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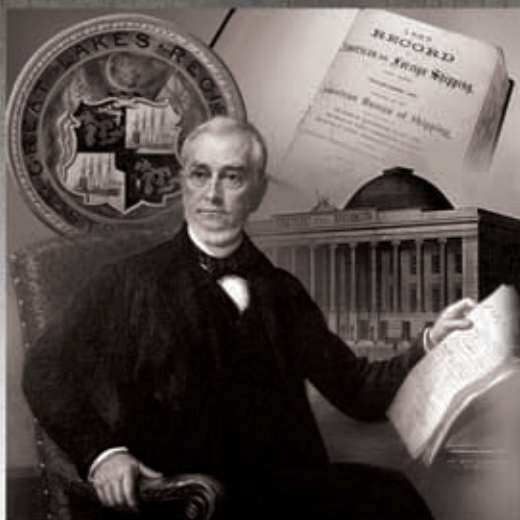
LNG *shipping*

REVIEW



- Market still upbeat
- Greek initiatives
- Dual fuel to stay
- Engines- gas is king
- Cruise/ferry potential
- Bunker stations coming

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Stena entered the LNGC market by purchasing the assets of TMT, which included three vessels.

Stena LNG was subsequently formed with the view of raising cash through an IPO to invest in four newbuildings, plus options.

However, similar to other projects, the economic situation has meant a postponement of the share issue.

LNG Shipping Review believes that this company is one to watch in the future.

Will the lack of finance kill the ‘Golden Goose’?



The LNG shipping segment has certainly lived up to all the hype surrounding its rebound in fortunes, thus far this year.

Charter rates have held up well into six figures and newbuilding orders for gas carriers were placed, or seriously discussed with shipyard building slots reserved.

Possible blips on the horizon include the lack of access to funds with which to finance the new contracts coupled with the lack of interest in IPOs to raise cash. At least one major project has been put on hold due to a delayed IPO, leaving the company concerned unable to finance a newbuilding project for the time being, although the contracts are still believed to be at a ‘letter on intent’ stage.

When researching the contents for *LNG Shipping Review*, we counted around 85 newbuildings still to be delivered. However, a more realistic figure is about 75, due to delays in firming contracts and firm orders actually turning out to be options.

However, this is till a considerable number of vessels when considering that the operational fleet only totals around 350 plus vessels. The price of newbuildings has dropped to just under \$200 mill for a standard LNGC but of course you will have to pay more for a sophisticated LNGRV.

Seeing the Greeks embracing the LNGC sector is a sure sign of good times to come – they are very rarely wrong. We counted around 39 new orders emanating from Greek interests adding to the 12 already in service. However, once again a few of the orders could still be subject to finance being put in place.

There has been only one LNGC recycled so far this year and this was the 1974-built French controlled *Tellier*, which has ended her days in a Belgian scrapyard. Indeed, such is the longevity of these vessels, we still have 1969 and early to mid 1970s-built LNGCs in service, which look likely to remain in operation for some time with a bit of ‘tender loving care’.

Owners and operators seem to favour the dual-fuel diesel-electric, or even the tri-fuel option for their vessels’ propulsion needs and the various membrane systems are favoured over the Moss containment systems.

REPAIR DOCK GROWTH

Large shipyards have sprung up, especially in the Middle East, aiming at building and servicing LNGCs. One such yard at Ras Laffan, Qatar had the distinction of docking

seven LNGCs in May of this year.

Nakilat-Keppel Offshore & Marine (N-KOM), part of the Erhama Bin Jaber Al Jalahma Shipyard, at the time said that the seven LNG carriers (*Al Jasra*, *Al Bidda*, *Al Wajbah*, *Dukhan*, *Al Gharrafa*, *Al Rayyan* and *Al Thumama*) would undergo drydocking repairs, including the overhauling of the main engine, valves, pumps and other general repairs and maintenance.

Most of these vessels are jointly owned by a consortium of Japanese shipping companies headed by MOL, NYK and K Line, while *Al Gharrafa* was technically managed by OSG Shipmanagement (UK).

Another shipyard, Oman DryDock Company (ODC) received its first LNGC for repair in October of last year. She was the *Muscat LNG*, which is owned by Oman Shipping Company.

LNGC GREEN AWARD SCHEME

Last year, the Green Award Bureau launched a certification scheme for LNGCs with the first vessel – MOL-managed *Dukhan* – gaining her certificate on 17th May 2011.

The organisation said that it had been

working hard on the requirements for LNG vessels. Preparations included consultation with the industry stakeholders and experts, not least of which was Qatargas, which kicked off the initiative, test surveys, extra training for the surveyors' team and extensive research.

Thus far, at the time of publication, 13 LNGCs had been certificated, primarily managed by Japanese interests, plus two from MISC.

Gas as fuel is on everyone's lips and there are some impressive forecasts being banded about for the number of vessels in service that will burn gas, either completely, or as an alternative fuel, in 20 years' time.

The pessimists point to lack of infrastructure to support gas burning vessels, however, the optimists counter this by saying that the same arguments were heard when sail gave way to steam and indeed steam to diesel. All of a sudden, in the late 19th and early 20th centuries, we had coal bunkers located worldwide to feed this new monster.

New technology driven by regulations will nearly always find a market for entrepreneurs to take advantage of. For example, regarding the lack of gas infrastructure argument, we are already seeing ports, gas providers and bunker concerns joining together to offer a solution, which will probably result in gas bunkering facilities coming on stream very quickly where they are needed.

Within the pages of *LNG Shipping Review* there are various references to schemes aimed at setting up bunkering stations. As we went

to press, Gasunie, Vopak and Shell announced that were going to construct a LNG breakbulk terminal for small scale distribution of gas around the Netherlands and northern Europe with Shell being its first customer.

The new terminal will be built at Maasvlakte, near Rotterdam and adjacent to the new Gate LNG import and regasification terminal. The companies said that the purpose of this terminal is to make LNG available for distribution to marine bunkering and truck fuelling stations.

It will receive LNG by pipeline from Gate and break down the LNG into smaller quantities for further distribution. Thus far, it will comprise a jetty and two truck loading stations and is expected to be operational at the end of 2014. The project is still subject to obtaining the relevant approvals, the companies said.

Other initiatives are ongoing, including at least two at Gothenburg, a traditional bunkering station serving local Swedish ports and the Skaw area.

As for gas engines, owners and operators of large vessels are opting for the dual, or tri-fuel options, as can be seen from the pages of *LNG Shipping Review*. There is also firm interest growing in the short sea and offshore sectors, as more orders are seen.

VIKING LINE INITIATIVE

Perhaps the vessel that will make everyone sit up and take notice is Viking Line's cruise ferry *Viking Grace*, which is currently under

construction. Due to her intended route in the Baltic – an ECA area - she will be powered by gas engines, making her by far the largest vessel and the first large passenger vessel to enter service powered by gas. The infrastructure has already been put in place to bunker the vessel.

In the listings section at the back of this publication, you will notice a few additions and a couple of companies missing. Among those to drop out are NITC and Maersk. It is difficult to see how the Iranian company can come back from the sanctions debacle in the short term to order LNGCs for its gas fields.

As for Maersk, the Danish company sold its entire LNGC collection to a consortium involving Teekay and Marubeni with the former managing the six vessels.

Added to the list were a handful of Greek owners, who have either signed firm LNGC contracts, or have taken out options. We have also included Russian energy concern Novatek, which is gearing up to ship gas from the Yamal project in a few years time. Designs of ice going LNGCs are already on the drawing board to transit through the Arctic region.

Another new entry is Swedish conglomerate Stena, which has formed Stena LNG, following the purchase of TMT's LNG assets last year. The original idea was to conduct an IPO to fund newbuildings, but this has been put on hold due to the financial situation, as have the newbuildings, although they are thought to be at the 'letter of intent' stage. ■



The Port of Gothenburg has at least two projects on the go aimed at setting up LNG bunker stations within the port to serve the Baltic ECA region.

Let the good times continue

LNG shipping has been performing exceptionally well in 2012, as indeed it did in 2011, according to Barry Rogliano Salles (BRS)*.

While most shipping segments have been trying to find a way out of the crisis, LNG remains an exception. Freight rates have been hovering at highly satisfactory levels for owners and the newbuilding activity has remained active, despite fears that a bullish sentiment would not survive in 2012.

In 2011, freight rates reached unprecedented levels (in the order of \$150,000 per day for short-term charters) and the new orders placed reached 50; resulting in an ordering wave only second to the years 2004-2005 (see Figure 1). What could be called the 'second wave of LNG shipping' in 2011 is likely to have a follow-up tail in 2012, which is much stronger than eight years ago (see 2005 orders compared to 2004 in Figure 1).

Although the LNG shipping market did not experience any dramatic events in the first half of 2012, it remained influenced by those that occurred last year, for example the tsunami disaster in Japan and the continuation of the shale gas exploitation projects, mainly in the US.

Japanese demand for LNG increased by more than 10% in 2011, compared to 2010 and has further increased by at least 20% in the first quarter of this year, compared to 1Q11. The 2012 balance will depend on how many

nuclear plants are brought back into service, as part of the country's energy mix. At the same time, the US market needs fewer and fewer imports, with the reversal in the LNG flows initiated by incoming cargoes' re-exports.

The gas price differentials among regional markets, which grew in 2011, have further widened in 2012. The Henry Hub gas price in the US has stayed below \$4/mmBTU, while spot LNG in Asia has been priced consistently above \$15/mmBTU. In the Atlantic the price has been moving in-between – NBP gas price has been kept below \$10/mmBTU.

In the first half of 2012, the scarcity of LNGC tonnage available for charter has persisted and the fleet utilisation has remained very high – overall in 2012, we expect it to exceed the 2011 levels. This can also be attributed to an increase in the average hauls. However, charter rate levels have eased somewhat, as the market has found a balance, mainly regarding the extra supplies required by Japan, which has attracted cargoes from many more sources. But LNG will mark 2012 as a lucrative shipping business.

NEW ORDERS AND PLAYERS

One delivery took place during the first half of this year, that of the 160 400 cu m *Cubal* by

Samsung to MOL in January. The vessel had been ordered back in 2007 and is to be operated by Angola LNG on a long-term charter.

New ordering activity kept pace in the first half of 2012, following the 2011 frenzy, which was a real event in the world of shipbuilding. Some 21 orders were recorded from January to June and if they continue alike in the second half, 2012 will be just a few ships short of the 2011 order total of 48.

Contracting came from old players, recent entrants, but also new ones. The Greeks continued their impressive record with eight new orders placed in the first half of this year and their share exceeds 45% of the total orderbook, while they own less than 4% of the existing fleet - both figures in terms of numbers of ships.

New entrants are Almi Gas with two order placements and the company announced bold plans for many more, while recent entrant Alpha Tankers ordered a second vessel. Tsakos placed an order after many years operating just one LNGC. Other players to order LNGCs in 1H12 were Golar LNG (4), MOL (4), Maran Gas (3), Dynagas (2), Sovcomflot (2), Hoegh LNG (1), Brunei LNG (1), and Oman Shipping (1).

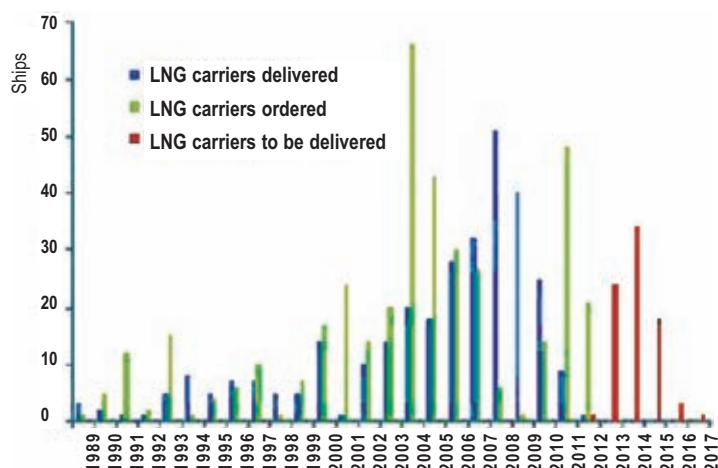


Figure 1. Source – BRS.



Figure 2. Source – BRS.

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Figure 3. Source – BRS.

A noteworthy event was the listing of GasLog on the New York Stock Exchange. With eight LNGCs on order, GasLog raised almost \$330 mill through its IPO.

Even following the announcement of a number of charter deals for newbuildings in 1H12, the speculative nature of new ordering activity remains strong. Uncommitted vessels currently represent about 45% of the orderbook (see indicative Figure 4).

The lion's share of orders placed in 1H12 went to South Korea (~80%, which corresponds to its share of the global LNG orderbook). Most - eight - were placed with Hyundai and the rest ~20% went to Japan. It is interesting to note that Japan is temporarily ahead of China in the global LNGC orderbook during this period. (see also overview Figure 3).

As for charter rates, 2011 was a year of tight market conditions for both short and medium term rates. In the first half of 2012, the short-term rates have eased on average, but still owners are enjoying returns not seen before 2011.

Reported rates in 1H12 are of the order of \$120,000-\$135,000 per day for short-term charters of three to three and a half years and even more than \$150,000 per day for shorter-term/spot deals (see Figure 4).

As noted in the BRS Annual Report, a two-pronged effect in charter-rates is being seen with a sub-division of the market in at least two classes of ships: the new dual-propulsion 160,000 cu m vessels and the older, steam turbine LNGCs with capacity of around 145,000 cu m. Moreover, the rate levels seen over the last 18 months or so has extended life for ships built in the 1980s, or exceeding 30 years of age.

While about 68% of the fleet operate under long-term deals (more than 10 years), and

13% are being operated by their owners, the remaining share open to the spot-shorter term deals represents a growing market. FSRU's (Floating Storage and Regasification Units) also represent a growing outlet for LNGCs, with seven in the fleet list having been converted.

NEW LNG PARADIGM

An LNG revolution has started in the US. With the official approval of the Cheniere project being given by the American Authorities (FERC) a few months ago, Cheniere will be the first LNG export scheme from the US. By the middle of this year, the project's financing is almost secure with \$2 bill of equity and a \$3.4 bill loan recently granted by a pool of banks.

Gas Natural, British Gas, Gail and Kogas will be the first clients for this US LNG, which will represent almost 16 mill tonnes per year of exports. This project is the cornerstone of the new LNG paradigm. LNG will be exported directly from US to Asia using a new shipping route through the Pacific Ocean and the Panama Canal. For the time being, more than 100 mill tonnes per year of liquefaction capacity is envisaged from US shale gas. Even if only a part of these projects are realised, the US will become a very important LNG player in the international arena and this will have a very strong impact on the global LNG market.

The cost of LNG bound to Asia will be very competitive, compared to Middle East LNG and this will create a new pricing scheme counter balancing the existing model. At the same time, optimum sizes of new LNGCs (up to 210,000 cu m capacity) will have to be defined in order to cope with the new Panama Canal lock constraints of a maximum width of 49 m.

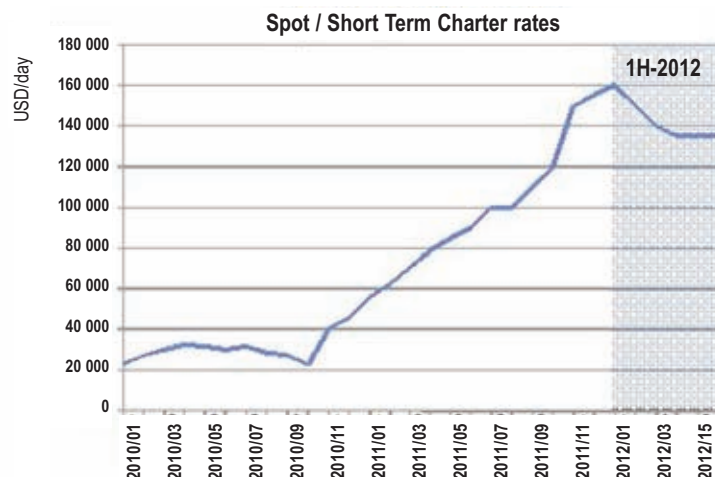


Figure 4. Source- BRS

The forces that will influence the fate of LNG shipping in the medium-to-longer term will be related to:

- The gas revolution in the US to the degree that it will turn it to an important LNG exporter.
- The balance that will be established (mainly regarding the required tonne/miles to meet global demand) as the big Australian projects, bringing the country in the next five years to the level of Qatar – currently the world's biggest supplier, if they come on stream on schedule.
- The demand growth, mainly by the emerging Asian markets, such as India and China.
- The development of offshore production-liquefaction projects and the spreading of offshore terminals (FSRUs).
- The commercial exploitation of the northern Arctic route that will open up new supply options in combination with new infrastructure (eg, the latest prospects for the Yamal project in Siberia).

**This article was written by K G Gkonis, BRS research department and P-A Leroy, LNG shipping department BRS.*

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Liquefied gas consultancy set up

Bernhard Schulte Shipmanagement (BSM) has established a consultancy service to build upon the company's extensive experience across the entire gas shipping market.

BSM is part of the Schulte Group, which has owned and operated liquefied gas tonnage (mainly LPG/Ethylene) for over 40 years - and is one of the pioneers of the business.

