when it arrives at a terminal and unloads its cargo.

It is those at the coalface that are relied upon to implement and facilitate the processes to the best of their ability, bearing in mind not only the safety of the operation itself but also regulations and codes, such as the International Gas Carrier (IGC) Code, classification society rules and the security and profitability of the whole organisation.

LNG is a relatively new sector that is growing swiftly and as new regulation comes into force and the industry it creates growth, so too does the requirement for professionally trained, qualified personnel.

BEST PRACTICE

Increasing both practical and commercial understanding will support the promotion of best practice, improve safety and security, and generate efficiencies. The intricacies of the gas, oil and chemical markets are complicated and often challenging to understand – LNG especially – yet it is vital that shoreside personnel and staff in shipmanagement offices, as well as seafarers, are properly trained - they too have a key role to play in upholding procedures and maintaining standards.

And maintaining standards is vital, for nearly 50 years prior to the 9/11 terrorist attacks, all discussions of risk in LNG transport focused on how to account for human errors. The major security issue considered in LNG infrastructure approval was accidental leakage from LNG storage and processing facilities. Residents of densely populated regions where LNG plants were planned expressed fears that gas could escape, and possibly ignite.

The risk is greatly exaggerated – LNG isn't flammable by itself, so LNGCs are not actually 'sailing bombs', as sometimes labelled. There have been a number of shipping incidents, due to operational mistakes, bad weather and collisions but to date, no major LNG leakage has ever occurred.

The courses were designed by Howard Candelet.

Even so the idea that terrorists could attack an LNGC, or LNG terminal must and is taken into account when mitigating risk. LNG terminals and tankers present particularly attractive targets, as LNG fires typically do not stop until all the gas is consumed.

Despite these risks, LNGCs have booked over 100 mill sailing miles without a major accident – an enviable safety record by anyone's standards. And to protect this achievement, and to minimise safety, security, environmental and financial risks, specialist training for all those involved in the business is fundamental; more-so as the market expands, looks to cite further terminals to meet demand and LNG's reputation comes under scrutiny.

This training has to be specifically designed to empower and equip employees with the knowledge and confidence to provide safe and secure terminal and jetty operations, reducing the physical, environmental and financial risk

Handling LNGCs in tight situations calls for highly trained personnel in every discipline.

synonymous with modern shipping and onshore services.

To address this need, GAC Training & Service Solutions (GTSS) - a partnership between GAC and the National Maritime College of Ireland – has created a two-day course blending practical and commercial skills to enable LNG professionals to better understand the drivers within the industry and ultimately improve their ability to perform their role in the value chain, both onshore and shipside.

Designed to offer insight into the mechanics of the LNG world, the course includes the buying and selling of LNG, operational safety issues, types of transportation agreements, world markets, shipping and trading. This course focuses on practical measures from logistical issues to return on investment, helping all involved to truly understanding their place in the LNG chain.

EFFECTIVE COMMUNICATIONS

The short storage time of LNG product and, in turn, the importance of ensuring the safe passage of LNGCs through restricted waters puts a real emphasis of effective communication meaning that the ship/shore interface at any terminal must operate at the highest standards. Thus the GTSS course ensures that each person fully understands their role in the LNG chain and the roles of their colleagues, breaking down the working silos and lubricating communication within that chain.

For example, understanding the value of time is key for anyone aligned with jetty operations. Delays and interruptions of loading or discharge not only bear a price tag, but also have knock on effects. These potential risks are amplified at this point in the supply chain because people with different skill sets are required to collaborate for a common goal, but are often restricted by their understanding of factors outside of their own role.

Those on board the ship have first hand practical knowledge and expertise but usually very little commercial experience. For example, the ship's officers may not fully understand the contractual importance of issuing a note of protest about a shoreside delay or problem.

Equally, office personnel directing cargoes from A to B, chartering ships, handling insurance claims and the like can lack the practical understanding of their seafaring colleagues. The vessel controller located somewhere in an office may not understand the root cause of a breakdown that has rendered the Notice of Readiness invalid.

Working in these operational silos compromises the smooth running of the overall process; it exposes weaknesses that at best diminish efficiency and at worst threaten security, both of which have serious implications for the bottom line and in extreme circumstances the industry as a whole. In any case knowledge of both the commercial and operational implications of various scenarios enables more effective management of the consequences.

An organisation relies upon its employees to do the best job that they are able; to make the right decisions and to take appropriate action on the company's behalf. With this expectation comes a responsibility to empower them to do so. In this regard specialist training for all those involved in the business is fundamental to promoting best practice and efficiency while minimising threats to safety, security and revenue.

DNV's glowing appraisal of the safety of LNG alongside its environmental and practical suitability for use within the North American ECA looks set to put further pressure for expansion on a market, which is already growing year-on-year, heralding the approach of a new world order for shipping.

But to navigate this new world with safety and profitability, training must be recognised as an investment with the ability to effectively bridge the gap between ship and shore and ultimately a pro-active measure to ensure safety, revenue and reputation of the LNG sector, as well as individual organisations. ■

**This article was written by Howard Candelet who was employed by the BG Group for 47 years. His last two positions in BG were - seven years as vice president of operations of Atlantic LNG, Trinidad and Tobago and then a further seven years as vice president BG Global LNG operations based in Houston. He developed and designed the GTSS' LNG courses. GTSS aims to provide innovative and cost saving training solutions for the LNG and tanker markets, as well as other commodity and maritime sectors. Further information is available on www.gac.com/gtss, or by email at nmci@gac.com*

Liquid Cargo Handling Simulator LCHS 5000

Liquid Cargo Handling Simulator LCHS 5000 now including LNG model: Meeting the STCW'10 and 'Beyond'

LCHS 5000 is a full-mission simulator which includes replicas of cargo operation workplaces and related control systems.

New LNG models provide training for personnel responsible for cargo operations onboard liquefied gas carriers:

- LNG Tanker (membrane)
- LNG Regasification Terminal

The simulator is designed for:

- Special training of the tanker personnel (officers and ratings) responsible for LNG cargo operations on membrane type LNG Tankers and LNG Regasification Terminal
- Joint operations training on LNG Tanker and Regasification Terminal
- General training of officers of any type of vessel in control of the ship's ballast system, control of ship stability and stress occurring in the ship's hull; and protection of environment against cargo leakage pollution

The models are based on real prototypes and provide the utmost level of training realism.

Tel: +46 31 769 56 00, Fax: +46 31 69 41 84
E-mail: info@transas.com, Web: www.transasmarine.com

TRANSAS®
SETS THE STANDARD

Developing RINA's rules for the classification of CNG carriers

The traditional means of natural gas transportation have so far been pipelines and LNGCs. However, in limited gas fields, relatively close to end-users, compressed natural gas (CNG) transportation can be competitive, as it avoids the challenges of the pipeline construction and the costs of natural gas liquefaction and subsequent regasification*.

The oil & gas industry is showing increasing interest in this new concept, and for this reason RINA is developing *ad-hoc* rules to cover the safety issues related to CNG transportation, with the aid of the 'Technology Qualification (TQ)' process to cover the most important aspects relevant to the fitness for service.

Pipelines are convenient and economically attractive onshore, but, going offshore, they become more challenging, as water depth, or length increase. The consolidated solution for overseas long transportation is LNG. However, the large investments required for the LNG chain make this solution viable for large quantities of gas, as well as long shipping distances.

Marine CNG technology is aimed at monetising offshore reserves that cannot be produced because of the unfeasibility of a pipeline, or because the LNG chain is too costly to be implemented. Furthermore, the development of such a technology is recommended by the increased environmental responsibility, as a way to reduce gas flaring.

Oil majors are increasingly looking at marine CNG to develop several limited gas fields, relatively close to the end-users. Several CNG ships have been proposed and are currently being studied, but no CNG ship is sailing thus far. Various technical challenges are to be faced, such as the use of fibre re-inforced plastic pressure vessels, the technology for cargo displacement, not to mention the safety issues or the unavailability of complete regulatory framework.

TQ, marinisation of existing technologies and risk assessment, which are already covered by RINA guidelines, are critical points for the development of marine CNG. In addition to that, RINA is developing new rules for the classification of CNG ships, which will provide a technical support and guidance to the developers of this new technology.

	CNG	LNGe
Fluid state	Gas	Liquid
Pressure	100-250 bar	1 bar
Temperature	30 °C to 40 °C	-163 °C
Loading	Dehydrate, compress	Treat, liquefy, store
Terminals	Jetty or buoy	Jetty, or regas offshore
Ships	Under development	Sophisticated, efficient
Receiving	Heat & decompress – utilise energy released	Store, regasify
Loading/offloading	Gas under pressure	As liquid
Compression ratio	110-270 : 1	600:1
Containment D/t	25 – 60	1000
Material	Fine grain normalised C-Mn steel, FRP, Composite	Aluminium, Stainless, Ni Steel

Table 1: CNG vs LNG main characteristics.

The paper provides a comprehensive review of the proposed technologies for marine CNG, highlighting the critical issues and providing a description of the new rules, currently being developed.

Just for reference, the main characteristics of the CNG vs LNG are summarised in Table 1.

The first attempts to ship CNG by sea date back to the '60s, when the Columbia Gas Company developed a CNG containment system aboard a converted vessel, the *Sigalpha*, having a capacity of 1,300 cu ft of natural gas, The ship received the approval for US service by the USCG. After about a dozen successful voyages: the concept of marine CNG was proven, but operations ceased due to the low value of natural gas at that time, combined with the high capital cost of the ship itself, and the project was abandoned.

Following this attempt, the transportation of gas by sea has been limited to LNG and to NG components, such as propane, butane and various LPG mixes, which are commonly shipped in pressurised and chilled storage systems on board barges and tankers.

The concept of marine CNG transportation is now being pursued with great interest and CNG shipping is at the threshold of being commercialised: as of today, there are several concepts which have been proposed for use and whose design has been preliminary approved. Nevertheless, the current state-of-

System	Sea NG	EnerSea	Trans-Canada	Trans Ocean Gas	Knutsen	CETech
Type of containment system	Coiled Pipe	Cylindrical PV	Cylindrical PV	Cylindrical PV	Cylindrical PV	Cylindrical PV
PV Type	I	I	II	IV	I	IV
Orientation	Vertical axis	Vertical	Horizontal	Vertical	Vertical	Horizontal
Material	Steel Pipe	Steel Pipe Reinforced	Composite Glass or CF Steel Pipe	Composite	Steel Pipe Glass or CF	Composite
PV diameter	150 mm	1040 mm	1040 mm	1040 mm	1020 or 1220 mm	1040 mm
PV length	18 km	24 to 36 m	24 m	12 m	18 to 38 m	220 m
Pressure	200 bar	90 to 130 bar	200 bar	240 bar	250 bar	250 bar
Temperature	10 °C	-20 to -30 °C	Ambient	-40 °C	Ambient	Ambient

Table 2: Overview of main proposed technologies for marine CNG.

the-art engineering does not provide a univocal solution for CNG ships and quite different solutions have been studied, in terms of pressure vessel technology, cargo pressure, cargo temperature, CNG module design and ship type. Nevertheless, there is not a solution currently standing out as the leading engineering trend.

Table 2 provides a brief overview of key features of some of the technologies proposed so far.

CNG vessels are designed as a solution for regional gas development and are deemed economical for short distances (typically 2,000 miles, or less), thus targeting different sectors of both supply sources and energy markets, compared to LNG. The major differences include the massively different project value breakdown: typically around 80% of the value for a LNG project is in the liquefaction and regasification terminals, while for CNG most of the highest technology (as well as the highest costs) is related to the vessels themselves.

Other peculiar features of CNG projects are redeployability and scalability: unlike pipelines and LNG projects, the great majority of CNG project capital is redeployable to other applications if needed, providing a useful risk management solution in case unexpected events occur in the supply chain, including reservoir, market, commercial and political risks. Furthermore, projects are easily

scalable by adding vessels to, or redeploying vessels from, the fleet.

CONTAINMENT SYSTEM

The classification of the technologies for marine CNG pressure vessel can be performed adopting the ANSI & Canadian Standards Association for CNG cylinders for Natural Gas Vehicles (NGV) (ANSI NGV 2-2007). The standard contains requirements for the material, design, manufacture and testing of serially produced, refillable containers intended for the storage of compressed natural gas for vehicle operation.

Five types are foreseen:

- **Type I:** All metal construction (steel or aluminum). This type is the most proven technology in terms of material properties and the more available in industrial terms. On the other hand the pressure vessels falling into this category are heavier than those belonging to the other types.
- **Type II:** Hoop Wrapped pressure vessels. Typically the pressure vessels belonging to this type are made of steel or aluminum with a unidirectional composite plies overwrapped in the cylindrical section only.
- **Type III:** Fully wrapped pressure vessels with metal liner, overwrapped entirely with composite plies. This type is the most common kind of composite pressure vessel. The liners are normally made of aluminium (contributing to the structural strength) with a filament wound with hoop and helical plies mode of composite material such as carbon fibre, fibreglass or Kevlar.
- **Type IV:** Fully wrapped pressure vessels with Polymeric Liner. This type of pressure vessel has multidirectional composite plies and metallic polar bosses to the interface with valves and fittings. The liner does not contribute to the structure strength. The weight is lighter and the cost is cheaper compared to the other types. It shows tolerable levels of gas permeation.
- **Type V:** All-composite pressure vessels without metallic or polymeric liner. The composite shell has the double function of supporting structural loads and providing a permeation barrier. It is potentially the type with the lowest weight even though it is still under development. Gas permeation on the long term strength might be an issue.

Metallic liners typically contribute to the load-withstanding capability of the pressure vessel and are thus to be included in the calculation of the vessel structural strength. Non-metallic liners, indeed, do not contribute to the load-withstanding capability of the pressure vessel and their main functions are to contain the gas and to provide support for filament winding.

REGULATORY FRAMEWORK

In order to give an overall picture of the applicable regulatory framework, which is not fully developed to cover marine CNG so far, this paragraph and the following one provide a brief overview of the existing applicable rules (and relevant limitations) to CNG pressure vessels and to CNG vessels respectively.

Regarding the CNG vessels for industrial application, as described in the previous paragraph, there are several options for the fabrication of pressure containing vessels. Accordingly, different international standards could be applied in order to define the main criteria for the design and construction.

