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REVIEW



- Political issues could cloud future
- LNGC opportunities via Panama
- Orders for Yamal
- Gas burning engines orders
- Bunker facilities gaining ground
- Engine conversion programme

September 2014



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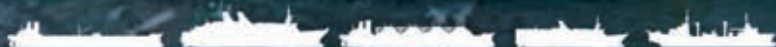
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The sun is certainly not setting on the LNGC sector, as more and more projects are due to come on stream by the end of this decade.

China and Russia (politics aside) are due to drive the forecast growth in the LNGC fleet. The Asian countries will remain the largest importers of natural gas as their needs for cleaner energy are set to grow considerably.

Technology is also keeping pace with this growth, illustrated by new engine and vessel design, especially in terms of low emissions and Arctic ice conditions.

It will be interesting to see where this shipping industry sector is in 12 months time.

Photo credit- BW Maritime.

A buoyant future but keep an eye on political issues



It seems highly appropriate that exactly 50 years after the first purpose-built LNGC entered service, the market is buoyant again.

The *Methane Princess* started to import Algerian gas from Arzew to the UK receiving terminal at Canvey Island in June, 1964. She was the first of two sisters, which were quickly followed by other LNGCs, most notably the French *Jules Verne*, culminating in the 131,235 cu m *Methania* in 1978, which at the time was the world's largest gas carrier.

At 27,400 cu m capacity, today the *Methane* sisters would be dwarfed by the world's largest LNGC, the 266,000 cu m Q-Max *Mozah*, delivered in September 2008. It is very doubtful whether this size will be surpassed in the future, except by static FLNGFPSOs and other storage units.

There are now around 400 LNGCs in service worldwide and around 125 on order. However, these figures are changing almost weekly, as new deliveries come on stream and new orders are announced. The number of vessels in service has increased by almost 40 since the same time last year.

Although the market was sluggish for a few years, recently it has taken off again with

forecasters predicting a 50% growth in the use of gas worldwide between the years 2010 to 2035. There are certainly many projects due on stream in the next few years, which will result in an increase in the transport of natural gas by sea.

By 2025, 15% of the world's natural gas exports will be exported in its liquid form on board LNGCs – the rest will be transported in pipelines, the forecasters predict.

Of course, these optimistic figures could be affected by politics rather than supply/demand factors, as there are question marks hanging over Russia's future as a natural gas producer and there is the possibility of Iran joining the list of countries exporting LNG in the longer term.

Giant gas production fields off Australia, Papua New Guinea (PNG) and in the Barents Sea are either coming on stream, or will do shortly. However, it is doubtful whether the huge Shtockman gas project will ever see the light of day. And then there is the US with its abundance of shale gas. The US is predicted to become one of the major natural gas

exporters within the next five to 10 years.

At present, the Middle East and Australia produce most of the world's natural gas, plus African and Asian countries, as well as Russia. The prime import markets are Asian countries, such as Japan, South Korea and China.

The next tranche of new production will occur in Australia 2014-2016, followed by US and Russia in 2016-2018, plus Canada and East Africa by the end of this decade- politics willing.

WEAK MARKET

As for the LNGC market, at the end of July, the 12-month timecharter rate stood at \$41,500 per day, while the spot market averaged \$42,500 per day, according to Fearnleys. Although the rates are down on those seen earlier in the year, the forecasts for next year and beyond are healthy.

There are more than 30 vessels due for delivery this year, which should result in a weak market throughout the rest of 2014. Improvement is expected in mid to late 2015.

However, the long term picture is forecast to be very strong, due to 120 mill tonnes plus of production per year under development in fields worldwide.

According to one report, LNGCs have been ordered at the rate of nearly one per week with almost \$5 bill invested up to the beginning of July. South Korean builders were expected to win about 75% of the nearly 50 orders forecast for this year.

Speaking to Platts, Santos LNG head David Knox said recently that the Gladstone LNG project was on track to ship its first cargo in 2015. The project will eventually deliver about 11% of South Korea's domestic gas needs and around 9% of Malaysia's gas demand for the next 20 years.

ExxonMobil's operated PNG LNG project - which became operational in May this year, six months ahead of schedule - is to ship a cargo every four to six days to term buyers in China, Taiwan and Japan for the next 30 years.

Santos' new projects are expected to hit the market at the same time as a raft of new developments in Australia, which will add over 40 mill tonnes of natural gas per year to the market by next year.

Interest in the Yamal project is being ramped up with several newbuilding specialised gas ship orders reported this year (see page six), although politics could also play a part here.

In Japan, shipbuilder Kawasaki said that due to the country's needs for cheaper energy after the 2011 Fukushima nuclear accident, domestic shipbuilders are counting on upcoming contracts for gas carriers to be used to ship gas from US shale projects.

Japan's four major shipbuilders, including Kawasaki, have together bid to build vessels earmarked to ship LNG from the Cameron terminal in Louisiana when it comes on stream in 2017. Mitsui & Co said that it planned to secure 10 LNGCs for the project. More talks on orders for other US shale gas projects could start this year.

Indeed, Japan's top shipping companies said that they will order around 90 new LNGCs in total worth about Yen1.8 trill (\$17.61 bill) by

2020, as they gear up to transport rising volumes from North America and Australia, according to reports from the country.

For example, Mitsui OSK Lines aimed to increase the number of its LNGCs to 110 by 2020 from about 70 today, it said. Nippon Yusen KK planned to raise its LNGC fleet to 100 vessels by 2020 from about 70, while Kawasaki Kisen Kaisha said it would order about 20 new LNGCs before the end of the decade.

Several of these orders could be placed through joint ventures. However, the exact number of vessels which will see the light of day depends on Japan's natural gas needs going forward.

VOYAGE CHARTERPARTY

To help serve the increasing spot market for LNGCs, BIMCO hosted an LNGVOY sub-committee meeting on 15th July this year.

The LNGC market is seen as traditionally a long term timecharter type operation. However, the spot market for LNGCs has increased lately.

In collaboration with the International Group of Liquefied Natural Gas Importers (GIIGNL), BIMCO has set out to develop an LNG voyage charterparty (LNGVOY).

The sub-committee consisted of representatives from MOL, Exmar, Vitol, Platou, Stephenson Harwood, GIIGNL, Nordisk and Thomas Miller. Shell was also invited.

BIMCO's head of documentation- Grant Hunter- told LNGSR that the task continued to be a challenge in establishing the basic principles that will be needed to create a fair and balanced voyage c/p for LNGC spot trips.

He said that the meeting was "very productive" but its entire focus was how to transcribe what occurs under period and timecharters into a voyage charter context.

Heel and boil-off dominated the discussions, mainly because the committee wanted to find a workable solution to the boil-off and the 'cargo used as fuel' issue where in a voyage charter, it is the owner who pays for the fuel and bears the risk of delay to the

voyage, unlike in a period, or timecharter, where the charterer, or operator, pays and takes the risk.

Grant said that Heel was another issue, as on delivery it belongs to the owners but should it be something the charterers have an option to buy from the owners, especially where smaller vessels are used and cargo needs to be maximised.

Issues relating to third party bills of lading holders were also discussed. "We do not know as yet whether the LNG spot market will result in cargoes being sold while afloat. If this does occur, then we suspect that bills of lading will need to contain special provisions relating to boil-off amounts – how much the owners may be entitled by the charterers to use as fuel, which will have an impact on the amount of cargo delivered," he explained.

"At present, we can say that we have lots of questions but fewer answers. What is encouraging is that our most recent meeting did produce some clear thoughts on how we can proceed and the solutions to these issues that we can offer.

"While in no way underestimating the difficulty of the task, the Sub-committee does believe that the development of an LNG voyage charter party is achievable. We have owners, charterers and traders on the drafting team and they are taking a very consensual and practical approach to this contract.

"We are at too early a stage of development as yet to be able to give out any details. However, we will be meeting again in September by which time the group will have had the opportunity to mull over the ideas aired at the 15th July meeting. If everyone is in agreement we should then be in a good position to apply the agreed principles and begin some solid drafting work," he said.

The intention is to have a 'first draft' ready to present to BIMCO's Documentary Committee (DC) for review in November. The DC normally requires new contracts to be presented at least twice during the development process for review and comment before they are put up for adoption, Hunter told LNGSR. ■

Although the market was sluggish for a few years, recently it has taken off again with forecasters predicting a 50% growth in the use of gas worldwide between the years 2010 to 2035.

New locks should provide opportunities for US exports

With all the attention being placed on large containerships, the potential for LNGC transits of the upgraded Panama Canal has somewhat slipped below the radar.

However, according to the Panama Canal Authority (ACP), when the newly widened canal opens for business at the end of 2015/beginning of 2016, it will handle an estimated 12 mill tonnes of liquefied natural gas per annum.

LNGCs are forecast to transit the waterway some 350 times per year and voyages to Asia from the US will cost 24% less than the traditional routes, according to calculations from the canal authority, Bloomberg reported recently.

The US will account for much of the traffic as it will become the third-largest exporter of LNG by 2020, Morgan Stanley estimated, on the back of the shale gas revolution.

The new locks will be able to accommodate 89% of the world's LNGCs, Silvia Marucci, a liquid-bulk specialist at the ACP, said at a conference in Singapore on 30th October last year.

A round-trip voyage to Fukuoka, Japan, from Sabine Pass, Louisiana, would cost \$8 mill and take 43.4 days through the canal, instead of \$11.4 mill and 63.6 days around Africa, Marucci claimed.

She said that this calculation assumed a 150,000 cu m LNGC chartered at \$85,000 per day sailing at 18.5 knots, burning 25 tonnes of fuel at \$613 per tonne and using 180 cu m of LNG boil-off per day for fuel.

For a standard 150,000 cu m LNGC, tolls may total \$347,400 with a cargo and \$295,500 when in ballast, according to preliminary figures in a presentation made by canal officials in February last year. The fees should have been finalised during the first half of this year, it was believed.

Teekay LNG has already booked two LNGCs to carry US exports on five-year contracts, the company said in June, 2013.

Buyers and sellers will have lower costs and

shipowners will profit from more trade, said Erik Nikolai Stavseth, an analyst at Arctic Securities in Oslo last year to Bloomberg.

When the canal's expansion work started in 2007, the US was importing 770.8 bill cu ft of LNG per year, making it the fourth-largest buyer behind Japan, South Korea and Spain.

"The major driver that supports exports is the differential between natural gas in the US versus Asian LNG pricing," Bobby Gaspard, vice president of LNG marketing at Freeport LNG Development, whose company is planning a Texas export terminal for 13.2 mill tonnes by 2019, told Bloomberg. "The expanded Panama Canal just improves the shipping, and it's a fairly significant improvement in costs, especially if these preliminary-type numbers actually hold."

Asian buyers have already booked two-thirds of Freeport's capacity. Other projects have been approved, and about 19 more permits to export LNG are pending at the US Energy Department. US export capacity will reach 72 mill tonnes by 2020, exceeded only by Australia and Qatar, according to Morgan Stanley, speaking late last year.

Cheniere Energy (LNG)'s terminal at Sabine Pass, Louisiana, will process 9 mill tonnes per year when it opens in 2015, eventually rising to 27 mill, according to the Houston-based company. The company also has plans to construct a liquefaction plant at Corpus Christi, Texas.

The canal might also be used for voyages to Spain from Peru and to Chile from Trinidad and Tobago, Marucci said.

Subsequently, on 10th June this year, four more gates for the new locks arrived, while ACP said that it expected the \$5.2 bill project to be completed by January, 2016.

Due to the almost sudden surge of interest in the possibility of LNGC transits, SIGTTO has produced 'Guidance for LNG Carriers

Transiting the Panama Canal', which has been published by Witherby Publishing Group.

The guide was written specifically for those vessels intending to transit via the new Cocoli (Pacific) and Agua Clara (Atlantic) locks and was written in consultation with the ACP. Each flight will consist of three chambers.

The guide commences with schematics and plans of the new locks and their approaches with an artist's impression of an LNGC heading north in Cocoli reach towards the Gaillard Cut. According to the ACP, the Cocoli reach will be 9 m higher than the Miraflores Lake.

New Panamax vessel dimensions

Length, max	366 m
Beam, max	49 m
Draught, max	15.2 m
Air draught, max	57.91 m

Safety of transit is probably the main consideration and the guide gives an overview of the ACP and the regulations, as they stand. Naturally, by the time the new locks open new rules/regs might be in place, thus an LNGC owner/operator/manager is advised to check when planning a transit, SIGTTO said.

ACP issues Maritime Regulations for the Operation of the Panama Canal (MROPC), which is published on 15th January each year. A copy is provided for all vessels making a maiden transit of the canal.

RISKS DETERMINED

Serious discussions and reviews have been carried out by SIGTTO and the ACP, which have resulted in significant measures being

taken to achieve an acceptable level of risk for an LNGC transit. These measures include canal design, risk mitigation and operational procedures.

A chapter is given over to pre-arrival procedures, including equipment testing, especially the mooring equipment and the anchors. As for general safety arrangements, all vessels seeking a transit are deemed to be have implemented the ISPS Code, despite the fact that it is not mandatory for the canal and locks.

All LNGCs are required to obtain the approved Panama Canal SOPEP, which is in addition to the MARPOL SOPEP/SMPEP already carried for anti-pollution purposes.

As for navigation in the canal, ACP operates a two-convoy pattern, one in the morning and the other during the evening in both directions. The morning convoy will consist of larger, more restricted vessels.

Two critical areas have been identified by the ACP- Gaillard Cut and the locks. A list of the measures in place is published to mitigate risks in these areas. Within this section of the guide is a sample transit plan.

According to simulations made of the new locks, the transit time at each end should take around two hours.

Pilotage is compulsory in the Panama Canal waters. Pilots are trained on bridge simulators at the ACP SIDMAR facility and have to undertake refresher courses every four years.

Following this, the guide addresses mooring and lock procedures and lists anchoring and mooring areas at both ends, plus the restrictions as known at present.

Tugs are used as escorts and for manoeuvring. In general, 82-tonne bollard pull tugs are used both fore and aft, while 64 tonne bollard pull tugs are used to the sides of a vessel, at the ACP's discretion.

The ACP prohibits cargo operations during a canal transit. These include -

- Shifting cargo from one tank to another.
- Cargo tank cooling operations.
- Gas freeing.
- Purging.
- Inerting.

Prior to and during a transit, LNGCs should ensure that the cargo tank pressure is within

acceptable limits, as specified in the vessel's safety management procedures.

The guide then gives an overview of the different types of propulsion given the high level of manoeuvrability needed during a transit.

As for bridge visibility, the ACP's requirements are more stringent than the IMO's rules. Both the Moss and the membrane types are discussed with tables and diagrams.

Environmental aspects and contingency planning are discussed and an Annex gives a list of the structural requirements needed for a transit, such as pilot shelters on bridge wings.

Attached to the inside back cover is a detailed map, which includes the new locks and their approach channels.

Of course, we still don't know whether the ACP will give priority to large containerships over all other types, as there are only one set of locks at each end, unlike the original layout, which has two sets. These will remain in operation once the new sets are in service, to enable traditional Panamax vessels to transit unhindered.



A potential opening for LNGCs?

Arc7 LNGCs ordered for Yamal

This year saw orders for the first specialist LNGCs earmarked for Russia's Yamal LNG production project in the Arctic.

To help overcome the technical barriers of operating gas carriers in these waters, classification society Russian Maritime Register of Shipping (RS) said that it had been involved in the technical aspects of the project, including design development of the unique Arctic LNGCs.

Since December 2010, RS has been supporting Yamal LNG advising on applicable rules and regulations, ice class requirements and features, participating in ice model tests, etc. RS was also involved in technical discussion on the LNGC's bow form - bulbous versus icebreaking.

In 2012, RS reviewed the bidding documents for the 'Arctic' 170,000 cu m LNGCs for compliance with RS' rules and applicable international requirements. The class notation, including ice class category and winterisation requirements, was then finalised for further application at the detailed design phase.

Later the same year, RS, in co-operation with Bureau Veritas, performed technical appraisal of six sets of bidding documents submitted by the leading South Korean shipyards with experience in LNGC construction.

"The technical challenges that project faced were mainly connected to the need for the vessels' high icebreaking capability (ice class category Arc7*), to ensuring 300 m-long vessel manoeuvrability and movement astern in heavy ice conditions -double acting principle- to the uniqueness of the propulsion system (three sets of AZIPOD thrusters), to the response of cargo containment system under ice induced vibration loads, as well as to the vessel's winterisation principles to cope with the harsh Arctic conditions (with the DAT, as low as -52 deg C)," explained Pavel Shikhov, RS COO.

Throughout 2013, technical discussions and clarification meetings with the potential builder continued and significant amount of time and effort was devoted by RS to the project, the class society said.

Plan approval procedure started in early 2014 and is continuing. "As you know, a

shipbuilding contract for the pilot Yamal LNG carrier has been concluded with Daewoo Shipbuilding & Marine Engineering. Having thoroughly analysed RS requirements to ice class vessels, DSME engineers demonstrated high level of professionalism and suggested a number of customised design solutions.

"At RS/DSME meetings, the parties always managed to achieve common understanding and mutually acceptable agreements, which are further implemented in project documentation," said Shikhov.

It is noteworthy that membrane cargo containment system (CCS) No 96, developed by GTT, passed the RS Approval in Principle procedure for compliance with Arc7 requirements well in advance - in December 2012, RS said.

Wide ranging research was performed under this procedure both by RS and Gaztransport & Technigaz (GTT). As a result of joint research, that included vibration calculation in ice conditions, strength assessment of CCS under ice impact and ship motions in design wave conditions, etc, the parties came to a conclusion that the membrane cargo containment system can be used on LNGCs with ice category Arc7, including vessels with

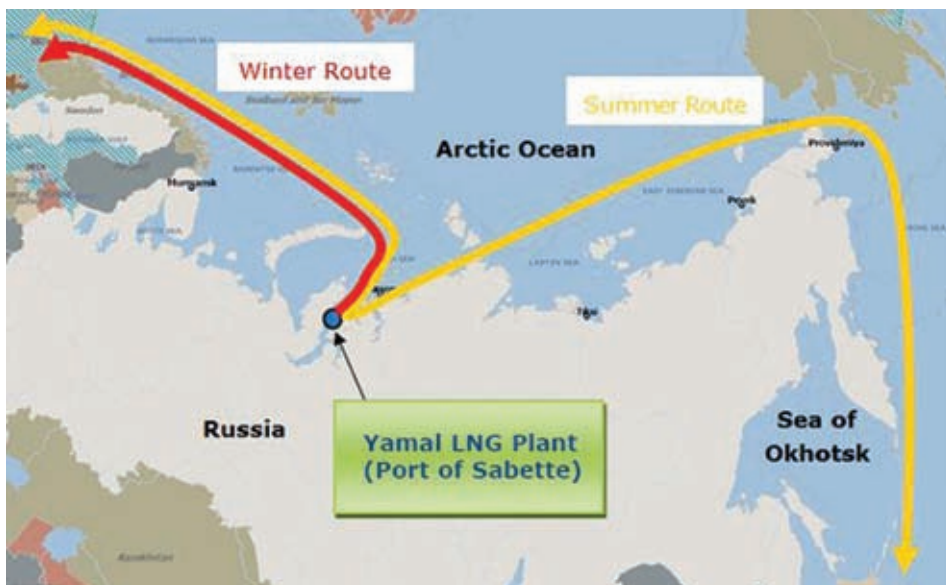
the ability to move stern-first.

In addition, an analysis of the calculating method for the dynamic interaction between LNGCs and icebergs was also undertaken as part of RS/GTT collaborative research.

"One particular technical challenge for the project worth mentioning here is winterisation of the ship and her equipment. For ships intended for operation at DAT below -50 deg C, due to their uniqueness, there are no standard solutions to date and therefore the applicability of requirements for ship equipment to ensure long-term operation at low temperature was the subject to special consideration," said Shikhov.

"Just by way of an example - radio and navigational equipment operable at -52 deg C is not available in the worldwide market meaning that manufacturers of this equipment would need to make post-production adjustments of the series-production equipment to ensure its operability at the lower temperature. This activity implies close co-operation between the yard, manufacturer of the equipment and class," he added.