The shipmanagement arm of the company - known as BSM since the individual daughter companies merged identities a few years ago - has extended this gas shipmanagement specialisation even further.

Today, BSM has over 130 gas carriers under management - nearly 10% of the entire world gas carrier fleet and far more than any other third party manager in the shipping business today. In addition to over 90 LPG carriers and 15 of the extremely sophisticated and specialist Ethylene fleet, BSM manages 27 LNG carriers of all types and sizes - with more to follow shortly.

TRAINING COURSES

This depth of experience across the entire industry has enabled BSM to establish the Liquefied Gas Consultancy (LGC) service. This offers a wide range of bespoke training courses, ranging from a one day introductory course for senior shore management, aimed at companies entering the gas business for the first time, to two day familiarisation sessions for those new to the day-to-day aspects of the gas business and five day STCW compliant Advanced Gas Safety courses.

Additional training to SIGTTO competency levels can also be offered for LNG and LPG sea staff - to take their knowledge &

understanding beyond STCW levels - as can LICOS cargo simulator instruction. The training can be conducted in any of BSM's Marine Training Centres, or at the client's offices at the customer's convenience.

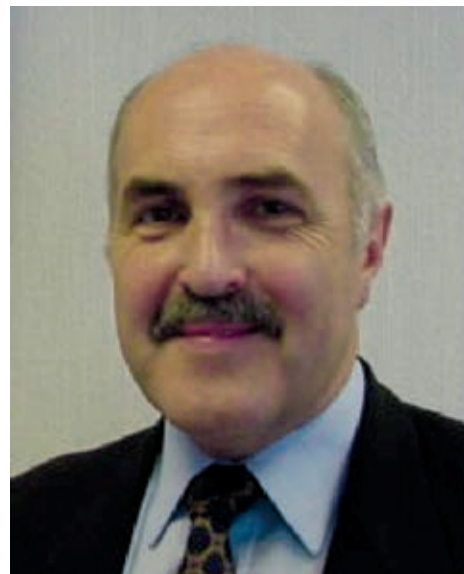
Training courses have already been run for several organisations with developing interest in gas shipping and have also been conducted for terminal operators and gas importers. The fast developing market for LNG as bunker fuel can also be addressed by special training for those involved.

BSM also has a specialist newbuild department - Schulte Marine Concept - which looks after all aspects of ship design and construction. Together with Liquefied Gas Consultancy, this is now available to clients wanting to develop shipyard specifications & contract and conduct plan approvals for gas carrier newbuildings.

Current projects range from LPG to Ethylene to LNG newbuildings - including an LNG FPSO design and the conversion of commercial vessels to operate on LNG bunkers. Among the other services offered are factory acceptance trials, sea trials and gas trials.

Expert Witness support is also part of the new company's portfolio. The cases handled include alleged LPG, Butadiene, Propylene and Ethylene contamination, plus slow cargo cooling and slow discharge rate claims.

LNG cargo claims are quite unusual, but LGC has one on its books at the moment, where the alleged carry-over of debris from a new terminal is said to have caused cargo



BSM's gas expert Chris Clucas.

pump damage.

In all of these cases, the cost of the cargo downgrading, or loss of ships' time is very significant indeed, so it is crucial to have the right advice from the outset - especially if the case is heading for a High Court or arbitration.

The new company is headed by Chris Clucas, who is BSM's group fleet director for the gas carrier fleet and is widely known in the industry - notably as Chair of SIGTTO's general purposes committee. Jonathan Crispe, technical director of BSM, is also closely involved with the LGC group and is a member of SIGTTO's newly-established advisory group on LNG for bunkers.

"BSM has established our Liquefied Gas Consultancy team to work with other stakeholders to share our deep in-house knowledge and expertise in the specialist area of liquefied gas shipping to create value," explained Ravi Korivi, BSM's chief marketing and business development officer. "With environmental concerns regarding bunker fuel being in the forefront of decision-makers minds at the moment, we expect a lot of interest in our services in connection with LNG - which is seen as the fuel of the future" ■

'BSM has established our Liquefied Gas Consultancy team to work with other stakeholders to share our deep in-house knowledge and expertise ...'

- Ravi Korivi, chief marketing and business development officer, BSM

Greeks sustain newbuild market

As usual, Greek owners have not been slow to react to a potentially profitable market.

Figures produced by LNGSR show that Greek interests have ordered, or are negotiating close to 40 new LNGCs on top of the 12 already in service.

Some of the new 'orders' are still subject to financing and some others maybe options with existing orders, but the numbers illustrate that despite the economic crisis, some Greek owner/managers have managed to dig into their savings, or obtain the finance necessary, to splash out around \$200 mill per vessel on newbuildings.

Most of the orders are thought to be of a speculative nature, but a few have long term business planned. For example, Maran Gas and GasLog have long standing relationships with BG, while the latter has two vessels on order on the back of a Shell contract, as well as BG.

Among the more recent entrants are Almi Gas, Alpha Tankers and Thenamaris, although the Almi Gas orders for two vessels, plus two option, are believed to be still the subject of financing and maybe delayed.

One company to take advantage of the Greek ordering spree is power generation

concern Wärtsilä.

The company said that more than 30 Greek managed LNGCs will be powered by Wärtsilä dual-fuel solutions. This series of orders represents a notable industry shift in replacing steam turbines for this marine application, the company said.

During the last 18 months Wärtsilä has been contracted to supply the main engines for 34 new circa 165,000 cu m LNGCs being built for GasLog, Maran Gas, Dynagas, Thenamaris, and Cardiff Marine.

Each of these LNGCs will be powered by four Wärtsilä 50DF (dual-fuel) engines running on a diesel electric mode, with the capability of being operated on gas, diesel or heavy fuel oil (HFO). The number of engines to be delivered totals 136. The vessels are to be built at Daewoo, Hyundai and Samsung for delivery between 2012 and 2015.

OPERATIONAL FLEXIBILITY

Wärtsilä's advanced DF engine technology provides maximum operational flexibility, environmental sustainability, and redundancy – all of which are current priorities of the

LNG sector. The diesel electric engine concept ensures maximum operational flexibility and environmental friendliness, the company claimed.

Wärtsilä first introduced the dual fuel electric machinery concept for LNGCs in 2006.

When taken into service in 2006, the 154,000 m³ LNG carrier *Provalys* was the largest LNG carrier in existence. The *Provalys* is propelled by dual-fuel engines and electric propulsion. The heart of the system is four dual-fuel engines; three 12-cylinder and one 6-cylinder Wärtsilä 50DF, giving a combined output of 39.9 MW.

The vessel is employed to carry liquefied natural gas (LNG) from Norway or Egypt. The propulsion solution for the *Provalys* uses dual-fuel engines for electric power generation. The ship is designed to be capable of responding to the alternative of trading on the spot market.

The electric power is supplied to an electric propulsion system, as with the diesel-electric propulsion systems on modern cruise ships. The solution offers LNG carriers a number of significant advantages, including lower overall fuel consumption, fuel flexibility, and reduced emissions.

Its acceptance was immediate since it offers very high efficiency over the entire output power range, the ability to use cheaper and cleaner fuel and the lowest emission levels among all prime movers.

All of the dual-fuel electric powered vessels are predominately operating in clean, gas mode. When operating on gas, the specific CO₂ emissions are typically reduced by 20% compared to HFO, or marine diesel oil (MDO) operation. The corresponding reduction in nitrogen oxide (NO_x) emissions is 85-90%, while sulphur oxide (SO_x) and particulate emissions are almost totally eliminated.

Wärtsilä already claims about 85% of the LNGC engine vessel market. It has been contracted for more than 400 engines in some 100 ships in service, or on order, thus far.



Popular with LNGC owners is Wärtsilä's 50DF engine.

“The LNG carrier market is expanding rapidly and Wärtsilä is at the forefront in providing owners and operators with engines that meet their needs for reliability, safety, redundancy, operational and fuel flexibility, and environmental as well as economic sustainability,”

- Lars Anderson, vice president ship power merchant, Wärtsilä

“Increased demand for short and medium term employment of LNG carriers, and the willingness of Greek owners to be positioned in this high potential segment are seen as the reasons behind this series of orders. Wärtsilä’s strong leading position in dual-fuel and gas engine technology is once again emphasised with the award of this series of contracts.

“The LNG carrier market is expanding rapidly and Wärtsilä is at the forefront in providing owners and operators with engines that meet their needs for reliability, safety, redundancy, operational and fuel flexibility, and environmental as well as economic sustainability,” said Lars Anderson, vice president ship power merchant.

A transition to LNG fuel is seen as being one of the most realistic options for significantly reducing the environmental footprint of marine transportation. The series of orders will further promote the use of LNG as a marine fuel on a global scale, Wärtsilä said.

LIFECYCLE SUPPORT

The new LNGCs will operate worldwide. However, in all cases Wärtsilä can provide lifecycle support through its global network of service and repair facilities.

The company also offers its dynamic maintenance planning programme for LNGCs. This programme is based on the condition monitoring (CM) system developed by Wärtsilä. It effectively predicts the

maintenance needs of the vessel through the continuous feed of the engines’ operational data and parameters into a database, which is evaluated at Wärtsilä’s CBM (condition based maintenance) centre.

The maintenance needs can thus be determined according to the actual condition of the equipment, rather than on arbitrary scheduling. The programme can also determine the ship’s optimal operating parameters.

The flexibility of Wärtsilä dynamic maintenance planning allows maintenance intervals to be amended according to actual need. This means that service work and spare part deliveries can be arranged accordingly, thus avoiding excess downtime and unnecessary costs, the company claimed. ■

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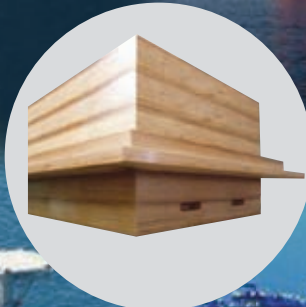
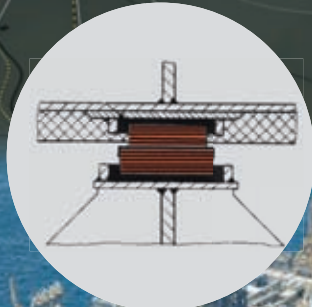


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The argument for dual fuel for gas-fuelled ships

The dual-fuel option for gas-fuelled ships offers economic benefits, as well as practical and environmental advantages.

According to Wärtsilä, the main driver behind the rapid adoption of gas as a ship fuel is emission regulation, while the likely increasingly attractive price of LNG provides another important incentive.

The need to lower sulphur levels, first to 0.1% in emission control areas (ECAs) from 2015, and then globally to 0.5% from 2020, means that shipowners presently using heavy fuel oils (HFO) have to opt for one of three solutions.

The options are to use alternative fuels, eg gas, to fit exhaust gas cleaning equipment (scrubbers), or to switch to distillate fuels, such as marine diesel oil (MDO). Which is the most appropriate will depend on many factors, but will be principally influenced by the relative costs of HFO, MDO and gas fuels and the time spent in areas where sulphur emissions are severely limited.

Demand for distillate fuels is likely to be very high, which will force up the cost relative to heavy fuels, which, consisting mainly of the residual oils remaining after the distillation process for other petroleum products, are likely to remain comparatively inexpensive. That should make the scrubber solution attractive for a number of vessels.

The third option is to switch to LNG and dual-fuel engines. As the price of gaseous fuels is likely to be more stable and could even come down in relative terms, as new extraction methods come on stream, this option looks attractive, at least in areas where the supply infrastructure already exists, or is planned.

The major difference between these new sulphur emission limits and previous regulations are that they will apply to all ships, not just new vessels. Wärtsilä can offer solutions based on all three alternatives. Engines in the current portfolio can run on either residual, or distillate fuels without modification, though ancillary systems, such as fuel pumps may need to be changed and particular attention must be paid to lubrication when running on low-sulphur fuels.

The company is able to supply scrubber equipment and can provide either its own freshwater-based system or, following the

Hamworthy acquisition, the Krystallon-designed seawater system. And Wärtsilä has long experience in gas- and dual-fuelled engines.

PROVEN BENEFITS OF GAS

Running on natural gas provides great savings – around 85% - in emissions of nitrogen oxides (NOx), as well as cutting sulphur oxides (SOx) by some 99%, thus providing a useful means towards meeting not only the forthcoming ECA limits but also IMO Tier III.

Wärtsilä ship power product management director Tomas Aminoff said that he expected particulate matter (PM) emissions to become the next major focus – comparatively little attention has been paid to these so far, but they will come under the spotlight as a result of tighter US Environmental Protection Agency (EPA) limits. Here again, with natural gas fuel, PM emissions are negligible.

The energy efficiency design index (EEDI) and ship energy efficiency management plan (SEEMP) regulations entering into force in 2013 will seek to regulate greenhouse gas (GHG) emissions. Because methane gas – the major component of most gaseous fuels – is a particularly potent greenhouse gas, the existence of unburnt gas in the exhaust (methane slip) means that the difference in GHG emissions when using gas fuel rather than diesel fuels in a dual-fuel engine is less marked than the reductions in NOx, SOx and PM.

However, running on gas still provides a significant benefit, with gas-fuelled ships typically producing a clear reduction in GHG compared to conventional fuels.

Wärtsilä's experience of large gas-fuelled engines dates back to 1987, when it introduced the gas-diesel engine (GD) for land-based stationary applications. This was followed by a pure gas spark-ignition (SG) engine in 1992, and shortly after, in 1995, the dual-fuel engine (DF), capable of running on either diesel fuels or liquefied natural gas (LNG).

Both the pure gas spark ignition and dual fuel engine types run on the Otto cycle (similar to a gasoline-fuelled vehicle engine) while the



Wärtsilä's Tomas Aminoff

gas-diesel engine runs on the diesel cycle. This means, said Aminoff, that only pure gas and dual fuel engines are able to meet IMO Tier III emission limits without after treatment.

The gas-diesel option also operates on high gas pressures, making it less suitable for ship power, while the pure gas engine lacks the fuel flexibility and redundancy inherent in the dual-fuel approach. Therefore Wärtsilä's choice for ship power is dual fuel. The company claimed that its dual-fuel engines have proven their reliability by reaching 5 mill running hours by 2012.

FLEXIBILITY, REDUNDANCY, ECONOMY

A major benefit of fuel flexibility is that it allows ships to choose fuel according to operational patterns and economic factors. For example, a vessel such as an FPSO may be optimised to operate on low-quality unrefined liquid fuels, or low-quality gas; a gas carrier will have the engine tuned for a balance between liquid and gas, using gas when readily available (eg as boil-off from cargo), when cheaper, or in ECAs and conventional fuel at other times; and a tug, offshore support vessel, or short-sea ferry will be optimised for running on gas as primary fuel, with a

capability to use liquid fuels for out-of routine operations, redundancy and re-positioning.

The dual fuel engines can start and stop in gas mode, can idle for up to eight hours in gas mode and can change between gas and liquid fuels and vice versa, while in operation. This flexibility provides the clue as to why the company believes the dual fuel option to be a better fit compared to pure gas engines for ship propulsion.

Taking a typical gas-fuelled installation, such as that on an offshore supply vessel, with a combination of two Wärtsilä 34DF and one Wärtsilä 20DF based generating sets, the engines are set up with both MDO and LNG supplies to all three engines, and in normal operation all engines will run on LNG from a single gas supply, such as Wärtsilä's LNGPac. In the case of a gas system failure to one engine, that engine can be simply switched to MDO operation. Similarly, should a problem be encountered with the main gas supply, all engines can be switched to MDO. So, full redundancy can be simply achieved.

To achieve the same redundancy level on a pure gas installation requires a greater investment on the gas handling side: "And the gas tank is one of the single most expensive components," said Aminoff. Additionally, the

full redundancy required under some class rules can mean the added complication of power take-in arrangements on each main shaft, and maybe, in some applications, even a second auxiliary running on MDO – thus negating the main advantage of a single-fuel gas installation.

Looking at the size of gas tanks needed, taking a typical autonomy of 14 days at 50 cu m per day with a 10% safety margin, a tank capacity of 770 cu m will be the minimum required. However, some missions (say one in 20) may be up to 18 days, and further, one in 20 may be during bad weather, which will require a 15% power increase, with a corresponding increase in gas consumption.

A dual-fuel installation will be able to switch to MDO to accommodate longer missions and poor weather, so the 770 cu m gas capacity will suffice. In contrast, the pure gas installation will require two systems, with a total capacity of at least 1,139 cu m.

Therefore, a pure gas vessel could require 48% more gas capacity to achieve an identical operational flexibility. And because gas tanks are costly and liquid fuel systems comparatively cheap, the total cost of a dual-fuel installation will work out significantly less than that of a gas-only system. And a dual-fuel installation allows vessels to be

easily moved from one operational area to another, which may not be possible because of the limited LNG supply infrastructure.

One area where the pure gas engine is sometimes claimed to be superior to a dual-fuel engine in gas mode is in transient load performance. However, Wärtsilä's trials indicated that the disadvantage is far less than suggested. Successive loading figures show that the 6L34DF engine in Wärtsilä's test laboratory can reach 100% power from zero in about 30 secs while still remaining well within the 5% variation in rev/min, as required by the regulations. These figures compare well with equal size diesel engines such as the Wärtsilä 32.