For metallic CNGCs, the reference Rule is ASME 2007 Boiler Pressure Vessel Code Section VIII. This standard provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures exceeding 15 psi (1 bar).

Division I of this standard reports design principles and construction practices based upon parametric formulas. The rules are applicable to vessels designed for pressures not exceeding 3,000 psi (207 bar). For pressures above 3,000 psi, deviations from and additions to these rules are necessary to meet the requirements.

Division II refers to the FEM analysis approach and provides an alternative to the minimum requirements for pressure vessels under Division I rules.

Division III provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures generally above 10,000 psi.

The reference rules for a composite CNG vessel are mainly reported in ASME 2010 Boiler Pressure Vessel Code Section X.

This standard provides requirements applicable to the design, fabrication, inspection, testing, and certification of fibre-reinforced plastic pressure vessels. It is important to note that when metallic parts are used in conjunction with reinforced fibre laminates, they are required to meet ASME BPVC Section VIII, Division I.

Adequacy of specific designs shall be qualified in accordance with the following methods:

- **Class I design:** qualification through the pressure testing of a prototype.
- **Class II design:** mandatory design rules and acceptance testing by non-destructive methods.
- **Class III design**: vessels with non-load sharing liners for gaseous hydrogen in stationary service qualified through a destructive pressure test of a prototype.

For Class I & II, the maximum design pressure shall not exceed 3,000 psi (207 bar) while for Class III the design pressure shall be in the range of 3,000 ÷ 15,000 psi (207 ÷ 1034 bar) with a maximum service life of 20 years.

Further technical considerations shall be taken into account in order to establish the service life of the pressure vessels to the service life on a vessel and it is important to highlight that ASME does not cover all the aspects related to the fitting of the vessels on board.

CNG VESSEL REGULATORY FRAMEWORK

Vessels, in general, are to comply with a set of international (eg SOLAS and MARPOL) and national rules according to flag of the country of registration, service type, navigation and characteristics.

The rules for the classification of ships apply for the assignment and the maintenance of classification of seagoing steel vessels. RINA Rules are subdivided into the following six parts (Parts A to F) and two volumes (Common Structural Rules):

- Part A – Classification and Surveys.
- Part B – Hull and Stability.
- Part C – Machinery, Systems and Fire Protection.
- Part D – Materials and Welding.
- Part E – Service Notations.
- Part F – Additional Class Notations.
- Common Structural Rules for Bulk Carriers.
- Common Structural Rules for Double Hull Oil Tankers.

A new service notation is being added in Part E to cover the requirements applicable to the vessels dedicated to the transportation of CNG.

SAFETY CHALLENGES

As a starting point of the RINA rule development, the vessel was assumed to be arranged with dry spaces which contain the CNG vessels, but other solutions could be proposed as the technology progresses.

For this reason considerations were also given to the possibility to use the pusher-barge concept, where a set of barge transporting CNG vessels are driven by interchangeable

pushers in order to increase the use flexibility and reduce the dead times imposed by the gas loading on board.

Since CNG transportation is a novel concept, the existing regulatory regime does not cover all the safety aspects involved. The main reference in the safety rules development was the SOLAS Convention integrated by the IGC Code. Although not strictly applicable to CNG vessels, who do not carry liquefied gas, this Code is deemed adequate to provide the general safety criteria valid also for this type of vessel.

On the basis of the IGC Code, stability and arrangement criteria, like intact and damage stability and the required space to guarantee the inspectability of CNG vessels, were drawn.

The general philosophy of fire & gas detection, overpressure protection, fire protection and extinction etc was also derived from the IGC Code, with the proper adjustment dictated by the presence of a large amount of high pressure gas. Critical aspects are the safety management of gas overpressure and possible leakages.

In turn, novel basic aspects of the design had to be tackled specifically and approached by engineering considerations. The most significant criteria included in the rules are briefly described in the following.

Cargo spaces arrangement (double hull): The minimum size of the double hull current mandatory for gas carriers is to be complied with, but a collision risk analysis is to be carried out in order to ascertain if further margins are to be adopted.

The results depend on the ship's expected utilisation, ie the navigation type (unrestricted vs restricted) and the preferred routes, to which the collision risk has to be associated. For this purpose, the population of the vessels operating in the relevant areas are to be collected to estimate the collision probability and the expected consequences (ie penetration).

CNG vessels layout: The number of vessels fitted in each tank is to be compatible with the criteria of inspectability, stability and inertisation. The latter can be ensured by the usual solutions adopted on ships carrying flammable products.

Fastening of CNG vessels: CNG vessels are obviously to be adequately connected to the hulls structures and the most adequate solution is assumed to be realised through clamps. Their dimensioning, as well as those of the supporting structures, is to be defined through analyses that take into account the expected sea motions, in turn linked to the navigation aspects, and the expansion of the vessel shell caused by the pressurisation.

Also the connection of the clamps with the vessel shell could be critical, in particular when different materials are used (eg steel clamps and fibreglass vessels).

Emergency scenarios: The rules address the means for leak detection, isolation of specific vessels by appropriate valves and safe discharge of the CNG inventory, which are to be provided in case of major accident scenarios.

RISK ANALYSIS

Due to the novelty of the design, the rules prescribe that the final design is to rely on extensive risk analyses to verify that the implemented solutions will make the CNG ship at least as safe as a conventional LNG ship. The rules makes reference to the 'RINA Guide for Risk Analysis'. A non-exhaustive

Application area	Technology		
	Proven	Limited field history	New or unproven
Known	1	2	3
New	2	3	4

Table 3 : Classification of novel technology.

list of expected hazards applicable to CNG transportation includes:

- High pressure (100 to 250 bar).
- Flammability of CNG.
- Size and weight of vessels.
- Great number of valves and fittings potentially prone to leakage.
- Possible use of materials uncommon for the marine gas transportation (eg fibreglass, carbon fibre, resins etc), with issues of fatigue and ageing to be investigated.
- Structural problems related to clamping solutions.

The risk analysis, qualitative (by means of HAZOP, HAZID, FMECA etc) and/or quantitative (relying on consequence models of fire, explosion, flammable cloud etc) according to the specific needs, will have to be developed starting from the design and covering the expected operating phases. The resulting risk-control options will then be implemented as safety measures additional to those prescribed by the rules.

The risk analysis will also be helpful to streamline the permitting process and to contribute to the documentation of the risks on board required by the ISM code as amended, entered into force on 1st July, 2010.

COMMERCIAL CHALLENGES

The regulatory aspects detailed in the above sections cover the safety issues. However, RINA is well aware that the success of a novel design lies in economic and commercial factors.

To be appealing to investors, logistic issues of the whole CNG transportation chain are to be carefully appreciated. In this context, it is essential to demonstrate that the CNG ship design is not only safe as guaranteed by compliance with rules and criteria as mentioned in the previous sections, but also fit for the intended service.

In other words, the issues potentially affecting the ship's availability (like maintainability, loading/unloading etc) and/or economics (e. the Emergency Efficiency Design Index of a CNG vessel is expected to be larger than that of an LNGC because of the less advantageous ratio displacement/ payload) ought to be appraised up front. A valid tool for this purpose is the TQ as described in the RINA 'Guide for Technology Qualification Processes', dedicated to novel technologies.

A novel technology encompasses the application of both a proven technology in a new environment and an unproven technology in a known environment, or an unproven technology in an unknown environment, as shown in the Table 3.

The items of the new technology are classified and dealt with according to their degree of novelty.

The TQ process can be used to certify that new solutions fulfil all the requirements of functionality, safety, reliability, availability and maintainability within the defined operational envelope. It is applicable either to pure technical items or to the project execution itself. It assesses that novel technology meets the requirements for its intended service, through a systematic qualification process including:

- Qualification basis, defined up front with the stakeholders, in which the fit-for-service criteria are defined.
- Definition of the aspects and challenges posed by the novel technology in the various operating phases.
- Risk assessment to identify, rank and control failure modes affecting safety and availability of the novel technology.
- Demonstration of the adequacy of the new technology and the mitigation measures adopted, through engineering analyses, tests and measurements to be agreed with the stakeholders involved.

The already mentioned RINA 'Guide for Technology Qualification Processes' contains a specific section dedicated to the identification and management of novelty aspects encompassed by CNG designs. It is intended that they are to be confirmed or expanded as necessary, based on *ad-hoc* analyses for each individual design.

Taking into account the above considerations, Table 4, taken from the RINA Guide, reports the list of issues to be covered, as a minimum, by the TQ process.

Table 5, also taken from the same Guide, illustrates the qualification methods and mitigation measures associated to the issues in Table 4.

The TQ process, although not required for classification purposes, is not completely

Item	Novelty aspects of the design	Potentially critical aspects for the fitness of service
Pressure vessels	• Dimensions • Materials (composite vs steel)	• Structural problems • Handling
	• Storage in cargo holds	• Inspectability • Securing • Effects of ship motions and thermal expansion / contraction. • Safety issues (resistance to fire, collision etc) • Domino effects of containment failure
	• Storage on deck	Compliance with the principles of the IMDG Code
	• Blowdown system	Not normally allowed on ships
Ship arrangements	• Heavy Cargo Containment System • Cargo discharge at pressure • Cargo filling limits	Effect on tank top structure Docking arrangements. Jet fires as opposed to pool fires. Jet cooling of adjacent structures, traditional drip trays may not contain leaks. Relief valve sizing for fire cases

Table 4 : Classification of novel technology.

separated from the classification aspects, but it can cover additional issues that are connected to the commercial service of the new design.

CONCLUSIONS

CNG ships appear to be a promising means of transporting natural gas in contexts where the process of liquefaction, transportation and subsequent regasification is too onerous or impractical. However, the technology is still under development, therefore no univocal CNG vessel design solution stands out for the time being.

Irrespective of the technology selected for the containment, it was deemed necessary to provide the normal framework for the ships that can be expected to carry CNG in pressure vessels, to be included in the next issue of the RINA Rules for the Classification of Ships as a dedicated service notation.

These rules are based on a minimum set of safety prescriptions, to be integrated by means of risk control options resulting from design-specific risk analysis that will be necessarily be class approved.

However, safety is not the only significant issue in such innovative ships; to be profitable, it is likely that criteria of functionality, safety, reliability, availability and maintainability will be set by the client, which designers will be asked to fulfil to demonstrate that the novel design is fit for its intended service.

This demonstration can be achieved by the TQ process, which makes use of a systematic approach inclusive of risk analysis, engineering studies, test programmes and what else deemed necessary to verify and certify that the novel technology can work reliably within specified limits.

Such engineering studies, in particular the risk analysis, will be mandatory in the framework of the permitting process by the authorities (in particular, the ships' flag states, but possibly the authorities of the ports the ship will be expected to call at). Conversely, the TQ certificate is likely to be required by the investors that are evaluating the stakes of the enterprise. The necessity to tackle together the two aspects – safety and fitness for purpose – is deemed almost inevitable, at least as long as some experience in this type of transportation is gained. ■

** This paper was written by L Brunori, D E Cervetto, B Pugliese, A Lo Nigro of RINA Services SpA and was presented at the 10th Offshore Mediterranean Conference and Exhibition in Ravenna, Italy, 23rd-25th March, 2011.*

Novelty	Possible critical Issue	Qualification method / mitigation measure
Dimensions	Possibly not covered by current codes and standards	• Review of the principles inherent in codes and standards for pressure vessels in order to obtain an ad-hoc framework • Seeking acceptance from the relevant administrations
Materials	If a non-conventional solution (ie composite materials) is selected: • not covered by current codes and standards • manufacturing • quality control	• Review of codes and standards • Review of the available manufacturing processes • Establishment of structural calculation and test methods suitable to marine environment
Storage in cargo holds	Resistance of clamping to sea motions	• Structural and fatigue analysis
	Inspectability (internal/external)	• Depending on the materials and manufacturing
	Vessels' integrity in case of collision/contact/grounding, fire or cryogenic spills	• Risk control options stemming from qualitative and quantitative risk assessment
	Loading/unloading vessels in/from cargo hold	• Qualitative Risk Assessment studies (HAZID, FMECA) • Definition of the appropriate lifting appliances and procedures
Storage on deck	Compliance with the principles of IMDG code, which gives requirements for much smaller packages	• Layout studies • Qualitative Risk Assessment studies
Blowdown system	Normally not allowed on ships	• Gas dispersion models

Table 5 : Classification of novel technology.

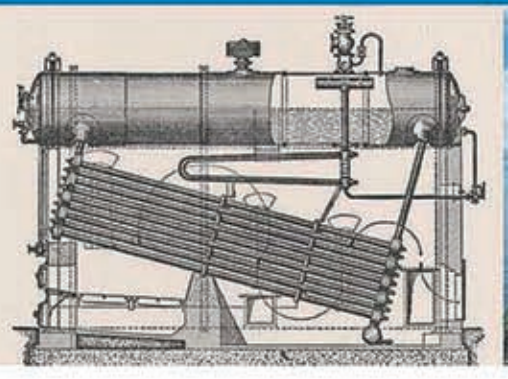
REFERENCES

1. ANSI NGV 2-2007, American National Standard for Natural Gas Vehicle Containers, 2007.
2. IMO "International Convention for the Safety of Life at Sea" (SOLAS Convention), as amended.
3. IMO "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)", as amended.
4. "International Management Code for the Safe Operation of Ships and for Pollution Prevention (The ISM Code)" amended with MSC 85 Resolution 273(85).
5. RINA "Rules for the Classification of Ships", 2011.
6. RINA "Guide for Technology Qualification Processes", 2010.
7. RINA "Guide for Risk Analysis", 2010.
8. IMO "International Maritime Dangerous Goods (IMDG) Code", as amended.
9. ASME VIII – 2010 - Rules for Construction of Pressure Vessels.
10. ASME X – 2010 - Fiber-Reinforced Plastic Pressure Vessels.

1856,
Babcock patented the World's 1st Water Tube Boiler

1894,
Babcock supplied the World's 1st Marine Water Tube Boiler

Over 150 Years Later,
Through our Joint Venture with Nico International UAE,
Doosan Babcock Energy remains as a global technology leader
and preferred supplier in today's LNGC & Marine Boiler Service Market



DOOSAN **Doosan Babcock Energy**

NICO INTERNATIONAL

Email: doosan.babcock@nicouae.com **Tel:** +971 4 3382135 **Fax:** +971 4 3381832

ABS becomes involved in FLNG projects

ABS vice president of Global Gas William Sember said that the classification society is in advanced stages of design review for a number of FLNG concepts.