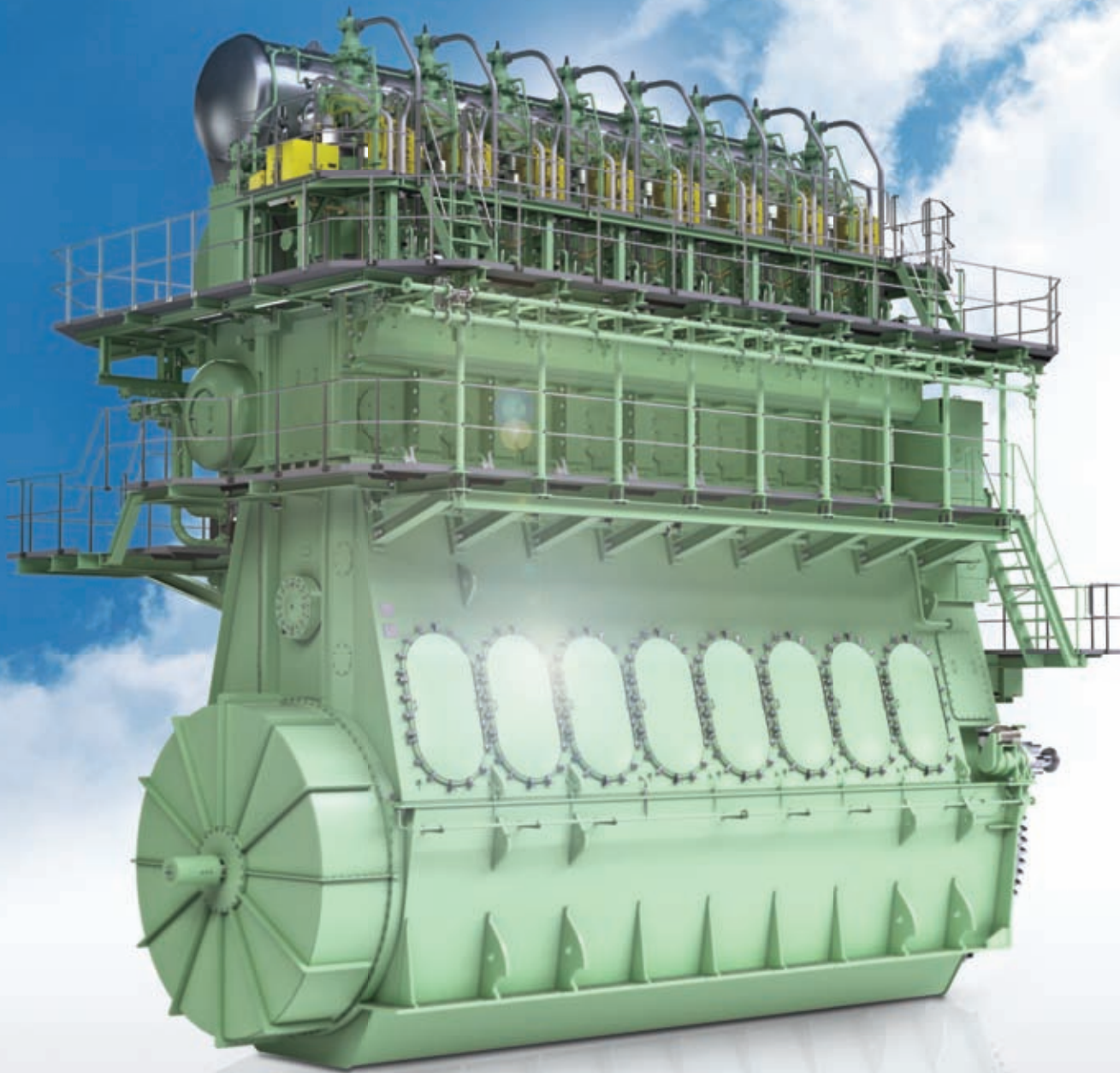
Yamal LNG is a joint venture between Russia-based Novatek (60%), French oil major Total (20%) and China-based China National



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Petroleum Corp (CNPC) (20%). It will consist of three LNG trains with a total expected capacity of 16.5 mill tonnes of LNG per annum. It is currently scheduled to come on stream in early 2018.

Yamal is based in the estuary of the Ob River in the Russian Arctic, which is ice-bound for nine months of the year.

The first nine orders have already been announced for vessels to ship gas from Yamal's loading terminal at Sabetta.

JOINT VENTURES

For example, joint venture companies involving MOL and China Shipping (Group) have signed shipbuilding contracts with DSME to build three Ice Class LNGCs.

These Ice Class LNGCs will have independent icebreaking capabilities that enable them to sail in conditions including a maximum of 2.1 m ice thickness. The vessels will be capable of transporting LNG from Yamal LNG plant at Sabetta on the Yamal Peninsula to the main gas markets worldwide.

During the summer period, the LNGCs will also be able to transit the Northern Sea Route (NSR) independent of icebreaker assistance in order to ship natural gas to East Asia.

Another order was also announced recently for six Ice Class LNGCs for the Yamal project.

Teekay LNG Partners, through a new 50:50 joint venture with China LNG Shipping (Holdings), said that it had finalised shipbuilding contracts for six internationally-flagged icebreaking LNGCs.

Under the agreement, the joint venture will build six 172,000 cu m Arc7 LNGCs at DSME for a total of about \$2.1 bill. The vessels will be constructed with a maximum of 2.1 m icebreaking capabilities in both the forward and reverse direction.

"We are pleased to finalise this previously announced accretive transaction, which solidifies Teekay LNG's role in Yamal LNG, a strategic international energy project sponsored by Novatek, Total and CNPC and further expands our partnership with China LNG," said Peter Evensen, CEO of Teekay Group at the signing ceremony. "These six newbuildings will both increase and extend the average duration of Teekay LNG's existing fixed-rate contact portfolio, providing further long-term



Schematic of Yamal Arctic LNGC. Source: MOL.

stability for the Partnership's cash flows.

"These vessels also add to Teekay LNG's existing pipeline of growth projects scheduled to deliver between now and 2020, which includes our five ME-GI LNGC newbuildings, 10 LPG carrier newbuildings ordered through our Exmar LPG joint venture and our ownership interest in four LNGC newbuildings that will be chartered to BG Group."

The signing by the owning co-operatives of the remaining newbuildings required for the Yamal LNG Project will take place in Russia at a later date.

At the same time, GTT announced an order to supply the containment systems for nine LNGCs, which will be built by DSME. As mentioned above, six ships will be owned jointly by TEEKAY & CLNG and the three others will be owned jointly by MOL & CSLNG and are expected to be delivered between 2017-2019.

They will be fitted with the NO 96 membrane technology, with has more than 20 years of operations at sea and is claimed to be well suited for the ice-breaking LNGCs. This system allows for an optimised daily boil-off rate of LNG cargo.

These nine LNGCs follow an identical Sovcomflot order, confirmed in March, 2014, also being built with the NO 96 containment system.

GTT said that it had not identified any technical, or political elements that could affect the vessels' operations in Arctic waters.

PROPULSION CONFIRMED

Meanwhile, power and automation technology provider, ABB, will supply electrical power and propulsion systems for the first of 16 Yamal LNGCs. The contract, which includes options to equip 15 further vessels, was signed in the first quarter of this year.

ABB's scope of supply includes turbochargers, generators, switchboards, transformers, electric drives, propulsion control and the Azipod propulsion units that will power the vessels through the Arctic conditions. By using Azipod propulsion units, the ship will move ahead in open water and in

moderate ice conditions and astern to cut through heavy ice. The ships will be able to transit the area without ice breaker escort except in extreme conditions.

"Operating LNG carriers in ice-locked waters year-round requires the highest standards in safety and efficiency," said Veli-Matti Reinikkala, head of ABB's Process Automation division. "ABB is very proud to have had its technology selected for such a project. Azipod propulsion has proved to be the technology of choice for more than 30 ice-going vessels, including shuttle tankers operating for Sovcomflot out of Varandey and for Norilsk Nickel's Arctic Express containerships."

Bestobell Marine, part of the UK-based President Engineering Group (PEGL), has won the contract to supply the cryogenic globe, check and FLIVs (float level isolation valves) for the vessels..

The order is for a complete ship set of globe and check cargo valves to be installed on the first LNGC, that will form part of a larger series of 16 vessels for the Yamal project.

Mark Henley, Bestobell managing director, said: "This order has the potential to be a major game-changer for us and will see us significantly increase the Bestobell Marine side of the business in the future. Russia is a relatively new area for Bestobell Marine, but one where we see huge potential in developing new business opportunities using our expertise in valves for LNG carriers."

The company will supply globe and check valves in sizes DN25, up to DN350, for the GTT cargo containment system on board the vessel, as well as supplying the FLIVs for the secondary float measurement system.

This contract comes just three months since Bestobell secured an order for its cryogenic globe, check and FLIV valves with DSME for five ship sets of valves that will be fitted on a LNGC building for Teekay LNG Partners. ■

**Arc7 is the ice strengthening notation to enable vessels to operate independently in Arctic ice of up to 1.7 m thick and under icebreaker escort in Arctic ice of up to 3.2 m thick.*

Principal Particulars - DSME Ice class LNGC

Length	299 m
Beam	50 m
Class and notation	RMRS Arc7
Propulsion	3 x ABB Azipods

Gas burning engines gain in popularity

Dual-fuel diesel-electric (DFDE) propulsion units remain the favourite among the owners and operators of LNGCs with over 100 hundred gas carriers on order, or building, being fitted with this type of system.

Although steam has been the favourite among owners and operators down the years, these plants now account for less than 10% of the almost 130 newbuildings.

Of course, as this article points out, it is not only LNGCs that are embracing gas burning technology, as several newbuildings of all types have recently been specified with dual-fuel type engines, able to switch from conventional fuel to gas and vice versa.

Indeed, in the following article, LNGSR highlights some of the initiatives ongoing in gas fuelled ship technology, as well as looking at a few examples in these pages.

A few tankers are even being built to specific designs enabling them to switch to gas burning engines at a later date. These include a series of Jones Act MR product tankers and four VLCCs recently ordered by Maran Tankers Management at Daewoo (DSME).

Both MAN Diesel & Turbo (MDT) and Wärtsilä are claiming considerable success in the field of gas engines, tri-fuel and DFDE propulsion systems for LNGCs, as well as other types of vessels.

Orders are beginning to accelerate for vessels other than LNGCs fuelled by LNG, especially to trade in areas where LNG bunkering will not be perceived as a problem with the infrastructure already on the drawing board, or under construction, or even in place.

Early this year, Sovcomflot, took delivery of the 170,200 cu m LNGC *Velikiy Novgorod* from South Korea's STX Offshore & Shipbuilding.

This ship was fitted with a DFDE system, generating a total rated power of 34 MW. The engines were built at MDT's Augsburg plant in Germany.

This propulsion system provided the LNGC with a highly efficient, low- emission propulsion unit, especially when running in gas mode. It also features a high degree of redundancy, while the MAN 51/60 DF engines provide multiple fuelling options, MDT said.

The 300 m long *Velikiy Novgorod* was designed for sailing through sea ice and has an Arctic ice classification. She was the first in a series of LNGCs to be built by STX Offshore & Shipbuilding.

While working on the Sovcomflot project, MDT said that it used the experience it gained from working on its first 51/60DF project, delivered in 2010 to Spanish shipping concern Elcano. She featured five MAN 8L51/60DF units.

An example of a gas carrier owner ordering gas injection 2-stroke engines is Knutsen OAS Shipping. This Norwegian shipping company has placed an order for two plus two 7G70ME-GI engines to be fitted on board two newbuilding 176,300 cu m capacity LNGCs.

These engines are based on MDT's new, ultra-long-stroke, G-type concept aimed at delivering even higher, overall propulsion plant efficiency.

FUEL SAVINGS

MDT verified that, even when compared to the best, modern DFDE propulsion solution, an

ME-GI (gas injection) engine delivers fuel savings of more than 30 tonnes of gas per day when operating at a normal ship speed of 15-17 knots. By the end of last year, MDT had won orders for 42 DF units, representing a power output of 780 MW.

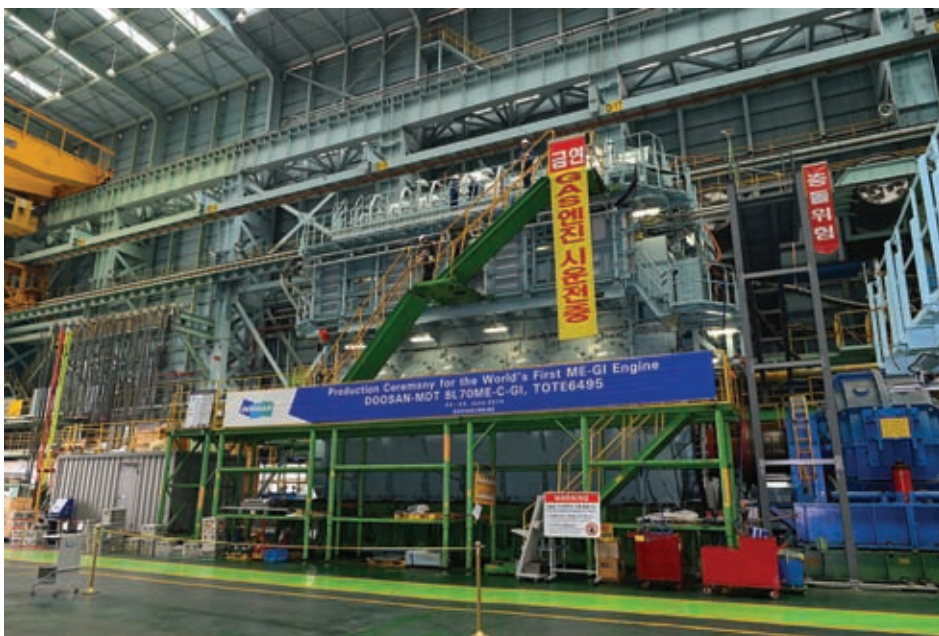
The ME-GI engine gives shipowners and operators the option of using either HFO, or gas – predominantly natural gas. An ME-LGI counterpart is also being developed that uses LPG and methanol.

Hyundai became the first MDT two-stroke licensee to demonstrate the ME-GI concept in Korea in late-2012, with Mitsui following in April 2013.

In July of this year, another milestone occurred with the delivery of the world's first dual-fuel slow-speed gas injection engine to General Dynamics' NASSCO's shipyard in San Diego, CA.

South Korea's Doosan Engine, under license from MDT, delivered the first 8L70ME-GI engine for TOTE's newbuilding 3,100-TEU 'Marlin' class containership.

Earlier this year, Doosan completed the



The Doosan manufactured 8L70ME-GI engine for TOTE.



Panorama of the engine room aboard the *Velikiy Novgorod* featuring a diesel-electric, dual-fuel propulsion system consisting of 2 × MAN 8L51/60DF and 2 × MAN 9L51/60DF engines.

engine's factory acceptance tests, a culmination of months of testing to ensure compliance with US regulations and restrictions.

On 3rd June 2014, Doosan successfully completed the engine's official trial run in the presence of the shipowner, shipyard, and classification society representatives.

The South Korean company also tested the ME-GI's fuel gas supply system (FGSS), which has 300 bar of operating pressure, at its Changwon plant. At the culmination of two months of extensive testing, the gas system passed all regulations and restrictions under ABS and the United States Coast Guard (USCG).

In addition to the engines, two 900 cu m capacity, 380 tonne tanks, manufactured by Cryos, were delivered.

Last November, it was reported that Matson Navigation Co had placed an order for two 3,600 TEU containerships, powered by two MAN B&W 7S90ME-GI dual-fuel engines. The deal includes an option for three further vessels.

At the time, these engines were the largest dual-fuel engines ever ordered in terms of power output with each engine developing 42,700 kW. The ME-GI engines and pertaining systems will be manufactured by MDT's licensee - Hyundai.

The new containerships are being built by

Aker Philadelphia Shipyard and are scheduled for delivery in the third and fourth quarters of 2018. Shortly afterwards, TOTE ordered its two 8L70ME-GI engines.

The following month MDT announced another order when Teekay LNG Partners placed an order for two LNGCs powered by 2 × 2 5G70ME-GI engines, including an option for three further ships. This order has since been increased to four vessels with five options.

Since then, Florida-based Crowley Maritime Corp has placed an order for two ConRo vessels. Each vessel will be powered by an MAN B&W 8S70ME-GI8.2 main engine and 3 × MAN 9L28/32DF auxiliaries.

The vessels will be built by VT Halter Marine of Pascagoula, Mississippi, and are scheduled for delivery in the second and fourth quarters of 2017, respectively.

Crowley said that the newbuildings will reduce the amount of CO₂ emissions attributable to each container by about 38%. In addition, the ships will meet, or exceed, all regulatory requirements and have the CLEAN notation, which requires limitation of operational emissions and discharges, as well as the Green Passport, both issued by DNV GL.

The engines will be built by Mitsui Engineering & Shipbuilding Co.

At a presentation in April in Copenhagen,

Ole Groene, MDT senior vice president for low speed engines said that the ME-GI had been successfully demonstrated on test to the licensor and licensees and by that month, it had undergone 20,000 hours of operations.

He also claimed it was the only diesel cycle high efficiency 2-stroke dual fuel engine. He said by using this type of engine, a vessel operator would not need to think about derating the engine, load ramps, low efficiency, methane slip, quality of fuel gas, ambient temperature variations, rough seas and engine detonations.

SEVERAL. ORDERS

As for rival Wärtsilä, this power generation concern has also won several orders to provide the main propulsion units for LNGCs and for dual fuel engines for other types of vessels during the past couple of years.

For example, two separate Chinese LNGCs newbuildings, which were similar in the scope of equipment supply, will be powered by a Wärtsilä 50DF engines, a controllable pitch propeller (CPP), a gearbox and related systems.

The Wärtsilä 50DF engines selected to power these vessels will enable them to operate primarily on LNG while retaining the option to switch to conventional marine fuels if necessary. Deliveries of the Wärtsilä equipment was scheduled to begin this

summer and the ships will be launched about the middle of next year.

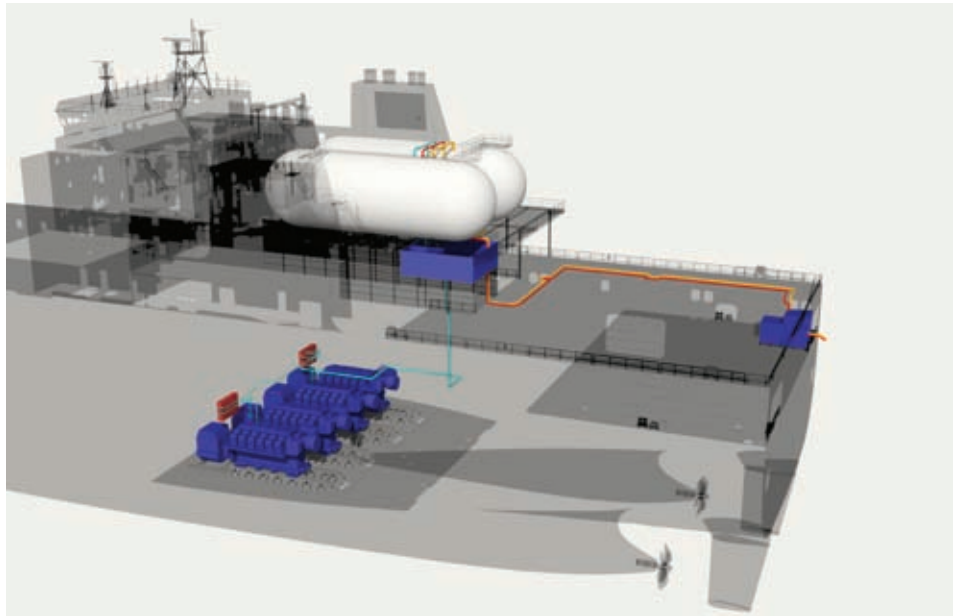
The first order was from the Ningbo Xinle Shipbuilding Group together with its trading partner, Shanghai CSR Hange Shipping Engineering, while the second was signed by Cosco (Dalian) shipyards.

The ships are being built for two different Chinese owners - Zhejiang Yuanhe Ocean Shipping Co and Dalian Inteh Group. They will operate mainly in Chinese waters, and will transport LNG between terminals and to other ships.

In another major milestone, the company's new 2-stroke, low pressure, dual-fuel engine Wärtsilä RT-flex50DF was selected by Terntank Rederi, the Danish-based tanker operator, to power two new environmentally advanced, 15,000 dwt tankers. These will be the first installations of this engine.

This new Wärtsilä technology was introduced at a customer event held at the company's Trieste, Italy facilities on 12th November last year, which was attended by LNGSR.

The significance of the availability of low pressure, dual-fuel engine technology for 2-stroke engines is that it provides notable economic and environmental advantages over



Totem Ocean conversion with Wärtsilä engines and LNGPac systems.

other technologies, Wärtsilä said. The new engine is IMO Tier III emissions compliant in gas mode without the need to fit NOx abatement equipment.

The company claimed that this engine will provide capital expenditure (CAPEX) savings of between 15 and 20%, compared to other 2-stroke gas engine technologies currently on

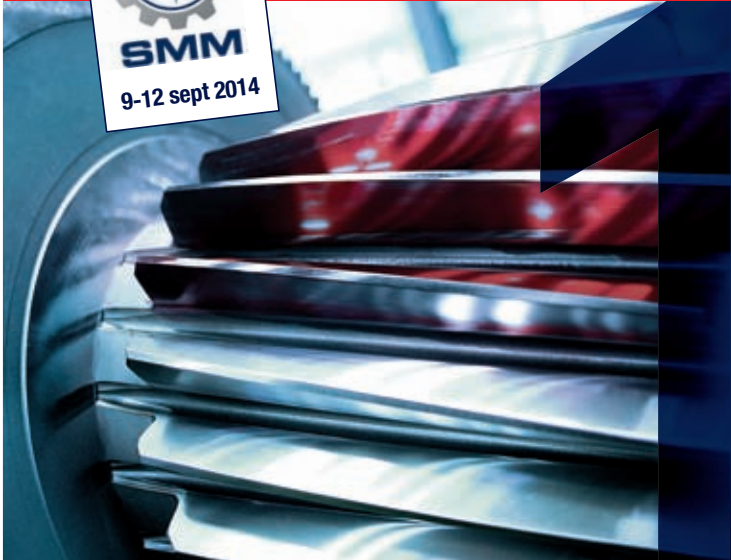
the market. This is possible thanks to the fact that no exhaust gas cleaning systems are needed and that the LNG and gas handling system is substantially simpler and of lower cost, since only low pressure gas compression is required.

Another key benefit claimed is that the Wärtsilä technology allows stable operation on



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gas across the entire load range, meaning that at low loads, there is no need to switch to diesel.

The selection of the Wärtsilä RT-flex50DF engine is a central feature of Terntank's 'Into the future - Baltic SO2lution' project, which is in response to the European Commission's TEN-T edict 2013 whereby 'Motorways of the sea actions' are identified to promote the sustainability and safety of transport and to improve either existing, or new maritime links.