The tests conducted in the Vaasa centre demonstrate that the 34DF is able to switch instantaneously and seamlessly from gas to diesel – as might be required in case of a problem with the gas system. The only noticeable change was that the smoother running characteristic of the Otto cycle gave way to the typically slight increase in vibrations with the Diesel cycle. Changing back from MDO to gas was also simply accomplished, thanks to the fully automated systems.

FUTURE DEVELOPMENTS

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Two views of Wärtsilä's DF20 type engine.

dual-fuel field will be concentrated on reducing methane slip and further engine optimisation. This can be achieved through software tuning in the control system, and further optimisation of the hardware.

Also currently in progress is the development of Wärtsilä's dual-fuel low speed engine, capable of running on LNG, MDO and HFO. Unlike other low-speed gas engines, it uses low gas feed pressure in conjunction with about 1% pilot fuel at 100% load. Gas feed pressure is below 10bar at all points, in all conditions, which allows the system to be fed by the handling system's own in-built pressure. More importantly, the adoption of pre-mixed lean burn combustion and the Otto cycle, allows the engine to meet IMO Tier III and 0.1% sulphur emission limits with no secondary equipment.

AVAILABILITY OF GAS

Whatever the advantages of LNG as a fuel, availability of gas is seen as a key issue – if ships cannot bunker LNG where and when it is needed, there will be no incentive to take up this option. Some experts draw an analogy with the advent of the motor ship, which needed

diesel fuel rather than the bunker fuels used by steam ships (only later were combustion engines developed to the stage when they could burn boiler fuels). That did little to halt the rise of the diesel engine for ship power.

LNG bunkering is seen by most experts as being a classic 'chicken and egg' situation. If the fuel is not available, there will be little demand, but without demand it is unlikely to be available. Shipowners surveyed by Lloyd's Register proved serious and upbeat about adopting LNG fuel, but regarded it as a long-term measure.

LR's study indicated that many of the major bunkering locations for oil fuels are conveniently close to LNG terminals and some, like Rotterdam, are in ECAs. So the physical aspects of LNG supply may not be as much of a problem as some fear.

On the other hand, some experts see too wide a difference between the large-scale LNG supply industry, as exemplified by terminal operators and the smaller-scale operations needed for bunker supply. LNG Brokers, in a paper given to the 2011 Gas Fuelled Ships conference, said that a logical contact point needs to be established between

the large scale and small scale LNG supply worlds, probably within the large regasification terminals.

Dual fuel engines provide an interim – and probably a long-term – solution to this dilemma. Wärtsilä pointed to the feasibility of a dual-fuel engined containership, for example, running between Asia and Europe, burning HFO outside ECAs and switching to LNG for ECA operations. Gas can, most likely, be bunkered in ports, such as Rotterdam, but one solution would be to use portable LNG tanks, the same size as a standard FEU container, several of which could be loaded onto the ship at a container port, and when empty, exchanged for full containers at another port.

SUCCESSFUL CONVERSION

In terms of actual operational experience, Aminoff pointed to the success of the *Bit Viking* project. This tanker racked up a number of 'firsts' – it was the first ship to be converted to LNG operation, the first to use gas fuel in conjunction with a mechanical drive (others are electrically powered), the first gas fuelled installation to gain 'single main engine' class approval, the first installation of Wärtsilä's own gas handling system and the first cargo-carrying merchant vessel other than a gas carrier to use LNG as fuel.

It has proved its ability to run continuously and reliably in gas mode, even in the severe weather conditions and sea states encountered in winter around the Norwegian coast, which impose considerable loads on propellers and engines. The ship has accumulated well over 3,000 running hours in gas mode, with 99% availability. It has bunkered every two weeks, at a transfer rate of 430 cu m per hour, which allows sufficient gas for two weeks of operation to be bunkered in about 2.5 hours. ■



Since her conversion to gas burning, Tarbet Shipping's *Bit Viking* has operated over 3,000 hours in gas mode.

Prototypes of new engine to be tested soon

Major players' interest has helped to push gas engine technology towards commercial maturity.

Earlier this year, MAN Diesel & Turbo held a second ME-GI customer test demonstration in Copenhagen. At this demonstration it was announced that HHI-EMD, the engine and machinery division of Hyundai Heavy Industries and Mitsui Engineering & Shipbuilding intended to build prototypes of MAN's gas engine.

This announcement meant that this gas engine has edged closer to commercial production, the company said. Both companies said that they propose to carry out full scale demonstrations of the ME-GI principle based on the temporary conversions of existing production engines to ME-GI units.

Accordingly, Hyundai intends to convert an 8S70ME-GI unit in November this year, while Mitsui will convert a 6S70ME-GI unit in the second quarter of 2013.

MAN Diesel & Turbo said that it saw that this announcement of the demonstrations stemmed from customer requests to employ the ME-GI engine in new projects and said that production capability for the ME-GI was already available.

Similarly, the company also reported that test beds and ancillary gas-supply systems will also be available in time for ME-GI delivery.

Ole Grøne, senior vice president low-speed promotion & sales, MAN Diesel & Turbo, said: "We view this latest development in the ME-GI project as very positive. It is immensely encouraging that some of our biggest licensees, based in the greatest shipbuilding countries in the world, are showing such tangible interest in this gas engine."

Grøne attributed the licensee announcements of full-scale ME-GI demonstrations to customer interest and said: "Over the years, MAN Diesel & Turbo has staged tests in Copenhagen with excellent results where we have improved efficiency and lowered pilot injection volumes, but these full-scale demonstrations mark the most significant milestone yet for the ME-GI."

Unveiled at a major event at MAN's Copenhagen Diesel Research Centre in May 2011, the ME-GI engine represents the culmination of many years' work that began in the 1990s with the company's prototype MC-GI dual-fuel engine. The first two-stroke GI engine,

a 12K80MC-GI-S, entered service at a power plant in Chiba, near Tokyo, Japan in 1994.

The ME-GI engine is a gas-injection, dual-fuel, low-speed diesel engine that, when acting as main propulsion in LNGCs, or any other type of commercial vessel, can burn gas, or fuel-oil at any ratio, depending on the energy source available on board and dictated by relative cost and owner preference.

Indeed, Mitsui reported adopting twin ME-GI engines as prime movers aboard its concept LNGC 'Double Eco MAX' in July 2011, a move that intended to result in a 30% reduction in fuel costs and CO₂ emissions.

Depending on relative price and availability, as well as environmental considerations, the ME-GI engine gives shipowners and operators the option of using either gas, or HFO, MAN said.

MAN said that the company saw significant opportunities arising for gas-fuelled tonnage, as fuel prices rise and modern exhaust-emission limits tighten. Previous research had indicated that the ME-GI engine, when combined with exhaust gas recirculation (EGR) and waste-heat recovery (WHR) technologies, delivers significant reductions in CO₂, NO_x and SO_x emissions fulfilling Tier-II and Tier-III regulations.

The company predicted a broad, potential market for its ME-GI engine, extending from LNG and LPG carriers to other oceangoing vessel segments, such as containerships, as well as vessels plying a fixed trade.

DUAL FUEL

Until now, the more traditional power plants built by MAN Diesel & Turbo for LNGCs have been the dual fuel solution.

For example, Russian-based Sovcomflot, recently selected the dual-fuel MAN 51/60DF engine for an LNGC newbuilding programme comprising of two confirmed vessels with an option for two more.

The dual-fuel diesel-electric propulsion system and the MAN 51/60DF engine have been selected to provide the vessel with a high efficient and low emission propulsion solution, especially when running in gas mode. A high degree of redundancy and the MAN 51/60 DF engine's multiple fuelling

options have been also taken into account.

The vessels are currently under construction at STX Offshore & Shipbuilding and will each be driven by sets of two 8L and two 9L51/60DF engines. The engines will be built at MAN Diesel & Turbo's Augsburg plant in Germany with delivery to the South Korean yard due in the fourth quarter of 2012. The first vessel is expected to commence commercial operations in the fourth quarter of 2013.

The company said that the new 51/60DF orders mark another major milestone in MAN's strategy of expanding its environmentally friendly dual-fuel-engine technology into the marine sector.

The first 51/60DF order for a marine application was signed in 2007 for Empresa Naviera Elcano's 173,600 cu m LNGC *Castillo de Santisteban* comprising of five 8L51/60DF units. This vessel has successfully operated commercially since the summer of 2010 transporting LNG worldwide.

The vessel, also built at STX, was fitted with five MAN dual-fuel 8L51/60DF engines each delivering 8,000 kW at 514 rev/min. Upon her delivery, the LNGC was assigned by her charterer, Spanish energy company Repsol – Gas Natural LNG (Stream), to the Peruvian Camisea/Pampa Melchorita gas project, the first natural gas liquefaction plant in South America.

The engine is specially designed for LNGC propulsion systems and gas-fuelled ships. Its design focuses on the safety requirements stipulated by classification societies for gas operation. It was designed to give the vessel a higher degree of redundancy in terms of maintenance while in operation and takes advantage of the 51/60DF engine's multiple fuelling options, MAN said.

The dual fuel engines can run on gaseous (for example, vaporised LNG), or liquid fuels of a wide range of qualities (HFO/MDO/MGO) and have low emission levels.

At 1.5 g/kWh (IMO cycle E2) in gaseous-fuel operating mode, the 51/60DF complies with future IMO Tier-III limits for NO_x by a considerable margin without the need for exhaust-gas treatment, or any other counter measures, the company claimed. ■

Wärtsilä DF technology reaches 100 LNGCs

At the end of May, Wärtsilä, announced that it had been contracted to supply 50DF dual-fuel propulsion engines to 100 LNGCs.

This milestone was recently passed with the supply of a LNGC in a South Korean shipyard. The 100 LNGCs represent just under 25% of the current global fleet.

As said in an earlier article, Wärtsilä's advanced dual-fuel technology was first launched in the early 1990s for use in land-based power plant applications. The first marine installation of the 50DF engine came a decade later.

The technology enables the engine to be operated on either natural gas, light fuel oil (LFO), or heavy fuel oil (HFO) and switching between fuels can take place seamlessly during operation, without loss of power, or speed. This ensures safety and continuous installation operability, the company claimed.

The Wärtsilä 50DF engine is designed to have the same output regardless of the fuel used.

The fitting of 50DF engines on board the first LNGCs in 2006 set a trend in the industry, as since its introduction, 65% of all new LNGCs have been fitted with Wärtsilä dual-fuel engines.

One of the reasons for the strong success of this particular engine over the alternatives is its superior propulsion efficiency, Wärtsilä claimed. The clear environmental advantages that operating on gas allows, is another factor in the success of this technology. As is often stated, when operating in gas mode, the NOx

emissions are at least 85% below those specified in the current IMO regulations, and CO₂ emissions are some 25% less than those of a conventional marine engine running on diesel fuel. In addition, the SO_x and particle emissions are negligible at almost zero percent.

"This is indeed an important milestone for Wärtsilä, and for the shipping industry as a whole. It confirms not only our leading position in the LNG transportation sector, but also the viability of Wärtsilä dual-fuel engines. They have demonstrated that they are a solid and reliable choice for owners and operators, enabling easy adaptation to different sailing patterns, in both arctic and tropical conditions, and to various operational profiles," said Lars Anderson, vice president, Wärtsilä ship power, merchant.

In addition to its success in the LNGC market, the Wärtsilä 50DF engine is increasingly being considered by owners and operators throughout the shipping industry. For example, in the cruise and ferry sector, where it is often necessary to operate in Emission Control Areas (ECAs), there is growing awareness of the advantages of operating on gas.

For example, the new Viking Line ferry to operate between Finland and Sweden will be the largest ferry in the world operating on gas.

Similarly, vessels serving the offshore oil and gas industry are increasingly being fitted with Wärtsilä dual-fuel engines. The need for

flexibility, fuel efficiency, and compliance with stricter environmental regulations, are the drivers behind this trend.

To date Wärtsilä has sold some 720 DF engines and has accumulated more than 5 mill running hours of experience with this technology.

The 50DF engine is manufactured in configurations from a 6-cylinder in-line version to an 18-cylinder version in V-configuration, giving 950/975 kW per cylinder and a total maximum mechanical output of 17,100 kW.

The engine speed is 500, or 514 rev/min, with 50 Hz and 60 Hz applications. The maximum thermal efficiency is higher than with any other gas engine, Wärtsilä claimed.

EXPANDED OFFERING

With environmental issues and fuel economy likely to be the future market drivers, Wärtsilä has recently expanded its merchant fleet equipment range to include solutions that address process efficiency and environmental compliance. As a result, it is now positioned as the most suitable systems provider for extended ship power solutions.

Following its recent acquisition of Hamworthy, Wärtsilä is now established as a market leader in the LPG and LNG carrier markets for the reliquefaction of boil-off gas, with solutions that offer both economic and environmental advantages. ■

'Following its recent acquisition of Hamworthy, Wärtsilä is now established as a market leader in the LPG and LNG carrier markets for the reliquefaction of boil-off gas, with solutions that offer both economic and environmental advantages.'

MHI to develop low-speed, 2-stroke, dual-fuel marine engine

Mitsubishi Heavy Industries (MHI) is to develop what it calls the 'UEC-LSGi,' low-speed, dual-fuel, marine diesel engine capable of using not only conventional heavy oil but also natural gas for their fuel.

The new engine will be added to the Mitsubishi UEC engine series, the company's 2-stroke, low-speed marine diesel engine brand. The new variant is scheduled to be launched in to the market in 2015 to reduce the economic and environmental burden on ship operators, the company said.

For the new engine, MHI will also develop new components required for dual-fuel use, including a new direct fuel injection system, a gas-fuel supply system and control system. The company said that its target was to complete preliminary testing by a single cylinder testing machine within fiscal year 2013 (by the end of March 2014).

Following this, the company will conduct verification tests for full-scale engines with dual-fuel use capability and bring an 11,000 - 18,000 kW class power output UEC-LSGi engine with a cylinder bore of 600 mm onto the market.

The price of heavy oil used as fuel for low-speed, 2-stroke marine diesel is expected to rise

in the future. In contrast, the price of natural gas fluctuates in a relatively narrow range and the supply of shale gas, a non-conventional type gas, has stabilised due to the advances and sophistication of production technology.

Given the above, the interest and expectation of those involved in the development of natural-gas firing low-speed, 2-stroke marine diesel engines, has increased, MHI said.

In addition, IMO is progressively strengthening regulations on sulphur content in fuel oil aiming to reduce SOx contained in gas emitted from ships. Ultimately, the sulphur content in the fuel used for vessels will be required to be less than 0.5% in 2020, considerably lower than the current figure of below 3.5%.

Operators of ships using heavy oil fuel are required either to use the costly low sulphur content fuel, or install sulphur removal exhaust gas treatment systems to engines. If a low-speed marine diesel engine that is capable of using natural gas as fuel is developed, those measures will become unnecessary, as it does not contain sulphur.

For the new engine, MHI will use the diffusional combustion method, in which high-pressure gas, about 300 bar, is injected in the air compressed by the cylinder stroke and

ignited by the pilot flame by a very small amount of fuel oil. The method is claimed to excel in response to changes in gas fuel composition and sudden changes in engine load, compared with the pre-mixed combustion method, in which low-pressure gas is mixed with air and then compressed. Incorporating this feature, MHI will develop the engine with a high combustion stability.

The UEC-LSGi will also be designed to be capable to operate with heavy fuel only to 100% engine load, which will enable it to meet various operational needs. For NOx, natural gas is slightly advantageous compared with conventionally used heavy oil. MHI will apply its EGR (exhaust gas recirculation) technology, currently under development and others for the new engine to comply with IMO rules.

MHI is the only licensor of low-speed, 2-stroke marine diesels in Japan. By functionally combining a wide range of marine-use machinery and technologies, the company is promoting 'Project MEET (Mitsubishi Marine Energy & Environmental Technical Solution System)' to propose solutions to comply with the strengthening of environmental regulations and at the same time, satisfying the need for energy-saving operations. ■

GE to supply propulsion systems for 23 new LNGCs

GE's power conversion business unit recently received a series of new orders from South Korean builders Daewoo Shipbuilding & Marine Engineering and Hyundai Heavy Industries.

The GE equipment will be installed on 23 new LNGCs and represents total propulsion power of 1,105 MW.

"These orders clearly demonstrate that GE's expertise in electric propulsion for LNG applications is recognised worldwide by the major players in the sector," said Paul English, marine vertical leader for GE's power conversion business. "Our continuous investment in innovation and competitive solutions allows us to customise and optimise our offerings to meet shipowners' specific requests."

The scope of GE's contracts includes MV7000 converters, induction motors, transformers, generators, main and cargo

switchboards and propulsion control systems.

Manufacturing for all propulsion motors is based in GE's rotating machines plant in Nancy, France, while the propulsion systems are engineered at the GE merchant marine centre at Belfort, France.

GE's motors and converter are designed and optimised to make the propulsion systems easy to maintain. The induction machines are driven by press-pack IGBT pulse wide modulation (PWM) converters to offer high levels of reliability in a compact design.

Traditionally, the propulsion of LNGCs has been based on boil-off boilers and steam turbines. In recent years, more and more ship owners have turned to dual-fuel engine systems combined with electric propulsion, as more efficient solutions, up to 30% at high loads. Moreover, these solutions increase cargo capacity by 3% to 5%, as they enable the ship designer to

optimise the equipment layout.