He was speaking at the recent Gastech 2011 conference, where he chaired the technical session on FLNG terminals and systems. Sember said that as recently as five years ago, floating solutions for the import and export of LNG were still considered new and novel concepts.

"Today, emerging proprietary technologies and transport designs have come of age and industry is poised for the first projects. With more than one-third of global gas reserves stranded by their location or field size without commercially viable access to world markets the attractiveness of FLNG cannot be denied," he said.

Major projects in progress include Shell's Prelude field in the Browse Basin off Western Australia, which gained environmental approval in late 2010 and has a target production start date of 2016. Also being closely followed are several projects offshore Papua New Guinea and Inpex's Abadi Field gas project offshore Indonesia.

FLNG offers a number of advantages over land-based terminals as they can result in lower overall project costs and reduced environmental footprint because facilities, such as long pipelines to shore, onshore development and offshore compression platforms, are not needed. With gas deposits often in remote or stranded areas far from the coast the 'marinising' of production, liquefaction and export facilities offers great potential for many future development projects.

Sember noted that the shipping and offshore industries have spent the past five years successfully advancing both the technology and commercial attractiveness of the FLNG concept as a means of delivering new sources of cleaner energy.

Technology developments have addressed issues as the integration of subsea architecture with FLNG; offloading systems, in particular for harsher environments with tandem configurations based on cryogenic hoses or flexible pipes; and the qualification and testing of components with regard to LNG transfer systems.

"From a class society perspective there are no technology showstoppers for FLNG. Liquefaction plants have been suitably optimised in order to efficiently use deck space while taking into account the safe and efficient operation of process equipment.

"The advances and level of sophistication in all these subjects are evident. The time for commercialisation and the first project is now," he concluded.

SLOSHING TESTS

In addition, ABS and Daewoo are concluding a one-year joint development programme (JDP) examining critical wave conditions for sloshing model tests and computational fluid dynamics (CFD) in the cargo tanks of FLNGs.

The results will offer up a new methodology to determine critical sloshing conditions more efficiently than in the past and the methodology promises to be valuable in reducing the cost and time duration for sloshing test campaigns, ABS said.

Designing for sloshing impact loads is a key concern in tank containment system design. As the cargo tanks have increased in size along with various filling conditions for offshore FLNG operations, the possibility of severe sloshing becomes more likely as well as the probability of structural damage to the containment system.

The new ABS-DSME methodology is being proposed as a pre-screening procedure for selecting the most severe critical sea states before the start of a sloshing model test or sloshing flow simulation.

"Model tests cannot cover all possible wave height, period, heading and filling levels since there are just too many combinations to determine the life time maximum sloshing loads," observed Yung Sup Shin, head of the containment system group, ABS Corporate Technology. "However, we have developed a robust way to determine a finite number of critical sloshing conditions consistently and efficiently compared to other existing methods."

The methodology, explained Shin, consists of two main steps. A sloshing pseudo-response amplitude operator (RAO) is defined based on the total sloshing wave energy and, second, the concept of sloshing severity is introduced based on the area under the sloshing energy response spectrum curve. This highly advanced theoretical formulation represents ship motion and sloshing interaction calculating the energy of the liquid cargo in the tank.

The numerical analysis of the fluid motion from this theoretical methodology has been validated by comparing the results to those from conventional sloshing tests for an FLNG cargo tank.

Shin pointed out that the validation is based on extensive sloshing model test data developed from a joint industry project (JIP) by DSME using Gas Transport & Technigaz (GTT NO 96) membrane containment system for an FLNG with a two-row cargo tank with centerline cofferdam arrangement. ABS was a participant in this two-row JIP along with other class societies and energy majors.

It is important to include any critical sea state in a sloshing test matrix, however, current state-of-the-art CFD codes have a limited value for evaluating the life time design sloshing pressures due mainly to the lack of computational efficiency. Shin said the total sloshing wave energy and severity computation developed jointly by ABS and DSME provides an alternative to selecting relevant sea states in sloshing model testing and analysis.

This new advanced numerical approach will join other methods of sloshing assessment developed over the past decade such as sloshing flow simulation techniques, scaling laws, fluid-structure interaction, corrugation effects on sloshing and partial filling operation.

Shin said associated software to carry out the sloshing methodology for site specific offshore FLNG application was due to be available soon. ■

Class societies move in on gas sector

Two leading class societies - Bureau Veritas (BV) and Russian Maritime Register of Shipping (RS) - have signed a three-year co-operation agreement covering the development of joint guidelines for LNGCs and offshore floating production units (FPUs).

Pierre Besse, BV's vice president research and development said, "We are delighted to have reached this agreement with RS, which will greatly facilitate research into two technologically challenges areas of shipping. The agreement is based on the exchange of information for the mutual benefit of BV and RS, and for the maritime industry generally.

"We will now be able to combine the particular strengths of the BV and RS rules, to produce definitive guidelines which draw on the experience and expertise of both organisations. In addition, the co-operation agreement enables us to exchange information from the results of recent research projects, including those relating – but by no means limited - to operations in Arctic conditions."

Dr Sergey Koshchy, senior RS vice director general, said: "The agreement sets out the key parameters for the co-operation and will help to concentrate our joint efforts in developing guidelines to enhance maritime safety and environmental protection"

Under the agreement, common guidelines for LNGCs, based on GAP analyses as well as the BV and RS rules and the IMO IGC Code, are expected to be published in first-quarter 2012. These will include the requirement for operating in Arctic areas.

Work on producing common guidelines for FPUs, meanwhile, will start in third-quarter 2011. In addition to the parameters used for the LNG guidelines, these will include feedback gained from work undertaken in connection with a project involving the Shtokman natural gas field in the Russian sector of the Barents Sea, one of the largest in the world.

NEW TEAM ESTABLISHED

Last February, ClassNK announced that it had established a new natural resource & energy development project team as part of a wider effort to expand its presence in the offshore sector.

The class society, which revealed that nearly 20 mill gt joined its register in 2010, had previously focused primarily on the maritime side of the energy sector. However, the establishment of this new team signals a shift in ClassNK's approach to the offshore field, especially the burgeoning FLNG market.

"With the incredible growth of the world fleet over the past decade, as a classification society we have focused on the maritime side of the industry," explained ClassNK chairman & president Noboru Ueda. "I am proud to say that we have made a positive and lasting contribution in this area. However, as one of the world's leading classification societies, we have a duty to support the development of the entire maritime industry, and I believe that we can make an equally positive contribution to the offshore sector as well."

The core of the new team is made up of members of ClassNK's former gas carrier team, including many of the society's top LNG experts. Around this core of experts, ClassNK has added numerous personnel from supporting fields in order to provide comprehensive support for the growing offshore energy sector.

"This new team," said team leader Hirofumi Takano "is comprised of some of the top minds at ClassNK, both in Japan and overseas. Among the team members we have not only LNG and offshore experts, but also machinery experts, material & equipment experts, top researchers from our research institute, and top level management from our offices in Asia, the Middle East, and Europe.

"By bringing together staff from various fields, as well as from around the globe, we've

"By bringing together staff from various fields, as well as from around the globe, we've created a team that will be able to respond rapidly and effectively to potential new projects anywhere in the world"

- Hirofumi Takano , team leader , Class NK

created a team that will be able to respond rapidly and effectively to potential new projects anywhere in the world," he claimed.

The establishment of this new team closely follows a number of other offshore related projects that ClassNK announced in the last part of 2009. Among these were ClassNK's new guidelines for the conversion of tankers into fuel storage & offloading units, and an expansive co-operation agreement with Japan's National Maritime Research Institute (NMRI), which in addition to being one of the world's leading maritime research centres, has also conducted pioneering research on FPSOs and FLNG offloading systems.

Although the new team has only just been officially established, it is already working on a number of energy development related projects being undertaken by the class society. These include completing a new set of guidelines for the construction and maintenance of FLNG facilities, which ClassNK is planning to release shortly.

The new guidelines are being developed based on research results from ClassNK's latest FLNG related joint research projects, and the archives of technical data that the class society has gathered over its long history in the LNG sector, as well as ClassNK's existing rules for floating offshore facilities.

Yasushi Nakamura, managing director in charge of ClassNK's research & development programmes, put the development of this new team in perspective by saying; "Much like with our more traditional classification activities, we are taking a comprehensive approach to supporting developments in the offshore sector. This means not only developing new rules and guidelines for FLNG installations, but also conducting joint R&D projects to better support the offshore energy sector."

Nakamura said; "ClassNK was long a leader in the LNG and the offshore sectors. For example, we classified the first liquefied gas carrier to make use of the SPB tank system, as well as the first LNG carrier to make use of the Technigaz MK III system. More recently we've provided approval-in-principle (AIP) for Mitsubishi Heavy Industries' IMO Type B independent tank with a prismatic configuration, which we think has tremendous potential for use in large scale LNGFPSOs.

"With the establishment of this new team, we now have the opportunity to combine our experience and expertise in the LNG sector with highly sophisticated and targeted R&D, and I'm confident that we will be able to more actively contribute to the growth and development of the offshore sector." ■

FOR GAS TANK GAUGING:
YOUR AFFORDABLE *AND* RELIABLE *SOLUTION*

- **6” Foot print**
- **Simple isolation valve design**
- **Easy to commission**
- **No possibility to loose the float**
- **20 bar design**
- **No electrical and measurement parts under pressure**

SNRI and **HENRI Systems Holland** have developed a full Stainless Steel Level Gauge with an Interlocked Isolation Valve

CONTACT : Mr LONGUET
SNRI SAS member of Valco Group
Marine & Cryogenic Director
Stanislas.longuet@snri.fr
Tel : +33(0)5 45 29 60 47

CONTACT: Mr DE VRIES
Henri Systems Holland B.V.
mdv@hsh.nl
Tel: +31 78 610 0999
www.hsh.nl

LNG as a fuel takes off following years of research

LNG Shipping Review has taken a look at some of the latest orders and initiatives in the drive for liquefied natural gas fuelled ships. There have been a few orders recently and conversion projects announced, as well as many research projects into the subject.

We have listed a few of what we consider to be the more important contracts and projects ongoing at present. Since the first installation of a gas engine on a Norwegian Fjord ferry in 2000, the level of interest had remained reasonably static…..until now that is.

Driven by environmental concerns over impending legislation, both nationally and internationally, the shipping industry has begun to sit up and take notice of the possibility of fuelling vessels with LNG.

Between 2000 and 2009, there were just a trickle of vessels fitted with natural gas burning main propulsion units, most of which were Fjord ferries, or offshore support vessels. In 2010, the industry suddenly seemed to pay more attention to the prospect of having to save fuel on economical and environmental grounds.

Due to the initial local Norwegian interest in fuelling vessels with LNG, Oslo-based class society DNV has stolen a march on its promotion. Indeed, at a reception in London late last year, the class society's head Henrik Madsen said that some 50% of the world's newbuilding vessels could be specified with LNG burning main propulsion units in 10 years' time.

He was speaking at the launch of a conceptual design project called Triality, which takes the form of a VLCC powered by LNG. This follows another project unveiled earlier in the year, which involved a containership, which has since been upgraded to a larger size.

FAST FERRY

Last November, Incat announced that the company had secured a contract to build the world's first high speed passenger ro-ro vessel powered by LNG.

The 99 m high speed ferry, with capacity for over 1,000 passengers and 153 cars, is being built at the Incat Tasmania shipyard at Prince of Wales Bay in Hobart for delivery in 2012 to Argentinian operator Buquebus.

Incat has joined together with Revolution Design engineers who are also working closely with technical personnel from GE in Europe and the US. The vessel will mark the first installation of LNG powered dual fuel engines in an Incat high speed ferry and the first high speed craft built under the High Speed Craft (HSC) code to be powered by gas turbines using LNG as the primary fuel and marine distillate for standby and ancillary use.

Providing the power will be two GE Energy LM2500 gas turbines driving two Wärtsilä LJX 1720 waterjets, which will be fitted in each catamaran hull. This is a departure from the normal use of two engines and two jets per hull, as used in the diesel powered Incat vessels, the company explained.

The gas turbines are to be modified to meet class requirements so that either LNG, or marine distillate can be burned. The LM2500 is derived from the CF6 family of wide body aircraft engines. Today, it powers many industrial and electrical generation applications around the world, using a large variety of gaseous and liquid fuels.

Fleets of naval vessels, as well as commercial ferries and cruise ships have installed the LM2500 for their marine propulsion needs. While these applications have used liquid fuel thus far, GE has now modified the fuel delivery system to accommodate LNG. This will allow lower emissions and operating costs for commercial fast ferries, Incat claimed.

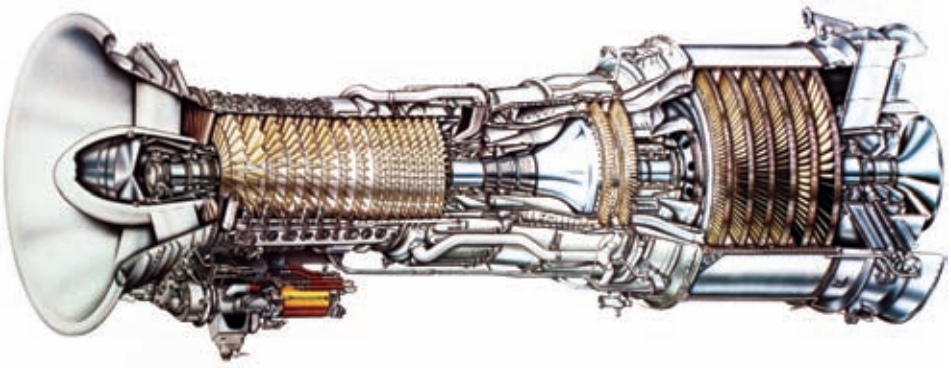
The LNG fuel tanks will be installed in a compartment above the double bottom marine distillate tanks. The change-over between the two fuels will be automatically controlled and seamless.

Incat chairman Robert Clifford said; "This is a significant step forward as the use of natural gas powered ships must replace ships with less environmentally friendly engines. This first LNG powered fast ship is expected to set the scene for the future."

CONTAINERSHIPS

Although DNV claimed to be the lead class society with reference to the number of

Incat's revolutionary high speed LNG powered craft.