The project supports the development of more environmentally sustainable and energy efficient shipping in the Baltic Sea region and the building of an LNG infrastructure. Since the Baltic is a designated Emissions Control Area (ECA), the use of LNG as fuel is seen as being an effective means of attaining cost-efficient regulatory compliance.

When operating in gas mode, NOx emissions from the RT-flex50DF engine are at least 85% below those specified in the current IMO regulations; CO₂ emissions are some 25% less than those of a conventional marine engine running on diesel fuel, while the SOx and particle emissions are negligible at almost zero per cent, the engine manufacturer said.

This Wärtsilä 2-stroke dual-fuel technology will be rolled out to the entire X Engine low-speed engine portfolio. Wärtsilä RT-flex50, Wärtsilä X62 and Wärtsilä X72 engines can already be delivered with a dual-fuel (DF) ready package to prepare the engine for a DF conversion, if needed at a later date.

Later, Terntank exercised options to build two more tankers bringing the order up to four Roll-Royce design, Wärtsilä-powered LNG-diesel dual fuel vessels at AVIC Dingheng shipyard. In addition to the new RT-flex50DF engines, each vessel will have LNGPac fuel systems supplied by Wärtsilä.

Wärtsilä also announced that the world's first LNG fuelled icebreaker is to be powered by the company's dual-fuel engines.

The icebreaker, being built by Arctech Helsinki Shipyard for the Finnish Transport Agency, will be powered by dual-fuel engines capable of operating on both liquefied natural gas and low sulphur diesel fuel. She is due to be launched in late 2015.

The full scope of supply calls for one 8-cylinder Wärtsilä 20DF, two 9-cylinder 34DF, and two 12-cylinder 34DF engines. The contract was signed in March 2014 and the delivery of the equipment to the yard will be made during the spring of next year.

The vessel will be able to move continuously through 1.6 m thick ice and be capable of breaking a 25 m wide channel in



Wärtsilä's 50DF engine.

1.2 m thick ice at a speed of 6 knots. It will also be able to reach an average assistance speed of 9 to 11 knots and in open water, the service speed will be a minimum of 16 knots.

While the main purpose of the vessel will be icebreaking, it will also be able to perform oil spill response operations and emergency towing under demanding conditions both in winter and summer. The vessel will operate all year round in the Baltic.

Subsequently, a 5-cylinder Wärtsilä RT-flex50DF engine, together with a gas valve unit and other relevant equipment, was ordered for a new LNGC being built for the Chinese shipowner and operator, Zhejiang Huaxiang Shipping at the Qidong Fengshun Ship Heavy Industry shipyard, to Chinese Class Society (CCS) standards.

The contract was signed in March, 2014. When delivered in August 2015, the 14,000 cu m LNGC will operate along the Chinese coastline to serve domestic LNG transportation lines.

"This second contract for the Wärtsilä low-speed dual-fuel engines in a few months demonstrates the fast market acceptance of this 'game-changer' technology. This is the first time that Wärtsilä low-speed DF engine will power an LNG carrier. It represents a very feasible solution for this vessel class. The extension of Wärtsilä low-speed DF engine portfolio to bigger bore sizes, such as the Wärtsilä X62DF and Wärtsilä X72DF engines,

will further expand the range of applications for the low-speed DF engine family to larger container vessels, tankers, LNG carriers and bulk carriers," said Mr Martin Wernli, vice president 2-stroke, Wärtsilä Ship Power, speaking at the time of the order announcement.

NEW 4-STROKE

Meanwhile, the introduction of the new 4-stroke medium speed Wärtsilä 46DF engine also emphasised the company's claim to the leading position in dual-fuel engine technology, it said. Compared to any other alternative currently available on the market, its specific fuel consumption is lower, output is higher and lifecycle costs are extremely attractive, the company claimed.

The fuel flexible Wärtsilä 46DF was specifically developed for the high-output market segment, including LNGCs and FSRUs and is capable of operating on natural gas, heavy fuel oil, or marine diesel oil.

The Wärtsilä 46DF comes in two different versions to meet specific customer needs. The high efficiency version offers lower fuel consumption with a cylinder power of 1,045 kW, while the high power version is capable of a cylinder power of 1,145 kW with excellent engine thermal efficiency.

For LNGC applications, the Wärtsilä 46DF can offer fuel savings of as much as 20 tonnes per day compared to the first introduced DF

engines. With up to 14 fewer cylinders installed, the overall lifecycle installation costs are significantly and positively impacted by roughly \$1,000 per day, the company said.

When operating in gas mode, the Wärtsilä 46DF engine is compliant with IMO Tier III regulations without any secondary exhaust gas purification systems. In liquid fuel oil mode, the Wärtsilä dual-fuel engines are fully compliant with the IMO Tier II exhaust emission regulations set out in Annex VI of the MARPOL 73/78 convention.

Similar to MDT, Wärtsilä has also won conversion contracts, including for Totem Ocean Trailer Express (Totem Ocean) who has announced that the company will supply main engines, generators and integrated LNG storage and fuel gas handling systems (LNGPac) for the largest LNG conversions ever undertaken in North America.

This contract was signed in the fourth quarter of 2013 and executives from both companies met on 17th February, 2014 in Tacoma, Washington to announce the project.

Totem Ocean's fleet of two 'Orca' class roll-on/roll-off vessels - *Midnight Sun* and *North Star* transport about one-third of all the goods required by the inhabitants of Alaska. As a result of the conversion, the Totem Ocean vessels will reduce their SOx emissions by 100%; particulate matter (PM) by 91%; NOx by 90% and CO₂ by 35%.

The conversion details are-

- Each of the vessels will be equipped with four 12-cylinder Wärtsilä 50DF dual-fuel engines and generator sets. The engines can be run either on natural gas, light fuel oil, or heavy fuel oil.
- Wärtsilä will also provide the vessels with two 1,100 cu m LNG fuel storage tanks and the associated automaton and fuel gas handling systems (LNGPac).
- In addition to the equipment, Wärtsilä is taking responsibility for the design, engineering and integration of the system and project, plus the site management for its scope of supply.

In July of this year, Wärtsilä signed technical management agreements with four Greek LNGC shipowners, Maran Gas Maritime, Dynagas, TMS Cardiff Gas and Thenamaris LNG. All the agreements cover condition based maintenance (CBM) for a total of 80 Wärtsilä 50DF dual-fuel engines for a five year period.

The agreements were signed between the third quarter of 2013 and the second quarter of 2014.

These agreements include a CBM system that brings flexibility to operations as

maintenance intervals are optimised. The system involves feeding engine parameters into Wärtsilä's database and the parameters are then evaluated by specialists at the CBM centre.

The agreements with TMS Cardiff Gas and Thenamaris LNG also include online remote support, which means that Wärtsilä's technical experts can support the LNGCs crew in real time via an online PC connection without the need for engineers to travel to the vessels.

Maran Gas Maritime's agreement covers 24 Wärtsilä 50DF dual-fuel engines in six LNGCs; Dynagas' agreement covers the technical management for 28 Wärtsilä 50DF dual-fuel engines in seven LNGCs; TMS Cardiff Gas agreement covers 16 Wärtsilä 50DF dual-fuel engines fitted in four LNGCs; while Thenamaris LNG's agreement

covers 12 Wärtsilä 50DF dual-fuel engines in three LNGCs.

STEAM PROPULSION

Last November, Mitsubishi Heavy Industries Marine Machinery & Engine (MHI-MME), received orders from Hyundai Heavy Industries (HHI) for four ultra steam turbine (UST) plants to be installed in four LNGCs HHI is to build for Petroliaam Nasional Berhad (PETRONAS), the state-owned oil and gas provider in Malaysia.

The orders, which were received with an option for additional USTs for four more carriers, marks the first time the MHI group has sold USTs outside Japan. Delivery is scheduled for 2015.

The four UST plants include four marine turbines and eight boilers. The technology



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incorporated into the UST was developed by MHI independently. The adoption of a reheating cycle, a field in which the company has a strong track record in onshore commercial power generation plants, results in a near 15% improvement in fuel efficiency compared to conventional steam propulsion plants, the company claimed.

MHI-MME is a Mitsubishi Heavy Industries (MHI) group company launched in October 2013 to take over MHI's former operations in the development, engineering, sale, after-sale servicing and licensing of marine machinery and marine engines.

The company claimed to provide the world's most diversified portfolio of marine machinery and marine engines, including 2-stroke low-speed engines, MET turbochargers, marine boilers and turbines, propellers, deck cranes, deck machinery and steering gears.

Elsewhere, GE's Power Conversion business (GE) is working closely with the Power & Control Systems division (PCSD) of Samsung Heavy Industries (SHI) to equip four LNGCs to be built by SHI at its Geoje facility in South Korea.

The four vessels were ordered by Bonny Gas Transport (BGT), a subsidiary of Nigeria LNG.

For each vessel, GE, in partnership with

SHI PCSD, will supply four power and propulsion systems comprising generators, main and cargo switchboards, transformers, MV7000 converters, motors and remote control. GE is responsible for the design, engineering, commissioning, training and assistance during the whole project execution including the sea and gas trials.

GE's worldwide network will provide BGT with a local content of expertise, as well as an after sales service for this project.

Last October, Dynagas announced that it had also chosen GE Power Conversion for two dual-fuel-powered LNGCs delivered to Dynagas by HHI—the *Arctic Aurora* and the *Yenisei River*.

Dynagas will also take delivery of five other LNGCs carriers in a year, or so, all equipped with energy-efficient variable-speed electrical power and propulsion systems developed and constructed by GE's Power Conversion business.

For each vessel, GE has and will supply a fully integrated power and propulsion package that includes a MV7000-series induction motor, alternator, converter, transformers and switchboard. Each package is fully tested on a real-time simulator that creates conditions at sea at GE's centre of excellence in Belfort, France, before being shipped for installation

by HHI at its shipyard in Ulsan, Korea.

GE's MV7000 drive technology is claimed by the company to deliver efficient and flexible control of electric power, which is said to be some 30% more efficient than steam-based mechanical power.

Another division, GE Marine, has signed a MOU with Lloyd's Register to identify potential gas turbine-powered commercial ship projects.

In a separate agreement signed last December, GE Marine, Dalian Shipbuilding Industry Company (DSIC) and LR have jointly developed a design for a gas turbine-powered LNGC.

This carrier will provide low life cycle cost, high environmental performance and flexible design, the companies said.

The initial LNGC design will be built around a GE gas turbine-based combined gas turbine electric and steam system (COGES) that will feature one 30 MW gas turbine, one steam turbine generator set and two dual-fuel diesel generator-sets for low power operation and backup.

However, the LNGC concept will allow for flexible configuration of prime movers, offering total installed power of more than 50 MW, if required. ■

There is new energy in the heart of the Mediterranean

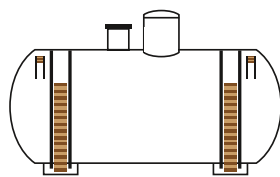
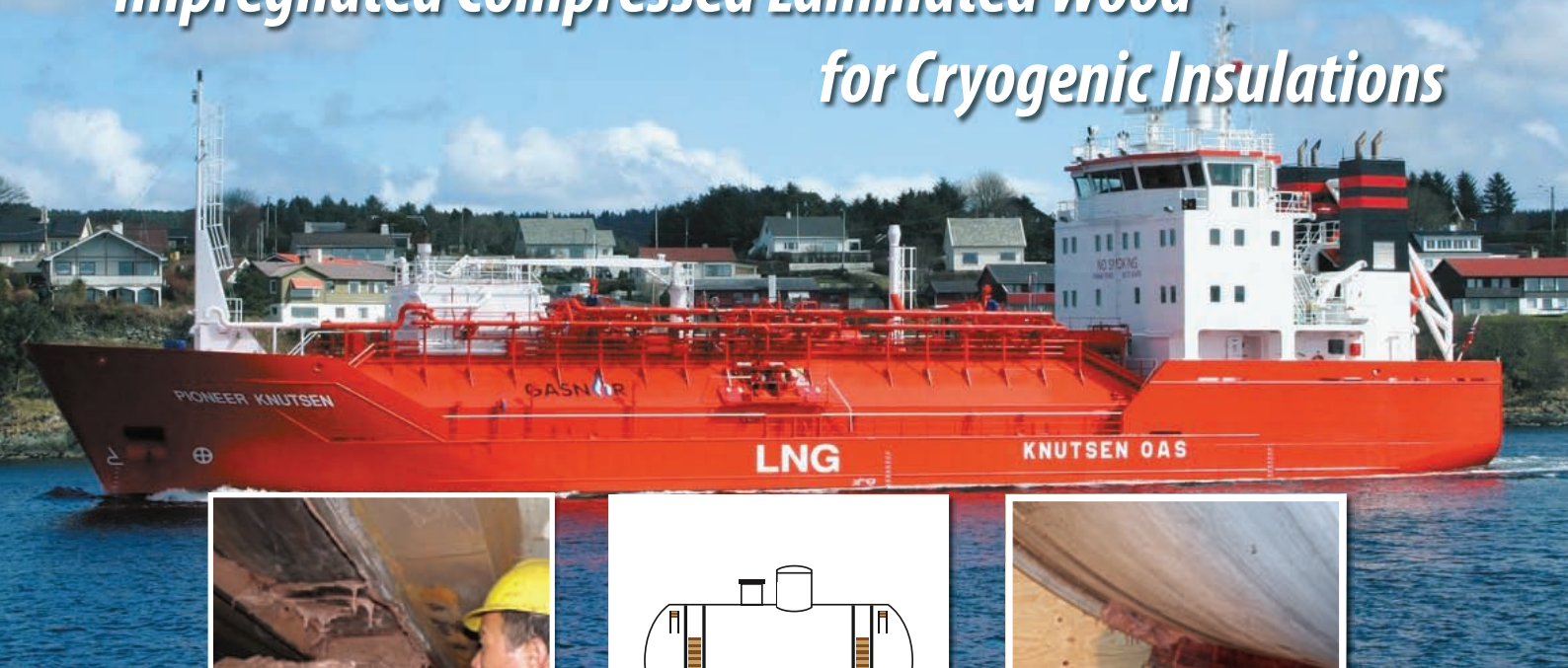
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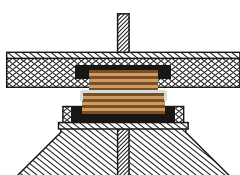
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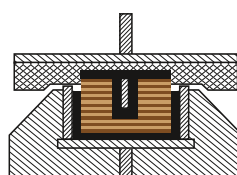
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Gas fuelled ship operations outlined

With the industry looking to adopt cleaner fuels to meet new environmental regulations, as well as future economic growth, the demand for LNG as a fuel for all types of vessels is rapidly increasing.

Tokyo-based classification society ClassNK held LNG-fuelled vessel technologies seminars in Shanghai and Singapore on 22nd July and 24th July 2014, respectively.

ClassNK said that it organised the seminars to provide the industry with the latest technical information on the use of LNG as a fuel and its related technology.

In addition to the class society's own LNG experts, specialists from the various sectors of the Japanese maritime industry, including shipbuilders, shipowners and marine equipment manufacturers, presented on a range of LNG related topics at the seminars.

Among the speakers was Prof Koji Takasaki, Graduate School of Engineering Sciences, Kyushu University who gave a

presentation entitled 'Development of Natural Gas Fuelled Ships in the World'.

He explained the advantages and disadvantages of the lean burn and gas injection type engines. In the former, combustion is achieved through flame propagation from pilot fuel to gas/air pressure in a pre-mixture.

Lean burn merits include a low pressure gas supply - only 5-6 bar for medium speed and around 10 bar for low speed engines. It also has the advantage of low NOx emissions and can meet Tier III regulations without any additional measures being taken.

The problems still to be solved include the possibility of abnormal combustion, such as knocking, as the combustion process is sensitive to the methane number; plus methane slip, which cancels out the greenhouse gas

emissions reduction claimed, Takasaki said.

Gas injection involves diffusive combustion of high pressure gas jet in air ignited by pilot fuel. Its main advantage is that this method is free from the knocking effect and it is not sensitive to the methane number and a high compression ratio is possible.

SOLVING PROBLEMS

The problems still to be solved with gas injection are a higher NOx emission than the lean burn type and the work needed to generate high pressure gas, for example 300 bar.

He also said that more than 40 vessels are in operation with gas burning engines. Many were supported by beneficial tax schemes, such as the Norwegian NOx fund. He also said that the LNG infrastructure was improving.

IGF Code & its discussion at IMO

IGF Code Structure (latest draft)

Ch. 1	Preamble	Ch. 11	Fire safety
Part A		Ch. 12	Explosion protection
Ch. 2	General	Ch. 13	Ventilation
Ch. 3	Goal and functional requirements	Ch. 14	Electrical installation
Ch. 4	General requirements	Ch. 15	Control, monitoring and safety systems
Part A-1	Specific requirements for ships using natural gas as fuel	Part A-2	Additional requirements for ships using Ethyl, or Methyl Alcohol as fuel
Ch. 5	Ship design and arrangement	Part B	
Ch. 6	Fuel containment system	Ch. 16	Manufacturing, workmanship and testing
Ch. 7	Material and general pipe design	Part C	
Ch. 8	Bunkering	Ch. 17	Training and operational requirements
Ch. 9	Fuel supply to consumers		
Ch. 10	Power generation (including propulsion and other energy converters)		

The seminar heard that there were four basic types of dual fuel diesel engine either developed or under development. These were -

- 1) 4-stroke DF, or gas engine/electric propulsion - used in ferries, supply vessels, etc. The main manufacturers were Mitsubishi:GSR and Rolls-Royce Bergen Diesel with Kawasaki working on a model.
- 2) 4-stroke DF, or gas engine coupled to the prop through a reduction gear. This system has been used on a chemical tanker and on tugs. The main manufacturers are Wartsila (50DF, 34DF, 20DF); MAN 51/60 DF; Hyundai-HiVISEN with Niigata, Daihatsu and Yanmar all working on versions.
- 3) 2-stroke DF directly coupled to the prop. Thus far there is no track record with this system, although units have been ordered for US container ships and LNGCs. The main manufacturer is MAN - ME-GI with MHI - UEC-LGSI under development.
- 4) 4-stroke DF (pre-mixed lean burn system). Main manufacturer Wartsila-RT-flex DF of which a few were recently ordered.

Gas fuel engine types

Type	4-st gas engine*	4-st DF engine**	2-st DF engine***
Ignition	Spark plug	Pilot oil	Pilot oil
Gas supply Pressure	4-5 bar	4-5 bar	300 bar
NOx Tier III	Conforms	Conforms	SCR, EGR, etc
SOx ECA	Conforms	Pilot oil	LSFO
Methane slip	1-2%	1-2%	Nil
Gas fuel quality	abt 80 MN	abt 80 MN requirement	No specific
Records	Good	Good	Nil

Footnote:

*Knocking concern- propulsion back up system required.

**Knocking concern- fuel consumption on FO mode (low compression ratio).

***Safety assessment for high pressure system required.

Source: ClassNK

Koichi Nishifuji, Manager of ClassNK's Natural Resource and Energy Department ended the seminar with a talk about the society's ongoing activities relating to LNG-fuelled vessels.

He outlined some of the common concerns expressed regarding gas fuel engines. These included gas leakage from piping, especially the high pressure piping. There is a risk of



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higher leakage from the flange joints, which can be tackled by using special seals.

The question of knocking (abnormal combustion) - there is a defined knocking & combustion failure area due to pre-mixed lean burn combustion. The stable combustion area is sensitively influenced by air/fuel ratio, gas supply temperature, gas fuel composition, etc.

These problems can be managed by combustion control improvements, he said.

Explaining about methane slip, Nishifuji said the main causes were a blow-by during overlap, unburnt gas in internal spaces and the internal boundary area of the combustion chamber.

These threats can all be reduced through technical improvements, he said.

TANK STORAGE QUESTIONS

He then went on to address the gas fuel tank storage question on board ship. The gas equates to about twice the volume of fuel oil (calorie equivalent) and the tank location will be limited by the rule requirements.

For on deck arrangements, there is no reduction in cargo capacity caused by the tank's installation; it is a simple arrangement with the tank size limited by the amount of deck space and it offers protection from mechanical damage.

Underdeck tank arrangements are usually for vessels having a smaller space on deck. Here, there will be some cargo carrying capacity reduction, due to the space taken up by the tank(s) and safety has to be taken into account against gas leakage in enclosed spaces, ie the tank connection space.

He explained that there are at least five different LNG bunkering methods being developed - ship-to-ship transfers from an LNG supply vessel; berthed and supplied by barge; a landside gas truck; direct from an onshore bunkering facility and by using tank containers on land.

Among the ports that have, or soon will have, LNG bunkering facilities are Gothenburg, Zeebrugge, Rotterdam, Stockholm, Singapore and others. Guidelines are being put in place by the relevant organisations and a risk assessment should be taken to establish a safe bunkering procedure.

The potential hazards when bunkering LNG include leakage, overfilling, over pressure, gas vent, fire, collision, loss of power, etc.

ClassNK is also involved in discussions at the IMO regarding the International Code of Safety for Ships Using Gases or Other Low Flash Point Fuels (IGF Code). In 2009, MSC 86 published the Interim Guidelines for Natural

Gas Fuelled Engine Installations in Ships.

A draft code should be approved this year and the issues still under discussion include - flexibility on the location of the fuel tank; additional requirements for ships using ethyl, or methyl alcohol as fuel; plus training and operational requirements.

The Code should be with the MEPC and MSC next year and approval given by both committees during the Spring of 2016 for possible entry into force on 1st July 2017.

The majority of LNGCs on ClassNK's books are MOSS type vessels. This is due to Japan's three major shipbuilders all choosing to use the MOSS type design for their own LNGC designs.