GE's power conversion unit was the first to be fitted to a full-size LNGC with electric propulsion. The order was placed in 2002 for the vessel *Gaz de France Energy*. This first project was followed by a series of orders in 2005 and 2006 for eight large LNGCs built in South Korea. During the following two years, GE was also selected to equip the latest generation of LNGCs with new advanced electric-propulsion systems.

Induction motors for the marine industry were developed 15 years ago by GE's power conversion business for the US, English and French navies. Today, GE remains the only company with marine applications that combine high-powered induction motors with PWM, the company claimed.

GE Energy acquired this unit in September 2011 when it was known as Converteam. ■

LNG fuelled engines may be the future, but what about today?

In response to rising industry demand for more sustainable shipping, the industry is turning to LNG as a primary fuel.

However, with inadequate LNG infrastructure, engine manufacturers are working with other industry stakeholders to provide alternatives.

The rising cost of energy and increased concerns about the environment have resulted in significant changes in the industry. Regulatory bodies in different states are working to introduce Emission Control Areas (ECAs). At present, sulphur emissions control areas (SECAs) are in effect in the Nordic region and the Baltic Sea and ECAs will be established in the English Channel, North America (already implemented) and some islands in the Caribbean.

Earlier this year, the EU published a consultation document, which considered a number of options for curbing emissions. These may either take the form of a market-based mechanism that would apply to ships' emissions in Eurozone waters or a 'compensation fund' that would require owners to make payments to offset damages caused by carbon emissions. At the same

time, bunkering prices have tripled over the last three years and most analysts agree that prices will continue to rise for some time.

NEXT GENERATION ENGINES

According to Trond Skaufel, managing director of Pon Power in Scandinavia, these changes have led to a rising demand for more fuel-efficient engines that help lower emissions. "LNG as fuel for ships is an attractive option, but until a global network of LNG bunkering terminals is established, LNG-fuelled vessels will be limited to coastal trades where a LNG bunkering network exists," he said. "In the meantime, engine manufacturers are busy developing a new generation of diesel engines optimised to reduce fuel consumption and corresponding emissions."

Skaufel said that Pon Power is seeing rising demand for new more efficient engine types and related tools to manage new regulations. "Quality engines, operational

reliability and good service remain critical to our success," he said. "But with pressure on owners to reduce fuel costs and comply with new regulations, we have to be able to work with other stakeholders to provide the right solutions, today."

PIONEERING INNOVATION

Skaufel noted that as a distributor for Cat and MaK Engines to the maritime and offshore segment, Pon Power has access to innovative engine technology. For example, Cat continues to develop ACERT™ technology, which enables the combustion process to be shaped and managed with an extremely high degree of precision, resulting in an engine that meets or exceeds emerging emissions requirements.

At the same time, MaK has announced the development of the MaK M 46 DF, a new marine dual-fuel engine platform. Pon Power also offers a full range of NOx reduction kits to improve the performance of existing engines.

Wärtsilä to supply DF engines for China's first LNG powered tugs

Wärtsilä is to supply the main engines for two environmentally sustainable tugs.

They are being built for CNOOC Energy Technology & Services Limited (CETS), a subsidiary of the state-owned China National Offshore Oil Corp (CNOOC).

The vessels are the first in a planned series to be fuelled by LNG and will be the first tugs in China ever to be operated on gas. They will also be the first tugs globally to take advantage of the dual-fuel benefits offered by the Wärtsilä DF engine technology.

The contract was signed in the beginning of July 2012.

CNOOC's strategy is aimed at achieving more clean energy in its operations and the Wärtsilä dual-fuel engine solution fits this profile, the company claimed.

The low emission levels made possible by this technology is particularly beneficial for vessels operating close to population centres, as tugs frequently are, while the high fuel efficiency enables lower operating costs.

The 6,500 bhp tugs will operate along China's coastline and will be fuelled from the company's own bunkering terminals.

"We are delighted to be co-operating with CNOOC in supplying the main engines for these gas fuelled tugs. It is a

landmark project that is very much in line with the marine sector's key targets of achieving greater sustainability with better fuel efficiency.

"We endorse CNOOC's strategic move towards cleaner energy and the use of LNG as a marine fuel, which is precisely in line with Wärtsilä's own strategy," said Aaron Bresnahan, vice president Wärtsilä ship power specials.

The vessels will each be powered by two 6-cylinder Wärtsilä 34DF in line dual-fuel engines. Delivery of the engines is scheduled for the beginning of 2013 while the first of the tugs is expected to be delivered in June 2013. ■



Pon Power's Trond Skaufel.

PARTNERING FOR SUCCESS

More recently, Pon Power was approached by Siemens to supply a specially modified propulsion package to be used in a new offshore supply vessel owned by Østensjø Rederi, which operates a large fleet of OSVs,

tugs and towage vessels.

The technology is built around a variable drive propulsion system, known as the patented BLUEDRIVE PlusC, which reduces fuel consumption and includes an SCR catalyst that can operate over the load range of 6 – 100%, resulting in significant reductions in both NOx and CO2.

According to Ketil Aagesen, Siemens' sales manager, the company had been working on variable drive systems for some years at the company's technology centre in Trondheim, Norway. "While we had to design new components and control systems, everything in the BLUEDRIVE PlusC is based on proven technology," he said. "It is how we integrated different components that makes the difference."

OPTIMISING ENGINE PERFORMANCE

In terms of emissions and fuel efficiency performance, the BLUEDRIVE PlusC is equal, if not better, than LNG fuelled engines and is also more affordable. "While the BLUEDRIVE PlusC is optimised for the OSV segment, we are working to develop the technology to apply to larger vessels and

different engines – including dual fuel," said Aagesen. "We have launched the concept in the US and Asia, and so far, we are pleased with the response."

To implement the project, Siemens and the owner spoke to a number of engine manufacturers before selecting MaK. "We were looking for a reliable engine with the right design parameters and good technical support," he said. "MaK and Pon Power fit the bill."

Together with the MaK factory in Germany, technicians at Pon Power have modified two MaK 6M25C and two MaK 9M25C propulsion engines to function with the new Siemens variable drive frequency concept.

"This technology represents a genuine innovation in engine efficiency," said Skaufel. "And by pairing BLUEDRIVE PlusC with our existing propulsion systems, we are confident we can better support our customers efforts to improve fuel and environmental performance."

Skaufel acknowledged that Pon Power can't deliver a whole engine room, but says that the company's technical competence, customer network in Scandinavia and support from Cat and MaK make Pon Power a strong partner in



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- LEG/LPG carrier
- LPG FSO/FPSO
- CO₂ carrier





MaK has developed dual fuel engine technology.

the region. “The industry’s renewed focus on sustainability has lead to a more co-operative approach between stakeholders and we remain open to collaborations in the future.”

WORKING TOGETHER

In 2008, the Ulstein shipyard together with NTNU, Norway’s leading technical university and Marintek, the Norwegian Marine Technology Research Institute, launched an initiative to improve strategic and operational aspects of production

systems. “Ulstein was seeking a new way of working with suppliers to streamline the build process and create a more modular approach to production,” said Skaufel. “NTNU invited a number of suppliers, including Pon Power, to help sponsor a long-term research and development project to optimise maritime production.”

Known as IGLO Maritime Production 2020, the programme brought together NTNU, Marintek, Pon Power, Ulstein, Siemens and Fiskerstrand shipyard to strengthen and



Pon Power was approached by Siemens to modify a new OSV propulsion package.

improve the competitive capabilities of the Norwegian maritime industry through a number of work packages.

This initiative produced a number of technical publications on a broad range of issues, ranging from CSR to innovation, sustainability to maritime supply chain networks. “While not every topic covered by IGLO has been relevant to Pon Power, we have gained a better understanding of yards and how we fit into the overall value chain,” Skaufel concluded. ■



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Illustration: Agneta Christope



LNG OneWorld.com

LNG and the cruise/ferry industry

LNG as a fuel is progressing and is one of several strategies to meet future needs for reduced fuel costs and comply with environmental regulations.

Class society DNV said that it had noticed a lot of interest in exploring LNG as an alternative fuel and believes it is more a question of when, rather than if, it becomes more commonly used.

Of particular interest recently was the launch of the Swedish Baltic ferry operator Viking Line's new gas fuelled ro-ro cruise ferry *Viking Grace* at STX Turku shipyard on 10th August. Upon her delivery in January next year, she will be the first of her kind to be powered by LNG.

Construction of the vessel started in September 2011 and she is scheduled to enter into service in January 2013, operating between Turku and Stockholm. "A voyage on the *Viking Grace* will provide our guests with enjoyable, eventful experiences in a sober and elegant environment on the most environmentally friendly cruise ferry in the world," said Viking Line CEO and President Mikael Backman at the time of her contracting.

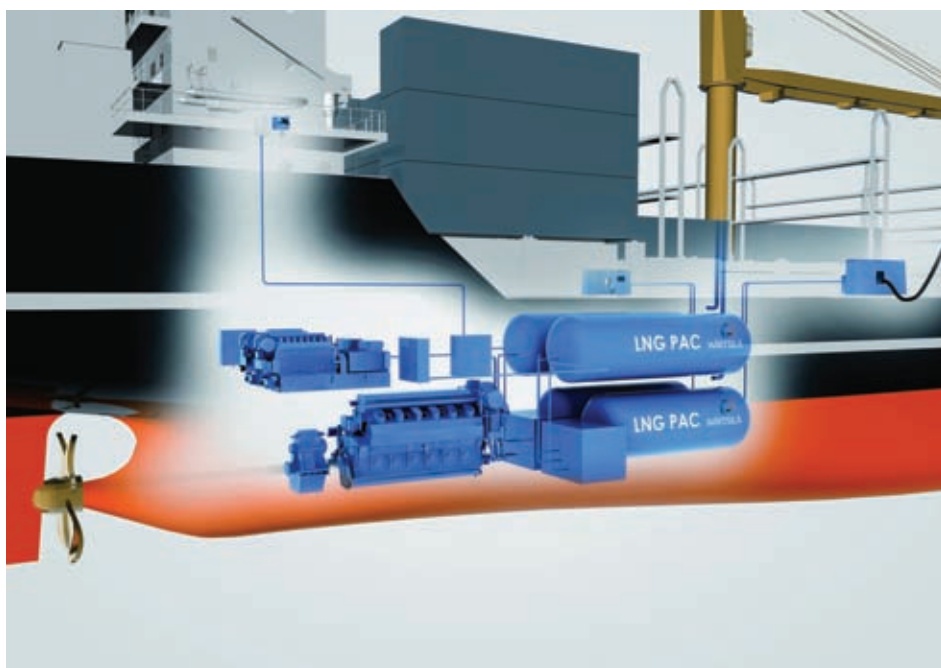
Viking Line's new cruise ferry will be capable of carrying cars, trucks and road trailers on short international voyages. She was designed to carry 2,800 passengers and 200 crew members.

The machinery, equipment and outfitting, as well as the structural work, is being undertaken under the watchful eye of Lloyd's Register.

PROPULSION MACHINERY

Wärtsilä was awarded the contract by shipbuilder STX Finland to supply the propulsion machinery for the *Viking Grace*. The agreement also included an option for the supply of equipment to a similar sister ship, if built.

The Finnish power generation company is to 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



The Wärtsilä LNGPac system allows the safe and convenient utilisation of gas fuel.

lowest possible pressure impulses for good vibration control.

LNG

She will be fuelled by LNG. The use of Wärtsilä's dual-fuel engine technology will enable this ferry to sail without restrictions in Sulphur Emission Control Areas (SECAs) and Nitrogen Emission Control Areas (NECAs).

"This unique and ground-breaking vessel will be the most environmentally sound large passenger ferry in the world. Thanks to Wärtsilä's technology, this ship will meet and even exceed the most stringent known future IMO and EU environmental regulations for maritime applications. Wärtsilä's long experience and strong competence in dual-fuel technology, with some 300 such engines already sold, was an important reason for Wärtsilä being awarded this order", said Tony Öhman, senior vice president, marine operations & newbuilding, Viking Line, at the time of the contract placement last year.

Wärtsilä was also awarded additional

equipment contracts, such as on board LNG storage and supply systems (LNGPac) and an advanced compact silencer system (CSS).

The LNGPac comprises on board liquid natural gas bunkering, two storage tanks and handling equipment with related safety and automation systems. These systems have been designed and developed by Wärtsilä.

The scope of supply also includes a patented cold recovery system, which utilises the latent heat of LNG for the air conditioning systems. By reducing electrical consumption from the cooling compressors, the cold recovery system brings significant operational savings and overall increased vessel efficiency, the company claimed.

The CSS technology enables noise emissions from the engines to be minimised. In particular, disturbing low frequencies will be eliminated. This silent operation is an important element of the specifications, not only for passenger comfort, but also because of the ship's sailing route through the islands of the Turku and Stockholm archipelagos.

“We see that LNG is on the cruise industry’s radar. Although there will probably not be a traditional cruise ship using LNG in the next five years, we believe we will see one in 10-15 years’ time.”

- leading class society DNV

As for bunkering the vessel, Viking Line has signed an agreement with AGA Gas to supply LNG to the *Viking Grace*.

“Viking Line’s and AGA’s investment in LNG represents major environmental advantages compared to traditional maritime fuel,” explained Backman.

GAS STORAGE TANKS

The LNG will be stored in specially built tanks fitted on deck at the rear of the vessel and will have a temperature of about -150 deg C when it is bunkered and stored on board.

As mentioned, the tanks are located outdoors on the ferry’s rear deck. If the gas comes into contact with air it rises, since it is lighter thus being ventilated away. In cooled form, the pressure in the tank and piping system is very low. The pipes are double-mantled meaning that no gas is emitted in case of any leakage. The vessel’s comprehensive gas detection system also shuts off the system if a leak should occur.

AGA will deliver the liquefied natural gas from its LNG terminal in Nynäshamn, which was inaugurated last year. The planning, pre-construction engineering and permit process for bunkering of the vessel at Stadsgården in the port of Stockholm is ongoing, the company said.

LNG is already used as a town gas in Helsinki and Stockholm and as a vehicle fuel.

About 35,000 vehicles on Swedish roads run on biogas and natural gas.

Elsewhere, Incat has secured a contract with Buquebus to build the world’s first high speed passenger ro-ro vessel powered by LNG. The 99 m wave piercing catamaran will start operating in the autumn of this year and will carry more than 1,000 passengers and 150 cars between Buenos Aires and Montevideo at speeds of up to 52 knots.

LNG ON RADAR

DNV commented “We see that LNG is on the cruise industry’s radar. Although there will probably not be a traditional cruise ship using LNG in the next five years, we believe we will see one in 10-15 years’ time.

“In the meantime, we will see a trend towards ferries, cruise ferries and short sea shipping moving to LNG. In addition, there is a lot of discussion about this within the traditional segments like container, bulk and tanker,” the class society said.

These developments will help to develop the infrastructure. DNV said that it believed that the technology is proven and ready for the industry; the challenges are to be found within four main areas.

LNG AVAILABILITY

This is a chicken and egg challenge, the

availability comes with demand. Very constructive approaches have been seen taken by LNG suppliers on a project basis, making LNG available for projects when needed.

Ferries, short sea shipping and support vessels will create local distribution and be the pathfinders that develop the initial distribution infrastructure, DNV said. In the Caribbean, however, small-scale power plants and industrial users may drive the demand for small-scale LNG operations faster than short sea shipping.

Cruise vessel owners want flexibility in the deployment of their fleets and reduced flexibility comes at a cost and a risk. An alternative is to design the vessel with dual-fuel capabilities. This risk and cost will be reduced, as the LNG distribution network increases.

The energy density of gas is about half that of oil products and the LNG storage tanks will occupy more space. This may affect the revenue-generating space on board. DNV said that it expected the development of prismatic tanks will mitigate the volume requirements somewhat.

One of the key questions is whether LNG will be perceived as dangerous, or as attractive, due to its environmental performance. Here, DNV said that there is a lot to learn from current projects and about how passengers perceive the risk and benefits.

In the class society’s view, the risk involved will be equivalent to that of conventional ships and its environmental profile will make LNG attractive. However, there is a communication and branding challenge that must be properly managed.

Regulatory concerns are a new area and there will be several stakeholders involved in, for example, defining regulations and obtaining approval for bunkering operations in port. These processes can be a little bit slow, but they are not showstoppers, DNV said.

These challenges will be solved over time and may be accelerated through co-operation between all the stakeholders in an LNG supply chain. DNV claimed that it is a catalyst for such co-operation around the world, with good results seen thus far in both Europe



Viking Grace seen at the outfitting quay after launching.

ECAs to control gas as a fuel use

There are 63 LNG-fuelled ships in operation, or under development as of May this year, up from 48 units recorded last December, according to a survey carried out by Zeus Development Corp.

These vessels do not include the LNGCs that also consume LNG as boil-off gas.

A key factor is IMO's Tier III emissions standards, which are scheduled to take effect in 2015-2016 is that the regulations require operators to reduce sulphur and nitrogen oxide emissions.

For existing ships, after-exhaust treatment is proving more popular, but for newbuilds, operators are taking advantage of LNG's unique properties, Zeus said.

"As LNG is better understood, architects are able to design ships specifically for LNG storage and propulsion," the company said. "Firms such as Wärtsilä now offer integrated on board fuel delivery systems and power units for shipbuilders."