A cutaway of a GE Energy LM2500 gas turbine.

vessels burning LNG as fuel classed, other societies are also working on this issue.

For example, Germanischer Lloyd's Ralf Plump, head of environmental research department, recently presented a study conducted by the Hamburg-based class society that shows that a gas powered vessel would not only produce fewer emissions but also reduce the operating costs.

Under certain conditions, a 1,500-TEU container feeder with a power output of 8,750 kW travelling at 16 knots could actually be more economical than an equivalent conventional vessel.

Plump's calculations accounted for the following parameters: a low-sulphur fuel price that is higher than conventional fuel, a CO2 fee, the loss of income caused by installing gas tanks at the expense of about 50 container slots and the investment costs for the gas tanks.

The surprising result of the calculations was that after 15 years of operation the cumulative costs of a gas powered propulsion system would be about $1 mill less than those of a conventional propulsion system.

The general rule is that the higher the difference between conventional fuel and low-sulphur fuel (eg, marine gas oil) the higher the cost savings when using LNG. GL is currently participating in a joint pilot project to work out the operational and technical details of this model.

ROPAX ORDER

Finnish ferry operator Viking Line has taken the plunge and ordered an LNG-powered ropax, which will be fitted with Wärtsilä engines.

The vessel will be built by STX Finland at Turku and will be the largest passenger ferry to operate on LNG when she enters service in 2013. Viking Line has also agreed an option for a sister vessel. Her intended route is between Turku and Stockholm.

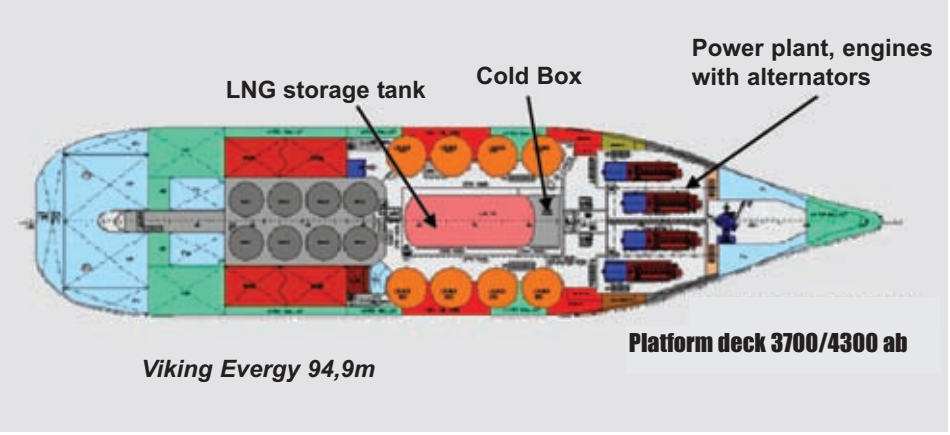
Wärtsilä's will supply four 8L50DF main engines, the transverse bow and stern tunnel thrusters, and two stainless steel fixed pitch, built-up main propellers with complete propeller shaft lines and environmentally sound shaft line seal systems. The propellers are designed with the lowest possible pressure impulses for excellent vibration control.

The use of Wärtsilä's duel-fuel engine technology will enable the ferry to sail without restrictions in ECAs and Nitrogen

Emission Control Areas (NECAs), the company claimed.

Viking Line's cruise ferry will be capable of carrying cars, trucks and road trailers on short international voyages. It is also designed to carry 2,800 passengers and 200 crew. The machinery, equipment and outfitting, as well as the structural work, will be classed by Lloyd's Register.

An LNG bunkering station will be set up at Naantali to bunker the new ferry. Operated by Gasum, the facility will be opened in 2013.



A diagram of an Eidesvik gas powered OSV showing the location of the bunker tanks.

PSV ORDERS

Last December, Wärtsilä announced an order to supply propulsion systems for a fifth gas powered platform supply vessel (PSV) ordered by Eidesvik Offshore.

Eidesvik claimed to be the world leader in environmental friendly gas powered PSVs. All of the company's gas PSVs, including this latest order, were designed by Wärtsilä and utilise the dual-fuel technology.

In addition to the complete design of the vessel, Wärtsilä's will supply the dual-fuel main engines and generating sets, the electrical power and propulsion system, integrated automation and the power management system. The vessel will be fitted for use in Arctic waters with 'winterisation' and de-icing solutions and is to be built at Kleven Verft in Norway.

The new Wärtsilä VS 489 Gas PSV design features outstanding energy efficiency, a unique hull form, fuel flexibility, and good vessel performance in areas such as fuel economy and cargo capacity, the manufacturer claimed.

Eidesvik's vessels include a unique configuration of the gas electric propulsion system. This is based on a combination comprising the 'low loss' concept for electric propulsion, the Wärtsilä 34DF main engines and the recently introduced Wärtsilä 20DF engine.

The dual-fuel units enable the use of gas as a main fuel for marine applications, in addition to heavy fuel oil (HFO) and marine diesel oil (MDO).

During recent years, Wärtsilä has claimed to be at the forefront in the development of dual-fuel technology, and has launched a series of gas engines. These 4-stroke engines, namely the Wärtsilä 50DF, Wärtsilä 34DF and Wärtsilä 20DF, represent some of the best technology available in terms of efficiency and low emissions, the company said.

Wärtsilä's 20DF engine is the latest addition to the company's portfolio of dual-fuel engines. In case of interruption to the gas supply, these engines automatically switch to diesel mode operation without any loss in speed or power output. Single fuel installations obviously lack this additional level of operational safety.

As for the Wärtsilä 50DF engine, the company said that was becoming one of Wärtsilä's most successful products and has been used in marine applications since 2006 when dual-fuel propulsion was introduced. These engines offer an operator the opportunity to switch between liquid fuels and gaseous fuels with no interruption in power generation.

In the Autumn of 2010, Wärtsilä initiated a major project to further develop its low-speed engine portfolio to include gas engines, alongside its medium-speed dual fuel engines, as part of the company's strategy.

To facilitate this move, a new test engine was installed in the Trieste engine laboratory in Italy in March this year. Engine testing started shortly thereafter.

The company said that the principal aim of this initiative was to strengthen Wärtsilä's leading position in gas engine technology.

"We believe the time is now right to further develop our natural gas solutions for the merchant fleet at large. Of course, we are aware of the challenges to be overcome as bunkering facilities are not yet in place for starters. A number of other practical challenges need to be addressed, but companies such as SeaCargo have led the way showing the market that it can be done. Others will no doubt follow," said Lars Anderson, vice president at Wärtsilä Ship Power merchant.

Wärtsilä has years of experience in dual-fuel engine technology, as the LNGC *Venator* was fitted with a low-speed dual-fuel 7RNMD90 engine in 1973. This installation was claimed to be successful in all aspects, however, the market was not ready to endorse the concept. Still convinced of the potential that natural gas held, Wärtsilä developed and successfully tested a high-pressure two-stroke gas engine in 1986. Again, the technology

Just like an ordinary OSV only more efficient?

was proven but Wärtsilä was once again ahead of its time and the market was still not ready for it, the company said.

In the mid 1980s, Wärtsilä also developed its first medium-speed high pressure gas engines, the GD series, targeting land-based and marine markets. In the 1990's Wärtsilä added the SG and the DF series medium-speed gas engines. On this occasion, the timing was right. Of these, the DF marine installations alone have accumulated over 1 mill running hours, with close to 60 vessels in service.

FJORD FERRIES

In February of this year, Rolls-Royce, signed a £20 mill contract to supply engines and propulsion equipment for four gas-fuelled ferries to be built for the Norwegian operator Torghatten Nord.

The vessels will be the first in the world to feature the Rolls-Royce hybrid shaft generator (HSG), which produces electrical power with reduced fuel consumption and emissions.

They will also include lean-burn Rolls-Royce Bergen gas engines and the company's integrated propeller and rudder system (Promas) that reduces drag and increases thrust.

Four ferries are to be built and a further three converted to burn LNG. The ferries will be constructed by Remontowa at Gdansk and the first one is due for delivery in the second quarter of 2012.

They will be 93 m in length and be able to carry 390 passengers and 120 cars at speeds of between 12 and 19 knots.

Torghatten Nord has signed a $283 mill contract to supply ferry traffic across Norway's western coast for 10 years starting from 2013.

The fuel for the seven ferries will be supplied by Barents NaturGass. The contract also stipulates that the trucks carrying the fuel must also be LNG powered.

BUNKERING STATIONS

Ports have not been slow to see the potential in setting up bunkering stations and storage facilities, especially in northern Europe and the Baltic.

One of the leaders is the Port of Gothenburg. Recently Jill Söderwall, head of energy at the port, set a definitive target. She explained; "The target is to bunker a ship with LNG at 13.00 hours on 13th June, 2013. If we are successful we will be among the first ports, perhaps even the first major port in the world, that can offer ship-to-ship bunkering with LNG."

To date, the LNG infrastructure in Europe is not well developed. At the heart of the Gothenburg initiative is the LNG-GOT project, which is a joint venture between the port authority, Göteborg Energi (western Sweden's leading energy supplier) and Norwegian gas company GasNor, which has established an LNG network across northern Europe.

The project will involve the construction of gas storage tanks within the port's energy terminal, as well the development of a capability to supply fuel using a bunker barge.

"Our biggest challenge is the uncertainty over which rules and laws apply, and how we will be able to handle LNG within the harbour area," explained Söderwall.

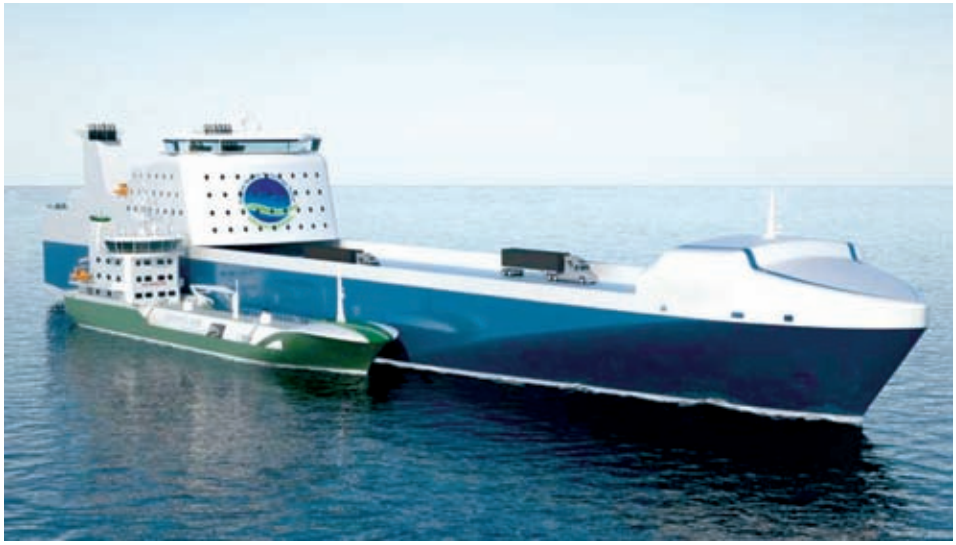
Another port looking at an LNG bunker station is Rønne on the Danish island of Bornholm.

The chairman of the port, Carl Ilsøe, said he saw a big opportunity for the port, if it can be a home port for a natural gas facility.

From 2015, new strengthened environmental regulations for sailing in the Baltic Sea will be introduced, and gradually more ships will use the more environmentally friendly fuel, he explained.

DANISH INITIATIVE

The Danes have never been short on initiatives, as illustrated by the 'Green Ship of the Future' project.



How LNG-GOT envisages a gas bunkering operation.

Now a project has been set up to look at LNG as a fuel for short-sea shipping. An EU grant has been applied for and some of Denmark's leading players have joined the project.

The group said that LNG as a fuel must be made competitive through an effective infrastructure and favourable framework conditions. They acknowledged that great efforts are needed to solve some of the challenges posed by some of the framework conditions and providing an infrastructure of LNG filling stations.

The final outcome of the project will form the basis of decisions made by shipping companies, ports, LNG providers, states, the EU and the IMO. This means that, in the years to come, the project participants will apply broad and many-faceted approaches to ensure that the use of LNG as fuel can become reality.

The project will deal with the following areas:

- **Safety** from a ship, a port and an LNG provider perspective.
- **Public authorities and public awareness** since the issue does not concern large LNG terminals with large ships, but rather decentralised terminals and small ships.
- **The technical possibilities of using LNG as fue**l both in connection with new-buildings and retrofitting.
- The use of maritime **LNG filling stations for other purposes** than ship-related ones in order to achieve economies of scale.
- **LNG filling stations**, including the stations' supply of LNG; integration with the natural gas network; various designs of filling stations, both mobile ones – ships, barges and lorries – and fixed ones; the potential of extending a given capacity; regulation of the physical location; legal, operational and financial models; bunkering requirements for various types of ships; and a map with ports for strategically located LNG filling stations.
- **Economy** from a ship, a port and an LNG provider perspective.
- **The LNG market** with possible price developments and market conditions.
- **The potential for using LNG** in the Baltic, the North Sea and the English Channel.

The recommendations will have a commercial aim and may, for example, take a point of departure in individual ports with the identification of the market potential for LNG,

Anthony Veder's *Coral Methane* transferring cargo to the smaller *Pioneer Knutsen*.

the supply of LNG for bunkering purposes, the design of LNG filling stations – both fixed and mobile ones – as well as safety.

EU SUPPORT

The project requires the EU to actively support the work on the project. Consequently, an application was submitted under the EU TEN-T (Trans-European Networks – Transport) call for motorways of the seas from May 2010. The application was filed on 31st August 2010.

Subsequently, the application is being evaluated by the EU system, and if this evaluation is positive, the work is expected to commence during the second quarter of 2011 and will be finalised during the first quarter of 2012.

The partners:

- States - Belgium, Denmark, Finland, Sweden and Norway.
- The Nordic Council of Ministers.
- Ports - Hirtshals (DK), Zeebrugge (BE), and Szczecin and Swinoujscie (PL).
- LNG terminals and gas companies - Fluxys (BE), Gasum (FI), Gasunie (NL), Energinet.dk (DK), Energigas Sverige (SE) and Gasnor (NO).
- The maritime cluster - Germanischer Lloyd (DE), MAN Diesel and Turbo (DK) and Lauritzen Kosan (DK).