LONGEVITY

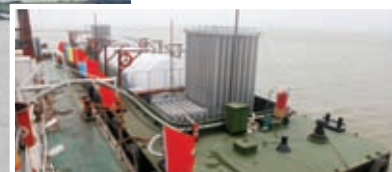
In an interview with Hayato Suga, General Manager of ClassNK's Natural Resources and Energy Department and chairman of the Tanker Structure Co-operative Forum, which appeared in the latest edition of ClassNK Magazine, he said that the society had been involved in LNG vessel design and construction since the 1970s.

"At that time, international regulations for gas carriers did not exist, but experts in Japan, including specialists from NK, had been working for many years in an attempt to establish them. That work became the basis for the IGC code,



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LNG AS A FUEL UPDATE

which was applied to all gas vessels constructed from July 1986 and the technical core of these rules remain in effect to this today," he said.

Much of the technological and technical development that served as the foundation for these new rules was carried out by an independent committee in Japan that drew its members from the top specialists in related industries. Experts from NK's staff were part of this committee and played an important role in establishing the technical and safety standards that would be applied to LNGCs.

This committee looked at every type of containment system available, including MOSS type tanks, membrane technology and IHI's SPB tank design.

While both MOSS and membrane tank technology had been developed overseas and licensed by Japanese shipbuilders, Japanese shipyards very much believed in the idea of the 'Manufacturer's Warranty', and in order to ensure the quality of these advanced vessels they carried out extremely detailed analysis of production methods and processes.

"Builders at that time had nothing like the tools we had today, and their analysis tools and software were still extremely limited, but in spite of that they carried out incredibly comprehensive and time-consuming calculations. Looking back it is incredible to see the amount they accomplished," said Suga.

"Our contribution to that process is really the basis for all of our work in the LNG field and our work today to contribute to the maintenance analysis, improve safety and support the development of new LNG carrier concepts draws directly from that lineage.

"Given the increasingly high environmental standards with which the industry has to comply I think it is almost inevitable that the industry will turn to using LNG as a fuel. But thanks to a variety of complicated factors I think it is very hard to say just when the use of LNG as a fuel will become an industry standard. At ClassNK we have supported a number of projects to develop designs, technology, and prototypes of LNG fuelled vessels.

"At the same time, LNG has been used safely as a fuel by LNG carriers for decades and with the rapid pace of development in the past few years I think there are no real technical challenges to using LNG as a fuel. Today it is really market-based challenges, including infrastructure development, supply, and port restrictions, as well as the safety concerns related to bunkering flammable liquid gases that are the key to the widespread use of LNG as a fuel.

"These are areas which have traditionally been outside of the purview of classification societies, but as global technical organisations, we are increasingly being called upon to help address the challenges and at ClassNK we are dedicated to taking a much more proactive role," he said.

Compared to ships, where there is a history of technical development and success reaching back thousands of years, the offshore field is still very new. Because of this, there is still an incredible amount of development and invention that can be done. This is the new frontier, Suga said.

"There is no standard format for offshore structures, so one has to evaluate the safety of each facility independently based on its individual concept, specification and design architecture. With FPSOs and FSOs, we are steadily developing construction and operational experience, but as an industry we still have no real experience with FLNG and our experience with FLPG is still extremely limited.

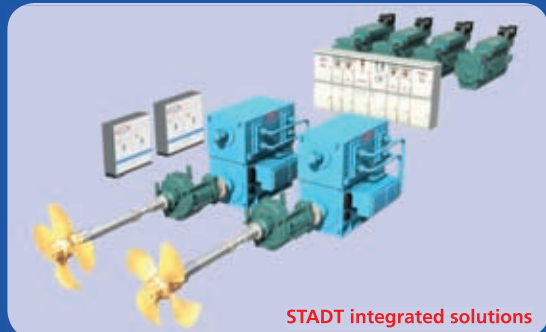
"With FLNG in particular however, we are just entering the stage where these facilities are actually being constructed and I think that these technologies will rapidly enter common use. At ClassNK our goal is to promote this and our joint research on new offshore concepts, providing our expertise to support designers, updating our rules to reflect new technology and creating new more practical rules for offshore facilities designers are how we hope to do that," he said. ■



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Bunker stations and barges on the horizon

In this article LNGSR gives a brief roundup of the latest initiatives to set up LNG bunkering stations and LNG bunker barges. Interest is now accelerating, almost worldwide.

In July, IACS' incoming chairman, Bureau Veritas' Philippe Donche-Gay called for joint industry guidelines to standardise LNG bunkering practices.

At present the major class societies have developed their own set of guidelines on bunkering and indeed, gas fuelled ship operations, which can vary from organisation to organisation.

For example, BV has published a comprehensive set of guidelines on LNG bunkering, with the aim of speeding adoption of LNG as a ship's fuel by kick-starting the LNG bunker chain.

Jean-Francois Segretain, BV's technical director, marine and offshore division, said, "We really believe that LNG has great potential as a clean fuel for shipping. But fears over its availability in the bunker chain are holding back owners from adopting it. Part of the issue is that ports and terminals wishing to provide LNG as bunkers and shipowners wishing to have LNG-powered ships do not have agreed international standard bunker procedures to work to. BV has very wide experience with LNG in the marine context and we hope that these guidelines will give ports, terminals, LNG suppliers and shipowners confidence to proceed."

BV's 'Guidance on LNG Bunkering NI 618' provides recommendations on LNG bunkering, focusing on the framework to be established with the port authorities and the bunkering organisations before any commercial operation, conditions to be observed before, during and after each bunkering operation, management of emergency situations and the training of staff involved in bunkering operations.

"We have done a lot of work on risk analysis for LNG bunkering, helping owners such as Brittany Ferries (see page twenty three) make the decision to switch to LNG as a fuel. Our risk management expertise combined with our deep LNG experience means we can help everyone involved to be more confident of a safe and standard



GDF Suez newbuilding bunker barge.

approach to LNG bunkering.

"We are not talking about specifying the equipment, which will be done by the ISO, we are talking about managing the risks and getting the procedures and people part of this right. We can also provide training for all the personnel involved, from the senior shipmanagement and the engineer receiving the LNG and the port management and LNG bunker staff delivering it. LNG is the future, and confidence in safe handling of it is the key to progress. We can deliver that confidence," Segretain said.

CHANGING ATTITUDES

Earlier this year, DNV GL said that it had seen a significant change in the shipping industry's opinion on the use of LNG as a marine fuel over the last two to three years. There is no longer any doubt that LNG will become one of the major shipping fuels.

As a result, DNV GL said that it expected the market to develop and that the ship types using LNG will increase from short-sea to long-haul trade. There will also be a greater need for harmonisation to ensure safety and

efficiency in the bunkering process worldwide, primarily to safeguard those who are involved and uphold the LNG industry's excellent safety track record.

DNV GL is co-ordinating an ongoing joint industry project (JIP). It is being run in collaboration with E&P companies and LNG market stakeholders and its aim is to contribute to the development of rigorous safety standards and guidelines for small scale LNG bunkering and filling stations.

The class society said that it has already made steps to harmonise LNG bunkering operations by launching its own recommended practice (RP), which provides guidance on how LNG bunkering can be undertaken in a safe and efficient manner, similar to other class societies.

Despite the mature large scale LNG market, challenges remain regarding the development of small scale LNG sector, for example, quality management, material specification, metering and sampling methods plus the general lack of safety standards and guidelines.

To address this, regulation authorities in

European countries, such as the Netherlands and UK are currently working on issuing standards for safe design, siting, construction and operation of LNG filling stations.

“The modelling community in Europe and risk assessment experts are uncertain about the capabilities of hazard tools in predicting LNG behaviour in the event of an accidental release of liquefied natural gas. DNV GL is therefore teaming up with industry partners to simulate several credible failure scenarios at small-scale LNG bunkering and filling stations at our Spadeadam test centre in the UK.

“This will generate valuable data to create well verified and approved models which accurately predict the behaviour of LNG in any type of system failure,” said Mohammad Ahmad, DNV GL’s project manager, at the time of the announcement.

The Spadeadam research will gather data to study and understand LNG behaviour (discharge, vaporisation, dispersion and flammable effects) following a system failure (puncture/rupture of a transfer hose or catastrophic rupture of a storage tank).

The experimental programme will also include tests of a demonstrative nature, which are needed to quantify certain major hazards.

The project will therefore provide information needed to carry out a quantitative risk assessment, the class society said.

DNV GL’s RP was launched for authorities, LNG bunker suppliers and ship operators. It provides guidance on how LNG bunkering can be undertaken in a safe and efficient manner. Lars Petter Blikom, DNV GL’s LNG director recently explained; “An ISO committee brought together the experience and knowhow of more than 30 industry professionals in 2011 and its draft guideline was published in June 2013.”

Earlier this year, DNV GL launched its RP in the Middle East & South Asia. The launch in Doha was in conjunction with Qatar’s announcement that it is going to introduce a strategy to supply LNG as a marine fuel in Qatar and the other countries within the Gulf Co-operation Council (GCC).

M Shahrin Osman, DNV GL regional manager, maritime advisory, Middle East & India explained; “Qatar’s entry as a provider of LNG for the marine industry will be a game-changer given that it is the largest single exporter of LNG globally. Launching the RP will ensure bunkering operations are predictable, safe and compatible in Qatar,

across the Middle East and the rest of the world.

“Another important reason for launching the RP is to minimise the barriers to entry in this market by establishing common equipment and procedural requirements worldwide. This will allow more players to enter the market so that individual ships are not limited to bunkering in just a few locations,” said Osman.

ROTTERDAM FACILITY

Apart from Qatar, other ports are currently finalising plans to offer LNG bunkering facilities. For example in July, Gasunie and Royal Vopak announced that their joint venture, Gate terminal, has taken the final investment decision to add LNG breakbulk infrastructure and services to the LNG receiving terminal at Rotterdam/Maasvlakte.

Construction is scheduled to start this year with the commissioning and start up scheduled for the first half of 2016. The terminal will be expanded with an additional harbour basin to enable LNG distribution for small scale use with a maximum capacity of 280 berthing slots per year. Shell has been contracted as launching customer.



Gothenburg will soon become an LNG hub.

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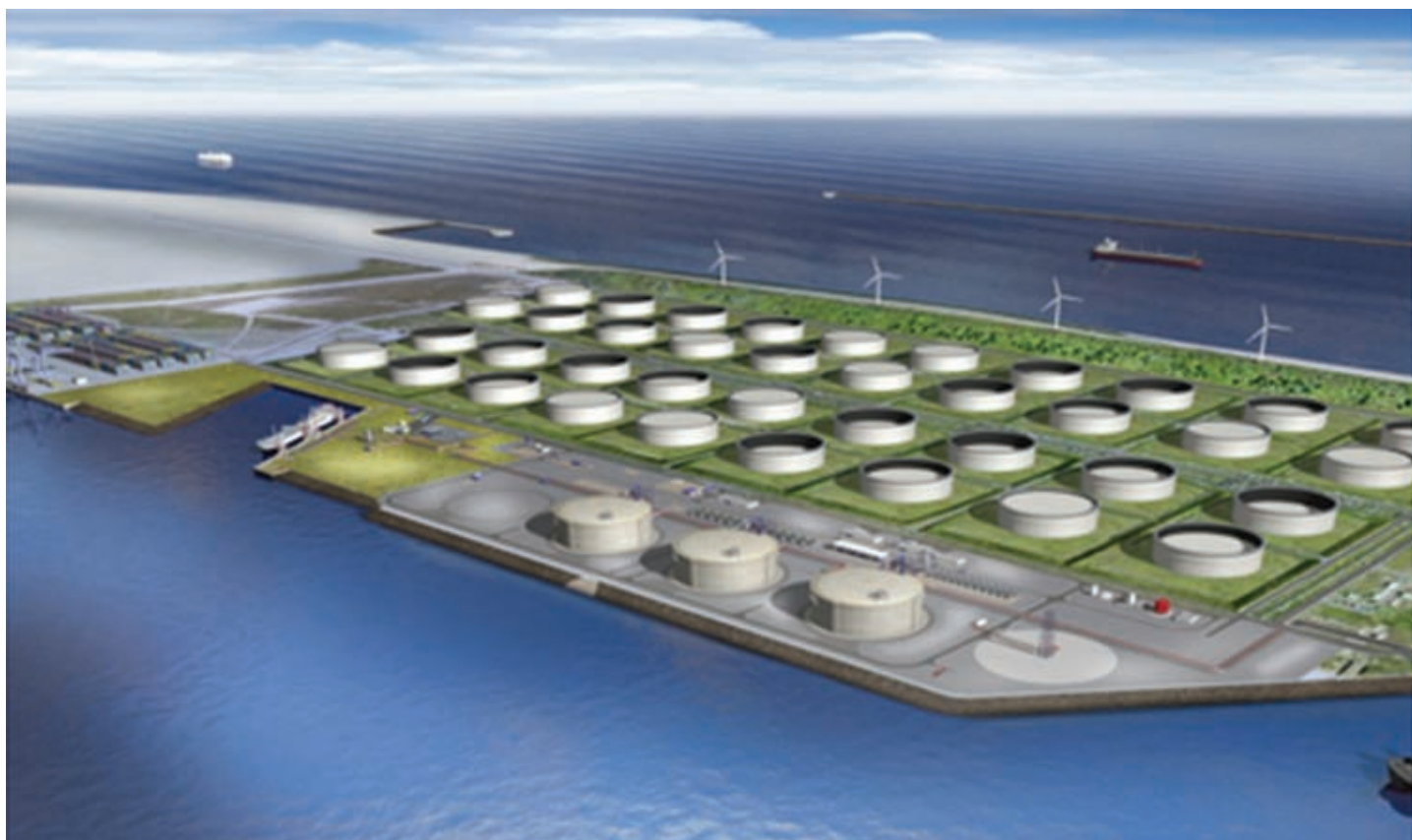


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Gate is to have a dedicated harbour for small scale LNGCs built into its Maasvlakte facility.

In January 2014, Gate launched a loading station for trucks and containers, with a total capacity of 5,000 trucks per year. Gate has also developed into a hub, from where LNG can be re-exported to other parts of Europe and worldwide.

The Port of Rotterdam Authority is also involved in the project with the design and construction of a dedicated harbour basin and has already introduced new regulations that allow LNG bunkering for inland barges and ship-to-ship bunkering of seagoing vessels.

From Gate, it will be possible for customers like Shell to supply LNG to bunker stations in the Wadden area, Scandinavia, the Baltic and also to stations along the Rhine, Main and Danube – thus providing a low emissions fuel alternative across Europe.

The project is key to facilitate LNG storage and to secure LNG supply in Northwest European ports, such as Gothenburg. The maritime connection between Rotterdam and this area is regarded as a part of the EU ‘motorways of the sea’ concept and has been selected for co-financing under the European Union's TEN-T programme.

Last October, the European Commission announced that it had awarded grants of €34 mill for the development of a small-scale LNG chain in Rotterdam and Gothenburg.

The Dutch/Swedish LNG collaboration involves both ports, together with gas infrastructure companies Gasunie (the Netherlands) and Swedegas (Sweden) and the international tank storage provider Vopak.

Vopak and Swedegas are planning a small-scale LNG terminal in Gothenburg to serve as key supply location for both shipping and industry in Scandinavia. The area's local administration recently gave the project the go ahead.

A permit has been issued for the construction of 33,000 cu m of storage handling up to 500,000 tonnes of LNG per year.

The LNG will arrive at Gothenburg by sea and will then be discharged into road tankers, or rail trucks, for onward distribution, mainly to industrial facilities throughout the country. Later, it is proposed to use some of the gas as bunker fuel for shipping.

TARIFF DISCOUNT

The Port of Gothenburg is offering a substantial reduction in the port tariff for vessels powered by LNG calling at the port.

The discount will come into effect in 2015 upon the implementation of the ECA and will continue for four years. The aim is to induce more shipping companies to switch to cleaner fuel, the port authority said.

LNG-powered ships receive a total tariff discount of 30% when they call at the port. The discount will apply until December 2018. In one year alone, this could represent a substantial saving for ships that call at Gothenburg on a regular basis, the authority said.

Carl Carlsson of the Swedish Shipowners' Association highlighted what he called Gothenburg's close understanding of the situation facing the shipping companies. "It's not technology that is the limiting factor, it's the financial considerations. Working within the framework of the Zero Vision Tool project, we will attempt to convince other ports in the Baltic to offer the same type of support."

Two indices will be applied as a basis for discounting – Environmental Ship Index, which is used by many ports around the world, and Clean Shipping Index, which is an environmental index where the freight-owners' make demands on the shipping industry.

At the same time, ships switching from oil to LNG will receive a further discount.

Then in July of this year GDF SUEZ announced that it had signed a framework agreement with NYK and Mitsubishi to develop LNG as a marine fuel worldwide through the building of LNG bunkering vessels.

This partnership has resulted in the two first

contracts -NYK's ordering of an LNG bunkering vessel and an LNG bunkering contract between GDF SUEZ and United European Car Carriers (UECC), a leading short-sea operator.

The partners said that they will provide their knowhow and experience to develop this first project in the Northern Europe ECA from Zeebrugge, in Belgium.

Jean-Marie Dager, executive vice president of GDF SUEZ in charge of the Global Gas & LNG business, said: "GDF SUEZ regards LNG as the future of bunkering. These new agreements emphasise the group's retail LNG strategy and demonstrates our commitment to the development of LNG bunkering business on a global scale, alongside harbour infrastructures and ship operators."

The LNG bunkering vessel will be built by Hanjin Heavy Industries with delivery expected by 2016. Its home port will be Zeebrugge where GDF SUEZ has already secured long term access rights in the Fluxys LNG terminal. The bunkering vessel will be operated by NYK.

The first customer will be UECC, which purchased LNG from GDF SUEZ on a medium-term basis for its recently ordered two new dual fuel -LNG and marine gasoil - car carriers, which are intended for operations in the North Sea and Baltic.

By the end of 2016, LNG will be delivered by means of ship-to-ship transfers from the LNG bunkering vessel to the new ships.

SINGAPORE INITIATIVE

Singapore has also taken steps to develop practical operational procedures and standards for LNG bunkering operations.

The Maritime and Port Authority of Singapore (MPA) and its appointed consultant, Lloyd's Register, have completed a study on the technical standards and procedures for LNG bunkering in the Port of Singapore.

The study consolidated information that needs to be addressed before LNG bunkering can take place into five key areas, as follow:

- 1) LNG bunkering standards and procedures within port limits.
- 2) Technical requirements and specifications for LNG bunker tankers and receiving

vessels with regard to transfer system, fittings and safety equipment.

- 3) Safety standards for LNG bunkering operations.
- 4) Identification of safety exclusion zones and emergency procedures.
- 5) Competency standards for personnel handling LNG bunkering.

Following the completion of the study, MPA will be organising industry consultation sessions to share the results of the study and to seek feedback.

In 2012, Singapore recorded bunker sales volume of 42.7 mill tonnes, retaining its position as the world's top bunkering port.

ANOTHER FERRY ORDERED

Returning to Northern Europe, Brittany Ferries has ordered an LNG fuelled ferry, following the lead taken by several other ferry companies worldwide. It is scheduled for delivery by the end of 2016.

She will be built by STX France at St Nazaire. GTT membrane technology has been selected by STX France to fit out PEGASIS (power efficient gas innovative ship). This vessel will be fitted with a GTT Mark III insulation system.

In addition, GTT has also been selected to design the tanks of three other Brittany Ferries ships to be converted to LNG propulsion.

Philippe Berterottière, chairman and CEO of GTT, said: "This order marks the entrance of GTT into the new field of LNG bunkering and demonstrates once again our clear expertise in the LNG industry."

One of Brittany Ferries' major turnaround ports is Portsmouth, in the UK. To facilitate bunkering at the port, LR has started a project to identify the technical specifications and develop operating procedures for safe LNG bunkering.

The project will help Portsmouth to reach its ambition of becoming an LNG bunkering facility and hub – the first in the UK.

Leonidas Karistios, LR's global gas technology manager, said: "Obviously with growing demand for LNG, ports are looking to understand how they can develop the capability to deliver LNG bunkering services safely. It has to be safety first and Portsmouth

is looking to ensure that they have the right, safe, approach to support operational and commercial ambitions.

"With a city adjacent to the port, significant ferry traffic and a large naval presence, there are substantial and varied stakeholder aspects to be addressed," he explained.

LR will provide detailed guidance to Portsmouth, including requirements for technical specifications of bunkering equipment; helping to ensure that the right operational procedures are established, port safety and emergency planning is provided for and that personnel competence can be developed effectively and put in place.

Thanos Koliopoulos, global special projects manager, commented: "We can use experience gained in projects like Singapore Port and *Viking Grace* to apply real project experience to deliver advice for the planning and execution of LNG bunkering to both the port and its bunkering service providers.

"Particular attention is given to the effective planning and execution of the port's main clients' compatibility of operations and all technical aspects for bunker tanker and receiving ship's facilities. We can help Portsmouth to get ready for real LNG bunkering operations, not only for ferry and shortsea shipping, but our global expertise and perspective can also help them to prepare for supporting LNG fuelled deepsea shipping requirements," he said.

LR pointed out that ship-to-ship transfers have been a principal area of development for large scale transfer of gas and is an important experience for the class society.

Risk leadership undertaken for bunkering operations at Stockholm to support the high-volume bunkering required for the *Viking Grace* ferry project, now successfully in operation carrying 2,800 passengers between Stockholm and Turku, has further added to LR's experience and track record.