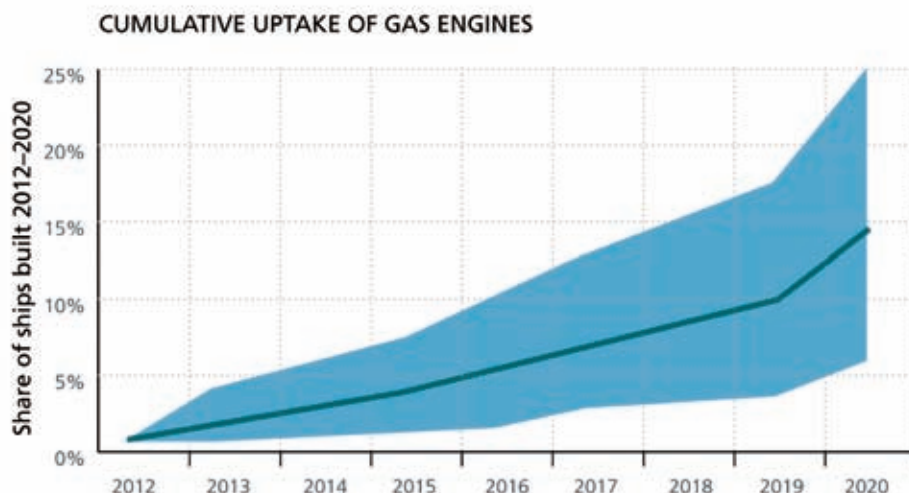
Zeus' survey found that LNG usage is growing beyond coastal ferries in Europe and offshore service vessels for the oil and gas industry, to large cruise ferries and container vessels while expanding geographically from Europe to North America and Asia.

Currently projects underway in Belgium, Sweden, Finland, South Korea, Singapore, Japan and elsewhere have made efforts to offer LNG bunkering and incentives to support LNG-fueled marine technology.

DNV REPORT

Earlier this year, DNV published a report on the likely energy savings technology used by the world's fleet in 2020.

To help answer this complex question, the class society developed a large scale simulation model, which predicted the world's fleet technology uptake by simulating



Source - DNV.

investment decisions, or individual vessels given different regulatory requirement scenarios, world economic growth and future fuel prices.

As regards to LNG as fuel, the report said that given LNG prices of around 30% cheaper than HFO, some 1,000 vessels will be powered by natural gas through 2020.

The number of vessels equals around 10-15% of the expected newbuildings to be placed before 2020. The total includes vessels purely run on LNG and those operating with dual fuel engines with full flexibility to switch fuels.

It was also found that larger vessels would benefit more from burning LNG as fuel, compared with smaller vessels due to economies of scale in equipment installation and the amount of fuel used by these vessels.

In the years 2018-2020, around 30% of newbuildings will be delivered fitted with

natural gas burning engines, the report said.

However, LNG only becomes a cost-efficient option for vessels spending more than 30% sailing time in an ECA. When the 0.1% sulphur limit is enforced in North America and Northern Europe in 2015, about 40% of the world's fleet will be affected, DNV said and small tankers and other types spending their entire time within an ECA area will be significantly affected.

The results showed that the threshold for LNG as a fuel being cost-effective is when a vessel spends around a third of its time in an ECA. However, very low gas prices could lower that threshold to 20%.

Newbuildings delivered in 2020 will emit up to 30% less CO₂ than a vessel delivered today with the EEDI being the catalyst of this reduction. Distillates will be the fuel of choice in an ECA, but the use of scrubbers would not be an option until at least 2020, DNV said, when the global sulphur emissions limit kicks in.

In the short term, the use of LNG and scrubbers will only have a limited impact on the need for LSFO.

DNV estimated that demand for LNG will be in the region of 10-15 mill tones in 2020, which is around 2-3% of the total LNG consumption within the EU last year. ■

"As LNG is better understood, architects are able to design ships specifically for LNG storage and propulsion,"

- Zeus Development Corp.



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Veka-Group develops small LNG tankers

Dutch-based Veka-Group has developed three new LNG tankers, which can also be used as bunker vessels.

Two tankers are destined for short sea trips and/or coastal services, while the third tanker, an LNG inland waterway bunker barge, is claimed to be the first of its type in the world.

The tanker sails almost completely on its 'boil off' gas cargo as fuel and is claimed to be 100% emission-free.

Following the delivery of the *Pioneer Knutsen*, the group has now unveiled three new designs.

With the *Pioneer Knutsen*, Veka-Group member Bijlsma Shipyard was years ahead of her time. "It was the first bi-fuel LNG tanker ever built", said managing director Arend Bijlsma.

"Especially for this project, we developed new technology for the storage of LNG and for the use of LNG as fuel for the propulsion engines. The combination of these two techniques made it possible to sail the tanker for a significant part on the 'boil off' - the gas that is released by keeping the load on the correct temperature. The engine switches to diesel in case of insufficient 'boil off' availability, which explains the term - bi-fuel, he explained."

Thanks to these innovations applied when



Veka's short sea LNG tanker concept.

building the *Pioneer Knutsen*, the design received the 'Clean Marine Award' from the European Commission.

"LNG is a natural gas made liquid by drying, cleaning and cooling it down to -164 deg C", explained Bijlsma. "The LNG stays

liquid in special thermally insulated storage tanks. During transport, a very small part of the load is released as gas. Before we found a way to use that gas as fuel for the propulsion engine, it was simply flared. The application of the gas as fuel is cost efficient and contributes to the environment."

Bijlsma said that he expected the use of LNG by vessels for coastal and inland shipping will increase rapidly. "Using LNG instead of gas oil gives already now a saving of roughly 25% on your fuel costs. Experts believe that the price of gas oil will reach a level of about €1,000 per tonne in the near future, whereas the price of LNG will not, or hardly increase.

"From a financial point of view, the use of LNG will be increasingly more attractive. In addition to this, the rules with respect to the environmental requirements are becoming stricter in more and more countries. For instance, in the Baltic Sea and the Gulf of Bothnia until a few years ago, vessels were allowed to use high sulphuric heavy crude. Now only low sulphuric crude is allowed. In the long term the environmental requirements



LNG inland 86 m bunker tanker concept.

Principal Particulars

Short sea LNG tanker

Length, overall	99 m
Beam, overall	15.4 m
Cavity	9.6 m
Draught	5.3 m
DWT	3,600
Loading capacity	2 x 2,000 cu m LNG tanks
Gas oil	50 cu m
Main engine	Dual fuel 1,400 kW

LNG – Oil Combi tanker

Length, overall	99 m
Beam, overall	15.4 m
Cavity	9.6 m
Draught	4.3 m
DWT	2,500
Loading capacity	1 x 2,000 cu m LNG container 4 x HFO, 2 MDO and 2 MGO containers = 2.960 cu m
Gas oil	50 cu m
Main engine	Dual fuel 1,400 kW

LNG inland bunker tanker

Length, overall	86 m
Beam, overall	11.45 m
Draught	3.5 m
DWT	2,050
Loading capacity	4 x 200 cu m LNG containers
Main engine	gas engine 1,000 kW

LNG containership

Length, overall	135 m
Beam, overall	11.45 m
Draught	3.5 m
DWT	4,000
Container loading capacity	268 TEU
Generators	2,400 kW gas engine

will be tightened worldwide. It is expected that then you will have to use gas oil again, or install a scrubber to remove sulphur and hydrates from the exhaust fumes. If you want to sail really clean and cost efficient, LNG is the only answer,” he said.

BUNKER STATIONS

As more ships will use LNG as fuel, there will be a growing demand for LNG bunker stations and tankers to supply these stations. “At this moment there are no small LNG tankers that can supply the LNG from the large terminals to smaller terminals, or directly to ships’, said Bijlsma. “Last year, an LNG ship moored for the very first time in Rotterdam and more will certainly follow. In the short term there will be a bigger market for small tankers. We want to be a pioneer in this field and therefore we started with the development of the LNG short sea tanker and the LNG – Oil Combi tanker.”

Both ships are equipped with dual fuel engines. “The engine runs for about 25% on the ‘boil off’ and for the rest on its own LNG cargo”, explained Bijlsma. “Because the engine can also run on diesel, a 1% diesel injection is used. The tankers are almost free of hazardous emissions. In a case where an LNG engine is installed, (the vessel) will be 100% hazardous emissions free. ’

This is already the case with the LNG inland shipping bunker tanker. “The 100% LNG engine burns the ‘boil off’ completely”, explained Veka project manager Robin Sijbrands. “The advantage of these engines is that with respect to the output they perform better than dual fuel engines. Therefore, only a very limited quantity of the LNG cargo is required for fuel consumption.”

This innovative tanker design has been

submitted for approval to the Central Commission for Navigation on the Rhine in Strasbourg and to the Maritime Safety Committee of the United Nations Economic Commission for Europe (UNECE).

“The results of the risk assessments carried out are very positive. The hull has already been completed. As soon as the plans have been approved, we will immediately proceed with the construction and completion of this tanker,” Sijbrands said. The LNG inland shipping bunker tanker is expected to enter service in late 2013.

Around the same period, an LNG inland shipping containership will also be delivered. ‘This ship, equipped with 100% gas engines, will be deployed on the Rotterdam – Duisburg route”, said Sijbrands. “It will be provided with two LNG tanks each having a capacity of 40 cu m.”

This ship, like the LNG inland shipping bunker tanker, is the claimed to be the first of its type in the world. “We have developed a system that enables the ship (while) in port to run the electrical network on board completely on batteries. This results in a situation of zero pollution, which is really unique. With additional battery sets, the ship can sail using electric power only,” Sijbrands said.

Also gas engines require much less maintenance than diesel engines. “You can sail much longer before an engine overhaul is required,” he said.

Sijbrands expected that this concept will quickly catch on in the market. “Especially for longer distances, the use of such a ship is profitable. We are sure that this ship, like the LNG inland shipping bunker tanker, will be another success for Veka-Group,” he concluded. ■



The innovative Pioneer Knutsen is operating along the West Coast of Norway supplying gas to the cross fjord ferry operators.

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The "Pioneer Knutsen" (which has also received the Clean Marine Award) is sailing proof that VEKA has been a frontrunner in the development and application of LNG and VDFE technology for many years now. Innovations that are proving their worth in practice, and that will propel your ship into a new era!

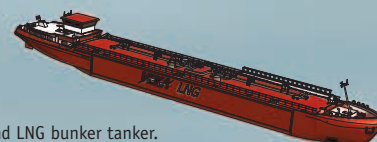
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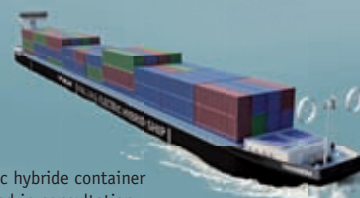
Pioneer Knutsen,
Already completed in 2008 and is used in Norway



4000 m3 short sea LNG tanker.
Under construction.
Completion end of 2013



86 m inland LNG bunker tanker.
Last phase development. Highly
developed LNG barge



Full LNG electric hybriide container
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Fuel	SO _x (g/kWh)	NO _x (g/kWh)	PM (g/kWh)	CO ₂ (g/kWh)
Heavy oil 3,5 % S	13	9-12	1,5	580-630
Gas oil 0,5 % S	2	8-11	0,25-0,5	580-630
Diesel <0,1% S	0,4	8-11	0,15-0,25	580-630
LNG	0	2	~0	430-480

Source: MARINTEK

Seven Baltic ports to start the ball rolling in bunker operations

The agreement in late June by seven Baltic ports to promote the development of an LNG bunkering infrastructure in the region marks a further important step in ensuring a future global role for natural gas as a clean-burning marine fuel*.

As the North and Baltic Seas are the originally designated ECAs, it is not surprising that there is a great deal of interest in the LNG option in Scandinavia and Northern Europe. Spurred by a national tax on NOx emissions, Norway has pioneered the use of LNG as a ship fuel.

The breakthrough vessel was the 95 m long, cross-fjord passenger/car ferry *Glutra* in 2000 and there are now 27 LNG-powered vessels, excluding LNG carriers, in service worldwide. All but one of the vessels, a Rotterdam-based inland waterway tanker, are small ships engaged in Norwegian coastal services and offshore. Furthermore, support for the LNG option is growing. As of early June 2012, there were more than 30 additional LNG-fuelled vessels on order.

The current orderbook includes Viking Line's 57,000 gt passenger/car ferry that will shuttle between Finland and Sweden, a pair of ro-ro cargo vessels earmarked for North/Baltic Sea duties, a Finnish patrol vessel, a Wadden Sea ferry and two 4,500 cu m LPG/ethylene carriers that will operate in the North Sea.

The seven Baltic ports that have agreed to promote the development of LNG bunkering infrastructure are Aarhus, Helsingborg, Helsinki, Copenhagen/Malmö, Tallinn, Turku, Stockholm and Riga. The project was initiated by the Baltic Ports Organization (BPO) and one-half of the €4.8 mill scheme will be financed by the European Union's TEN-T transport infrastructure programme.

The initiative commits the participants to a harmonised approach in their drive to realise the required LNG infrastructure. This means that the ports will share the results of their environmental impact assessments, LNG terminal and bunkering vessel feasibility studies, project proposals, regional market studies and safety manual development work. In

this way the bunkering infrastructure that each of the ports elects to provide can draw benefit from the communal effort, not last in the ability to make informed, cost-effective decisions.

The intention is to open the dialogue beyond the ports themselves to include the full range of stakeholders that would have a role to play in any LNG bunkering infrastructure development. Such players will include shipowners, terminal operators, gas utilities, energy traders and bunkering companies.

One of the outcomes of the BPO project, which is scheduled for completion in December 2014, will be the preparation of an LNG guidebook, which will lay down best practices and recommendations on how to develop port LNG infrastructure.

The approach of the entry-into-force dates for the stricter ship emission requirements; the relatively high price of oil; and the long lead times involved in providing the necessary LNG bunkering infrastructure are helping to provide the momentum that is overcoming the traditional roadblocks to utilising gas as fuel. The growing orderbook of LNG-fuelled ships and initiatives such as the BPO port co-operation scheme are evidence that the logjam has been breached.

In addition to the seven ports mentioned above, other LNG terminal projects are at various stages of development in a number of Northern European ports. These include Sweden, which already has one small LNG terminal, at Nynäshamn; is building another at Lysekil; and is studying the construction of bunkering arrangements in Gothenburg. The Norwegian gas liquefaction plant at Risavika, near Stavanger is a key supplier of LNG for both Nynäshamn and a new terminal at Fredrikstad, near Oslo and will be sending cargoes to a number of additional Baltic receiving facilities over the next few years.

Projects that will provide bunkering stations at Brunsbüttel, which is strategically located at one end of the Kiel Canal and the mouth of the River Elbe and at Hirtshals in Denmark are also poised to move ahead. Hamburg, too, is studying the provision of an LNG fuel supply chain, including a dedicated bunker vessel.

Another key feature of Northern Europe's evolving LNG infrastructure is the bunkering hub role that a number of large LNG import terminals will play. Poland is building such a facility and the provision of a bunkering station is a strategic part of the arrangement. Elsewhere, a similar Finnish import terminal/bunkering hub project is poised for take-off.

Two existing LNG import terminals are also being equipped to provide a bunkering service. The Zeebrugge terminal in Belgium, which is already capable of loading small coastal LNG carriers at its main jetty, is being provided with a second jetty able to accommodate even smaller LNG bunkering tankers.

The role of the Gate import terminal at Rotterdam/Maasvlakte will be similarly augmented to enable the commencement of bunkering operations at the port, including for a growing fleet of LNG-powered inland waterway vessels. Because the main Gate import terminal is unlikely to be able to undertake the bunker hub function itself, a supply of LNG will be directed to a new small-scale depot in the vicinity. ■

**This article first appeared in BIMCO News by whose kind permission it is reproduced in LNG Shipping Review. It was written by Mike Corkhill, who is a technical journalist and consultant specialising in oil, gas and chemical transport, including tanker shipping and chemical logistics. A qualified Naval Architect, he has written books on LNG, LPG, chemical and product tankers.*

Storing LNG as fuel in containers

Today, gas as fuel is quite standard on board LNGCs. There is no real secret in this anymore and more or less standard equipment is used, a leading German consultancy said.

Gas as fuel for non-gas carriers is the key subject and even here, there is no magic in running engines with gas, or turbines - the challenge is to locate the fuel and to get it safely on board and handled by normal, not experienced, or trained crew in handling LNG.

Many people and companies are keen on getting the gas on board by 'normal' methods, for example, bunker facilities and company tie-ups are under discussion, as are bunker station design and development and start-ups.

One consultancy working on these and other issues, regarding the use of LNG as fuel is Hamburg-based Marine Service GmbH, mother company to German shipmanagement entity Chemikalien Seetransport.

However, according to Jörg Redlin, director marketing & LNG division of Marine Service, the consultancy is following a different philosophy and is currently developing a logistics chain using LNG tank containers, stackable up to six high, connected to the LNG fuel system by dry quick couplings.

The couplings are designed as fail safe connection method for a normal seafarer and will even uncouple under wet conditions with only some few drops of liquid released. The basic technology of these couplings is used and proven in the aero industry.

Marine Service also provides gas handling units (sometimes called cold box) and the fuel gas system down into the engine room connecting to the gas valve unit of the individual vessel's engine(s).