A steering group is being established with partner participation, as well as a reference group to which interested parties will be invited.

Furthermore, the application contained a full-scale pilot project for the LNG operation of two ships owned by Fjordline Danmark engaged on voyages between Denmark and Norway.

The grant for the LNG infrastructure project was valued at €600,000 and for the Fjordline pilot project of €9 mill. The two projects were contained in one application to the EU and earlier this year, contract negotiations were underway.

NEW GUIDELINES

Integral to satisfying demand for a new generation of low emissions vessels powered by natural gas to the commercial market, are technical solutions to store and handle LNG on board ship.

For conventional diesel plant manufacturers, the coming strictures are demanding considerable investment in combustion technology and the materials used for key components, so that engines can work at higher pressures and temperatures.

Tier III demands engine NOx emissions for ships constructed on or after 1st January 2016 reduced to just 3.4 g/kWh inside an ECA (less than a quarter of that demanded by the globally applicable Tier II). At the same time, it is not a matter of if, but when shipping will come under UN provisions to control CO2 emissions, leading systems supplier Hamworthy said.

IMO administrations have been working on new guidelines covering the storage and handling of LNG as a fuel on a range of ship types currently driven by diesel plants.

Reidar Strande, Hamworthy Gas Systems, explained that the IMO's 'Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships', which are part of the revised so-called IGF-Code envisaged for entry into force in 2014, offered the regulatory framework for wider adoption of gas fuelled technology.

The new guidelines provide criteria for the design arrangements and installation of propulsion and auxiliary machinery powered by natural gas to ensure integrity, safety, reliability and dependability equivalent to that of comparable machinery burning conventional fuel oil. Under them, natural gas may be stored in gaseous or liquid states.

***Coral Methane* loading LNG at Zeebrugge.**

Much of the groundwork has already been done by class societies, such as DNV in particular, which has been participating in gas fuelled ship classification for Norwegian coastal ships since 2000, when the Fjord ferry *Glutra* entered service.

"From designers through to charterers, many involved in shipping are now considering the potential for LNG as a commercial alternative," Strande said.

"As a company already intimately involved in providing storage and handling solutions for new LNG carriers able to run on boil-off gas and with solutions on board new floating production and storage units, Hamworthy has made sure that its experience is being made available to the wider market," he said.

Hamworthy has been closely involved in providing storage and handling technology for such new generation ships. Through a non-exclusive agreement with Rolls-Royce, it is participating in the SeaCargo project to build what are believed to be the world's first seagoing cargo vessels to be fuelled solely by LNG.

These 132 m long ships are to have a straightforward mechanical drive propulsion system, with main engines coming from Rolls-Royce (as well as the overall vessel design). They can be considered conventional in all but the fact that LNG is the fuel, according to the engine builder.

On delivery from the Bharati shipyard in India they will operate on a 10-day round trip covering Baltic, Norwegian and UK ports, bunkering gas fuel at one location.

Strande explained that Hamworthy's part in the project involved providing the solution for cold liquid gas to be stored in two insulated tanks forward of the engine room, in a ventilated enclosure offset to one side to clear a vehicle ramp.

"This space will also house the evaporator system that converts the liquid into a low pressure, warmed gas and supplies it to the gas engine that turns the propeller through a reduction gear and also supplies the vessel's electrical load by means of a generator driven off the gearbox," he said.

Another recent contract is for a 70 m long vessel is to be built in Turkey for NSK Shipping to carry feed to fish farms along the Norwegian coast. In this case, Hamworthy's storage solution involves LNG fuel being stored in a single 90 cu m insulated tank.

Strande emphasised that with a wider uptake of gas-only fuel solutions, it was imperative that owners and yards were familiar with the technology they were tapping into.

Hamworthy's LNG storage and handling system (LNG fuel gas system) is typically delivered as a complete skid prepared for installation in vessels. All hook up works and interconnecting piping to the vessels system (eg utilities as electricity, heating water, purging, gas to engine and LNG) are performed at the shipyards.

The LNG fuel tank skid (one/two units per ship) encompasses equipment and systems for storage, evaporation, heating and pressure holding. Each skid typically has the capacity to supply gas of 50% to 100% of the gas engine(s) requirement. The skid will supply natural gas at required pressure and temperature to the gas engine's gas regulation unit.

Careful consideration needed to be given to the storage and handling system fitted in with the overall design of the vessel. Strande said. "The tank room should extend below and somewhat above the LNG fuel tank. A space might be made in the ship's tank top (deck) to allow for a smaller extension below the tank

room. The extension of the tank room above the LNG fuel tank might influence deck structure below the tank room."

Hamworthy's LNG fuel tank is a double shell vacuum-insulated pressure vessel design, but its size is specified by the client. The gas tight tank room contains equipment for evaporating LNG, heating natural gas, and pressure holding.

"The equipment in the tank room is kept to a minimum," said Strande. Typical equipment includes; LNG vaporiser, natural gas heater and pressure build-up unit, as well as piping and control instrumentation.

R-R BREAKTHROUGH

Rolls-Royce recently made a significant breakthrough for the gas only fuelled option in the offshore sector, with Island Offshore choosing LNG-powered propulsion for its latest pair of UT776 platform supply vessels.

However, it is essential to remember that builders of mainstream merchant vessels have also offered engines that can run on LNG and that many owners now see the long available 'dual fuel' option as the preferred means of meeting ECA restrictions.

For example, Tarbit Shipping's Type II chemical tanker *Bit Viking* (24,783 dwt) is due to be converted to use LNG as a fuel. In addition, Reederei Stefan Patjens is ready to convert auxiliary engines and boilers on board a four-year old 5,000 TEU container vessel – *Maersk Drury* - the first box ship ever to partially operate on LNG. By converting cargo space next to the engine room into a gas technology room and using additional LNG containers on deck, LNG will be supplied using only containers.

This conversion is a joint co-operative venture between DNV, MAN and TGE. Work is scheduled for next year.

SOUTH KOREAN PROJECT

On 18th November last year, SSPA, FKAB, White Smoke and Swedish Marine Technology Forum entered into a joint agreement with the South Korean energy giant KOGAS.

This project was set up to evaluate the possibilities for developing a South Korean system for delivery of LNG to gas-fuelled ships. The project was carried out until April 2011 and will form a basis for further development of an LNG supply system in South Korea.

The project was divided into seven areas; the Swedish cluster had the main responsibility for five of these. Each of these five tasks had a special focus, such as national and international regulations,

An illustration of a SeaCargo vessel fitted with Hamworthy's LNG fuel tank.

demand forecasting and risk evaluation. The project delivered a common report and was also presented at a common workshop held in South Korea at the beginning of April this year.

The contract between the Swedish marine cluster and KOGAS was the first result of the joint study agreement between Business Region Göteborg and KOGAS that was signed in July 2009. The purpose was to develop co-operation between Sweden and South Korea in the fields of biogas, natural gas and bioDME to promote business in these areas.

SWEDISH DESIGN

Swedish ship design concern FKAB has also unveiled an LNG powered container feeder vessel project, as well as an LNG bunker tanker.

The bunker tanker FKAB L2-design is tailor made for regional distribution of LNG. The LNG is stored in three insulated cargo tanks of bilobe type, classified by IMO as 'Independent Type C'.

They have spherical heads and a design pressure of 4.1 barg. Each tank is equipped with two submerged deepwell pumps for easy discharging. The discharge capacity is 6 x 300 cu m per hour.

The design's main fuel is boil-off gas and regasified LNG from the cargo tanks. This will reduce fuel cost when operating the vessel, FKAB said.

Despite this, the L2 is designed to be as energy efficient as possible with among other things a slender hull and a heat recovery system. These measures reduce costs further but will also reduce the environmental footprint of the vessel.

To maintain flexibility and for emergency use, the machinery is of dual fuel type and the vessel also has the capacity to lift MGO.

FKAB also has a conceptual design of an LNG and light marine oils bunker tanker – FKAB L1.

The LNG bunker tanker can carry both liquefied natural gas and light marine oils and will deliver the products at highest possible safety standards, the company claimed.

FKAB L1 both delivers and runs on LNG. The design complies with the upcoming IMO regulations on both SOX (2015) and NOX (2016) emissions for ECA areas.

QUANTUM LEAP

As mentioned earlier in this article, stepping up in size is the Quantum concept developed by DNV and MAN Diesel & Turbo.

A year ago, DNV launched its container ship concept – Quantum. This concept ship was designed to stir up a debate about shipping innovation. MAN Diesel & Turbo responded positively, and over the past few months the engine manufacturer and the class society have worked closely together to move the concept one step nearer to becoming an actual ship.

The choice of the first vessel was determined by market studies undertaken by AXS Alphaliner and Dynamar. This was a 'baby post Panamax' of 6,200 TEU fitted with 1,200 plugs given the design a high reefer capacity. The latest design – Quantum 9000 - is as the name suggests a 9,000 TEU containership.

This has been designed to be more efficient and environmentally friendly than existing ships without introducing major complications when the ship is to be built or operated.

One of its major improvements is related to the engine. MAN Diesel & Turbo has developed a gas-fuelled two-stroke ME-GI

engine. In addition to having dual-fuel engines, Quantum 9000 achieves full fuel flexibility and at the same time meets the upcoming ECA requirements. The ship's energy efficiency is also better than that of conventional existing container ships.

In addition to the use of gas, the engine solution includes waste heat recovery to improve the energy efficiency and exhaust gas circulation to reduce the emissions. A number of other improvements have been made possible by adopting a twin island arrangement, such as increased cargo capacity and reduced need for ballast water.

The ship's LNG fuel capacity will be similar to that needed to sail from East Asia to the east coast of the US –without any loss of cargo space.

Eirik Byklum, DNV's Project Manager, introduced the first version of the Quantum concept vessel a year ago and is also in charge of its second phase. "When we introduced this concept a year ago, we called it a concept ship. And it still is, but by improving the machinery as well as the hull design and arrangement, we have moved it one step closer to becoming a real ship."

The second revolutionary concept to be launched by DNV last year was the VLCC design - Triality.

Although like the Quantum projects, Triality would cost more to build, its selling points, compared to a conventionally powered VLCC, are –

- Emit 34% less C02.
- NOx emissions reduced by more than 80%.
- SOx and PM emissions reduced by 95%.
- Entirely eliminate the need for ballast water.
- Entirely eliminate VOC venting.

ELIMINATES BALLAST

Again the hull design is such that it removes the need for ballast, thus also eliminating the fitting of ballast water treatment systems.

The VLCC would be fitted with two high pressure dual-fuel 2-stroke main engines fuelled by LNG with marine gasoil (MGO) as pilot fuel. In the next stage of the project's development, the use of dual-fuel medium speed engines and pure gas engines will be examined.

The generators/auxiliaries will be fuelled by LNG and MGO, while the auxiliary boilers producing steam for the cargo pumps will operate on recovered VOCs. To handle the LNG, the vessel would be fitted with two IMO Type C pressure tanks capable of holding 13,500 cu m of natural gas fuel – enough for 25,000 miles of operation, DNV claimed. These are located on deck forward of the accommodation.

Although a DNV led project, this was very much an industry initiative with several leading players offering advice, such as MAN Diesel, Wärtsilä, Hamworthy, plus others. At the time of the presentation, Madsen claimed that at least three South Korean builders had expressed an interest in the concept.

Other initiatives include a joint EMSA, ECSA and ESPO future report on European LNG bunkering facilities and needs.

Fjord Line is thought to be considering LNG powered ferries. A decision is expected by June 2011. The vessel, to be delivered in late 2012 by Fosen, will serve the company's Bergen-Stavanger-Hirtshals and Kristiansand and Hirtshals routes.

Elsewhere, Wärtsilä and Deltamarin have introduced LNG powered ferry designs. These vessels have also been designed with exhaust cleaning facilities on board. ■

The LNG Shipping Forum

A LNG journal conference

NOR-SHIPPING OSLO MAY 24-27 2011 Conference Partner

*Within 2 minutes walk of the Nor-Shipping Exhibition centre

25 May 2011 ◆ Thon Hotel Arena*, Oslo

LNG Journal's 'LNG Shipping Forum' conference focuses on the LNG shipping market, and will include the latest market developments, demand and supply issues, changes in fleets and important technical and operational issues. It is primarily aimed at shipowners, shipmanagers and technical suppliers to the LNG shipping fleet. This timely one-day conference will bring together key industry experts from the LNG industry to create a platform for the exchange of ideas, opinions and

Key industry experts who will be covering a range of important topics include:

Per-Christian W. Fett, *Director*, Fearnley LNG

Dr. Pierre C. Sames, *Strategic Research and Development Senior Vice President,* Germanischer Lloyd SE

Keith Bainbridge, *Partner*, RS Platou

Eirik Melaaen, *Business Unit Manager*, Hamworthy

Jim Sandkvist, *Vice President*, SSPA SWEDEN AB

Lars Petter Blikom, *Segment Director LNG*, DNV

Giulio Tirelli, *Marketing &Application Development Manager*, Wärtsilä

Trude Gullaksen, *Head of Commercial Department,* Gasnor

Peter Blomberg, *Managing Director,* Nordic LNG

Bazul Ashhab, *Advocate & Solicitor,* Singapore, *Barrister at law,* Lincoln's Inn, *OON & BAZUL LLP* Singapore

Egil Rensvik, *Science & Technology Counsellor,* Innovation Norway

P R O G R A M M E

- LNG shipping market update - are you a Bull or Bear on vessel demand
- LNG as fuel
- So how do we control the most important link in the LNG chain especially in the light of the Japanese earthquake disaster?
- LNG DFDE Operations
- Location and market demands on marine LNG Terminals
- A contrarian view on LNG demand outlook: LNG demand is clearly arising from unexpected and unprojected consumers, how will this impact future demand, supply, pricing, and LNG shipping fleet capacity
- LNG-powered new-buildings and retrofits: the way ahead
- LNG Fuelling the Future
- Singapore as choice of venue for International Arbitration

Interested in attending?
Contact Narges on
narges@lngjournalevents.com

Panel Discussion: Understanding the latest developments, issues and challenges in LNG today

Maritime Content Ltd, 2nd Floor, 8 Baltic Street East, London EC1Y 0UP, UK.
Tel: +44 (0)20 7253 2700 Fax: +44 (0)20 7251 9179 www.lngjournal.com

Confidence returns in the shape of newbuilding contracts

One of two changes to report in the 2011 listing, as the leading players start to invest in new tonnage again. A Norwegian investment concern has also appeared on the scene by snapping up three elderly LNGCs from Japanese interests.