Recent LNG-as-fuel class contract wins include a wide variety of innovative projects in Norway, Sweden, Finland, Canada and the Netherlands for sophisticated gas-fuelled ships, as demand for LNG-as-fuel moves beyond small domestic ferry applications, LR claimed. ■

"We can help Portsmouth to get ready for real LNG bunkering operations, not only for ferry and shortsea shipping, but our global expertise and perspective can also help them to prepare for supporting LNG fuelled deepsea shipping requirements"

Thanos Koliopoulos, global special projects manager, LR

Q-Max engine conversion programme commences

MAN Diesel and Turbo (MDT) is to convert the Nakilat operated Shell managed 2010-built Q-Max LNGC *Rasheeda* to use LNG as an alternative to heavy fuel oil in the main engines.

The vessel's low-speed diesels will be converted by Nakilat-Keppel Offshore & Marine (N-KOM) at the Erhama Bin Jaber Al Jalahma Shipyard facilities in Ras Laffan. The modification will utilise MDT's ME-GI (M-type electronically controlled – gas injection) systems.

This will be the world's first low-speed marine diesel engine to be converted to use LNG as a fuel. The modification will meet all the current known and future stated global emissions regulations, the engine manufacturer said.

In-step with the emissions regulations, MDT

said that it had made technical advancements to the low speed diesel engine to have the flexibility to burn LNG, as an alternative fuel source employing the ME-GI concept. Earlier evaluation of the proposed ME-GI design for the Q-Flex and Q-Max vessels had shown a high confidence level with regards to safety and reliability of the propulsion system.

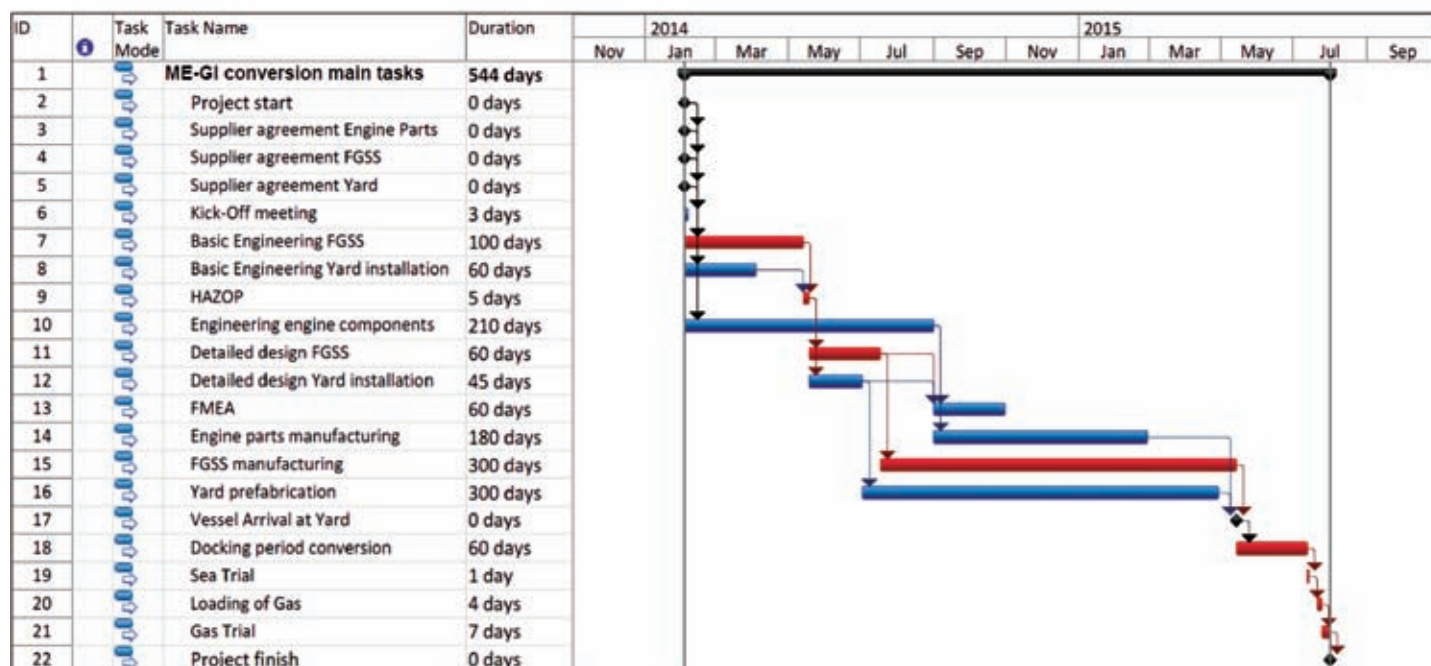
Thus far, the use of natural gas as a bunker fuel in the LNG shipping industry has been applied to conventional steam driven LNGCs and more recently to dual, or tri-fuel diesel-electric powered vessels fitted with low pressure injected, medium speed four-stroke diesels.

The use of ME-GI as an alternative will allow cleaner fuel technology with a significant reduction in environmental emissions, cleaner burning engines with the potential to increase the time between maintenance periods, provide flexibility of fuel supply to react to market changes and reduce bunkering activities.

N-KOM began fabrication work for the conversion project a few months ago. *Rasheeda* is believed to be due at the repair yard to undergo a special survey in April, 2015.

At *Tanker Operator's* Copenhagen conference last March, Jan Jensen, MDT PrimeServ's manager refit sales, outlined the

Typical Timeframe (based on LNG FGSS)



project in more detail.

He said that the scope of supply for retrofits from MC, or ME, to ME-GI engines were cylinder covers, gas control block, complete gas injector valves, sealing oil unit, control- and sealing oil pipes, modification to the engine hydraulic system, modifications for exhaust valves atomizers for fuel injector valves, fuel oil high pressure pipes, gas pipe arrangement on engines and control and safety system (GI-ECS).

Additional equipment needed for MC, or MC-C engines included an hydraulic system, pump station, supply pipe, automatic fine filter unit, hydraulic cylinder unit (HCU), fuel booster including actuator, modifications for exhaust valves, ME-B control system, Tacho system at flywheel and a fore end Alpha cylinder lubrication system.

As for the out of scope supply for an ME-GI refit, Jensen said the equipment needed included inert gas system for flushing the gas system, double pipe system in the engine room, block and bleed valve systems, silencer for gas venting, fuel gas supply system

(FGSS), LNG tank systems, LNG bunkering systems, gas detection system, plus firefighting systems.

Jensen also outlined the rough cost split of such as conversion project as -

- 1) Yard installation = 40%.
This includes the systems installation, hull work, auxiliary systems work, piping/ structural engineering and cabling, etc.
- 2) Project management = 25%.
This includes handling, QHSE, HAZID/HAZOP and external consultants.
- 3) Engine refit = 10%.
- 4) Fuel gas supply system (FGSS) = 25%.

In total it was estimated that the conversion of a Q-MAX would take 544 days (see chart on previous page).

Jensen broke this down into zero days for the start up, supplier agreements for engine parts, FGSS and the yard., while the first meeting would take three days.

The FGSS' basic engineering would take 100 days and the basic engineering yard installation would take 60 days. HAZOP would take five days.

The engineering of the engine components was due to take 210 days, while the detailed FGSS design work was estimated at 60 days and the yard installation design for the FGSS would take 45 days.

The FMEA would take 60 days, while the engine parts manufacturing would take 180 days , while the actual FGSS manufacture was estimated to take 300 days, the same time as the yard's prefabrication work.

The vessel's docking period for the conversion was said to be 60 days, although Nakilat estimated is could be undertaken in less time. Following the docking there will be one day of sea trials and four days for gas loading.

Gas trials would take a further seven days before the vessel is finally handed back to her operator, marking the end of the project, Jensen said.

At another presentation in Copenhagen recently, MDT's 2-stroke engine expert Ole Groene said that all ME Engines can be retrofitted to ME-GI with unchanged power and efficiency. ■

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First US LNG bunker barge project gains momentum

Houston-based LNG America has spent its first year putting into place the strategic assets that will support the growth of LNG as fuel for the marine communities operating on the Gulf Coast and beyond.

In May, LNG America selected the American Bureau of Shipping (ABS) to class North America's first LNG bunker barge, a 3,000 cu m unit being designed by Seattle-based Jensen Maritime, a subsidiary of the Crowley Maritime Corp.

"Our concept utilises distributed LNG, providing LNG where needed, when needed and in the quantity needed," said LNG America's president and CEO, Keith Meyer. "In order to service the marine market, there was a need to have a bunker/shuttle barge as part of our logistics network. The barge will have the capability to deliver LNG to our marine-based LNG storage facilities as well as provide ship-to-ship bunkering services."

LNG America conducted an in-depth feasibility study to determine the commercial viability of North American LNG as a global marine and high-horsepower fuel. With domestic supply expanding, there appeared to be no technical or market-driven reasons why the growth of LNG bunkering assets in Europe

and elsewhere wouldn't migrate to the US.

The sector just needed a kick-start, companies willing to invest in the infrastructure to make LNG as a bunker fuel available.

"The industry is in a classic chicken or egg syndrome: Without the ability to refuel with LNG, shipowners and builders are wary of taking the step toward conversion,"

Meyer said. "Our network of LNG storage depots and emerging delivery infrastructure, including LNG bunker barges, will help to provide marine and other fuel-users with the confidence that LNG will be available on a reliable basis, taking some of the risk out of the decision to convert."

The current expectation is for the first barge to be deployed in the US Gulf, where LNG America has a large supply position. However, Meyer said demand was also appearing on the other US coasts and that LNG America would provide service in those areas as demand warrants.

TRADITIONAL BUNKERING

While LNG America has yet to officially unveil the design, it will make LNG bunkering work like traditional product bunkering, allowing fuel buyers to make as few operating changes as possible. The design was developed with the basic ideas that the barge needed to be safe and able to function with ship-to-ship and ship-to-shore capabilities.

"It needed to be able to carry enough LNG to meet a vessel's demand and have the ability to be operated on any of [the US.] four coasts, meaning the vessel had to be compliant with the Jones Act, allowing it to work between US ports," Meyer explained. "We also looked at the practical design requirements to make sure that we would have the best possible outcomes for stability and draft."

As a virtually new asset class, LNG bunkering barges face several challenges from the technical and regulatory perspectives, elements such as new vessel specifications and service requirements, bunkering practices to transfer the LNG from the barge to gas-fueled ships and the development of new regulations surrounding the transport of LNG by barge.

From a regulatory perspective, the transport of LNG as a cargo has a 50-year history. Classification rules, international regulations and flag-state requirements that support the ship design, construction and service of the vessels are mature. For gas carriers, the IMO's International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) applies to deepsea ships, but not to barges, which are not self-propelled and/or which commonly do not operate on international voyages.

As such, the designer, shipyard and owner will need to rely on class requirements and flag-state regulations and/or policies, said Roy Bleiberg, ABS' director, Gas Solutions.

The ABS Rules for Building and Classing Steel Barges are applicable to LNG tank barges. There are several liquefied gas tank barges in service; many are US-flagged. Most, however, transport liquefied petroleum gas, not LNG.

For US-flagged tank barges, the regulations are well defined for oil and chemical tank barges, but not necessarily for tank barges transporting LNG, Bleiberg said.

"The US Coast Guard is actively addressing the need for regulations to support industry. Although the current US regulations for LNG carriers and the IGC Code may be used as the starting point, many regulations are not practical or are not applicable to tank barges," he said. "Fundamentally, however, these safety concepts are proven and effective to promote



LNG America president and CEO Keith Meyer.



ABS director Gas Solutions Roy Bleiberg.

safety. So it is envisioned that flag administrations will establish requirements based on these principles.”

CONTAINMENT SYSTEM

One of the first decisions that will need to be made when designing an LNG bunker barge is to determine which containment system will be employed. This will have a wide-ranging impact on many elements of the barge design, including the vessel arrangement, inspection access and what operating equipment will be required.

LNG America chose an IMO Type ‘C’ independent tank containment system. Type ‘C’ independent tanks are vessels designed for pressures generally greater than 2 bar, and are cylindrical, or bi-lobed, in shape.

From the class perspective, the design and certification of these cryogenic pressure vessels is a well-understood process. ABS engineers perform a design review on the tanks; they review the plans in light of the rules and recognised standards, validate the analysis and assumptions made by the designer and, finally, conduct an independent design assessment of the LNG tanks.

When this is complete, an ABS surveyor bears witness to the fabrication, testing and installation of the tank. However, for US flagged barges, there are still some questions related to the assumptions of the containment-system design.

For example, the ‘dynamic-motions’ criteria used to design and construct cargo tanks for barges under 46 CFR subchapter D (tank vessels) is very different than what is used for gas carrier design under 46 CFR subchapter O (specific dangerous bulk cargoes), which is based on acceleration components that are

determined from the long-term distribution of the vessel’s motion and speed.

Also, gas carriers require that a tank must be designed to withstand a 21-day pressure build up due to boil-off without going above the set pressure of the safety-relief valve. Will an LNG bunker barge be required to withstand longer than a 21-day period? Or will its design even have to meet gas carrier requirements?

“These types of regulations for dynamic loads and pressure build up will impact the optimisation of the containment system design and are part of the tank-related challenges that designers will have to face when contemplating the assumptions in the design of their containment system,” Bleiberg said.

Other issues still to be clarified include manning, access to the barge from a tug, the level of automation and controls for boil-off gas management and, in some cases, the use of gas-fuelled equipment on board the barge.

Bleiberg said the key to addressing each of the regulatory issues is to develop a mature design based on the principles of the IGC Code, start any discussions with the regulators early and obtain approval before construction begins.

VARIOUS LNGC DESIGNS

Another unique challenge for the LNG bunker barge is that the design of the ships they plan to serve may vary greatly. The transfer pipes and connections have yet to be standardised. The location of and the access to the fuel-loading flanges may vary greatly and vapour management may differ for each vessel.

The relationships between the traditional LNG terminal operators and the LNGC operators are strong and effective; best practices to promote safety are commonly shared throughout the industry with support from organisations such as the Society of International Gas Tanker and Terminal Operators (SIGTTO). Further, ship-to-terminal

compatibility, communications, emergency procedures and responses are well defined.

Still, operators of LNG tank-barges and gas-fuelled ships, need to form relationships with open communications, specific and clear procedures and experience so this asset class also can develop and learn from best practices, Bleiberg said.

While LNG bunkering barges constitute a relatively new asset class with some inherent challenges, Meyer pointed out that his company was not reinventing the wheel from an initial design perspective.

“We didn’t try to design the prototypical future bunker vessel today – the market will help its evolution over time. The first LNG America barges will serve a dual purpose, both a shuttle vessel delivering LNG to the marine storage depots and as a bunker barge,” he said. “In the future, as demand grows, we expect these vessels to be dedicated to single ports and serve primarily as bunker vessels only, with the shuttling service being handled by larger vessels.”

As for how many units LNG America may build, that also will be decided by the market.

“Given market adoption of LNG as a preferred bunker fuel there will be a lot of bunker barges and shuttle vessels needed. It’s tough to predict how many, or when they will be needed. But it’s a sure thing that the shipbuilders, shipowners and operators are interested in lowering their operating costs and that the regulators are placing increasingly strict emissions requirements on them. Both are driving the adoption of LNG as a fuel of choice.

“While we don’t know exactly how big or how fast that market will develop, we do know we will be in a position to move with the market and ideally with enough lead time to provide the marine community with the confidence to make the switch to America’s clean energy source,” Meyer concluded. ■



The barge will be fitted with an IMO Type ‘C’ independent tank containment system.

Full steam ahead



Photo credit- BP Shipping

Since last September's edition of LNGSR, activity in this particular sector has continued at an ever increasing pace.

However, as usual, politics could play a part, as much of the gas is and will continue to emanate from Russia, while Iran could return to the fold and start to build up its gas fields again.

China will be the largest importer of LNG, partly driven to shore up its collapsing shipbuilding industry and partly to beef up its energy supply chain in the wake of its ongoing growth forecasts.

Up to 50 of the 225 LNGCs vessels forecast to be added to the fleet by the end of 2020, are expected to be built in China, according to estimates from ABS, reported Reuters.

Last year, Beijing unveiled a plan for domestic shipyards to target a quarter of the global market for high-tech ships, including LNGCs.

"In future, our output is going to outstrip that of Japan and Korea," said Yang Baohe, principal naval architect at the Marine Design

& Research Institute of China, a subsidiary of China State Shipbuilding Corp (CSSC).

More than 70% of the around 125 LNGCs and gas storage vessels currently on order have gone to South Korean shipyards such as Daewoo and Samsung.

As more LNG production plants come on stream in the US, Australia and Russia to feed Asia's ever increasing gas demand, another 100 gas carriers are expected to be ordered for delivery between 2017-2020, reported Reuters.

China - under pressure to switch from coal to cleaner fuels to cut carbon emissions - plans to more than double its total gas supply by 2020. It is looking to triple its LNG imports to around 60 mill tonnes, or about 82 bill cu m.

Last year, six vessels constructed by Hudong-Zhonghua accounted for half of China's LNG imports, the rest arriving on vessels chartered to bring gas from producers such as Qatar and Indonesia.

Today, CSSC owned Hudong-Zhonghua has been contracted to build 14 ships to transport LNG from Papua New Guinea and Australia to China.

Dalian Shipbuilding, also part of the CSSC group, is negotiating to build four ships costing up to \$230 mill each.

China alone needs to put about \$9 - \$10 bill into expanding its fleet, said Bill Sember, vice president of global gas development at ABS, reported Reuters.

ALPHA TANKERS & FREIGHTERS

Earlier this year, troubled STX Offshore & Shipbuilding said that the orders for two 160,000 cu m LNGCs for the company were still in place, despite rumours to the contrary.

A list of orders compiled by containment system manufacturer GTT shows just one vessel on order at STX for 2015 delivery (see BSM entry overleaf).

It had been reported that STX Jinhae Hull

No 1670 and STX Jinhae Hull No 1671 had been cancelled, due to the builder's parlous financial position.

In June of this year, the company told *TradeWinds* that it wished to remain in the LNG sector without elaborating.

Alpha ordered the first vessel in 2011 by way of converting an existing Capesize bulker contract into an LNGC. A contract for a second vessel was placed in July 2012.

A new management company, Alpha Gas had been formed to operate the vessels.

AUSTRALIAN LNG SHIP OPERATING CO (ALSOC)

No changes to report at ALSOC, as the company still operates the four Australian flag LNGCs, out of the seven vessels originally built for the Northwest Shelf project.

The four entered service between 1989 and 1994, while at least six have undergone life extension dockings undertaken by Sembawang.

AWILCO LNG

Norwegian investment vehicle Awilco started operations in 2011 with the purchase of three elderly former Japanese LNGCs and formed Awilco LNG.

Since then, the company has formed a technical management concern and ordered two 156,000 cu m tri-fuel diesel-electric (TFDE) LNGCs at Daewoo.

Both the *WilForce* and *WilPride* were delivered last year and sold on a bareboat lease back purchase basis to Teekay LNG Partners.

They were bareboat chartered back to Awilco for four years, plus a one year option period.

The repurchase obligations at the end of the charter period is \$130.9 mill per vessel after four years and \$123.5 mill after five years. The bareboat rate was fixed for the entire period at \$49,100 per day per vessel.

BERNHARD SCHULTE SHIPMANAGEMENT (BSM)

BSM is responsible for the technical management and crewing operations of the three Thenamaris' 160,000 cu m TFDE LNGCs, two of which - *Cool Voyager* and *Cool Runner* - have been delivered.

The third- *Cool Explorer*- is due for delivery this year.

BSM has also been awarded the technical and crewing management contract for a 160,000 cu m DFDE LNGC by Alpha Gas, which is due for delivery next year.

BSM has developed extensive training

courses for LNGC operations direct from the yards and into service.

Crewing operations are provided for four Q-flex LNGCs each powered by heavy fuel oil burning diesel engines and with a cargo boil-off reliquefaction plant fitted. In addition, another 16 LNGCs are under crew management.

BSM is also involved with the delayed FLEX LNG project by way of providing plan approvals and newbuilding supervision for the two vessels.

Chris Clucas, BSM's Group Fleet Director, is also chairman of SIGTTO's general purposes committee, while BSM COO David Furnival sits on the organisation's board. In addition, Clucas was named inaugural president of The Society of Gas as a Marine Fuel (SGMF).

BG GROUP (METHANE SERVICES)

The former British Gas group has been shedding assets this year.

The company explained that its approach over the past year is as it has always been - to keep all of the assets under review to ensure shareholder funds are put to best use. And while some transactions do generate funds, the aim is not exclusively to raise cash.

Often the transactions are undertaken to enable a particular part of the business to operate more efficiently, BG explained.

Among the assets sold this year were six of Methane Services' 13 LNGCs in two tranches of three. All six have been purchased by their technical manager - GasLog - on lease back deals.

The first three sales were finalised in April and the second in June. The six vessels were timechartered back to Methane Services for 5.5, 6 and 6.5 years so that the vessels will not redeliver at the same time.

The BG subsidiary will also have the option of extending two of the three ships' charters for another three, or five years.

GasLog undertook newbuilding supervision, followed by full technical management of the six 2007-built 145,000 cu m vessels upon their delivery. GasLog said that the aggregate cost for three of the vessels was \$468 mill. It was believed that the other three vessels commanded the same total.

In addition, Teekay LNG Partners has acquired interests in four 174,000 cu m TFDE LNGC newbuildings, which will be constructed by Hudong-Zhonghua.

The vessels, which are scheduled to deliver between September 2017 and January 2019, will each operate under 20-year time-charter contracts, plus extension options,

with Methane Services.

Through this transaction, Teekay has acquired a 30% ownership interest in the first two LNGC newbuildings with the balance of ownership held by CETS (an affiliate of China National Offshore Oil Corporation (CNOOC) and China LNG Shipping (Holdings) (CLNG) and a 20% percent ownership interest in the second two LNGCs with the balance of ownership held by CETS, CLNG and BW Group.