"Due to the arrangement of the LNG tank container, we are able to build up stacks of tank containers thus forming a larger tank, either all connected together forming one big tank, or using individual

tank stacks, or one by one in a single operation," Redlin explained.

The tanks are super-insulated and will give a range of about 80 days standing time before the safety valve on the individual tank container will blow.

The system can be retrofitted on various vessel types, such as ferries, ro-ros, conros, cruise vessels, container feeder vessels, etc, ie all vessels going into ECAs. Similarly, the system can be installed on newbuilds. Moreover, the LNG/gas storage can be disconnected easily should a vessel not need gas as a fuel on board all of the time, as she may be operated in areas where 'clean' fuel is not required, ie outside ECAs.

Marine Service is currently working on several projects for different types of vessels and is building a prototype of the LNG tank container, which will be presented at SMM this month in Hamburg. The type approval is making good progress with a major class society and the first certificate is expected soon.



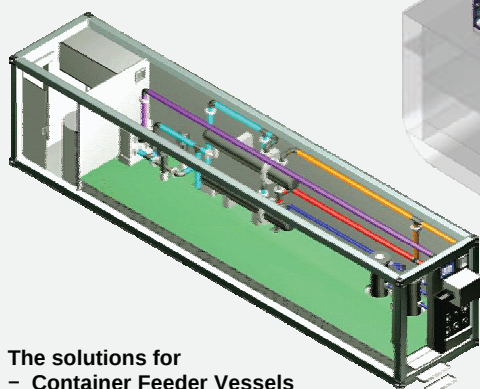
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Gothenburg to be LNG bunkering hub

A terminal for liquefied natural gas, LNG, could be completed in Gothenburg, the largest port in Nordic region, as early as 2015.

This is the aim of a letter of intent, signed by the Gothenburg-based Swedegas and the Dutch company Royal Vopak a little while ago. Once on stream, the terminal will be able to supply LNG to both shipping and industry and will be open to all parties interested in the Swedish market, including bunkering.

Royal Vopak, a specialist in the storage of liquefied natural gas and other energy products, and the infrastructure company Swedegas, which owns and operates the gas grid in south-west Sweden, started a feasibility study for an LNG terminal with the support of the Port of Gothenburg earlier this year.

Magnus Kårestedt, Port of Gothenburg CEO, said: "We welcome this initiative. Royal Vopak and Swedegas offer a strategic alliance with a strong combination of international experience and local market knowledge. The Port of Gothenburg has worked for a long time to be able to offer the shipping industry LNG 2015 by the latest".

LNG can be transported by sea, rail and road and it can reach parts of the country that at present have no gas infrastructure. Therefore, an LNG terminal in Gothenburg

would be of major strategic value, not only for shipping and the West Coast but also for industry in other parts of the country, the port said.

The planned terminal will have a capacity of 20,000 cu m, with further expansion possible, according to market demand. Natural gas will be brought to the terminal by sea using LNGCs.

The terminal will be open to all companies that are interested in supplying the Swedish gas market. The feasibility study, as agreed, will include technical and financial parameters and is expected to be completed by the end of this year.

The Port of Gothenburg will be among the first major ports in the world where vessels will be able to refuel, or bunker with LNG without having to enter a special terminal. As is the case today in the port, bunkering will take place from a bunker vessel while the vessel is being loaded, or unloaded.

ANOTHER LNG PROJECT

It was also reported recently that the port has already been working with local energy company Göteborg Energi in a partnership, labelled LGGOT, that has the same objective of building up LNG bunkering infrastructure.

LGGOT has confirmed that it is studying the feasibility of developing a bunker terminal

in Gothenburg, having launched studies in 2009 when the Port of Gothenburg and Göteborg Energi joined forces with Norwegian gas provider Gasnor, which has now dropped out of the partnership.

It has not yet been decided whether there will be one or two terminals in Gothenburg by 2015, as there is the possibility of the LGGOT project becoming part of a separate Vopak/Swedegas partnership.

Recently Hamburg welcomed its first arrival of an LNG powered vessel. The vessel's visit was in support of the LNG – the Norwegian Experience conference, organised by the German-Norwegian Chamber of Commerce with Innovation Norway and DNV Germany.

Also, a Dutch consortium, which includes the Port of Rotterdam Authority, announced that it is seeking to accelerate the introduction of LNG as transport fuel. The group of companies, which also includes employers' organisation Deltalinqs, have agreed with the Dutch ministers of Economic Affairs and the Environment to collaborate in a national LNG project, according to the Rotterdam Climate Initiative.

The 'National LNG Platform' aims to co-ordinate various initiatives that are underway to use LNG as transport fuel in and around the port of Rotterdam and in the north of the country. ■

Joint venture to market gas supplies in Northwest Europe

The Linde Group is setting up a 50/50 joint venture with bunker supplier Bomin to build a European infrastructure for the supply of LNG fuel for ships.

The JV is due to start its operations in the latter part of this year and will be headquartered in Hamburg.

The new joint venture will set out to establish an LNG supply chain and to provide reliable, safe and environmentally friendly fuel to shipowners and operators.

Linde will contribute its experience in cryogenics and its engineering knowhow, while Bomin will support the joint venture with its track record in maritime bunker fuel trading and operations.

Once in operation, the new venture will establish operations in a number of key ports throughout ECAs in Northwest Europe. For LNG to become an effective option for

meeting increasingly strict emissions limits, a network of LNG storage facilities needs to be set up for the bunkering of vessels in main European ports and harbours.

"With the new joint venture company we want to offer LNG to shipowners as an alternative energy source with a lower environmental impact than traditional bunker fuels. The knowhow combination of Bomin and Linde will enable us to offer attractive solutions in this emerging market," said Dr Claus-Georg Nette, executive board member of Bomin's parent Marquard & Bahls.

"Bomin is committed to the bunker business on a global scale. Combining our expertise in bunkering with Linde's gases and engineering knowhow adds support to the emerging LNG fuel market. As this partnership shows, Bomin is determined to remain innovative, offering multiple fueling solutions wherever we can," said Peter Schreiber, Bomin Group CEO.

"A readily available and cost-effective LNG infrastructure is key to the development of LNG as a maritime fuel," Prof Dr Aldo Belloni, Linde executive board member said. "This new joint venture underpins our LNG strategy, already visible in our recent opening of the LNG terminal in Stockholm harbour and our study for the introduction of LNG with the Hamburg Port Authority."

A Linde subsidiary has won the contract to supply gas to Viking Line's newbuilding cruise ferry *Viking Grace*, which will be supplied from the new facility at Stockholm.

Global demand for LNG is expected to increase by more than 10% per year, making it the fastest growing energy product in the world. By 2015, some 70 vessels are expected to run on LNG in the Nordic region. According to a study by the Danish Maritime Authority the consumption potential of LNG is estimated to reach about 4 mill tonnes by 2020. ■

Partnership looks at Singapore's LNG potential

In Southeast Asia, the Maritime and Port Authority of Singapore (MPA), has established a Joint Industry Project (JIP) to investigate the operational feasibility of LNG bunkering in collaboration with DNV's clean technology centre and 21 industry partners.

The JIP, co-funded through MPA's MINT fund, kicked off in January 2012 with the aim to provide recommendations to the Singapore government authorities on enabling LNG bunkering in Singapore, ensuring operational safety, alignment with industry expectations and best practice, and compliance with relevant international rules, regulations and standards.

LNG bunkering can be accomplished by transferring gas from the LNG carrying trucks, barges, or onshore tanks. Switching from conventional marine fuel to LNG fuel provides both environmental and economic benefits to shipowners and public alike, DNV said.

However, the most common key barriers to a more widespread adoption of LNG as a fuel for ships seem to be insufficient local LNG supply and immature bunkering infrastructure coupled with a lack of regulatory schemes for both shore-based and ship-to ship bunkering.

The feasibility of LNG fuelled shipping also depends on the simultaneous development of the entire value chain; the lack of such

concurrent evolution would be a major challenge and increase investment risk for each stakeholder.

The LNG bunkering JIP was conceived to address these feasibility issues and to reaffirm Singapore's commitment towards maritime sustainable growth. As the world's largest marine fuel bunkering port, it is strategically important to enable Singapore to offer LNG bunkering in the near future.

"With the growing need to reduce the environmental impact of shipping and its related activities, Joint Industry Projects such as these allow us to evaluate the feasibility of alternative marine fuel sources. This is also in line with MPA's commitment to clean and green shipping in Singapore. The results of this study will provide MPA and the maritime industry with the operational and technical information necessary to implement LNG bunkering in Singapore," said Capt M. Segar, MPA's group director (hub port).

The JIP represents a platform where a consortium of industry players can collaborate with each other to share knowledge on the topic and identify and recommend solutions to the issues faced by the sector.

This JIP is project managed by DNV and co-sponsored by the MPA, plus 21 industry partners including BG Group, DNV Petroleum Services, Energy Markets Authority, Fearnleys, Gas Supply Pte Ltd, Hong Lam Marine, IM Skaugen, IHI Corp, Innovation Norway, Keppel

Offshore & Marine Technology Centre, Land Transport Authority, Maritime and Port Authority, Mitsui & Co, Norgas (Asia), NYK Line, Rolls Royce Marine, Shell, Singapore LNG Corporation Pte Ltd, SPT Marine Services and Star Cruises.

The partners will share their expertise, technical and market insights, rendering the JIP an informed and productive platform capable of identifying recommendations on the solutions addressing the specific needs of Singapore.

Dr Anthony Barker, general manager for BG Singapore Gas Marketing and chairman of the JIP steering committee said "This study provides an opportunity for established and experienced LNG industry players to work with Singapore bunkering stakeholders to ensure best in class safety standards and operating procedures are incorporated from the outset of this exciting development".

"This JIP is a school book example on how industry and regulators can work closely together to accelerate the implementation of new technologies and industry solutions that one single player cannot accelerate alone. The JIP is an excellent platform driving a safe and predictable scaling of regional LNG bunkering business solution. It is yet another important step in developing Singapore's maritime cluster towards a Maritime Knowledge HUB", said Bjorn Tore Markussen, managing director for DNV clean technology centre. ■

Brunsbüttel to get LNG bunker station

DNV is to undertake risk studies of the proposed bunker station to be built at Brunsbüttel, conveniently located at the entrance to Kiel Canal and in the Elbe River estuary.

The LNG bunker station is the brainchild of Gasnor and Brunsbüttel Port. DNV has been contracted to conduct the risk studies of the project, which will be the basis for the authorities' approval of the project.

The planned LNG bunker station will provide a safe, reliable and cost-effective way for fuelling sea vessels and barges with LNG, the companies claimed.

Gasnor has signed up DNV to conduct the risk studies that will be the basis for the authorities' approval of the project. Important elements in the risk analysis are a safety screening of the site and a safety analysis for the chosen location in terms of quantitative risk analysis, emergency planning and nautical

risk analysis.

In addition DNV will be supporting the communication process with approval authority LLUR (Landesamt für Landwirtschaft, Umwelt und ländliche Räume/agency for agriculture, environment and rural areas).

"With this project, Gasnor and Brunsbüttel Ports GmbH are clearly taking a crucial step in the development of LNG bunkering infrastructure in this geographical area", said Mohamed Houari, head of solutions, Central Europe of DNV.

"We are pleased to work with Gasnor and Brunsbüttel Ports GmbH – a strong team that safely and responsibly will contribute to the development of a LNG infrastructure in North Germany," said Jan Tellkamp from DNV Germany.

THREE-PORT OPERATION

Brunsbüttel Ports is owner and operator of

three ports at Brunsbüttel (Elbehafen, Oilport and port of Ostermoor). The Elbehafen, being multi-purpose port with water draft of 14.4 m, provides ideal conditions for an LNG bunker station for shipping from and to Hamburg, as well as for all traffic on the Kiel-Canal. In 2010, 31,933 ships used the Kiel Canal and 9,843 ships called at the port of Hamburg.

"With this project we move forward within the demands of 'Green Ports'," said Frank Schnabel, managing director of Brunsbüttel Ports.

Gasnor is involved with the distribution and sale of natural gas in Norway. The company supplies customers with natural gas via pipeline network, in the form of Compressed Natural Gas (CNG) and LNG.

"We wanted DNV to do these risk studies as they have an impressive track record with regards to several LNG aspects," said Gasnor's Leiv Arne Marhaug. ■

Portable gas detection: an essential component of LNG vessel safety

In a World of mass global trade, the logistics industry has never been more prevalent than it is today. The constant need to move raw materials and other items is facilitated predominantly by commercial vessels*.

On these floating high-tech units, safety is an important factor, due to the fact that emergency help might not be as immediately available, as it would be on land.

Due to the extreme flammable potential of the materials carried on board vessels, such as LNGCs, ship designs include extensive gas detection and fire suppression systems that are automatically activated by the ship's safety control system.

Even with such equipment in place, additional protection is required to negate flammable gas migration risks and also the hazard posed by toxic gases like Carbon Dioxide, Carbon Monoxide, Nitric Oxide, Nitrogen Dioxide, Sulphur Dioxide and volatile Organic Compounds (VOCs). Oxygen depletion also poses a considerable risk on board LNGCs.

SOLAS regulation II-2/4.5.7 outlines the mandatory use and maintenance of portable

gas detection equipment on board liquefied gas tankers and states that *"tankers shall be equipped with at least one portable instrument for measuring Oxygen and one for measuring flammable vapour concentrations, together with a sufficient set of spares. Suitable means shall be provided for the calibration of such instruments."*

This makes the use of robust portable gas detection, capable of delivering simultaneous monitoring of flammable, toxic and Oxygen gas hazards an essential aspect of gas tanker safety. Solutions should also feature MED or ABS approval and as a benchmark, both certifications.

SEAFARER SAFETY

It is also important to remember that when it comes to personnel safety, a portable gas detector provides the first line of defence and with this in mind, protection from such a device can mean the difference between life and death.

The on board locations where portable gas detection is recommended are numerous; including personnel working in, or near any confined or enclosed spaces (such as tank spaces and inter-barrier spaces), locations where permits to work are required and engine, or cargo control and compressor rooms (unless classed as gas-safe). Portable gas detection should also be worn by a seafarer when carrying out inerting/purging of tanks.

Multi-gas portables, such as those produced by Honeywell Gas Detection (which comprises the brands Honeywell Analytics, BW Technologies by Honeywell and Biosystems), provide the ideal on board solution, delivering high-performance detection combined with intuitive, minimal training use, simplified ongoing device care and the ability to reduce costs, the company claimed.

With MED and ABS approval, Honeywell

Analytics' Impact Pro delivers high-specification 4-gas (flammable, toxic and Oxygen) monitoring that is capable of meeting every on board application. Its automatic integrated pump makes this device highly flexible for environmental monitoring and stratified testing prior to area entry.

With ABS approval, BW Technologies by Honeywell's GasAlertMicro5 5-gas monitor delivers an additional sensor and includes photo ionised detection (PID) technology for 0-1,000 ppm monitoring of VOCs. An optional automatic pump with visible integrated filter is also available, delivering additional flexibility.

When the most comprehensive solution is demanded, Biosystems' PHD6 6-gas ABS approved monitoring solution delivers maximised detection flexibility with additional monitoring capabilities, including PID technology for 0-2,000 ppm monitoring of VOCs, electrochemical technology for Oxygen and toxic, catalytic 'hot bead' technology, IR technology for flammable and Carbon Dioxide. An optional automatic pump is also available with this device.

As outlined in the SOLAS regulation 11-2/4.5.7, the ability to be able to calibrate and maintain such devices is also an important requirement. The products mentioned all have their own compatible automatic test, calibration and data-logging stations, providing simplified, one-button-interaction that not only allows the most time and cost-efficient solution to ongoing device care, but also one that requires minimal training.

In addition, Impact Pro's automatic solution – Enforcer – is fully portable with no batteries required, delivering additional dimensions through its portability. ■

**This article was written by Honeywell Gas Detection.*



CAPTION

Effective exhaust gas cleaning now possible

As has been well publicised, to reduce sulphur dioxide emissions on a long-term basis, the sulphur content in vessels' exhaust gases should be reduced from 3.5% at present to 0.5% by 2020, according to the IMO*.

As of 2015, there will even be a limit of 0.1% in the North Sea and Baltic Sea – a problem for many gas tankers and other types of vessels that operate in this region. To comply many will have to be converted to other fuels at great expense.

A less expensive, but just as effective alternative is retrofitting with scrubbers (exhaust gas cleaning devices). To further improve the effectiveness of the scrubbing process SAACKE GmbH now uses a special solids separator in its systems in which a major portion of the soot is separated before desulphurisation. This makes it possible to filter out up to 97% of the fine dust and sulphur dioxide, thus reducing air pollution to a minimum.

Currently there are around 50,000 vessels operating that altogether consume about 370 mill tonnes of heavy fuel oil per year. For decades, highly toxic components of the exhaust gas like sulphur dioxide, which is produced during the combustion of heavy fuel oil, were simply emitted into the environment. Among other things, such oxidation products are a cause of acid rain, which contaminates the world's ecosystems. For this reason the IMO has tightened its regulations in recent years.

In the North and Baltic Seas, for instance, there are already SOx emission control areas (SECAs), in which a sulphur limit of 1% applies. As of 2015, this will drop further to just 0.1%. This limit has already been applied in all European ports since 2010.