AUSTRALIAN LNG SHIP OPERATING CO (ALSOC)

ALSOC operates the four Australian flag purpose built LNGCs, delivered between 1989 and 1994 for the Northwest Shelf project.

They are still operating between Dampier and Japanese receiving terminals.

Six of the vessels operating within the project have recently completed life cycle upgrades at Sembcorp Marine.

AWILCO LNG

Awilco LNG is a privately owned and newly established Norwegian based owner and operator of LNGCs intended for international trade.

The company currently owns three recently purchased elderly 125,600 cu m LNGCs. These are the *WilGas, ex Dewa Maru, WilPower, ex Bishu Maru* and *WilEnergy, ex Banshu Maru.*

They were built in 1982-1983 for Kawasaki operation.

V ships LNG has been awarded the technical management of the vessels, while Awilco will handle the commercial management and Wilhelmsen Marine Services will act in the capacity of supervisory technical management.

Awilco and WMS have extensive experience within the shipping and offshore segment through their involvement, establishment and ownership of several shipping and offshore companies including the previously stock listed companies Awilco Offshore and Ocean HeavyLift, the company said.

BERNHARD SCHULTE SHIPMANAGEMENT (BSM)

BSM IoM, formerly Dorchester Marine, has four new generation Q-Flex LNGCs under management each powered by heavy fuel-oil burning 2-stroke diesels and fitted with a cargo boil-off reliquefaction plant.

BSM developed extensive training courses to prepare the crews to take these vessels from the delivery yards and into service.

The Isle of Man office currently has 16 other LNGCs under crewing management contracts, including vessels operated by National Gas Shipping Co (NGSC) of Abu Dhabi and another five for BP Shipping.

The company is also conducting the plan approval and newbuilding supervision for the four FLEX LNG FPSOs under construction at Samsung.

BG LNG SERVICES

Under the banner of Methane Services, BG operates seven 145,000 cu m capacity and four 170,000 cu m capacity LNGCs.

In addition, the company has a minority stake in another 145,000 cu m LNGC.

They are all managed by Ceres LNG Services and operate under the prefix – *Methane*.

The larger vessels were delivered last year and are fitted with reliquefaction capabilities and tri-fuel diesel electric propulsion plants.

Parent BG group is a regular charterer of tonnage to cover its cargo requirements.

At the time of writing, the two newbuildings earmarked for a joint venture with CNOOC to operate from the Queensland Curtis LNG project to China had not been ordered.

BW Gas' two latest LNGCs are operated by GDF SUEZ.

BLUESKY LNG CORP

Bluesky is the LNG shipping arm of Taiwan Maritime Transport (TMT), which has been renamed Today makes Tomorrow.

The company took delivery of the LNGC *Bluesky* in 2006. She is managed by V Ships' Glasgow office.

The two ordered from Daewoo of 171,800 cu m capacity had still not been delivered by the beginning of this year, despite being scheduled for delivery last year.

Bluesky also charters in to cover its parent's cargo needs as and when necessary.

BP SHIPPING

BP Shipping owns and operates seven LNGCs in two classes.

The first three, the 138,000 cu m *Trader Class,* were delivered in 2002-2003, while the second tranche – a 155,000 cu m quartet named after gemstones were delivered in 2007-2008.

The latter class is powered by dual-fuel diesel-electric propulsion units, which are claimed to be more efficient that the steam turbines fitted on board the first three vessels.

In addition, the UK concern also manages the *Northwest Shearwater,* which operates within the Northwest Shelf consortium, whose vessels load at Dampier and discharge at Japanese receiving terminals.

BW GAS

A private company within the BW Group, BW Gas owns 13 LNGCs, the last of which was delivered in 2009.

The last two – *BW GDF Suez Brussels* and *BW GDF Suez Paris* – are chartered to GDF SUEZ. However, the first vessel is on a three-year charter operating as an FSO at Mejillones, Chile.

BW Gas also manages eight gas carriers, ranging in capacity 146,000 cu m to 149,000 cu m all of which operate for Nigeria LNG. The company also manages two other LNGCs for GDF SUEZ in addition to the *Berge Arzew,* which is operating for Sonatrach.

Last October, Marubeni said that it would invest nearly $710 mill in BW Gas and in particular the eight LNGCs in the Nigeria LNG joint venture.

The Japanese finance conglomerate said that this was its first foray into LNGCs and said that it envisaged the energy supply chain, including the transport of LNG, as one of its core growing businesses.

BW Group CEO Andreas Sohmen-Pao said in October last year: "This is a win-win partnership. Marubeni has the opportunity to invest in a well established LNG business with long-term cashflows, while BW is rebalancing its asset portfolio and establishing a partnership to pursue future opportunities."

BW Gas is also involved in a Norwegian project – Energy Management in Practice. The company's role is researching alternative fuels, such as LPG and LNG.

A BP dual fuel diesel-electric LNGC.

CERES LNG SERVICES

This company manages BG Group's subsidiary Methane Services' 12 LNGCs for which it undertook shipbuilding supervision.

Ceres is also supervising the building of two vessels of 155,000 cu m capacity each ordered by affiliate GasLog, as well as managing the two that entered into service for the same company last year purchased from Chevron.

The new vessels are due to be delivered in 2014.

CHEMIKALIEN SEETRANSPORT

This Hamburg-based shipmanagement concern still has the two elderly LNGCs in its portfolio.

These are the 35,500 cu m *Annabella* and the 31,600 cu m *Isabella*. The *Annabella* doubles up as a training vessel.

They are both operating on cross-Mediterranean routes.

CHEVRON SHIPPING

Chevron Shipping manages the 2004-built LNGC *Northwest Swan*, which is operating for the Northwest Shelf consortium.

In 2008, Ceres LNG Services purchased two 154,800 LNGCs ordered by Chevron at Samsung.

The energy concern was believed to be close to ordering four 160,000 cu m capacity LNGCs at Samsung for delivery 2014-2015. They are earmarked to transport gas from the Gorgon project off Western Australia.

CHINA LNG SHIPPING (INTERNATIONAL)

This shipmanagement concern based in Hong Kong has five LNGCs under its wing plus another newbuilding.

Three of the 147,500 cu m capacity vessels are running between Dampier and Guangdong, while the other two are operating between Bintulu and Shanghai.

Another newbuilding was ordered to serve Petronas' loading terminal at Bintulu and will probably discharge at Shanghai when delivered under a charter to CNOOC.

All of the vessels, including the newbuilding, were built at Hudong-Zhonghua in Shanghai to a French design.

It is thought that more newbuildings could follow once the Chinese receiving terminals get up to speed.

CYGNUS LNG SHIPPING

Cygnus was established by NYK and Tokyo Electric Power (TEPCO), plus the Mitsubishi Corp to import gas for TEPCO.

TEPCO put up 70% of the capital while Mitsubishi and NYK provided 15% each.

On the back of this investment a 147,200 cu m Moss type LNGC was ordered from Mitsubishi named *Cygnus Passage.*

She was delivered to NYK in January 2009 and operates between the Sakhalin II loading terminal at Prigorodnoye and Japan.

DISTRIGAS

The Belgian energy concern has been importing LNG from Algeria since 1982 and from Qatar from 2007, using the Zeebrugge receiving terminal.

In May 2009, Italian energy major ENI bought a majority stake in the company.

Distrigas owns the 1978-built 131,235 cu m *Methania* and 49% of the *BW Suez Boston* with BW Gas.

In March 2007, the company signed a 20-year contract with RasGas to import gas from Qatar and regularly uses the spot market to top up its cargo requirements.

Methania is managed by Exmar (which see) and has had various periods in layup and was reported at Setubal in January.

DYNAGAS

The Greek-based shipmanagement company was formed by George Prokopiou's Dynacom group to manage three 149,700 cu m LNGCs.

They were built at Hyundai and delivered in 2007-2008. During the middle of 2008, Dynagas added the 1977-built 129,300 cu m *Edouard LD* to its fleet. She was renamed *Transgas*.

For optimal flexibility, two of the newer vessels - *Clean Power* and *Clean Force* - have been assigned with the Lloyd's Register Ice Class Notation 1A for Hull and Propulsion System, allowing navigation within first year ice thickness of up to 80 cm.

Apart from the extra strengthened side shells (ice belt) and specially designed propeller, shafting, sea chests locations and class requirements, the vessels are equipped with various winterisation features enabling them to navigate under very low ambient temperature conditions.

EMPRESA NAVIERA ELCANO

This Spanish-based owner manages two LNGCs having taken delivery of a newbuilding last year.

The 173,600 cu m *Castilla de Santisteban* was delivered from STX Shipbuilding to operate for the Peru LNG project on a charter to Repsol.

Similar to several Spanish LNGCs, she is being operated by Stream – an operating company set up by Repsol and Gas Natural.

The other vessel in Elcano's fleet is the 2003-built 138,000 cu m *Castilla de Villalba.*

EXCELERATE ENERGY

The US-based concern commercially manages nine LNGCs managed by Exmar (which see).

The fleet includes one traditional LNGC, plus eight Energy Bridge regasification vessels (EBRV). An EBRV is an LNGC fitted with a regasification plant.

The company pioneered the concept of LNGC ship-to-ship transfers and all the vessels are equipped to discharge at traditional receiving terminals, as well as Energy Bridge ports, which include buoy-based STL mooring systems for offshore locations.

On 29th March, this year, Excelerate Energy's regasification LNGC *Exquisite* received a transfer of 126,881 cu m of LNG, which represented the company's 100th STS transfer.

The operation took place in Kuwait at the Mina Al-Ahmadi GasPort® using the tandem LNG transfer system. Out of these 100 STS transfers, 55 involved the use of flexible hoses where two ships where moored alongside each other.

Excelerate Energy implemented the world's first commercial STS transfer of LNG on 25th August, 2006 between the vessels *Excelsior* and *Excalibur*, transferring LNG while underway in the Gulf of Mexico.

In April it was announced that the company had pulled the plug on its Gulf Gateway LNG import facility in the Gulf of Mexico, which was rendered obsolete by the surging US domestic supply.

EXMAR

The Antwerp-based shipmanagement concern manages 11 LNGCs.

Previously known as Tracto and at one time attached to the CMB group, Exmar can trace its LNGC history back to 1978 with the delivery of the 131,235 cu m *Methania*, which is now owned by Distrigas but still technically managed by Exmar.

In the late 1990s, Exmar embarked upon a newbuilding programme of 138,000 cu m LNGCs, the first of which – *Excalibur* – was delivered in 2002.

Through its partnership with Excelerate Energy (which see) the company then ordered three LNGCs fitted with regasification plants. The first – *Excelsior* – entered service in 2005.

***Express* – one of Exmar's new generation 151,000 cu m LNGRVs. Photo credit – Exmar.**

Subsequently, five more were ordered from Daewoo of 151,000 cu m each. The last in the series – *Exemplar* – was delivered last year.

Last November, it was announced that Teekay had finalised the purchase of a 50% share in Exmar's LNGVR *Excelsior* and the conventional LNGC *Excalibur*. Exmar remains responsible for the management and operations of the two vessels.

Exmar said that the transaction would generate a profit of around $52 mill. In addition the transaction will reduce the company's debt by more than $104 mill, the company said.

GASLOG

The Ceres affiliate owns 11 LNGCs and has another two on order.

Nine of the vessels are operated in the BG fleet by Methane Services.

The two 2010-built GasLog owned vessels were purchased from Chevron in a deal thought to be worth $500 mill, while the two 155,000 cu m newbuildings are due for delivery in 2014.

All of the vessels are technically managed by Ceres LNG Services.

GAZOCEAN

The French shipmanagement concern looks after the three LNGCs operated by GDF SUEZ (which see).

In addition, Gazocean manages the small elderly 40,000 cu m capacity LNGC *Tellier*, which is operating for Messigaz between North Africa and southern France.

Golar is bullish on the prospects for FSRUs. This vessel was converted and sold for operation off Italy.

GDF SUEZ

This energy group was born out of a merger between Gaz de France and GDF Suez in 2007.

GDF SUEZ owns three St Nazaire-built LNGCs – *GDF SUEZ Global Energy, ex Gaz de France Energy, Gaselys* and *Provelys*.

The *Gaselys* is under part ownership with NYK, which holds a 60% share in the vessel.

All of the vessels are technically managed by Gazocean (which see).

GOLAR GROUP

As usual, nothing stands still for long in John Frediksen's Golar Group.

Golar LNG Limited has ordered six 160,000 cu m LNGCs from Samsung Heavy Industries in tranches of four and two. The final two were declared options.

The newbuilding contracts were originally entered into by companies affiliated with Golar's largest shareholder World Shipholding. Golar has acquired the newbuilding contracts from the affiliated party based on the original contracting terms.

The last two vessels are set for delivery in 2013 and 2014 at a total cost of about $400 mill. In addition to the now six confirmed vessels Golar has fixed priced options to add further capacity.

Within the vessels' design parameters, Golar has the possibility to include ice strengthening/winterisation, as well as regasification equipment.

In addition to the newbuilding programme, Golar is in final discussions regarding firm commitments for construction of multiple FSRU carriers, the company said.

The board anticipates that the total financing for the existing newbuilding commitments can be arranged through existing cash, working capital and additional bank financing. The board does not see a need to raise additional equity to finance the existing newbuilding program.

Last year, the company formed Golar Commodities to manage and trade LNG cargoes and also joined forces with Wilhelmsen to establish Golar Wilhelmsen Management (GWM).

The new management concern was established in May last year with the intention of transferring the management of all Golar's LNGCs and FSRUs into the new company.

Also last year, the ownership of Golar Management, the company's in house manager

One of the two Hoegh-managed LNGSRVs on charter to GDF SUEZ.

and GWM joint venture partner, transferred to Golar Energy. By bringing the fleet together under one manager, Golar will have better control over and more day-to-day involvement with the technical operation of, in particular, the company's FSRUs, the company said in a statement.

Golar Energy has also announced that Oscar Spieler has stepped down from his role as CEO and that Doug Arnell has taken over the role of CEO with effect from 1st March, 2011.

Arnell was chief commercial officer and deputy CEO of Golar Management having joined the company from BG Group in September 2010.