BG said that through Methane Services, it will continue to keep all options open to procure shipping capacity. The company told LNGSR that it makes decisions based on the prevailing market conditions and its performance objectives.

BONNY GAS TRANSPORT (BGT)

Bonny Gas Transport Limited (BGT) is the shipping arm of Nigeria LNG Limited (NLNG) and was established in 1989.

BGT owns 13 of the 23 LNGCs operated by the company to lift cargoes owned by its parent company.

Last year, BGT ordered six LNGCs at a cost of \$1.6 bill from Hyundai Heavy Industries (two vessels) and Samsung Heavy Industries (four vessels) to boost its shipping capacity.

As part of the agreement signed with the shipbuilders, 580 Nigerians will be trained in different aspects of shipbuilding and construction in fulfilment of Nigerian Content Development for the 'BGT Plus Project'.

NLNG is owned by four shareholders, namely - the Nigerian Government, represented by the Nigerian National Petroleum Corporation, NNPC (49%); Shell Gas BV, SGBV, (25.6%), Total LNG Nigeria (15%) and Eni International (10.4%).

Some of the vessels are managed by STASCO on the back of an agreement signed with NLNG for a shipmanagement knowledge transfer project in 2008.

Anglo-Eastern (AESM) is also involved in the management of the LNGCs. The merger with Denholm a few years ago, gave the group a UK office from where the LNGCs are handled.

As a result of the shipmanagement knowledge transfer agreement signed between NLNG and both STASCO and AESM, Nigeria LNG Ship Management Services (NLNGSS) was formed in June 2009.

This agreement provided a framework and timeline for skills transfer and NLNGSS started operations in 2011 with the handover of management of four LNGCs - *LNG Cross Rivers*, *LNG Rivers*, *LNG River Niger* and *LNG Bayelsa*.



One of BP Shipping's *Gem* class LNGCs. Photo credit BP Shipping.

BP SHIPPING

No change to report at BP Shipping since our last review.

This leaves the UK oil major with seven LNGCs - three 138,000 cu m *Trader* class and four 155,000 cu m *Gem* class.

In addition, BP technically manages the 1991-built *Northwest Shearwater*, which operates for the Northwest Shelf group.

BRUNEI GAS

Brunei Gas Carriers Sendirian Berhad (BGC) was established in 1998.

It is a joint venture company incorporated in Brunei by the Government, Shell Gas and Diamond Gas Carriers.

BGC owns one 135,000 cu m and two 147,000 cu m LNGCs and provide management services to Brunei Shell Tankers Sendirian Berhad (BST) that own two 75,000 cu m and 77,000 cu m LNGCs.

In addition, the company has ordered two 155,000 cu m LNGCs from Hyundai valued at around \$210 mill each for delivery this year and next.

BW GAS

In May, BW Group and Pavilion Energy entered into an agreement to form a joint venture, BW Pavilion LNG, to acquire, manage and charter maritime LNG assets, including LNGCs.

This marks Pavilion Energy's entry into LNG shipping. The joint venture's assets will initially be established with one existing and two new LNGCs.

On 22nd June, 2014, BW's first 170,000 cu m FSRU was launched at Samsung Heavy Industries (SHI) in Geoje, Korea. She is the first of two FSRUs ordered by BW from SHI and is due for delivery in April 2015 with the second following in November 2016.

The entire construction period from contract signing to delivery for the first LNG FSRU will be a relatively short 27.5 months.

BW exercised an option for a second LNG FSRU with SHI on 29th November, 2013. Each newbuilding will be fitted with DFDE engines and a direct seawater cooling regasification system.

In addition, BW manages 14 LNGCs and has another two 155,000 cu m units on order at Hyundai Heavy Industries (HHI) for delivery this year and next.

Among the 14 managed are eight for Nigeria LNG and four for GDF SUEZ. The vessels are part owned by the BW Group.

CHEVRON SHIPPING CO

Chevron Shipping Co owns a one-sixth interest in each of seven LNGCs operating on the Northwest Shelf project.

The California-based shipping arm of the US oil major is due to take delivery of the first two of a possible eight 160,000 cu m LNGCs this year.

The first *-Asia Vision* - was due to be delivered from Samsung in June, while sistership *-Asia Energy* - was believed to be scheduled for delivery at the end of September.

Chevron originally contracted six LNGCs Samsung and apart from the two vessels, due



BW Group has ordered two more LNGCs from Hyundai.

to be delivered this year, two are due next year with the remaining pair scheduled to enter service in 2016, according to industry reports.

Chevron was also thought to have another two LNGC newbuildings on option at Samsung, although would not confirm their existence.

It was said that the first four newbuildings are earmarked to lift cargoes from the Chevron-led Gorgon LNG project in Australia, which is due on stream in mid-2015.

Chevron said earlier this year that the three-train, 15.6 mill tonne per annum Gorgon project is almost 80% complete, with two-thirds of its output already committed to buyers.

It has been reported that the remaining two vessels are likely to be used to ship gas from Chevron's 8.9 mill tonnes per annum, two-train Wheatstone LNG project, which is also based in Australia. This is due to be operational sometime in 2016.

Chevron Corp said that its Australian subsidiaries have signed long-term agreements with Tohoku Electric Power Co (Tohoku) to supply LNG from the Chevron-operated Wheatstone Project in Western Australia.

Under the agreements, Chevron subsidiaries, together with subsidiaries of Apache Energy and Kuwait Foreign Petroleum Exploration Co, will supply Tohoku with 0.9 mill tonnes per annum of LNG for up to 20 years.

The company currently operates four LNGCs. One vessel is operating on the joint venture Northwest Shelf project, while three are managed on behalf of Angolan state energy company Sonangol for the Angola LNG project.

In addition, last year Chevron fixed Thenamaris first 160,000 cu m LNGC newbuilding - *Cool Voyager* - for three years, according to local reports.

CHINA LNG SHIPPING

China's involvement in the LNG industry began in Guangdong in 1998, with the development of China's first LNG terminal at Dapeng Bay, to the east of Shenzhen, later known as Guangdong Dapeng LNG (GDLNG).

The Northwest Shelf project in Australia won the contract to supply 3.7 mill tonnes of LNG per year, for 25 years in 2002 and terminal construction began in December 2003. The first delivery was made in May 2006.

Meanwhile, two leading Chinese shipping companies - COSCO and China Merchants - formed Guangdong LNG Transportation Project Office (GLTPO), to design and

implement the LNG shipment arrangements.

As part of the tender process for the supply of LNG, bidders offered shipping collaboration proposals, including a commitment to support a new LNG shipmanagement company, which was to be responsible for managing the LNGCs being built in Hudong-Zhonghua's yard in Shanghai.

In 2004, GLTPO became incorporated as China LNG Shipping (Holdings) (CLNG), a Hong Kong registered company owned 50:50 by COSCO and China Merchants.

As one of the participants in the North West Shelf project, BP Shipping agreed to act as the 'foreign partner' in the shipmanagement joint venture and to provide support, mainly by secondments of experienced sea and shore staff.

In July 2004, BP Shipping joined CLNG in forming China LNG Shipping (International) (CLSICO) - a Hong Kong registered company. It is owned 60% by CLNG and 40% by BP Shipping. Shipmanagement agreements for the two GDLNG LNGCs (a third was added later) were signed in August 2004.

Subsequently, CLSICO was awarded contracts to manage two LNGCs for Fujian LNG (FJLNG) and, more recently, one LNG carrier for Shanghai LNG.

By June 2012, CLSICO had become sufficiently mature to enable BP Shipping to exit the agreement in mid-2013. As a result, BP shipping sold its shares in CLSICO to CNOOC on 1st August, 2013.

Today, CLSICO manages six 147,000 cu m LNGCs under a 25-year contract with their respective owners.

All six are chartered to three terminal companies also for a 25 period each - *Dapeng Sun*, *Dapeng Moon* and *Dapeng Star* are fixed to Guangdong LNG; *Min Rong* and *Min Lu* to Fujian LNG and *Shen Hai* to Shanghai LNG.

They were built at Hudong-Zhonghua to a French design.

It was recently announced that the *Shen Hai* will go to the Malaysia Marine and Heavy Engineering (MMHE) shipyard at Pasir Gudang, Johor, Malaysia, for her first intermediate drydocking in September 2014.

CHINA NATIONAL OFFSHORE OIL CO (CNOOC)

CNOOC led consortia have ordered four 174,000 cu m LNGCs at Hudong-Zhonghua for about \$950 mill in total.

This order was previously placed by the BG Group. However, the gas giant appears to be gradually withdrawing from gas carrier ownership.

The CNOOC consortia also involves

Teekay LNG.

The Chinese energy giant is also involved with other LNGCs through various consortia.

CHINA SHIPPING DEVELOPMENT

China Shipping Development (CSDC) has ordered three LNGCs for Russia's Yamal LNG Project valued at \$932 mill in total.

The three newbuildings will be owned by single vessel owning joint venture companies, in a partnership between CSDC's China Shipping LNG and Japan's Mitsui OSK Lines (MOL) in Hong Kong.

The ice class LNGCs will have independent ice-breaking capabilities that will enable them to sail in a maximum of 2.1 m thick ice.

The vessels are designed to lift LNG from Yamal at the Sabetta loading terminal located on Yamal Peninsula. During the summer period, they will also be able to transit the Northern Sea Route independently to ship LNG to East Asia.

These are in addition to six 174,000 cu m LNGCs on order at Hudong-Zhonghua, which are due for delivery in 2016-2017. They were also ordered in a joint venture with MOL at a cost estimated to be \$1.51 bill.

A consortium involving Sinotrans, China Shipping, China Energy Shipping Investment (CESI) and MOL are involved in these vessels. CESI, 51% owned by China Shipping LNG and 49% by Sinotrans, will take an 80% stake in the vessels, while MOL will take the remaining 20% share.

These vessel are earmarked for long term charters to Sinotrans for the company's Australia Pacific LNG project.

CYGNUS LNG SHIPPING

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

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

As a result, a 147,000 cu m Moss type LNGC was ordered from Mitsubishi and named *Cygnus Passage*.

She was delivered in 2009 and has since been trading between Prigorodnoye (Sakhalin II) and TEPCO's Japanese receiving terminals.

DISTRIGAS/ENI

Belgian-based Distrigas is a subsidiary of Italian energy giant Eni, which purchased a majority stake in the company in 2009

The company receives natural gas from the Netherlands, Norway, Algeria, France and Qatar primarily through its terminal at Zeebrugge.

Distrigas currently operates one 1978-built, 131,235 cu m LNGC- *Methania* - which is wholly owned. At the time of her delivery, she was the world's largest gas carrier.

Methania is currently managed by Exmar, which see. She has endured several periods of layup, most notably at Brest, but is trading again at the time of writing.

DYNAGAS LNG PARTNERS

This company was formed by Dynagas Holding to own and operate LNGCs on long term charters.

The current fleet consists of three 149,700 cu m LNGCs, while the investment vehicle has an option to purchase seven Dynagas newbuildings, the first of which - *Ob River*- became the first natural gas carrier to transit the Northern Sea Route in 2012.

The seven TFDE 155,000 cu m LNGCs were ordered from Hyundai for delivery through 2015.

In June of this year, Dynagas LNG Partners announced the purchase of the 2013-built LNGC *Arctic Aurora* from Dynagas Holding for \$235 mill.

In April, the company chartered out the 2008-built 149,700 cu m winterised Ice Class LNGC *Clean Force* to Gazprom Marketing & Trading Singapore for 13 years. She is to be named *Amur River*.

Gazprom also has the *Yenesei River* and the *Lena River* on long term charter. All the vessels are Ice Class and winterised.

EMPRESA NAVIERA ELCANO

The Spanish shipping company manages two LNGCs - a 2003-built 138,000 cu m vessel and a 173,600 cu m vessel delivered by STX in 2010.

The newer vessel was built to lift gas cargoes from the Peru LNG project under a charter to Repsol.

Similar to other Spanish controlled LNGCs, the vessels were operated by Stream- a joint venture between Repsol and Gas Natural before it was taken over by Shell.

It was believed that Imabari was close to signing a two ship contract with Elcano. They will be fitted with GTT's Mark III Flex containment systems and ME-GI propulsion systems.

EXCELERATE ENERGY

Excelerate Energy controls a fleet of 10 LNGCs, which includes one traditional 138,000 cu m LNGC and nine floating storage and regasification units (FSRUs).

The FSRUs are based on a conventional LNGC design but have the added capability of on board regasification.

Once the LNG is loaded, there are three different ways of discharging the LNG cargo - as liquid at a traditional LNG regasification terminal; as gas via Excelerate's Energy Bridge Gateway buoy-based STL system; or via the patented dockside GasPort system, which utilises a jetty-mounted high-pressure gas-offloading arm.

Excelerate operates three Gateway facilities and four GasPorts, with one under development.

In addition, the ships are equipped to discharge LNG at traditional receiving terminals.

In August 2011, Excelerate Energy and Petrobras signed an agreement for the construction and 15-year charter of a 173,400 cu m FSRU, the largest thus far.

The FSRU, *Experience*, was delivered from Daewoo to Petrobras' Guanabara Bay facility in Brazil in May of this year.

She is capable of operating as both an FSRU and a fully tradeable LNGC.

Excelerate has been providing bridging services to Petrobras since the end of 2012 by supplying the company with one of its existing FSRUs while the *Experience* was under construction.

In addition, the company is involved in several terminal projects, the latest of which is for a discharge facility, plus an FSRU, to be moored near Moheshkhali Island in the Bay of Bengal.

The terminal will provide natural gas to the Southeastern Chittagong region of Bangladesh.

The FSRU will be chartered for 15 years and will have 138,000 cu m of LNG storage capacity and a base regasification capacity of 500 mill standard cu ft per day.

The project will include the installation of a subsea buoy system offshore. The buoy system will act as both the mooring mechanism for the FSRU and as the conduit through which natural gas is delivered ashore through a subsea pipeline.

EXMAR

Antwerp-based LNG and LPG owner and manager Exmar manages eight LNGRVs and another three conventional LNGCs.

The company became involved in the LNGC sector in 1992 when as CMB, it took over the ownership of the 1978-built 131,000 cu m *Methania*, now owned by Distrigas/ENI, but managed by Exmar.

Exmar pioneered the LNGRV concept with El Paso, before the US company exited the natural gas market. Exmar then joined forces with George Kaiser who formed Excelerate Energy, which see.

This led to the chartering of the LNGRV *Excelsior* in 2005 to Excelerate followed by the purchase of a second LNGRV and the ordering of a third in a joint venture. Subsequently five more larger 151,000 cu m LNGRVs were ordered from Daewoo, the last of which was delivered in 2010.



Several of Dynagas' LNGCs are chartered to Gazprom.

In November, 2010 it was announced that Teekay had purchased a 50% stake in the LNGRV *Excelsior* and the conventional LNGC *Excalibur*. Exmar retained the technical and commercial management of the vessels.

During the middle of December last year, the LNGC *Excel* was laid up, because of tight product and longer tonnage markets and due to the increasing number of larger more efficient newbuildings being delivered.

However, ConocoPhillips has confirmed that it will charter the vessel for six months, plus two months option, starting in the second quarter of this year.

EXMAR is currently constructing the world's first floating liquefaction barge, under the patented brand name of EXPORT. It is to be stationed offshore Colombia, on the Caribbean side, during the second half of 2015 and is under construction at Wison Heavy Industries at Nantong.

The IFC (World Bank Group) has completed its screening of the project with respect to technical, operational, safety, environmental and other project risks. The financing agreements are currently being finalised, Exmar said earlier this year.

The company said that it was working on several other projects worldwide. Following the strategic partnership agreement with EDF Trading in 2013 projects will be jointly developed in North America.

For its floating liquefaction project in British Columbia, Exmar said negotiations were continuing with potential new stakeholders in BC LNG to develop the first floating unit in Canada.

In February this year, EXMAR and Pacific Rubiales ordered a 25,000 cu m capacity floating storage and regasification barge for which long term employment is being discussed. The barge is also being built at Wison and is due for delivery in mid-2016.

Recent reports suggested that DSME had signed another contract to build a \$170 mill LNGC for Exmar. However, this could not be confirmed at press time.

GASLOG

The company has continued its rapid expansion programme and has formed investment vehicle GasLog Partners.

However, GasLog Ltd has taken over the ownership of six LNGCs recently purchased from Methane Services (BG Group).

At present, the company has 15.25 vessels in operation with another 10 under construction. This includes three owned by GasLog Partners.



Gazprom has taken Dynagas' 155,000 cu m LNGC *Lena River* on long term charter.

The latest vessel to join the fleet is the newbuilding 155,000 cu m LNGC *Solaris*, which has been fixed on a medium term timecharter to Shell Tankers Singapore.

She is another in a large newbuilding series of TFDE propelled LNGCs on order at Samsung and more recently Hyundai.

Another sistership is due to join the fleet later this year, one in 2015, four in 2016 and a final four in 2017.

The last two vessels were ordered in June of this year and are 174,000 cu m LNGCs and will be built by Hyundai for delivery during the second half of 2017.

In addition, GasLog said that it had secured up to four additional priced options from Hyundai with delivery dates in late 2017 and early 2018.

In June of this year, GasLog Ltd announced that it had finalised the purchase of another three 145,000 cu m LNGCs from an affiliate of the BG Group. The first three sisterships were purchased in April.

The second three are to be chartered back to BG for 5.5 years, six years and 6.5 years, respectively, to stagger the redelivery times of the vessels. BG has an option to extend the charters on two of the vessels by either three, or five years.

GasLog oversaw their construction at Samsung and has also technically managed the vessels since their deliveries.

To complete the transaction, GasLog Ltd drew down on its \$325.5 mill credit facility with a syndicate of international banks and satisfied the remainder of the \$468 mill consideration with cash raised in a follow-on equity offering.

GasLog LNG Services has five LNGCs

under technical management for third parties. GasLog Partners, a master limited partnership formed by GasLog, owns three LNGCs.

GAZOCEAN

The French shipmanagement concern - a joint venture between GDF SUEZ and NYK - manages three LNGCs operated by GDF SUEZ (which see) and two 150,000 cu m NYK LNGCs - *Grace Acacia* and *Grace Cosmos*.

GAZPROM MARKETING & TRADING (GM&T)

The London and Singapore-based commercial arm of OAO Gazprom, the Russian energy giant, currently operates five LNGCs on long-term timecharters - three from Dynagas and two from Sovcomflot.

The Dynagas LNG Carriers are *Ob River* (149,000 cu m), *Yenisei River* and *Lena River* (155,000 cu m each).

The Sovcomflot LNG Carriers are *Velikiy Novgorod* and *Pskov* (170,200 cu m each).

In July 2015, GM&T will take delivery of its sixth vessel on a long-term timecharter - Dynagas' 149,700 cu m *Clean Force* (to be renamed *Amur River*) which will be used to lift LNG cargoes from Sakhalin.

GM&T has also recently signed an agreement to buy LNG from the Yamal LNG project for a period of 20 years.

LNG will be supplied under FOB (free on board) terms to be loaded at a transfer point in Western Europe to be transhipped to Asia/Pacific markets, primarily to India. LNG production is due to start at the end of 2017.

All of GM&T's chartered vessels are ice class and winterised.



GDF SUEZ has chartered Hoegh LNG's GDF Suez Cape Ann.

GDF SUEZ

This European gas group was born out of the merger between Gaz de France and GDF SUEZ in 2007.

The company owns, or part owns the three St Nazaire-built LNGCs - GDF SUEZ *Global Energy*, *Gaselys* and *Provalys*. NYK has a 60% share in the *Gaselys*. All of the vessels are technically managed by Gazocean, which see.

The company is involved in many projects, which has, or will involve the chartering in of LNGCs to transport the gas.

GOLAR LNG

At the time of writing, the Golar group (Golar LNG Limited and Golar LNG Partners) fleet is comprised of nine LNGCs, five FSRUs and three floating liquefaction vessel (FLNGV) conversion candidates.

In addition, Golar LNG Limited (Golar) has seven LNGCs and two FSRUs under construction.

Upon delivery of the last of these nine newbuilds in November 2015, the group fleet will total 26 vessels and FSRUs.

Thirteen of these will be larger 160-170,000 cu m units featuring fuel efficient TFDE propulsion and low boil-off technology.

Today, one of the FLNG conversion candidates is undergoing a retrofit from vessel to FLNGV and the company said that it is confident that it will have exercised options with Keppel Shipyard for a second and possibly the third of its three candidates to be converted into FLNGVs.

Of the 17 units currently in operation, nine come under the auspices of Golar LNG

Partners (Golar Partners).

Golar Partners completed its IPO in April 2011 with two LNG vessels and two FSRUs on long term contracts. Today, it owns four LNG carriers and five FSRUs, all of which are on longer term charters.

The remaining eight LNGCs on the water are owned by Golar. Five of these are employed on spot and short term charters and three are in layup pending conversion to FLNGVs.

Whenever Golar secures a contract exceeding five years on its LNG assets, it will offer these for sale to Golar Partners, the company explained to LNGSR. This enables Golar to quickly monetise the asset and its associated cash flows and Golar Partners to grow and increase its annual distributions to unit holders.

The next candidate for sale to Golar Partners will be the *Golar Eskimo*. One of the two FSRUs currently under construction, she will be delivered at the end of 2014 and commence a 10- year contract with Government of Jordan in early 2015.

All 17 of the Golar group vessels are managed by Golar Wilhelmsen, a joint venture between Golar and Wilhelmsen that draws upon the established technical LNG expertise of Golar and the scale of Wilhelmsen's shipmanagement operations.