Shipping companies have already responded to the new and coming regulations. When new ships are ordered, the owners either attempt to do without heavy fuel oil, or equip them with scrubbers. However, for all vessels currently in operation it would be expensive and, in some cases, even impossible to convert them to burn other fuels. In these cases, it would be economically more efficient to retrofit them with scrubbers, since the costs are amortised

after only two years in many cases.

As a rule, these devices operate with spray nozzles in which the exhaust gases are brought into contact with a fine water mist. In closed systems, the washing water is mixed with sodium hydroxide to dissolve the sulphur out of the exhaust gas. However, this requires a considerable amount of water in which the chemical agent additionally has to be dissolved.

SCRUBBING WITH PURE SEAWATER

To implement more compact systems and avoid having to carry additives on board, seawater is usually used in scrubbers. The alkalis contained in seawater bind the sulphur without the necessity of chemical additives. In this process seawater is pumped into the scrubber and used in the spray nozzle. In the first cleaning stage, the exhaust gases are fed through a kind of spray mist, while in the second stage they go through a water cascade. The contaminated seawater can then be diluted with pure seawater in an open loop until the pH value reaches a normal level again and – in accordance with the IMO provisions – discharged into the sea.

Another option is to mix the contaminated water with lime in a closed loop. The resulting mixture can subsequently be used again.

To further improve the cleaning capacity of the scrubber and thus be prepared for future requirements, SAACKE additionally employs a special fan (VentSep) with an integrated separator. In this way the solids are removed from the exhaust gas even before nozzle scrubbing. The separated particles thus no longer enter the seawater, making disposal easier. Since the VentSep reliably separates all particles from a size of 2-3 µm, it is possible to filter out and collect a substantial portion of the soot. During nozzle scrubbing the soot would otherwise form a sludgy mass that is difficult to dispose of. The previously



Scrubbers can be used on LNGCs.

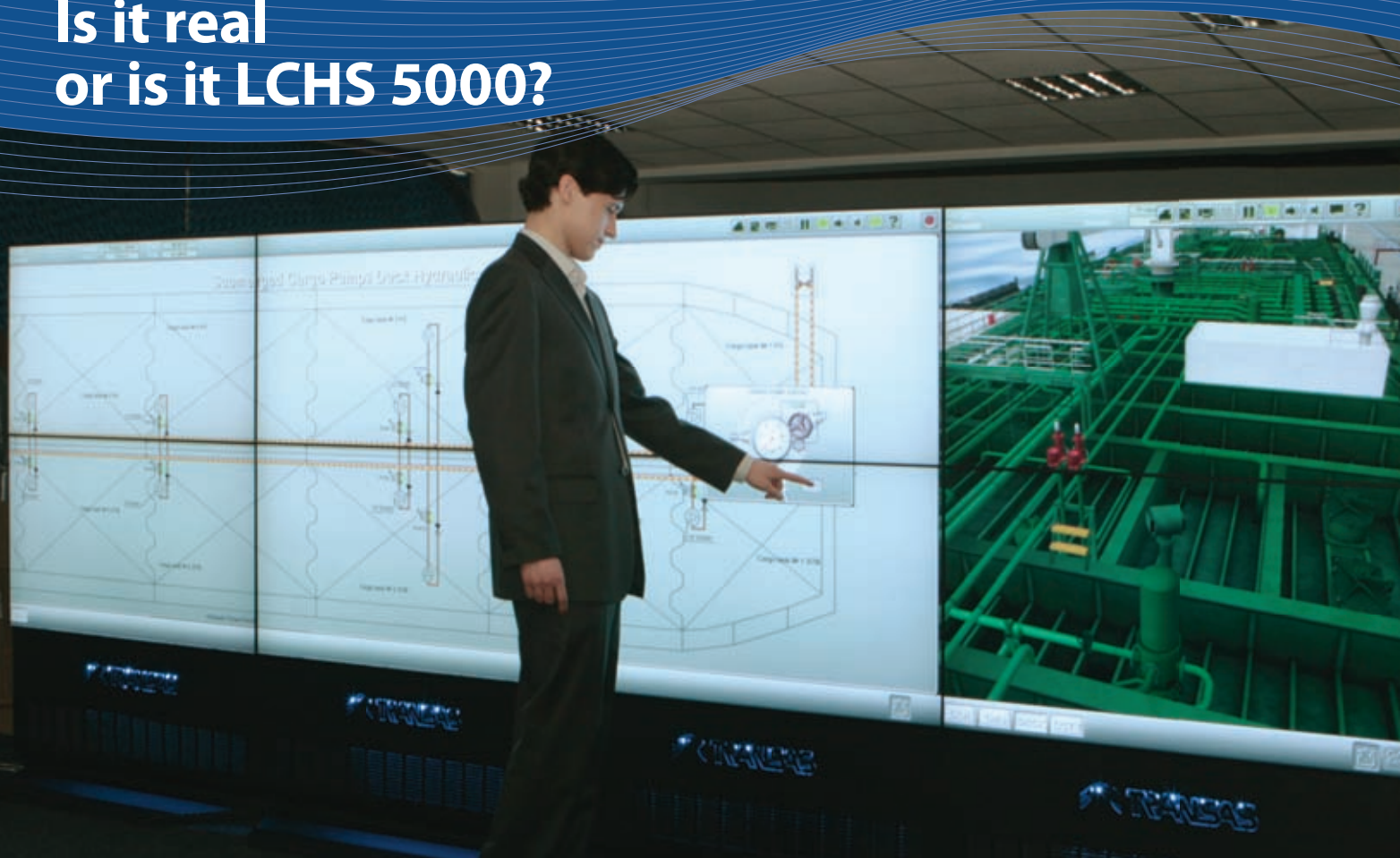
separated soot, by contrast, can be stored on the ship to be taken ashore at a later stage.

At exhaust gas temperatures in the normal range the VentSep can be placed directly in the exhaust gas flow of a boiler. Should the temperatures exceed a certain limit, however, it is necessary to connect a heat exchanger in between.

In addition to boilers, the scrubber can also be connected to the main propulsion unit. The advantage here is that connected flue gas heat exchangers are no longer contaminated. This reduces cleaning and maintenance requirements significantly. ■

**This article was written by Saacke GmbH of Bremen, Germany.*

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Orders still forthcoming, but finance a problem



Photo credit BG (Giles Barnard).

Again, a few changes to note since the last issue, especially the rise of the Greeks as major players. However, several orders are thought to be still on subjects, or just purely options, at this stage.

ALMI GAS

This Greek concern, a recently formed affiliate of Almi Tankers, has reportedly ordered two 159,800 cu m capacity LNGCs at DSME, which are rumoured to have been delayed, due to financing problems.

According to company reports, Almi Gas was also thought to have another two LNGCs on option at the yard.

The optional vessels are for 2015 and 2016 delivery, if firmed up.

ALPHA TANKERS & FREIGHTERS

Alpha Tankers & Freighters, an affiliate of Agelef Shipping, was thought to have joined the list of Greek-based shipowners in ordering LNG tonnage.

The company reportedly ordered two 160,000 cu m LNGCs at STX Offshore & Shipbuilding. One of the LNGC newbuildings was thought to be a converted contract originally placed for two Capesize bulk carriers

with an option to build a second gas carrier.

The second vessel was thought to have been recently firmed up with a delivery date of March 2015. The price was variously reported as \$192 mill - \$195 mill.

It is also believed that an option for a third vessel is still being held.

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 completed life cycle upgrades at Sembcorp Marine about 18 months ago.

AWILCO

Awilco acquired three 125,000 cu m LNGCs from Japanese owners and established Awilco

LNG ASA in the first half of 2011.

In Addition, in May last year, the company ordered two 156,000 cu m LNGCs at DSME for delivery in August and November 2013, respectively.

Awilco LNG ASA is listed on the Oslo Stock Exchange (Oslo Axess) with Awilco's ownership being around 34%.

BERNHARD SCHULTE SHIPMANAGEMENT (BSM)

BSM IoM, formerly Dorchester Marine and now part of the Bernhard Schulte Shipmanagement (BSM) group, has four 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 has developed extensive training courses to prepare the crews to operate these vessels direct from the newbuilding yards and into service. In addition, BSM recently formed

Liquefied Gas Consultancy, a service which now includes the various training courses.

The Isle of Man office currently has 16 other LNGCs under crewing management contracts, including vessels operated by National Gas Shipping Co 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 GROUP

The BG Group currently claims to control one of the largest fleets of modern LNGCs of any international oil and gas company.

The group said that its strategy is to try to secure and control a competitive, flexible, safe and reliable LNG shipping portfolio with sufficient capacity to meet its LNG transportation requirements.

BG Group has a core fleet of vessels under ownership - two 138,000 cu m capacity, seven 145,000 cu m capacity and four 170,000 cu m capacity LNGCs.

All of the owned vessels are operated by GasLog LNG Services.

BG Group is also an active charterer of third-party tonnage to capture business opportunities and maintain a balanced shipping position, the company said. In total BG Group operates around 25 LNGCs.

The Group said that it is also finalising a joint venture with China National Offshore Oil Corporation (CNOOC) for the design and construction of two LNGCs in China, which will also serve BG Group's global trading needs.

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 'Gem' class are powered by dual-fuel diesel-electric propulsion units, which are claimed to be more efficient than 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 14 LNGCs, the last of which was delivered in 2009.

In September last year, BW Maritime announced that a \$400 mill contract to build two 155,000 cu m capacity LNGCs, had been placed with Hyundai Heavy Industries.

An option was also agreed for another two vessels of the same type.

These membrane-type LNGCs are due for delivery in the second half of 2014 and the first half of 2015, respectively. The ships will be powered by dual fuel diesel engines (DFDE).

BW Gas currently manages eight gas carriers, ranging in capacity from 146,000 cu m to 149,000 cu m, all of which operate for Nigeria LNG in which BG has a 50% stake. The company also manages two other LNGCs

for GDF SUEZ in addition to the *Berge Arzew*, which is operating for Sonatrach.

Marubeni is to invest nearly \$710 mill in BW Gas and in particular in the eight LNGCs in the Nigeria LNG joint venture.

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

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.

CARDIFF MARINE

George Economou's shipmanagement concern - Cardiff Marine - has recently joined the swelling ranks of Greek owner/managers ordering gas carriers.

Four 159,800 cu m capacity LNGCs are currently building at DSME for delivery from 2013 through 2014.

Another two options are believed to be held.

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 COMPANY

Chevron Shipping operates the 2004-built LNGC *Northwest Swan* in association with the North West Shelf joint venture.

This year, Chevron also commenced the ship management and operation of three LNG carriers owned by Sonangol, Angola's national oil company.

The company was reported as ordering four 160,000 cu m capacity LNGCs at Samsung for delivery 2014-2015, although Chevron told *LNGSR* that these orders were not confirmed.

They were believed 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



The 145,000 cu m *Methane Lydon Volney* seen berthing at the Dragon Terminal, Milford Haven. Photo credit BG (Giles Barnard).

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 to Japan.

DISTRIGAS/ENI

Now owned by the ENI Group, 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, but was believed to be trading again.

DYNAGAS

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

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

For operational flexibility, the two 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.

Recently, Dynagas reportedly ordered seven 155,000 cu m LNGCs from Hyundai for delivery from 2013 through 2015.

EMPRESA NAVIERA ELCANO

This Spanish-based owner manages two LNGCs having taken delivery of a newbuilding in 2010.

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 owns or operates nine LNGCs.

The fleet includes one traditional LNGC, plus eight Energy Bridge brand Floating Storage Regasification Units (FSRU). An FSRU is an LNGC fitted with a regasification plant.

Excelerate Energy has another 173,400 cu m capacity regasification vessel on order at

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The 138,100 cu m *Excelerate* seen commissioning Excelerate Energy's Northeast Gateway facility in Massachusetts Bay in 2008.

Daewoo for delivery in 2014. She is earmarked for the Petrobras VT3 project.

In addition, the company recently announced that it had entered into a shipbuilding option agreement with DSME for the delivery of up to another eight sister FSRUs for delivery between early 2015 and early 2017.

However, Excelerate said that it held the option to build smaller, or larger, capacity

vessels depending on the future requirements of the market.

Excelerate has developed and commissioned six LNG import facilities worldwide, with a seventh facility entering service in the fourth quarter of 2012 and an eighth terminal currently in advanced stages of development in Puerto Rico.

Looking forward, Excelerate has a significant project development portfolio for both floating regasification, as well as floating LNG production projects. The additional vessels will support the advancement of these projects, Excelerate said.

The company claimed to have pioneered the concept of ship-to-ship transfers of LNG and all the vessels are equipped to discharge at traditional receiving terminals, as well as Excelerate's GasPorts and Gateways, which include buoy-based STL mooring systems for offshore locations.

EXMAR

Antwerp-based Exmar became involved in the LNGC sector in 1992, when as part of the Compagnie Maritime Belge (CMB) group, the company acquired the 1978-built 131,000 cu m *Methania*, which was on long-term charter to the Belgian importer, Distrigas.

The vessel was subsequently sold to Distrigas/ENI with Exmar retaining her management and the vessel is still in service.

Subsidiary Exmar Shipmanagement - previously known as Tecto - currently manages 13 LNGCs - eight of which are LNG re-gasification vessels (LNGRVs). Recently awarded shipmanagement contracts included two Distrigas/ENI-operated LNGCs.

Exmar developed and pioneered the LNGRV concept for El Paso before the

company exited the LNG sector and later the company embarked on a newbuilding programme, starting with two LNGCs ordered from Daewoo. They entered service in 2002-2003, respectively.

Following the collapse of energy trader Enron and the withdrawal of El Paso from the market, Exmar then worked with George Kaiser who formed Excelerate Energy (taking over El Paso's LNG portfolio), which timechartered the 2005-built LNGRV *Excelsior* from the company on a long-term basis and purchased a second LNGRV through the George Kaiser Family Foundation.

Exmar and Excelerate then jointly ordered a third LNGVR of 138,000 cu m capacity.

Subsequently, five more were ordered from Daewoo of 151,000 cu m each. The last in the series - *Exemplar* - was delivered in 2010.

In November 2010, 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.

Down the years, Exmar has developed into a diversified shipowning and operating group active in the offshore, LNG, and LPG/NH3 and petrochemical gas sectors.

GASLOG

GasLog owns 2.25 LNGCs with a further eight LNGCs on order.

Under subsidiary GasLog LNG Services, this Livanos-family (Ceres) controlled company manages and operates 14 LNGCs, excluding the newbuildings.

These include own ships, as well as 11 LNGCs owned, or leased by BG Group



Exmar's 151,000 cu m *Exquisite*.



The 145,000 cu m *GDF Suez Neptune* seen at Boston, Mass.

(Methane Services) and one additional LNG carrier in which the company has a 25% interest.

GasLog LNG services is supervising the building of another eight 155,000 cu m capacity LNGCs ordered by GasLog from Samsung, as well as managing the two that entered into service in 2010, purchased from Chevron.

Of the eight vessels ordered at Samsung, plus two options, four will enter service for BG, two are earmarked for Shell, while the last two were still charter free at the time of publication. They are to be delivered from January 2013 through 2015.

When delivered, all of 10-owned ships will be sisterships equipped with the latest tri-fuel diesel electric (TFDE) propulsion technology.

GAZOCEAN

The French shipmanagement concern, a subsidiary of GDF Suez and NYK, looks after the three LNGCs operated by GDF SUEZ, which see, plus the 150,000 cu m *Grace Cosmos*, owned by NYK.

In addition, Gazocean used to manage the small elderly 40,000 cu m capacity LNGC *Tellier*, which operated for Messigaz between North Africa and southern France.

In April of this year, she arrived in Ghent to be recycled.

GDF SUEZ

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

GDF SUEZ owns, or part 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).



GasLog's 145,000 cu m *Methane Lydon Volney* is operating for Methane Services, part of the BG Group. Photo credit - BG (James Lacombe).

GOLAR LNG

In 2010, Golar joined forces with Wilhelmsen to establish Golar Wilhelmsen Management (GWM). Today, GWM manages all 13 of Golar's LNGCs and FSRUs.

Golar has four converted FSRUs operating on at least 10-year charters – two with Petrobras, one with the Dubai Supply Authority and the latest one with Nusantara Regas using the recently converted LNGC *Khannur*.

Another FSRU was sold in 2010 to Italian interests and is operating off Tuscany.

Several other projects are under negotiation and with this in mind, the company has reactivated the laid up LNGCs *Gandria* and *Hilli*, following the re-entering into service of the *Gimi*.

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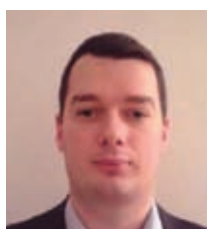
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LNG TIMES



One of Exmar's LNGCs seen adjacent to a Golar FSRU in Brazil, operating for Petrobras.

Having previously announced two firm newbuild contracts with Hyundai Samho Heavy Industries, the company announced on 26th February, this year that it has entered into firm contracts with Samsung for two more LNG carriers to be delivered in the second quarter of 2014 and early 2015, respectively. Both orders include two options.

The aggregate price for the latter two ships was about \$400 mill. Attached to both options is the right to select an FSRU alternative and the vessel contracted for delivery in early 2015 also comes with the option to build it as an FSRU.