Thus far, Golar has three converted FSRUs operating on 10-year charters – two with Petrobras and one with the Dubai Supply Authority. Another FSRU was sold last year to Italian interests and is operating off Tuscany.

Another FSRU project was firmed up on 20th April between Golar and Nusantara Regas to finalise the timecharter party for the West Java FSRU project.

The project is Golar's fourth FSRU project and is set for a period of about 11 years with a contract value of around $500 mill. It involves the conversion of Golar Energy's 1977 built LNGC *Khannur* into an FSRU with 500 mill cu ft per day regasification capacity (about 3.8 mill tones per annum) and the provision of associated mooring infrastructure.

Golar said that in general, activity within the FSRU market was becoming more firm. For example, during the 4Q10, Golar Energy had been pre-qualified for the both the Medan LNG FSRU project in Indonesia and the Bahrain Petroleum Company (BAPCO) LNG project.

In addition, Golar has entered into agreements to timecharter four modern LNGCs (*Golar Grand, Golar Viking, Golar Arctic* and *Golar Maria*) for periods of between 12 and 18 months to various charterers. The commencement of the different fixtures ranged from February to April 2011.

The company also said that it intended to keep the elderly LNGCs *Gandria, Gimi* and *Hilli* in layup through the first half of this year, but would consider their re-introduction to the charter market, or for conversion projects, as necessary.

HANJIN SHIPPING

Hanjin operates four LNGCs all of which are long term chartered to KOGAS, lifting LNG from Indonesia, Oman and Qatar to South Korean gas receiving terminals.

The company took delivery of South Korea's first membrane LNGC – *Hanjin Pyeong Taek* – in 1995. She is of 130,600 cu m capacity.

HOEGH LNG

Hoegh manages seven LNGCs, including two shuttle and regasification vessels.

In April, the company announced that it had signed a 'letter of intent' with Hyundai for two 170,000 cu m capacity FSRUs. The deal also includes a further two, plus another two, options.

The company said that it was generic design based on its in-house design 'Hoegh FSRU™'. It is based on a 170,000 cu m storage capacity with flexible regas capacity aimed at qualifying for the technical requirements for various regas projects worldwide.

Last year, Hoegh LNG took delivery of two LNGCs under management contracts on the same day.

On 1st June, the second shuttle and regasification vessel (SRV) – *GDF SUEZ Cape Ann* – was delivered to Hoegh LNG and co-owner Mitsui OSK Lines (MOL).

Hoegh manages the vessel under a long term timecharter agreement with GDF SUEZ. Both 145,000 cu m capacity SRVs were built by Samsung and incorporate the reinforced GTT MKIII cargo containment system.

The second vessel to be delivered on 1st June was the conventional 153,000 cu m LNGC STX *Frontier* built by Hanjin. Hoegh has chartered the vessel for three years from STX Pan Ocean and at the same time sub-let the LNGC to Repsol for the same period.

The company is also involved in the development of the deepwater ports (DWP), such as Port Dolphin, near Tampa and Port Meridian in Morecambe Bay in the UK, plus the Neptune DWP off Massachusetts.

For LNGFPSO projects, Hoegh has joined together with Prosafe, now part of BW Offshore and has also signed an agreement with KBR for the topsides and procurement services. The company also claimed to have several partnerships in place to develop specific projects.

A Moss-type Golar FSRU in operation for Petrobras.

HUMPUSS INTERMODA TRANSPORTASI (HITS)

HITS is still the only Indonesian concern to operate and manage LNGCs.

The company manages four vessels, one of which is wholly owned. This is the 136,400 cu m *Ekaputra*.

In addition, HITS manages the 127,385 cu m *Dwiputra*, the 19,475 cu m *Surya Ki* and the 23,096 cu m *Surya Satsuma* on behalf of a consortium. They are operated by Pertamina.

HITS also has six Japanese-controlled LNGCs on crewing management contracts.

HYPROC SHIPPING SERVICES

Hyproc is the shipmanagement arm of Algerian energy concern Sonatrach.

The company is believed to have eight LNGCs on its books, including two 75,500 cu m capacity Medmax types.

HYUNDAI MERCHANT MARINE (HMM)

HMM operates around 10 LNGCs, of which seven are wholly owned.

They all operate for KOGAS carrying

The 2010-built LNGC *Sevilla Knutsen*.

cargoes to the South Korean receiving terminals.

HMM's first LNGC – *Hyundai Utopia* – was also the country's first gas carrier when delivered in 1993.

IINO KAIUN KAISHA

Iino has interests in at least 15 LNGCs as of September 2010 and wholly owns the 138,300 cu m *SK Sunrise*, operated by SK Shipping on charter to KOGAS.

The company also manages the 2008-built 145,000 cu m *LNG Ebisu.*

KAWASAKI KISEN KAISHA (K LINE)

K Line claims to be the first Japanese concern to take delivery of an LNGC when in 1983, the 125,600 cu m *Bishu Maru* joined the fleet.

She and two of her sisters were recently sold to Norwegian financial concern Awilco.

Since then, K Line has participated in Indonesian and Qatari projects, plus gas transportation from the MEG to South Korea and India, plus Norway to Spain/US and Qatar to Europe.

The company is also involved in compressed natural gas (CNG) projects.

As its gas interests expanded, K Line opened offices in London and Houston.

K Line has interests, either wholly, or partially in about 46 LNGCs, the latest of which were three vessels delivered in 2009-two from Samsung and one from Imabari.

KNUTSEN OAS SHIPPING

At the end of November last year, some 10 years after Knutsen OAS Shipping signed its first LNG-contract with the Spanish oil company Repsol, the LNGC *Ribera Del Duero Knutsen* left DSME shipyard in South Korea on her maiden voyage.

This event marked the end of Knutsen's newbuilding programme.

Today, Knutsen OAS Shipping manages one small and eight large modern LNGCs operating worldwide.

In a series of firsts, the *Cadiz Knutsen* loaded the first ever cargo at Damietta, while her sister, *Bilbao Knutsen* delivered the first LNG cargo to Canada. In Peru, *Barcelona Knutsen* picked up the maiden cargo from the first LNG terminal to be located on the South American mainland.

In addition, the company manages the small *Pioneer Knutsen* operating on Norway's west coast delivering gas as a fuel to the ferries plying along the Fjords.

The company also has CNG and other LNG floating project designs on the drawing board.

KOREA GAS CORP (KOGAS)

Almost 25 LNGCs are operating for KOGAS, South Korea's state-owned gas concern.

However, there are no more newbuildings to come at this point in time.

KOREA LINE (KLC)

Beleaguered KLC has participated in the KOGAS LNGC consortium since 1990.

The company is shown as wholly owning four LNGCs and has a part share in another four.

Two were delivered in 2000 and the second pair in 2008.

Similar to other Asian owners, KLC also manages four smaller coastal gas tankers in joint ventures with other interests.

At the time of writing, it was still not known if the company's gas sector was affected by the ongoing financial upheaval.

LNG SHIPPING SPA

Formed in 2001, this shipmanagement concern is 100% owned by Italian oil major ENI.

The company manages four LNGCs, two of which are elderly.

It is also involved in Italian coastal offshore LNG terminal projects, such as the one off La Spezia.

MARAN GAS MARITIME

Part of the Angelicoussis shipping empire, Maran Gas manages five LNGCs, the last of which was delivered in July 2007.

Four out of the five are operating for RasGas projects on 20-year charters with options attached.

The fifth serves GDF SUEZ under a charter that terminates early next year.

It is believed that a VLCC contracted by sister company Maran Tankers Management will, or has been, converted to an LNGC order.

MISC BERHAD

The Petronas subsidiary owns 29 LNGCs, the last of which, the 157,700 cu m *Seri Balqis*, was delivered in 2009.

The vessels are trading worldwide, as well as lifting gas for Malaysian LNG, another Petronas subsidiary.

MISC claimed that some of the vessels are capable of two port discharges achieved by lifting part cargoes

The company also claimed to have made a breakthrough in the Asia/Pacific gas markets with a strategic alliance formed with Petromin to ship LNG from Papua New Guinea and at the same time, increasing the number of Japanese clients to 16.

In addition, MISC has received an approval in principle from ABS for its MISC FSRU solution.

The last two vessels delivered – *Seri Balhaf* and *Seri Balqis* – were the first vessels in the fleet to be fitted with dual fuel diesel-electric propulsion plants. They were built on the back of 20-year charters to lift cargoes for Yemen LNG.

MITSUI OSK (MOL)

MOL still claims to manage or operate 25% of the world's LNGC fleet.

The Japanese conglomerate has interests in more than 70 gas carriers with still more to come.

In January of this year, MOL signed a contract with Hudong-Zhonghua to construct four 170,000 cu m capacity LNGCs for around $220 mill each. This contract marked the first LNGCs won by Chinese yards for overseas clients.

They will be used to lift LNG from the Papua New Guinea (PNG) and Gorgon Jansz LNG projects and will be jointly owned by MOL and China Shipping (Group) Co (CS).

Last year, an ExxonMobil affiliate and its partners in the PNG LNG project entered into a sales and purchase agreement with Sinopec for the long-term supply of LNG amounting to about 2 mill tonnes per annum.

Also in the same year, an affiliate of ExxonMobil and PetroChina signed a sales and purchase agreement for the long-term supply of around 2.25 mill tonnes per annum of LNG from ExxonMobil's equity share of the Gorgon Jansz LNG project in Western Australia.

The four LNG carriers are expected to be delivered in 2015-2016.

MOL was also awarded two long-term charters by an ExxonMobil affiliate and their partners in their Papua New Guinea LNG Project.

The charters are for MOL's two existing 177,000 cu m capacity LNGCs fitted with tri-fuel-diesel electric propulsion systems and built at Hyundai in 2010.

They are co-owned by MOL and Itochu Corp (MOL 70% and Itochu 30%). The vessels are operated by MOL.

In 2008, MOL claimed to be involved with around 35 worldwide gas projects, a figure which was likely to increase, the company said at the time.

At the end of 2009, the company took delivery of the first of two regasification vessels ordered in a 50:50 joint venture with Hoegh LNG. The second vessel followed last year.

Both vessels are managed by London-based Mitsui OSK Bulk Shipping (Europe), which has several LNGCs on its books.

Since then, Tokyo Gas subsidiary Tokyo LNG Tanker has received a minority stake of the shares owned by MOL in the joint-venture companies owning the LNGSRVs.

The two LNGSRVs are long time chartered to GDF SUEZ to serve the Neptune LNG Deep Water Port terminal off Boston (Mass), as well as other requirements.

MISC is one of the world's largest owners of LNGCs.

AP MOLLER-MAERSK

APM's LNGC interests are now part of the Maersk FPSO division, but carry the brand name of Maersk LNG.

Today, the division has eight LNGCs – two with steam turbine and six with dual fuel diesel-electric propulsion systems.

The last vessel in the newbuilding programme was delivered in January 2010. The *Maersk Meridian* was the final vessel in a series of six 165,500 cu m LNGCs built at Samsung.

The previous vessel – *Woodside Donaldson* – was also delivered in January 2010 and will enter into a 15-year timecharter to Woodside Energy during 2Q11.

The vessels can carry partial loads of up to 115,000 cu m up to the maximum capacity.

NATURAL GAS SHIPPING CO (NGSCO)

NGSCO was formed in December 1993 to transport LNG on behalf of Abu Dhabi Gas Liquefaction Co (ADGAS).

NGSCO operates a fleet of eight LNGCs, each with capacity for 137,000 cu m.

The company took delivery of its first vessel *Al Khaznah* in July 1994, followed by a further seven vessels, the last of which was delivered in June 1997.

The first four vessels were built in Japan, while the other four vessels were built in Finland. Both the Japanese and Finnish built

vessels are of the Moss Rosenberg design and were the largest LNG carriers in the world when built.

The Company's LNG fleet was initially managed by third parties but since the end of 2007, all vessels are fully managed by NGSCO.

In addition to the supply of LNG shipping to ADGAS, NGSCO has a contract of affreightment (coa) for the carriage of LPG from Das Island.

In 2009, the company's supporting services were merged with ADNATCO. The merger boosted both companies position and created a pool of versatile and experienced personnel in preparation for any expansion, the company claimed.

NITC

We have included NITC once again due to it possibly ordering LNGCs in the long term.

However, any contracting is still a long way off and an NITC spokesman told *LNG Shipping Review* recently that no orders would be placed until the gas trains out of Iran were in place.

This year, we have seen the added frustration of US and EU sanctions biting into the company.

In addition, Iranian elections are due to be held later this year.

NIPPON YUSEN KAISHA (NYK)

NYK manages more than 30 LNGCs and will have interests in over 70 by 2012 as the Japanese group has many joint ventures, including with Sovcomflot for the Sakhalin project.

In March of this year, the company took the plunge and ordered a 145,400 cu m LNGC at Mitsubishi.

This vessel will be built on the back of long term charter to LNG Marine Transport.

Upon her delivery in 2014, the LNGC will be used to ship LNG for TEPCO from export terminals on Papua New Guinea, or alternative supply sources.

This vessel is the first of its kind to adopt the MHI Ultra Steam Turbine Plant (UST), a new turbine plant which enables approximately 15% higher fuel efficiency than conventional steam turbine plants, a feat achieved through efficient utilisation of thermal energy by reheating steam, the company claimed.

TEPCO has signed a 15-year agreement with LNG Marine Transport to import gas.

On 17th September 2010, a naming ceremony was held at the Sakaide shipyard of Kawasaki Shipbuilding Corp for a 145,330 cu m LNG vessel being built for joint owners NYK; CPC Corporation, Taiwan (CPC); and Mitsui & Co. Ltd.

Named *Taitar No 4*, it is jointly owned by CPC (45%), NYK (27.5%), and Mitsui (27.5%), and was due to be completed by October, 2010.

The vessel is the fourth of four sisterships and joins *Taitar No 1, Taitar No 2,* and *Taitar No 3* for the shipment of about 3 mill tonnes of LNG per annum from Qatar to Taiwan under long-term contracts of 23 to 24 years each.

Another 177,000 cu m LNGC is under construction at Kawasaki for a Tokyo Gas charter.

Also this year sees the delivery of a quartet of 160,400 cu m LNGCs from Samsung. They were ordered in a joint venture with Teekay and trading house Mitsui & Co.

They will be operated by Angola LNG lifting Angolan cargoes to the US under 20 year charters.