Golar itself is a project based company that assumes the commercial and financing risks associated with ordering new vessels and FSRUs ahead of obtaining short, medium and long term employment for them.

It also assumes the risks associated with developing new technologies which have

previously involved converting LNG carriers into FSRUs and today entails converting carriers into floating liquefaction units.

Whilst its initial FSRU conversions were speculative in nature, their timing allowed Golar to be the first to market with a floating regas solution. Today, Golar holds the largest market share in terms of long-term contracted FSRUs on the water and the company intends to emulate this success with its FLNGV concept.

In July, Golar announced that it had entered into an agreement with Keppel Shipyard for the conversion of the 125,000 cu m LNGC *Hilli* into an FLNGV. Keppel simultaneously entered into a sub-contract with Black & Veatch who will provide the liquefaction equipment, engineering and commissioning support.

The contract with Keppel includes options for the conversion of the remaining two vessels - *Gimi* and *Gandria*. Although speculative, Golar said that it is confident that employment will be secured for the converted *Hilli* well ahead of completion, scheduled for the first quarter of 2017. Multiple projects in Canada, the US Gulf Coast, Mexico and West Africa are at various stages of development.

In addition to the most attractive economics associated with floating liquefaction, Golar will seek to tie in associated shipping and FSRU infrastructure and where possible take ownership of some of the gas molecules. Most contracts are expected to exceed five-years making the associated asset a candidate for sale to Golar Partners.

Although commercially complex, execution of the above will realise Golar's strategy, which is to use its technical, commercial and financing structure to fully integrate the LNG midstream, the company told LNGSR.

HANJIN SHIPPING/HAHN

Cash-strapped Hanjin Shipping has been trying out various ways to improve liquidity, including the sale of its industrial-carrier division to private-equity fund Hahn & Co, which includes seven gas carriers.

In December, Hanjin sold a 76% majority stake in its bulk shipping arm to Hahn, with the former retaining the remaining 24%. Hanjin contributed 36 vessels, including seven LNGCs from its fleet of 200 ships, to the new venture.

As part of the deal, Hanjin has agreed not to compete with the joint venture for long-term contracts from companies, such as Korea Electric Power Co (KEPCO) and Korea Gas Corp (KOGAS), among others.

The joint venture now has four LNGCs



Hoegh LNG's PGN FSRU Lampung was recently hooked up and is now in operation.

under 20 year, or 25 year long term contracts with KOGAS to import LNG from Indonesia, Oman and Qatar.

HOEGH LNG

Höegh LNG Partners, a Marshall Islands limited partnership formed by Höegh LNG Holdings commenced an initial public offering of 9,600,000 common units on 3rd July.

The partnership was formed to own, operate and acquire floating storage and regasification units (FSRUs), LNGCs and other LNG infrastructure assets under long-term charters.

The initial fleet will consist of interests in the following vessels - a 50% interest in the *GDF Suez Neptune*, a 50% interest in the *GDF Suez Cape Ann* and a 100% economic interest in the *PGN FSRU Lampung*.

Earlier this year, the first of the four FSRUs was delivered to the Perusahaan Gas Negara (PGN) owned facility at Lampung, offshore Sumatra, Indonesia and was hooked up.

The *PGN FSRU Lampung* further completed receiving its first cargo of LNG through a ship-to-ship (STS) transfer on 27th July and has now entered its final commissioning phase. The contract with PGN is for 20 years.

The second -*Independence* - has entered the short term charter market before starting a long term contract with AB Klaipedos Nafta by which she will be moored off Klaipeda, Lithuania, while the senior secured credit facility for the financing of the third- *Hoegh Gallant*- and the fourth FSRU was increased to \$412 mill, thus completing their financing.

The company also signed a letter of intent with Egyptian Natural Gas Holding (EGAS) for a five-year FSRU contract at Ain Sokhna,

involving the *Hoegh Gallant*, which is expected to start operations during the third quarter of this year.

Hoegh said that it is currently bidding for two FSRU projects with an expected contract award by the end of this year. Furthermore, during the first quarter of 2014, it submitted one initial bid for a newbuild FSRU project with a start up during the second half of 2017 and was pre-qualified for bidding on two projects with an expected start up within a similar time frame.

Also during the quarter the company awarded pre-FEED contracts to a major shipyard and an EPC contractor for the initial work on Höegh FLNG's proprietary FLNG barge design.

The company said that it will make a decision on how to proceed into the FEED stage soon with the target to place an order for an FLNG barge during the second half of this year.

Furthermore, Hoegh LNG signed a letter of intent for the joint development of a North American barge based FLNG project during the first quarter and a decision will be made whether to proceed to the next stage with this project.

In addition to the above, Hoegh LNG operates four traditional LNGCs.

During the fourth quarter of last year, the veteran LNGC *Norman Lady* was sold for recycling.

HUMPUSS INTERMODA TRANSPORTASI (HITS)

HITS appears to have survived financial problems and said that it was to raise at least \$500 mill to fund new projects, some of which

will involve the LNG sector.

The company still manages four LNGCs, operated by Pertamina.

HITS also supplies LNG vessels with crew.

HYPROC SHIPPING SERVICES

Hyproc Shipping Services is the shipmanagement arm of Algerian gas major Sonatrach.

The subsidiary technically manages eight LNGCs, all operated by the parent company.

HYUNDAI MERCHANT MARINE (HMM)

HMM's involvement in the natural gas transportation sector came in 1994 with the introduction of South Korea's first LNGC – *Hyundai Utopia*.

She was built under a 20-year contract with the Korea Gas Corp (KOGAS).

Last year, Lloyd's Register Marine Consulting was appointed to undertake a longevity study on the *Hyundai Utopia*.

HMM now operates 10 LNGCs transporting KOGAS cargoes to South Korean receiving terminals. Eight are wholly owned and two are chartered in.

HMM has also been undertaking shipmanagement services to Tsakos for the 2007-built LNGC *Neo Energy*.

IINO KAIUN KAISHA

The Iino Kaiun Group has long participated in Japanese, as well as trilateral LNG transportation projects.

From 2005, the company also began LNGC shipmanagement, starting with the *SK Sunrise*, a LNGCC chartered by the Korea Gas Corp (KOGAS).

In 2008, Iino began joint LNGC operations with the Kansai Electric Power Co (KEPCO).

Today, the company is believed to be involved with around 25 LNGCs in various projects worldwide.

KAWASAKI KISEN KAISHA (K LINE)

Late last year, a consortium comprising K Line, Nippon Yusen Kabushiki Kaisha (NYK), Mitsui OSK Lines (MOL) and the Shipping Corporation of India (SCI) signed an agreement with Delhi-based Petronet LNG Limited (PLL) for a long-term timecharter of a new 173,000 cu m capacity LNG.

At the same time, the consortium signed a contract with Hyundai Heavy Industries to build the vessel. The new LNG carrier will be employed in the Gorgon LNG project.

The four-company consortium that announced the contract for the new carrier also operates the three vessels already in service and will continue to ensure a steady supply of LNG to India, where energy demand continues to grow, K Line said.

K Line also announced last year the signing of two long-term timecharter contracts concluded with a subsidiary of INPEX Corp and with a joint venture of INPEX and French oil major Total's subsidiaries.

As a result, K Line signed shipbuilding

contracts with Mitsubishi Heavy Industries (MHI) and Kawasaki Heavy Industries (KHI) for one vessel each. The Mitsubishi vessel will be of 155,300 cu m and is due for delivery by the end of 2016 to coincide with the first gas due from the Ichthys project to ship gas to Japan and Taiwan.

Also last year, K Line signed a long-term t/c contract for one vessel with Chubu Electric Power, which resulted in a newbuilding contract placed with Kawasaki for a newly developed hull form Moss-type 164,700 cu m LNGC.

She is due for delivery by the end of next year and has been specially designed to transit the expanded Panama Canal.

Through various consortia, K Line has interests, or manages 43 LNGCs, according to its website.

The Japanese major claimed to be the first local company to become involved with natural gas transportation when it took delivery of the 125,000 cu m *Bishu Maru* in 1983.

KNUTSEN GAS SHIPPING

Knutsen OAS Shipping entered the LNG market following the delivery of its first LNGC in 2004.

The first 138 400 cu m LNGCs were built in Spain with steam turbine propulsion. During

2010 Knutsen took delivery of four vessels from DSME all fitted with dual fuel engines.

All the large LNGCs are fitted with GTT NO 96 membrane cargo containment systems. These vessels are designed to transport LNG at an operation speed of 19.5 knots.

To achieve this speed without experiencing delays with hull cleaning, etc, the vessels have highly advanced polymer based antifouling, Knutsen said.

Pioneer Knutsen is the smallest LNG carrier in the world delivering LNG along the Norwegian coast, occasionally using ship-to-ship transfers from a larger unit.

This vessel has two high pressure tanks installed carrying a total amount of 1,100 cu m of LNG and is used to bunker the increasing number of LNG-powered ferries and other vessels along Norway's vast west coast and fjords.

Knutsen operates nine LNGCs, the last of which, the *Ribera del Duero Knutsen* was delivered from DSME at the end of 2010.

She has DNV ice class 1A and 'winterisation' notation and is constructed with a super-reinforced cargo containment system.

The Knutsen Group/TS Shipping Invest signed a long term agreement with NYK to run the shuttle tanker business - forming the company Knutsen NYK Offshore Tankers (KNOT).



Knutsen's latest LNGC *Ribera del Duero Knutsen* delivered by DSME in 2010.



Several of MGM's vessels are operating in a joint venture with Nakilat.

Since then, the partnership has concluded joint investment and financing arrangements on a 50:50 basis for two new 176,000 cu m ME-GI powered LNGCs that will be chartered to Spanish energy company Gas Natural on a 20-year plus basis.

They are to be delivered by Hyundai Heavy Industries in the second half of 2016.

KOREA GAS CORP (KOGAS)

Around 25 LNGCs are operated by KOGAS, South Korea's state-owned gas concern.

It is thought that there are no more newbuildings to come.

KOREA LINE (KLC)

Financially troubled KLC has managed LNGCs operating for KOGAS since 1990.

The company is still thought to own four LNGCs and has a part share in another four. The last two were delivered to KLC in 2008.

Similar to other Asian owners, KLC is also thought to manage four smaller coastal gas tankers in joint ventures.

LNG SHIPPING SPA

Formed in 2001, this company looks after the management and transportation of natural gas on behalf of parent ENI, the Italian energy giant.

It is now connected to Exmar Shipmanagement and is shown as owning two LNGCs.

The company is also involved in offshore LNG terminal projects.

MARAN GAS MARITIME (MGM)

Maran Gas Maritime is the gas shipping subsidiary of the Angelicoussis Shipping Group Limited (ASGL).

MGM was set up in July 2003 to manage ASGL's LNG and LPG carriers and in the same year ordered its first LNGC, which was delivered in July 2005.

MGM has teamed up with Qatar's Nakilat in a joint venture, which now accounts for 11 LNGCs, having secured three more in April of this year.

Nakilat said in a statement earlier this year that it has secured \$669 mill in financing from QNB Group to enable the joint venture Maran Nakilat to purchase existing MGM ships and refinance two others already in the joint venture.

This figure has since been raised to \$807.4 mill.

In total, Nakilat has now arranged around \$1.60 bill in refinancing for the joint venture, following an earlier fund raising scheme last year.

MGM had chartered its first four LNGCs to Qatar's LNG supplier RasGas.

Maran Nakilat has grown its fleet's capacity over three different stages. The initial fleet consisted of four vessels, which was expanded to eight and now to 11 vessels.

In June, 2013, Nakilat also increased its ownership of the joint venture from 30% to 40%.

By June, MGM was managing 11 LNGCs of up to 161,870 cu m capacity. In addition, there were 15 newbuildings- seven of between 159,800 cu m and 174,000 cu m due for delivery next year and another eight of 174,000 cu m set for delivery in 2016.

Apart from the four RasGas chartered vessels, 15 are believed to be chartered to BG and two to Woodside.

MISC BERHAD

Last October, MISC Berhad parent company Petronas announced that it had ordered four 150,200 cu m Moss type LNGCs from Hyundai for delivery from the second half of 2016.

The order also includes four options.

MISC will act as the project manager and technical consultant to Petronas for their construction.

It is not clear whether MISC will manage

and operate the vessels once delivered.

MISC currently owns 27 LNGCs, the last of which was delivered in 2009.

Some of the vessels are capable of two port discharges by lifting part cargoes.

The last two LNGCs delivered to the company were built on the back of 20-year charters to lift Yemen LNG cargoes.

Two other LNGCs were converted into FSUs to operate at Malaysia's first regasification terminal, which is now in operation.

MISC is also involved with the Petronas FLNG project.

MITSUI OSK (MOL)

MOL first participated in an LNG transport project in 1983.

Ten years later, as a representative of a Japanese consortium, it played a key role in the conclusion of the largest LNG transport contract in the 20th Century, the Qatar Project, moving 6 mill tonnes of LNG annually from the Middle East to Japan.

In 2003, MOL signed a service support contract with the government of the Sultanate of Oman aimed at developing the nation's ocean shipping industry.

In 2010, MOL concluded a basic agreement with ExxonMobil for the construction and chartering of LNGCs to serve Papua New Guinea/Australia and China. This agreement set the stage for MOL to become the first non-Chinese shipping company to become involved in China's LNG market.

MOL has established LNGC management companies worldwide and currently manages vessels through offices in Tokyo, London, Jakarta, Muscat (Oman), and Arzew (Algeria) and today claims to be involved with more than 25% of the world's LNGCs through various joint ventures and consortia.

In October, 2013, MOL announced that in a joint venture with Kansai Electric Power Co (KEPCO) will own two newbuilding LNGCs that will transport gas under long-term charter contracts signed in June 2012.

KEPCO will hold a 70% share in the Bahamas-based MOL subsidiary that will own the two carriers, with MOL holding the remaining 30%.

With this agreement, MOL and KEPCO will jointly own three vessels following the *LNG Ebisu* (delivered in September 2008), the first LNGC directly owned by KEPCO.

The first of the newbuilding LNGCs will be a Moss type steam turbine 164,700 cu m vessel to be built by Kawasaki. The second will be a 155,300 cu m LNGC to be built by Mitsubishi.

The highlights of this year included MOL's 175,100 cu m LNGC *Spirit of Hela*, which is jointly owned by MOL and Itochu Corp. She left Papua New Guinea carrying the first LNG cargo from the ExxonMobil-led PNG LNG project during May.

The vessel loaded LNG at the project's marine terminal, which is located near Port Moresby, PNG's capital. This cargo was delivered to Tokyo Electric Power Co (TEPCO).

A few weeks earlier, MOL and other two other companies, including Chubu Electric Power decided to invest in a joint venture called Trans Pacific Shipping 2 (TPS2), an LNGC owning company.

MOL established TPS2, a 50:50 joint venture with Mitsubishi Corp in May, 2012, aimed at transporting LNG from Australia for Chubu Electric Power. TPS2 signed a long-term charter contract with Chubu Electric in October, 2012.

The 153,000 cu m 'Sayaendo' type LNGC is due to be delivered from Mitsubishi in December this year.

In another deal, MOL signed a Head of Agreement on the joint ownership and 20-year charter contract for a newbuilding 165,000 cu m LNGC with Tokyo LNG Tanker, a wholly-owned subsidiary of Tokyo Gas.

At the same time, MOL signed a contract with Japan Marine United Corp (JMU) to build the new vessel. She is due for completion in 2017.

MOL will manage the new LNGC, which will transport LNG mainly from the US Cove Point LNG project to Tokyo Gas' facilities. She will be fitted with the self-supporting prismatic shape IMO Type B (SPB) cargo tank, which was developed by IHI Corp and JMU.

MOL operates nine of 12 LNGCs owned and managed by Tokyo LNG Tanker, including this newbuilding and directly manages six of the nine ships.

In July of this year, MOL announced that in co-operation with China Shipping Development, it had signed shipbuilding contracts with DSME to build three ice class LNGCs.

These 172,000 cu m ice class vessels are intended for Yamal LNG project and were reportedly valued at \$932 mill.

The newbuildings will have independent ice-breaking capabilities that will enable them to sail in a maximum of 2.1 m ice thickness. They will ship LNG from the Yamal LNG plant at Sabetta in Yamal Peninsula, Russia.

During the summer period, the LNGCs will be able to sail independently on the Northern

Sea Route transporting LNG to East Asia.

They will be of the double acting type fitted with Azipods and will break ice while going astern.

NATIONAL GAS SHIPPING CO (NGSCO)

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

The company still operates eight LNGCs, each with capacity for 137,000 cu m.

NGSCO 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 LNGCs in the world when built.

The eight LNGCs were initially managed by third parties but since the end of 2007, all vessels are fully managed by NGSCO.

In 2009, the company's supporting services were merged with ADNATCO coming under the umbrella of one management concern.

NIPPON YUSEN KAISHA (NYK)

Nippon Yusen Kaisha (NYK) said that it plans to invest in more LNGCs over the next five years.

Setting out its mid-term management plan, the company said that it will be looking at the growing demand from Japan and developing countries for gas and the removal of the shale gas export ban by the US.

The company also said that it planned to expand its fleet of LNG carriers from 67 at present, including jointly owned vessels, to over 100 by 2019.

Noting shortage of highly skilled seafarers for LNGCs, NYK plans to develop its training at its in house academy in the Philippines, plus other institutions. It is also looking to develop a new business around LNG as a fuel.

In the offshore sector, NYK plans to expand its presence in the floating production market, including FLNGs, to provide long term stable revenues.

Similar to the other Japanese majors, NYK entered the LNG transportation business in 1983

NYK owned 67 LNGCs, including those in various joint ventures/consortia, while the group operated 29 of these, as at the end of March, 2014, the end of NYK's fiscal year

There have been several more developments this year, including a contract with Hanjin

Heavy Industries to build the world's first LNG bunkering vessel to provide natural gas to LNG-fuelled vessels.

In a joint initiative to develop a global market for the LNG bunkering business, NYK concluded a framework agreement with GDF SUEZ and Mitsubishi Corp on 13th May, 2014.

The vessel will be delivered in 2016 and will be based at Zeebrugge, Belgium.

GDF SUEZ is a regular charterer and co-owner of NYK's LNGCs. GDF SUEZ, Mitsubishi Corp and NYK intend to establish a company to own the LNG bunkering vessel, as well as an LNG-fuel sales company, which will charter the vessel. In the future, the joint venture aims to expand its business globally, NYK said.

Further to the partnership between NYK and the Knutsen Group/TS Shipping Invest (TSSI), which see, with respect to the Knutsen NYK joint venture shuttle tanker business (KNOT), the partners have concluded joint investment and financing arrangements on a 50:50 basis for two new 176,000 cu m ME-GI powered LNGCs that will be chartered to Spanish energy company Gas Natural on a 20-year plus basis.

They will be built by Hyundai Heavy Industries for delivery in the second half of 2016.

In addition, Chubu Electric Power has joined NYK and the Mitsubishi Corp to become a shareholder of Trans Pacific Shipping 1 (TPS1), which currently holds a timecharter contract with Chubu Electric Power for a new LNGC.

The 153,000 cu m vessel will transport LNG from Australia to Japan for about 15 years starting in 2017 and NYK will be responsible for shipmanagement. She will be built by Mitsubishi.

On 30th April, NYK concluded a timecharter contract for a new LNGC with LNG Marine Transport, which is a subsidiary of Tokyo Electric Power Co (TEPCO). At the same time, NYK also concluded a contract with MI LNG Co for the construction of the LNGC.

The ship will be delivered in 2017 and assigned to transport LNG for TEPCO from the Wheatstone LNG project - in which TEPCO, Mitsubishi Corp and NYK participate. LNG Marine Transport will be responsible for the operational management of the vessel.

The new vessel will be a 155,300 cu m 'Sayaendo' type vessel in which four Moss spherical tanks will be protected by a continuous cover integrated with the ship's hull.

MI LNG was jointly established in April 2013 by Mitsubishi Heavy Industries and Imabari Shipbuilding and the vessels will be built at Mitsubishi's Nagasaki shipyard.

Earlier, on 28th February, NYK and Tokyo LNG Tanker, a wholly owned subsidiary of Tokyo Gas, agreed to a 20-year contract for the charter and joint ownership of an LNGC.

NYK also concluded a contract with Japan Marine United Corp (JMU) for the 165,000 cu m vessel's construction.

NYK and Tokyo LNG Tanker jointly own two LNGCs and the new vessel will be the third operated under joint ownership by the two companies. Upon completion in 2017, the ship will be mainly used for LNG transportation from the US Cove Point LNG project.

NOVATEK

In May of this year, a heads of agreement was signed for the supply of LNG between Yamal Trade, majority owned by Novatek through



SCF's first 170,000 cu m ice class LNGC *Velikiy Novgorod* will eventually serve the Yamal project.

Yamal LNG and Gazprom Marketing & Trading Singapore.

The agreement provides for the supply of up to 3 mill tonnes of LNG per annum produced by Yamal LNG for more than 20 years.

LNG will be supplied on the free on board (FOB) basis at a transshipment point in Western Europe for further delivery to the Asian/Pacific region, primarily to India. The LNG price is crude oil indexed.

Chairman of OAO Gazprom, Alexey Miller, said at the time of the signing: "This agreement significantly strengthens the long-term LNG portfolio of Gazprom and enables us to increase LNG trading volumes and utilise our own fleet of LNG carriers."

The Yamal LNG project is to start commercial production in 2017. Yamal LNG shareholders include NOVATEK (60%), TOTAL (20%) and CNPC (20%). Yamal Trade is a wholly owned subsidiary of Yamal LNG.