These orders take Golar's total newbuild orderbook to 13. All the vessels will be delivered with tri-fuel diesel electric engines, with the lowest boil-off rate available of around 0.1% and a service speed of 19.5 knots.

Overall, two LNGCs are to be built at Hyundai Samho and the other 11 LNGCs, including two FSRUs, will come from Samsung.

In its second quarter 2012 presentation, Golar said it is optimistic with regards to further prospects for growth in the company's FSRU business. With the delivery of the West Java Project, the company's fourth operational FSRU, Golar remains the only company in the world to have delivered operational FSRU projects based on the conversion of an LNG carrier. The company said that it was also encouraged by current market demands against a small supply pool of FSRU owner/operators and FSRU assets in the 2013/2014 time frame.

Golar has been shortlisted for another two FSRU projects, while a third, for which Golar

had been previously shortlisted, is nearing a decision point. As a result, the prospects for at least one new FSRU contract being awarded to the company this year looks increasingly promising, Golar said.

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

Höegh LNG, which is listed on the Oslo Stock Exchange, owns and operates a fleet of six LNGCs, as well as two floating storage and regasification units (FSRUs).

Last year, the company ordered three new 170,000 cu m FSRUs and took delivery of one additional LNGC.

With rising demand for natural gas, the company has emerged as a leading provider of floating regasification services.

In January 2012, Höegh LNG signed an agreement with Perusahaan Gas Negara (PGN) to provide an FSRU to serve as a new LNG import terminal in Sumatra, Indonesia, where it will be moored offshore and connected to the existing gas grid, via subsea pipelines.

This agreement takes the form of a firm 20-year time charterparty with two five year period extension options. Operations are scheduled to start in 2014.

In the first quarter 2012, Höegh LNG also entered into a 10-year timecharter for an FSRU to be moored at Klaipeda, Lithuania, to provide an alternative source of natural gas to the country. This FSRU is expected to commence operations in the second half of 2014.

Höegh LNG's strategy is to continue growing within the FSRU market and the



Höegh LNG's winterised 148,000 cu m Arctic Princess.



The K Line-managed 155,000 cu m *Trinity Arrow* was the first vessel to be fitted with GTTs M-III membrane system when delivered in 2008.

company is actively involved in several tender processes for new floating LNG import terminals, it said.

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- 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 Indonesian energy concern 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 has eight LNGCs on its books, including two 75,500 cu m capacity Medmax types, all operating for Sonatrach.

HYUNDAI MERCHANT MARINE (HMM)

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

They all operate for KOGAS carrying 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 26 LNGCs and wholly owns the 138,300 cu m *SK Sunrise*, operated by SK Shipping on charter to KOGAS.

In 2008, Iino began a joint LNG transport operation with Kansai Electric Power Company (KEPCO), thus boosting its LNG fleet interests.

KAWASAKI KISEN KAISHA (K LINE)

K Line claims to be the first Japanese concern to take delivery of an LNGC when, in 1983, the 125,000 cu m *Bishu Maru* joined the fleet.

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 2010, 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.

Earlier this year, Knutsen confirmed that the *Ribera del Duero Knutsen* was technically ready to carry LNG to Japan/South Korea through the Northern Sea Route (NSR). Knutsen OAS Shipping said that with some reservations, it had received the approval of Russian authorities, allowing the ship to undertake a passage in the coming season, the company said.

"We started preparations in the spring of 2010. The Murmansk based NSR administration has now approved our application, subject to our acquiring charts, navigation equipment and warm clothing for the crew," the company said.

The LNGC is claimed to be the only vessel of this size in the world capable of carrying out such a journey. It is classed with the notation ice class ICE 1A by Det Norske Veritas and has a winterisation notation.

"We estimate that the passage from northern Europe to Japan will take half the time it takes to sail through the Suez Canal. On parts of the passage, we shall need the assistance of two Russian nuclear icebreakers," Knutsen said.

Today, Knutsen OAS Shipping manages one small and eight large modern LNGCs operating worldwide, including the *Pioneer Knutsen* operating on Norway's west coast delivering gas as a fuel to the ferries plying across 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.

KUWAIT OIL TANKER CO (KOTC)

Within part of KOTC's recently announced fourth phase of its newbuilding programme, three LNGCs were mentioned.

During August, a company official outlined the next \$1 bill newbuilding phase without giving any details.

KOTC primarily lifts cargoes for its parent Kuwait Petroleum Corp (KPC).

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



Two of Maran Gas-managed LNGCs, the 145,800 cu m *Maran Gas Coronis* and her sister ship *Al Jassasiya*.

LNG terminal projects, including the one planned 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.

However since then, the company has ordered seven 159,800 cu m LNGCs from DSME and another four 161,900 cu m vessels from Hyundai Samho.

At least four of the DSME units and all of the Hyundai Samho vessels are thought to be chartered to BG.

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

MISC BERHAD

The Petronas subsidiary owns 27 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 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 LNGCs 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.

Two other MISC LNGCs – *Tenaga Satu* and *Tenaga Empat* were recently converted at Malaysia Marine and Heavy Engineering (MMHE) and Keppel Shipyard, respectively, into FSUs to be moored at Malaysia's first regasification terminal with a start-up targeted for the third quarter of this year.

They will be timechartered to Petronas Gas, which will deploy the vessels at its Sungai Udang terminal in Malacca. Each vessel will be able to store 130,000 cu m of LNG, transferred from laden LNGCs.

Both vessels were previously laid up having come off charter in 2010.

MISC is also undertaking a front-end engineering and design (FEED) study and project for a Petronas floating LNG (FLNG) project.



MISC's 145,000 cu m *Seri Angkasa*.



The MOL-managed 147,000 cu m *Fuwairit* recently carried RasGas' 100th cargo from Ras Laffan.

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 2008, MOL claimed to be involved with around 35 worldwide gas projects, a figure which is likely to increase.

In January 2011, MOL and its partner ExxonMobil announced the ordering of four 177,000 cu m LNGCs at Hudong-Zhonghua for delivery 2015-2016.

They will be used to ship 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).

In June of this year, MOL announced the signing of a long-term contract for two new LNGCs with Kansai Electric Power. At the same time, MOL concluded contracts to build a 164,700 cu m LNGC at Kawasaki Heavy Industries and another 155,300 cu m vessel at Mitsubishi Heavy Industries.

The ships are due for delivery in 2016 and 2017, respectively. MOL will manage and operate the vessels, which will transport LNG for Kansai Electric Power.

The first vessel will be a Moss-type LNGC, based on a new design from Kawasaki. Upon delivery, this vessel will be the largest in its class that will be able to pass through the expanded Panama Canal,

which is scheduled for completion in 2014, while maintaining a hull size allowing it to call at major LNG terminals around the world, MOL claimed.

The second vessel is one of the 'Sayaendo' series carriers developed by Mitsubishi, featuring a continuous cover over its four Moss-type spherical tanks. The peapod-shaped continuous cover is integrated with the ship's hull, achieving weight reduction while maintaining overall hull rigidity. This will increase fuel efficiency, MOL said.

In addition, MOL has two more 155,000 cu m LNGCs building at Mitsubishi in a joint venture with Osaka Gas. They are due for delivery in 2014-2015, respectively.

NATIONAL GAS SHIPPING CO (NGSCO)

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

NGSCO currently 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



NGSCO's 138,000 cu m *Umm Al Ashtan*. Photo credit Solar Solve.

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 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, it said.

NIPPON YUSEN KAISHA (NYK)

NYK operated 28 LNGCs and had interests in 66 at the end of March this year. The Japanese group is involved with many joint ventures, including one with Sovcomflot for the Sakhalin project.

In March 2011, the company ordered a 145,400 cu m LNGC at Mitsubishi 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. TEPCO had signed a 15-year agreement with LNG Marine Transport to import the gas.

In October 2010, an 145,330 cu m LNGC built for joint owners NYK; CPC Corp, Taiwan (CPC) and Mitsui & Co was named *Taitar No 4*. She was the last of four sisterships and joined *Taitar No 1*, *Taitar No 2*, and *Taitar No 3* to ship about three 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 was delivered by Kawasaki for a Tokyo Gas charter.

Also last year saw the delivery of a four 160,400 cu m LNGCs from Samsung. They were ordered in a joint venture with Teekay and trading house Mitsui & Co on the back of a charter to 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.

NOVATEK

Novatek plans to order 10 LNGCs for its Arctic project, according to reports from Russia.

The vessels, which will have a capacity ranging from 183,000 to 208,000 cu m, will be used for the transportation of LNG from the future Yamal LNG plant.

The information about the vessels was

submitted to the Russian Shipping Register, Portnews.ru reports. The ships are currently in a conceptual design phase and will be built after a tender planned to be held this year. They will be able to operate year-around in harsh ice conditions.

According to the *BarentsObserver*, Novatek intends to export most of the LNG from Yamal to western markets. However, the company had earlier indicated that it also will use the Northern Sea Route (NSR) for eastwards export to Asian markets.

The Yamal LNG project will serve the nearby South Tambey field. It will be developed and operated by Yamal LNG, a joint venture of Novatek and project partner Total. Project production start-up is planned in 2016.

The giant Shtokman project in the Barents Sea, might also eventually need a total of 20 LNGCs to export the gas, the influential newspaper said recently.

OMAN SHIP MANAGEMENT

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

In addition, Hyundai is building a 162,000 cu m LNGC for delivery in 2014. This vessel will have accommodation for up to six cadets, plus an instructor.

OVERSEAS SHIPHOLDING GROUP (OSG)

The commercial and technical 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 25 year charters to QatarGas.

PETRONET LNG (PLL)

Petronet is a consortium of India's leading gas enery 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 this year.

In May of this year, Petronet LNG and Gangavaram Port Limited (GPL) signed an

agreement to develop a land-based LNG terminal at Gangavaram Port, Andhra Pradesh with a capacity of 5 mill tonnes per annum.

It is scheduled to come on stream in 2016.

Two Indian LNGCs have served the Dahej terminal since 2004. They came under the technical management of SCI in 2008. They are used to transport 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.

More recently, Petronet has signed a contract with GDF Suez for the supply of LNG.

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 of the joint venture 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 nine 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

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, the Japanese-led consortium of Mitsui OSK, NYK, K-Line, 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.

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

In 2010, shell awarded Samsung a contract worth about \$4-\$5 bill to build a 220,000 cu m LNGFPSO. The FPSO will be delivered by

2017 and is jointly designed by Samsung and Technip.

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

Earlier this year, Shell agreed to long term charter two of Sovcomflot's four ice class 170,000 cu m LNGCs under construction at STX Offshore & Shipbuilding in co-operation with JSC United Shipbuilding Corp.

The first vessel is due to enter service in late 2014, while the second vessel will follow early in the following year.

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.

In 2007, KOGAS awarded SK Shipping a further 22-year contract to transport LNG to South Korea.

IM SKAUGEN (IMSK)

Last year, IMSK took delivery of the sixth hybrid gas carrier – *Bahrain Vision* - capable of transporting LNG, ethylene and LPG.

She is being operated by Bahrain LNG and is the first vessel in the Norgas pool to operate for the Middle East company.

The first vessel in the series - *Norgas Innovation* - was delivered into the Norgas pool in 2010.

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

IMSK has also become involved in the complete LNG supply chain by signing a partnership deal with Lyse Gass, which has opened 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 – Sonangol - operates three 173,000 cu m LNGCs delivered in 2007-2008 from DSME.

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 and 2008, 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 for the Tangguh project in a joint venture with NYK and Samudera.

In addition, SCF ordered four ice class 170,000 cu m LNGCs from STX Offshore & Shipbuilding. They are being built in co-operation with JSC United Shipbuilding Corp and will be delivered from 2013 through 2015.

Two of the vessels will be operated by Gazprom, while Shell has taken the other two on long term charters. The first of the Shell vessels is due to be commissioned in late 2014 and the second vessel in early 2015.

The involvement of the Russian shipbuilding group in the newbuilding project



The 1976-built STASCO-managed 121,900 cu m LNG Lagos proves the longevity of gas carriers. She is operating for Bonny Gas Transport. She was originally managed by Nedlloyd as the *Gastor* and spent some time in layup in Scotland.



SCF's 145,000 cu m *Grand Aniva* seen bunkering at Nakhodka. She was the first gas ship to bunker at the Russian Far East port. Note enclosed bridge for harsh weather operations.

will enable sophisticated, higher value ships to be built in Russia and will provide for the future specialist gas carrier needs of Russian oil & gas companies, for work on the continental shelf, in order to develop Arctic and sub-Arctic offshore fields, SCF said.

SCF vessels are mostly managed in Limassol by subsidiary SCF Unicom.

STENA LNG

Last year, Swedish shipping company Stena Bulk purchased three ice class LNGCs from Taiwan-based shipping company TMT for a total of \$700 mill and this year formed Stena LNG to handle all the Stena Group's LNG activities.

A proposed IPO in Oslo has been put on hold, due to the current economic conditions.

The three LNGCs purchased included the 145,000 cu m LNGC *Stena Blue Sky* and the two newly delivered 173,400 cu m gas carriers *Stena Clear Sky* and *Stena Crystal Sky*.

Upon their delivery, the two newbuildings cleared vetting and management audits in record times.

Since then, the company is contemplating firming its growth strategy and supervision by ordering LNGCs at DSME and Samsung, although the contracts have not been confirmed thus far.

Northern Marine Management, a fully-owned Stena company, is the technical manager for the *Stena Crystal Sky* and *Stena Clear Sky*, while V Ships was retained as managers for the *Stena Blue Sky*.

Stena Teknik, a division of Stena Rederi, is the in-house supervisory technical R&D division and has the responsibility for technical yard specification analysis and newbuilding supervision for the LNGCs, as well as Stena's other vessels.

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 in 2010 and is managed by Hoegh Fleet Services.

STREAM

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

Stream currently operates around 18 LNGCs having taken delivery of two vessels chartered from Knutsen and one from Elcano a year or so ago. The trio were built for the Peru LNG project.

In February of last 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 also 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).

TEEKAY LNG PARTNERS

Teekay entered the LNGC market in 2003 and a year later, Teekay LNG Partners was formed, leading to an IPO in 2009.

The Partnership now claims to be the world's third largest independent owner and operator of LNGCs, providing LNG, LPG and crude oil marine transportation services primarily under long-term, fixed-rate charter contracts with major energy and utility companies through its interests in 27 LNGCs (including one LNG regasification unit), five LPG/Multigas carriers and 11 conventional tankers.

Teekay LNG's ownership interests in these vessels range from 33% to 100%.

The increase in the number of LNGCs controlled, or part controlled by Teekay LNG Partners, was boosted by the purchase of 52%, in a joint venture with Marubeni, of six Maersk LNGCs, which was finalised earlier this year and by taking a 33% stake in four Angolan LNGCs from Teekay Corp in August 2011 and January of this year.

Non-controlling interest includes a 30% equity interest in the RasGas II project (which owns three LNGCs), a 31% equity interest in the Tangguh Project (which owns two LNGCs), a 1% equity interest in the two Kenai LNGCs, a 1% equity interest in the Excalibur joint venture (which owns one LNGC) and a 1% equity interest in the five LPG/Multigas carriers, which in each case the



The Teekay-managed 151,700 cu m *Al Marrouna* seen in drydock at N-KOM, the Nakilat-Keppel Offshore & Marine Erhama Bin Jaber Al Jalahma Shipyard. Photo credit – International Paint.

Partnership does not own.

Teekay LNG Partners' head Peter Evensen said recently in a presentation; "The LNG shipping market continues to exhibit strong fundamentals, which enabled the Partnership to recently secure a new three-year timecharter for the *Magellan Spirit* at a rate which is approximately 20% higher than under its existing charter.

"The new contract will commence in September 2013 when the *Magellan Spirit*'s current timecharter expires. In addition, the Partnership has been actively assessing opportunities to make additional accretive investments in new LNG-related projects and existing LNG assets with long-term contracts. With approximately \$400 mill of available liquidity, the Partnership is well-positioned for further acquisitions," he concluded.

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

THENAMARIS

The Greek shipowner/manager recently entered the market and ordered three 160,000 cu m LNGCs at Samsung for 2013-2015 delivery.

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

From a slow start, the vessel was recently chartered at a rate, which is claimed to be nearly four times as much as the rate it was earning in the second quarter of 2011.

By placing a tri-fuel LNGC newbuilding order of 162,000 cu m this year (plus an option for an additional vessel), TEN said that it can leverage this modest exposure to its long term advantage.

The new vessel is due to be delivered in the first quarter of 2015, while the option is declarable by October of this year for delivery in the fourth quarter of 2015.

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.

Boosted by the success of the *Coral Methane*, Anthony Veder ordered a larger hybrid gas carrier from Meyer Werft in January of last year.

To be named *Coral Energy*, she will have a cargo capacity of 15,600 cu m and will be powered by a dual-fuel engine. She is due for delivery at the end of this year and will then enter into a long term charter with Skangass.

Meyer Werft's sister company, Rostock-based Neptun Werft, is involved in the construction and outfitting of the new vessel.

The Papenburg-based shipyard's focus is on mid-scale ships of this type, as well as its cruise ship designs. "We see that the smaller-scale LNG market has a great future," said Bernard Meyer, managing partner at Meyer Werft, talking at the time of the contract placement. ■

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