NYK also manages one cadet ship gas carrier and another one is planned.

OMAN SHIP MANAGEMENT

A subsidiary of state-owned Oman Shipping Co, this commercial management concern operates seven LNGCs.

The latest was delivered in December, 2008.

All of the vessels are managed by MOL, who acts as a consultant to the company, which was formed in 2003.

OVERSEAS SHIPHOLDING GROUP (OSG)

The commercial management of the four Q-Flex LNGCs jointly owned with Nakilat falls under OSG's products business unit.

The 216,000 cu m vessels were delivered in 2007-2008 and are all on long term charters of 25 years to QatarGas.

OSG is also involved in a CNG project with TransCanada CNG Technologies.

PETRONET LNG (PLL)

Petronet is a consortium of India's leading gas energy players, including GAIL, ONGC, IOCL and BPCL.

GDF SUEZ is a strategic partner, while RasGas has signed an agreement to supply the gas to India through Petronet.

Two LNG receiving plants will be operated by the venture. The first at Dahej, Gujarat has been in operation since Janaury 2004. The second at Kochi in Kerala state is scheduled to come on stream in 1Q12.

In August last year it was announced that an Australian subsidiary of ExxonMobil and Petronet had signed a sale and purchase agreement for the long term supply of LNG from the Australian Gorgon project.

Under the terms of the agreement, the supply will amount to about 1.5 mill tonnes per annum for 20 years and it will be delivered to Kochi.

Two Indian LNGCs have been serving Dahej since 2004. They came under the technical management of SCI in 2008. They are transporting RasGas cargoes to India under a contract due to last until 2028.

A third LNGC was delivered at the end of 2009 on the back of an extended contract signed with RasGas to supply LNG from Ras Laffan.

PRIMORSK SHIPPING CO (PRISCO)

Prisco is involved in a consortium, which operates the LR ice class 1C 145,200 cu m *Grand Mereya.*

The other members are MOL and K Line. The vessel is managed by MOL but operated by PRISCO to load at Prigorodnoye (Sakhalin II) under a long term contract with Sakhalin Energy.

PRONAV SHIP MANAGEMENT

Pronav manages seven LNGCs from Hamburg, including four Q-Flex types and five from Stamford, Conn.

The standard LNGCs are mostly elderly having been built in the US in the late 1970s and early 1980s and are operated by an MOL-led consortium.

QATAR GAS TRANSPORT (NAKILAT)

All of the 25 Q-Flex (11) and Q-Max (14) LNGCs ordered by Nakilat are now in service.

Along with 29 other gas carriers owned in joint ventures, this brings Nakilat's fleet up to 54 vessels made up of nine LNGCs of between 145,000 cu m and 154,000 cu m, 31 Q-Flexes and 14 Q-Maxes.

The partners have stakes ranging from 20% to 60% and include Teekay, OSG, MOL, NYK, K Line, Pronav, Maran Gas and Petronet.

Shell Shipping was appointed to technically manage 25 LNGCs for periods of eight to 10 years, following the delivery of the last Q-Max – *Rasheeda* - in August 2010.

Nakilat intends to take over the daily operations once the company is technically up to speed.

RASGAS

RasGas' fleet currently includes 27 vessels - 14 conventional LNGCs with a cargo-carrying

Earlier this year, Shell's *Gemmata* sailed from the Isle of Grain to Snohvit.

capacity of 138,000 cu m to 151,700 cu m and 13 larger vessels with capacities of up to 266,000 cu m.

The fleet has been built up through timecharter agreements with shipping companies and consortia, including Qatar Shipping, Maran Gas Maritime, Japanese-led consortium of Mitsui OSK, NYK, K-Line (an AP Moller-Maersk and Qatar Shipping consortium), the J5 Nakilat and Teekay Nakilat Corp.

Between May and September 2008, RasGas took delivery of 12 Q-Flex vessels, each with a capacity ranging from 210,000 cu m to 217,000 cu m.

In October 2009, RasGas took delivery of *Al Dafna,* its first 266,000 cu m Q-Max, thus completing RasGas' shipbuilding programme.

SHELL SHIPPING

Shell can trace its involvement in LNGCs back to the two Methane vessels that were purpose built to serve the now closed Canvey Island gas receiving terminal in the mid-1960s.

Since then, the oil major and its partners have been involved in around 25% of the world's gas carriers and operations.

Today, Shell has a stake in around 50 LNGCs. In 2007, the company was awarded the technical management contract for 25 Nakilat Q-Flex and Q-Max LNGCs and in addition manages eight 'B' class, six 'G' class, 12 for Nigeria LNG (Bonny Gas Transport) and five for the Northwest Shelf project.

In January 2008, the company ordered two 147,000 cu m LNGCs from Daewoo for Brunei Shell Tankers. They are due for delivery this year.

Shell is also involved in LNG FPSOs and other floating gas terminals including the regasification processes offshore.

Last year, shell awarded Samsung a contract worth about $4 bill-$5 bill to build an LNG FPSO. Samsung said that the FPSO will be delivered by 2016 and will be jointly designed by Samsung and Technip.

This is the first firm contract since Samsung agreed in 2009 to build LNG FPSOs for Shell over a period of 15 years.

SK SHIPPING

The company claimed to be the first owner/manager to be involved with all three types of gas containment systems – Moss Rosenberg, Technigas and Gaz Transport.

At least five of the six vessels in the fleet are operating on long term charters to KOGAS, as in 2007, the South Korean energy concern awarded SK Shipping a further 22-year contract to transport LNG to South Korea.

IM SKAUGEN (IMSK)

This year, IMSK will have six hybrid gas carriers in its fleet, capable of transporting ethylene and LPG.

The first vessel – *Norgas Innovation* – was delivered recently.

Another four could be ordered soon, once the finance is in place, the company said.

IMSK's *Norgas Innovation* is the first of six hybrid gas carriers, capable of loading LNG.

Called the 'Multigas' class, they range in size from 10,000 cu m to 12,000 cu m and are being built at IMSK's Chinese shipyard – Skaugen Marine Construction.

They will be operated in the Norgas pool, mainly in Chinese waters.

Skaugen said that there was a shortage of so called small-scale LNG distribution chains worldwide and the company was looking to fill that gap.

The company intends to be involved in the complete LNG supply chain and as an example, signed a partnership deal with Lyse Gass, which is soon to open a liquefaction plant near Stavanger.

Under the terms of the agreement, IMSK will provide the vessels to lift the LNG from the plant.

SONANGOL

The Angolan state owned oil company ordered three 173,000 cu m LNGCs in November 2007.

They are being built at Daewoo for the Angolan LNG project and are due for delivery this year and next.

SOVCOMFLOT (SCF)

The Russian shipping giant has six LNGCs on its books, two of which are elderly and four modern.

To gain the experience needed in managing and operating such vessels, SCF purchased the 1969-built *SCF Arctic* and *SCF Polar*, which are on charter to Gas Natural.

In 2007, SCF took delivery of the 145,000 cu m newbuildings *Grand Aniva* and *Grand Elena*. They were built in a joint venture with NYK for the Sakhalin II project.

Another two 145,700 cu m LNGCs were delivered in 2008 and 2009 for the Tangguh project in a joint venture with NYK and Samudera.

All the SCF vessels are managed out of Limassol by subsidiary SCF Unicom.

STX PAN OCEAN

STX now operates two LNGCs – the 153,000 cu m *STX Kolt* and *STX Frontier.*

They were constructed on the back of long term charters to KOGAS to lift Yemeni cargoes.

The *STX Frontier* was delivered last year and is now commercially managed by Hoegh Fleet Services under a charter to Repsol.

STREAM

This commercial operating company was formed in 2005 by Gas Natural Fenosa and Repsol.

Stream currently operates around 19 LNGCs having taken delivery of two vessels chartered from Knutsen and one from Elcano. The trio were built for the Peru LNG project.

In February of this year, *Golar Grand* joined the fleet under a short term charter agreement.

The company has also signed an agreement with the Nigerian Government to build and operate a liquefaction plant in Nigeria. In addition, Stream holds a 80% stake in a regasification facility at Damietta and a 7.3% share of a similar plant in Qalhart, Oman.

Through Repsol, Stream supplies the new Canaport LNG import terminal and regasification terminal at St John (NB).

One of SCF's vessels operating out of the Sakhalin II project.

TEEKAY LNG PARTNERS

Teekay entered the LNGC market in 2003 and a year later, Teekay LNG Partners was formed.

In May 2009, the company underwent an IPO and today owns 17 LNGCs through various partnerships.

In addition, Teekay has another four 160,400 cu m LNGCs on order at Samsung in a partnership with Mitsui and NYK, in which the Teekay has a 33% stake.

Once delivered in 2011-2012, they will enter into 20 year charters with the Angola LNG project.

Teekay has also signed an agreement to jointly develop CNG technology using the Coselle containment system.

TOKYO GAS

This Japanese energy concern has been involved in gas imports since 1969, mainly in the Tokyo Bay area.

The company has long term chartered a 177,000 cu m LNGC currently under construction at Kawasaki for delivery to NYK this year.

TSAKOS ENERGY TRANSPORT (TEN)

TEN still manages the 150,000 cu m *Neo Energy,* which it built to gain experience in operating such vessels.

ANTHONY VEDER

The Rotterdam-based small gas ship concern manages the 7,500 cu m hybrid *Coral Methane.*

She can carry LNG, ethylene and LPG and is on long term charter to Gasnor for LNG deliveries from Spanish receiving terminals to Norwegian customers.

In January of this year, Anthony Veder ordered another LNGC from Meyer Werft.

She will have a cargo capacity of 15,600 cu m and is due for delivery at the end of 2012.

Meyer Werft's sister company, Neptun Werft in Rostock-Warnemünde, will be involved in the construction and outfitting of this new LNGC.

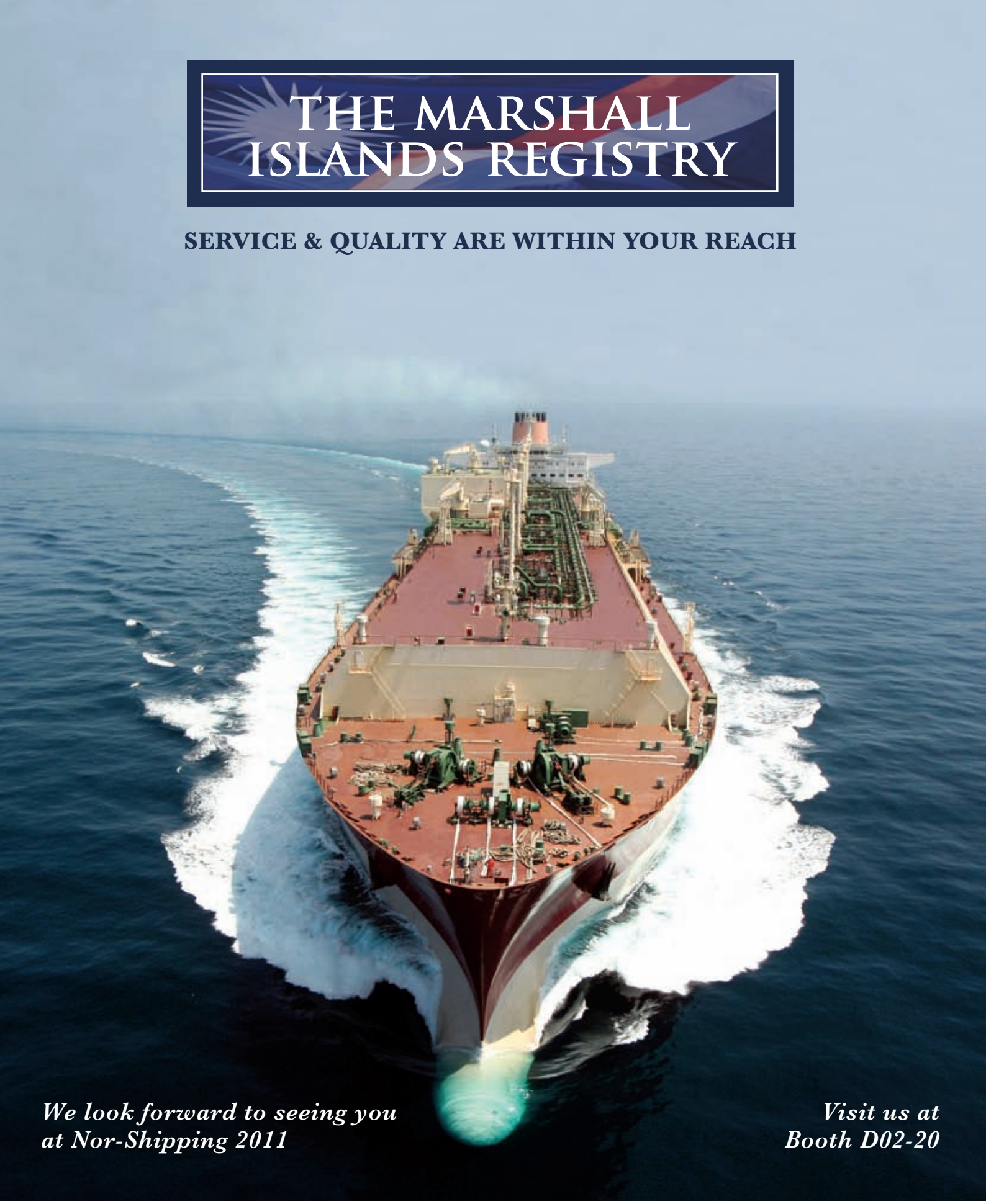
The Papenburg-based shipyard's focus is on mid-scale ships of this type. "We see that the smaller-scale LNG market has a great future," said Bernard Meyer, managing partner at Meyer Werft. ■

LNG
JAPAN
CORPORATION

LNG OneWorld.com

THE MARSHALL ISLANDS REGISTRY

SERVICE & QUALITY ARE WITHIN YOUR REACH



We look forward to seeing you at Nor-Shipping 2011

Visit us at Booth D02-20

INTERNATIONAL REGISTRIES (U.K.) LIMITED
The Marshall Islands Maritime and Corporate Administrators

THE MARSHALL ISLANDS REGISTRY

TEL: +44 20 7638 4748
LONDON@REGISTER-IRI.COM

For a complete list of offices please visit:
WWW.REGISTER-IRI.COM