Yamal LNG announced last year that it had signed a preliminary agreement with DSME for up to 16 LNGCs to serve the project. The vessels will probably be ordered by third parties on the back of long term charter contracts.

A memorandum of understanding was also signed last year between Sovcomflot, Novatek and Vnesheconombank to build two Ice Class 170,000 cu m LNGCs in what was described as a 'pilot project' for Yamal LNG.

OMAN SHIP MANAGEMENT

A subsidiary of state-owned Oman Shipping Co, this commercial management concern formed in 2003, operates seven LNGCs, the latest of which - the 162,000 cu m *Adam LNG* - was delivered this year.

All of the vessels are technically managed by MOL, which continues to act a consultant to the company.

The latest vessel has accommodation for up to six cadets, plus an instructor.

OVERSEAS SHIPHOLDING GROUP (OSG)

Despite its problems, OSG still commercially and technically manages four Q-flex LNGCs owned by Nakilat.

The 216,000 cu m LNGCs were delivered in 2007-2008 and are operating on 25 year charters to QatarGas.

PAN OCEAN

STX Pan Ocean changed its name to just Pan Ocean in January of this year.

The company's involvement in LNGCs can be traced back to 2005 when it won a contract to lift Yemeni gas for KOGAS for 20 years

and started to operate the 153,600 cu m *Kolt* in 2008.

Pan Ocean also operated the 2010-built *STX Frontier* but sold the vessel to GasLog in September last year for around \$160 mill.

PETRONAS

Last October, Malaysian state-owned energy giant Petronas signed a contract with Hyundai Heavy Industries to build four 150,200 cu m Moss-type LNGCs for about \$850 mill.

The contract also includes options for four additional LNGCs of the same class.

The four newbuildings are scheduled to be delivered to PETRONAS from the second half of 2016.

MISC Berhad will act as the project manager and technical consultant to PETRONAS for the construction of the LNGCs.

Hyundai said that the Moss types were "the preferred choice for offshore storage work where harsh sea conditions are a significant factor." They have been ordered to serve Petronas' FLNG projects.

In June 2012, Petronas took a final investment decision on its first FLNG project.

The hull of the first FLNG was launched at the DSME shipyard in Okpo, South Korea on 5th April this year. The facility, scheduled to be completed in the fourth quarter of 2015, will be the world's first floating LNG facility to come on stream.

The PFLNG1, also known as *PFLNG SATU*, will be moored in Malaysia's Kanowit gas field, 180 km offshore Sarawak and will produce 1.2 mill tonnes of LNG per year.

Petronas is also planning a second FLNG, with a capacity of 1.5 mill tonnes per year, to be located offshore Sabah, East Malaysia. In January of this year, Petronas approved the final investment decision (FID) for this second FLNG facility (PFLNG 2) project.

Subsequently, the company issued a letter of award for the engineering procurement, construction, installation, commissioning (EPCIC) contract for the project to a consortium involving JGC Corp, Samsung Heavy Industries, JGC (Malaysia) and Samsung Heavy Industries (M).

The EPCIC contract award followed the 2012 dual front end engineering design (FEED) study for the project undertaken by two consortia - Modec, CB&I Nederland and Toyo Engineering Corp consortium and the JGC Corp, Samsung Heavy Industries, JGC (Malaysia) and Samsung Heavy Industries (M) consortium.

This second FLNG will be moored at the Rotan gas field in deep water Block H,

offshore Sabah. It is scheduled to be ready for start-up by early 2018.

PETRONET LNG (PLL)

Petronet LNG, India's largest liquefied natural gas importer, will charter a fourth LNGC from a consortium of state-owned Shipping Corp of India (SCI) and Japanese companies.

SCI and MOL, NYK Line and K Line have won a global tender to charter one LNGC to Petronet for transporting gas from Gorgon in Australia to Kochi in Kerala, where Petronet has built a 5 mill tonnes per annum LNG import and regasification terminal.

The consortium already operates three LNGCs for Petronet for gas imports from Qatar to its Dahej terminal in Gujarat.

Petronet has an option to take 26% stake in the new shipping venture but no decision has been made thus far, the company said.

The company already has a 3% stake in one of the three consortia formed to lift 7.5 mill tonnes per annum of LNG from Qatar to Dahej. SCI holds 29.08% stake in the 138,000 cu m capacity *Disha* and *Raahi* LNGCs and a 26% stake in the 155,000 cu m capacity vessel *Aseem*.

Petronet said that it needed a 174,000 cu m capacity vessel for 19 years to ship 1.44 mill tonnes per annum of LNG it has contracted from Gorgon, Australia. Supplies from Australia were due to start by the end of July, while the consortium has committed to deliver the ship in 2016.

It was later reported that a 173,000 cu m capacity LNGC has been ordered at Hyundai by a company called India LNG Transport for \$200 mill for delivery in 2016.

Petronet operates the Dahej 10 mill tonnes per year LNG import and regasification facility, which is to be expanded to 15 mill tonnes by next year.

Besides the recently commissioned Kochi terminal, it is also constructing a 5 mill tonnes capacity facility at Gangavaram in Andhra Pradesh.

Petronet, which is part owned by Oil and Natural Gas Corp (ONGC), GAIL India, Indian Oil Corp and Bharat Petroleum Corp (BPCL), received its first LNGC *Disha* on 9th January, 2004 followed by a second - *Raahi* - on 16th December, 2004 and the third - *Aseem* - on 16th November, 2009.

Two of the Indian LNGCs have supplied Dahej since 2004. They have since been taken under technical management by SCI and they lift Qatar's RasGas cargoes to the Indian terminal under a contract due to last until 2028.



The Q-Flex LNGC *Al-Gattara* at the Zhuhai LNG terminal.

PRIMORSK SHIPPING CO (PRISCO)

PRISCO is involved in a consortium that operated the Ice Class 1C 145,200 cu m LNGC *Grand Mereya*.

The other consortium members are MOL and K Line, while MOL undertakes the technical management of the vessel.

PRISCO operates the vessel, which loads gas at Prigorodnoye (Sakhalin II) under a long term contract with Sakhalin Energy.

PRONAV SHIP MANAGEMENT

Pronav manages nine LNGCs from its Hamburg office.

These include four Q-flex types and five conventional LNGCs, which are getting to the veteran stage having been built in 1978 onward.

They are all operated by an MOL-led consortium.

QATAR GAS TRANSPORT (NAKILAT)

Nakilat was established in 2004 as a joint stock company — owned 50% by its founding shareholders and 50% by the public.

The shipping concern claims to operate the largest LNG shipping fleet in the world, which was recently increased to 61 LNGCs, along with four VLGCs.

Since its inception, Nakilat has diversified its activities and developed the Erhama Bin Jaber Al Jalahma Shipyard, a large shiprepair and shipbuilding facility located in the Port of Ras Laffan.

A joint venture - Nakilat-Keppel Offshore & Marine (N-KOM) - was established with Keppel Offshore & Marine to operate the shipyard's shiprepair facility.

To operate the shipyard's shipbuilding facility, Nakilat entered into a joint venture with Damen Shipyards Group to establish Nakilat Damen Shipyards Qatar (NDSQ).

As for the LNGC fleet, in April of this year, Nakilat added three new LNGCs to its fleet through its joint venture Maran Nakilat, which had closed \$807.4 mill of refinancing provided by Qatar Islamic Bank (QIB) and Barwa Bank.



Maran Nakilat has boosted Nakilat's already strong fleet still further.

Maran Nakilat is a joint venture formed in 2005 with Greek shipping company Maran Ventures, part of the Angelicoussis Group. Four of the original LNGCs in the joint venture are on long term charter to RasGas.

These new vessels increased the joint venture's total fleet from eight vessels to 11 and grew Nakilat's LNG fleet from 58 vessels to 61.

Maran Nakilat has grown its fleet's capacity in three stages and in June 2013, Nakilat also increased its ownership of the joint venture from 30% to 40%.

Nakilat also pioneered with Q-Flex and Q-Max types of which there are 31 and 14, respectively. Those involved in partnerships to own, manage and operate the vessels include Teekay, OSG, K Line, MOL, NYK, Pronav, Maran Gas and Petronet.

STASCO was appointed technical manager of 25 LNGCs for periods of between eight and 10 years, following the delivery of the last Q-Max - *Rasheeda* - in August 2010.

Following the ending of the contract, Nakilat intends to take over the vessels' technical management.

RASGAS

Through long term charters, RasGas operates a dedicated fleet of 27 LNGCs

The RasGas fleet, comprising conventional, Q-Flex and Q-Max vessels, delivers LNG to a number of terminals worldwide, including the Qatar Terminal Company LNG receiving terminal, in the Adriatic Sea, off the Coast of Italy.

The fleet includes 14 conventional LNGCs with a cargo-carrying capacity of 138,000 cu m to 151,700 cu m, and 13 large LNGCs, including Q-Flex and Q-MAX types.

RasGas' charter fleet has been built up through a series of timecharter agreements with separate shipping companies and consortia, including Qatar Shipping, Maran Gas Maritime, the Japanese-led consortium of MOL, NYK, K Line (an AP Moller and Qatar Shipping consortium), the J5 Nakilat and Teekay Nakilat Corp.

The first ship in the fleet - *Fuwairit* - entered service in February 2004 and celebrated its 100th cargo loaded at Ras Laffan in 2012.

The agreement with J5 Nakilat and Teekay Nakilat was, at the time of signing, one of the largest-ever commercial shipping contracts. Its Q-Flex LNGCs can access around two-thirds of LNG terminals worldwide.

In October 2009, RasGas took delivery of its first 266,000 cu m Q-Max vessel - *Al Dafna*.

Q-Max types are currently the largest LNGCs in the world. As with the Q-Flex types, the improved carrying capacities of Q-Max LNGCs result in lower transportation costs per journey compared to conventional LNG ships. Nearly half of the world's existing LNG terminals can, or with some modifications, could accommodate these ships.

Since the beginning of its LNG shipbuilding programme, through economies of scale and propulsion, RasGas claimed to have reduced the cost of transportation by 30 - 35%, giving Qatar a competitive advantage, the company claimed.

SHELL SHIPPING (STASCO)

Shell was involved with the world's first two purpose-built LNG newbuildings in the mid-1960s. They were built to serve the Canvey Island, UK receiving terminal with Algerian gas, loaded at Arzew.

Since then the UK oil major has made a major commitment to LNG and today accounts for around 25% of the world's gas carriers in various tie ups, both commercially and technically. This amounts to more than 50 LNGCs although some are being taken back into management by their owners, most notably the Nigerian LNG vessels operating for Bonny Gas Transport - which see.

Shell also charters in when necessary to cover its cargoes, for example GasLog's latest 155,000 cu m newbuilding *Solaris*, which has been fixed on a medium term charter contract and given a Shell 'name'.

In 2007, Shell was awarded the management contract of 25 of the Nakilat-operated Q-Flex and Q-Max types, which is due to last for around 10 years per vessel.

Shell is also involved with Samsung in a project to build standard design LNGFPSOs over a 15-year period and in 2010 awarded the South Korean shipbuilder a \$4-\$5 bill contract to build a 220,000 cu m capacity LNGFPSO-*Prelude*.

Her hull was recently launched and she is due to be delivered in 2017. *Prelude* was designed by Samsung in co-operation with Technip.

Once completed she will be moored about 475 km Northeast of Broome, Western Australia.

In 2012, Shell signed a contract to charter two of Sovcomflot's four Ice Class LNGCs under construction at STX Offshore & Shipbuilding in co-operation with JSC United Shipbuilding.

The first vessels is due to enter service at the end of this year and the second following in 2015.

In 2013, Shell agreed to acquire the LNG assets of Spanish concern Repsol, including Stream, which expanded the Anglo-Dutch concern's interests in South America.

The deal, finally concluded earlier this year, included the operation of 13 vessels together with their charters, plus the equity in Repsol's LNG production assets in South America.

Stream was founded in 2005 by Repsol and Gas Natural to manage the 13 Spanish-controlled LNGCs.

Repsol has retained its non-LNG shipping interests.

SK SHIPPING

Marubeni Corp in collaboration with SK Shipping has concluded long-term charter contracts for two LNGCs for a UK subsidiary of Total.

With a loading capacity of 180,000 cu m, the LNGCs will be the largest gas carriers, which will be able to transit the expanded Panama Canal.

By establishing joint shipowning companies, Marubeni and SK Shipping, have signed contracts with Samsung Heavy Industries for the two vessels, charter contracts with Total and loan agreements with several financial institutions.

The ships are scheduled for delivery by January and October, 2017, respectively and will be chartered to Total for a maximum of 30 years under the ownership and management by the joint venture companies.

The two ships will transport LNG from separate projects - the Australian Ichthys LNG project and the Sabine Pass liquefaction project where US shale gas will be processed into LNG for the first time.

Once delivered, the two vessels will bring SK Shipping's fleet up to eight LNGCs. The company's first gas carrier - *YK Sovereign* - was delivered in 1994.

IM SKAUGEN (IMSK)

IMSK was one of the first companies to develop the hybrid gas tanker concept, which is basically an LPG/ethylene carrier, which can also lift LNG in separate tanks.

Of its current fleet of 15 gas carriers operated by Norgas, six are capable of carrying LNG, in addition to petrochemical gases and LPG. They are called the 'Multigas' class.

Four of the six are of 10,000 cu m capacity, while the other two are slightly larger at 12,000 cu m capacity each.

They were delivered between 2010-2011 and were built in Chinese shipyards under the management of Skaugen Marine Construction.

SONANGOL

Sonangol subsidiary Sonangol Shipping Holding was formed in 2007 and operates three 173,000 cu m LNGCs delivered from Daewoo that year and in 2008.

The Angolan state-owned concern has a 22.8% stake in Angola LNG along with Chevron (36.4%), BP (13.6%), ENI (13.6%) and Total (13.6%).

In July of last year, Angola LNG delivered its first cargo to the Guanabara Bay receiving terminal in Brazil.

Since then a series of accidents has shut down the Soyo plant and it is not due to reopen until next year.

Before the problems, Angola LNG had said that around 70 cargoes per year were due to be loaded at the Soyo terminal, which will also handle butane, propane and condensate at its three jetties.

SOVCOMFLOT (SCF)

The SCF Group has four 170,000 cu m Ice2 (1C) Atlanticmax LNGCs on order, the first of which - *Velikiy Novgorod* - was delivered earlier this year from STX Offshore & Shipbuilding.

The second- *Pskov* - was due to be delivered as *LNG Shipping Review* went to press, while the third - *SCF Melampus* - is due to join

Shell's fleet in December of this year and her sistership in April, 2015.

In addition, SCF has announced that it has ordered an Arc7 Ice Class 172,000 double acting LNGC at DSME for transporting Russian gas from Yamal. She is due for delivery in June, 2016.

Other owners have also confirmed orders for similar vessels this year for the Yamal LNG project, which unlike Shtokman, is on schedule to come on stream in about 2017.

To gain experience in LNGC operations, SCF purchased two elderly gas carriers a few years ago. One - *SCF Polar* - was recently recycled, while the other - *SCF Arctic* - is still trading.

In 2007-2008, SCF took delivery of the 1C Ice Class newbuildings - *Grand Aniva* and *Grand Elena*. The 145,000 cu m LNGCs were built for a consortium involving SCF and NYK to ship gas from Prigorodnoye, the loading terminal for Sakhalin II.

Another two of a similar size followed - *Tangguh Batur* and *Tangguh Towati* - built for SCF, Samudera and NYK to serve the Tangguh project in Indonesia.

All of SCF's wholly-owned vessels are managed by subsidiary Unicom out of Limassol, Cyprus.

STENA BULK

In 2011, Stena Bulk purchased three LNGCs from TMT for about \$700 mill.

The three LNGCs currently operating in the fleet are the 145,000 cu m *Stena Blue Sky* and the 173,400 cu m sisters - *Stena Clear Sky* and *Stena Crystal Sky*.

They were built by DSME to Ice Class 1C and they are all on medium term charters.

All three vessels are commercially operated by Stena Bulk and technically managed by Stena controlled Northern Marine Management in Glasgow.

Stena Bulk took the vessels back into the fold in January of this year from Stena LNG.

TEEKAY LNG PARTNERS

The Teekay Corp subsidiary has committed to the Yamal LNG project by ordering six newbuildings.

The orders, worth around \$2.1 bill, were placed with DSME through a 50:50 joint venture with China LNG Shipping (Holdings).

Each vessel will have a capacity of 172,000 cu m and will be built to Ice Class Arc7 notation

The vessels will be constructed with maximum 2.1 m icebreaking capabilities in both the forward and reverse direction and will be propelled by Azipods thus enabling a double acting mode.



The 1968-built *SCF Arctic* recently joined the USCG's Qualship scheme.

Yamal LNG, a joint venture between Russia-based Novatek (60%), French oil major Total (20%) and China National Petroleum Corp (CNPC) (20%), will consist of three LNG trains with a total expected capacity of 16.5 mill tonnes of LNG per annum and is currently scheduled to start-up in early-2018.

Earlier, Teekay LNG Partners had purchased ownership interests from BG in four 174,000 cu m TFDE LNGC newbuildings to be built at Hudong-Zhonghua Shipbuilding.

The vessels, which are scheduled to deliver between September, 2017 and January, 2019, will each operate under 20-year timecharter contracts, plus extension options, with Methane Services, BG's wholly-owned subsidiary.

The Partnership acquired a 30% ownership interest in the first two LNGC newbuildings with the balance of ownership held by CETS (an affiliate of China National Offshore Oil Corp (CNOOC)) and China LNG Shipping (Holdings) (CLNG) and a 20% ownership interest in the second two LNGC newbuildings with the balance of ownership held by CETS, CLNG and BW Group.

Teekay Corp will provide the construction supervision services for the newbuildings and technical management of the vessels upon their respective deliveries.

The Partnership will finance its pro-rata equity interest in future shipyard instalment payments using a part of its available liquidity with the balance of the total cost of the vessels financed with equity contributions by the other partners and a new \$800 mill long-term debt facility secured by the vessels.

Together with the five ME-GI engined LNGC newbuildings, due for delivery in 2016-2017, Teekay LNG Partners has interests in 44 LNGCs carriers (including one LNG regasification unit and 15 newbuildings), as well as 30 LPG/Multigas carriers (including five chartered-in LPG carriers and 10 newbuildings) and nine conventional tankers.

The first two of the 173,400 cu m LNGCs powered by twin M-type, electronically-controlled, gas injection engines, were ordered in December 2012 at DSME and chartered for five years each to Cheniere Marketing.

Teekay has since firmed up orders for three more of the same type from DSME.

The Partnership's interests in all of the LNGCs range from 20% to 100%.

TIANJIN MARINE

In April, it was announced that the Hainan Airlines Group company - Tianjin Marine - had signed a letter of intent with Dalian

Shipbuilding Industry for four LNGCs.

According to the reports, Tianjin has six months in which to firm up the order.

Within the framework of the expansion plan, which includes 10 VLCCs, the company said that it would raise up to \$1.96 bill to help finance the purchase of 14 new vessels.

Under the contract, the prices for each vessel range between \$200-\$230 mill. The planned LNGCs were said to be between 160,000 cu m to 175,000 cu m in capacity.

TOKYO GAS

This Japanese energy giant has been importing natural gas for its power plants since 1969.

LNG is mainly imported into Tokyo Gas' facilities in Tokyo Bay.

The company charters in several LNGCs both on a long and short term basis to cover its cargo requirements.

TSAKOS ENERGY TRANSPORT (TEN)

TEN took delivery of the 150,000 cu m *Neo Energy* in 2007 to gain experience in managing this type of vessel.

Since then, the company has ordered a 174,000 cu m LNGC from Hyundai for delivery in 2016.

She is to be named *Maria Energy*.

ANTHONY VEDER

Since Anthony Veder launched world's first small scale combined LNG/LPG/LEG carrier *Coral Methane* in 2009, the Rotterdam based company has been a market leader in small scale LNG shipping operating three LNGCs.

The development of the first small scale carrier, the *Coral Methane*, started in 2006 as a study by Anthony Veder for Norwegian based Gasnor, today part of Shell.

Gasnor produces and distributes natural gas as a clean energy source to various Norwegian

locations and in 2006, decided to expend its extensive Norwegian pipe and truck distribution network by using small capacity LNGCs.

A challenging logistical solution was overcome by the vessel's optimal size and flexibility. A unique concept was developed for a small LNGC in that she was fitted with diesel/gas/electric propulsion with pods for maximum operational flexibility, manoeuvrability and safety in Norwegian's fjord located small ports and terminals.

Another major operational challenge was transshipping LNG from large terminals to various small terminals along the Norwegian coast. As a result, the ship is fitted with two manifolds (high and low) and flexible hoses in order to accomplish various LNG transfers from ship to shore and vice versa.

Coral Methane has loaded several cargoes at LNG terminals at Zeebrugge, Huelva and GATE (Rotterdam). She can load various cargoes (LNG/LPG/LEG), which makes her deployable in multiple trades resulting in her higher than average utilisation.

Following the *Coral Methane*, Anthony Veder started the development of the LNGC *Coral Energy*, the world's first direct driven dual-fuel ice-class 1A LNGC.

This vessel's development started in 2010 for Skangass, Scandinavia's natural gas provider and she was delivered in 2012.

To distribute LNG in Scandinavia, Skangass was looking for a small to medium scale LNGC. With the building of the *Coral Energy*, Skangass and Anthony Veder make it possible to deliver LNG to remote places and to smaller terminals where the LNG can be used as bunker fuel for other ships, power generation and retail distribution.

Another hybrid, *Coral Antheia*, was delivered in 2013 and will be deployed in Europe in the small scale LNG trade in late 2014.



Anthony Veder's first hybrid -- *Coral Methane* -- was delivered in 2009.

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