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TANKER UPDATE

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LNG AS FUEL

SKANGASS

IACS HARMONIZED RULES

GASLOG

CONTENT

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EDITORIAL

Håkon Skaret
Business Director Tankers
Hakon.Skaret@dnvgl.com

The only constant is change

In the past 15 months, the tanker NB market has experienced dramatic changes. The newbuilding price index for tankers in China, which bottomed out in February last year, has rebounded to a level not seen since before 2011. Meanwhile, yards in Japan and Korea have full order books, which will keep them busy through 2016. In addition, the market for second-hand vessels has seen a significant improvement. These are surely encouraging signs, yet it should be noted that time charter rates have fallen again, despite the strong recovery in the 4th quarter 2013 and 1st quarter 2014. It seems like the fundamental challenge of tonnage oversupply in the tanker segment is continuing to depress rates.

We are also seeing some big changes in LNG transportation. In the US, the growth in non-traditional (shale) gas and tight oil production has upset long-established trades in LNG and crude, creating both challenges and opportunities. Indeed, most analysts believe that, in the short term, rates for deep-sea LNG carriers will remain weak, as operators of new LNG carriers anxiously await the commissioning of new LNG liquefaction plants, while the mid- to long-term outlook is better. At the same time, the LPG sector is booming in that increased US exports and record-high charter rates have stimulated orders of new tonnage to a record level of 39% on order compared with the existing fleet (dwt).

Looking ahead, I fully agree with those who believe that the next five years may bring bigger changes to the tanker industry than the previous decade. Consider that a series of new regulations covering ballast water treatment systems, emissions regulations and stricter EEDI requirements will have a big impact on the development of new technologies. Furthermore, the introduction of alternative fuels, such as LNG, methanol and LPG, may raise some difficult questions for owners working to comply with new regulations: is it more cost effective to invest in scrubbers or in engines powered by alternative fuels? And which fuel is the best choice for my ships?

In this issue of Tanker Update, we examine a number of these questions and offer some insights as to where the tanker segment is heading. From fuel strategies to LNG containment systems, ballast water treatment and how new regulations are likely to impact the segment going forward, DNV GL has the experience and technical expertise to be a valuable resource to a segment undergoing rapid change. As always, our goal remains the same: to help the industry become safer, smarter and greener.

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DNV GL
NO-1322 Høvik, Norway
Tel: +47 67 57 99 00

Text: Martin Christian Wold and Kjersti Aalbu
Martin.Wold@dnvgl.com and Kjersti.Aalbu@dnvgl.com

LNG AS FUEL ON A NEW BUILD MR TANKER

– A COMMERCIALLY ATTRACTIVE OPTION?

Stricter environmental regulations, rising fuel costs, and availability of new energy sources are increasing the likelihood for a transition away from the current marine fuel mix dominated by heavy fuel oil (HFO) and marine diesel oil (MDO) to other, alternative fuels. These trends provide an interesting price spread between conventional fuel oil and the competing alternative fuels such as LNG.

▲Kjersti Aalbu
▼Martin Christian Wold

While alternative fuels or energy carriers such as biofuel and ship electrification are interesting options for the shipping sector, liquefied natural gas (LNG) is the key alternative fuel for new build tankers today. LNG as ship fuel responds to both upcoming regulations and costs drivers. LNG can for example reduce fuel and other operational costs; ensure compliance with the upcoming SOx and NOx regulations; and reduce CO_2 emissions.

The (commercial) risk of choosing LNG is seen as high by many actors – but what is the risk of not considering LNG fuel? A vessel ordered today will still operate in the 2030s, in a world with unknown fuel availability, fuel prices, and regulatory requirements. Making the wrong fuel choice today can have major implications for the commercial performance of a ship over its lifetime, including tradability and the second hand value.

A ship owner has two options when considering the use of LNG as fuel in the new build phase:

1. Building a LNG ready ship - a ship ready for future retrofit, and
2. Building a LNG fuelled ship - a ship ready for LNG operation from day one

A LNG ready ship is a good option in situations where LNG will not likely be available for another few years or if the commercial terms today are considered to be not sufficiently favourable. The second option, a LNG fuelled ship, is the preferred option when there are no anticipated barriers for using LNG from the date of completion.

In this article, we present the business case for building a dual fuel medium range (MR) tanker. We examine the commercial

Operational profile

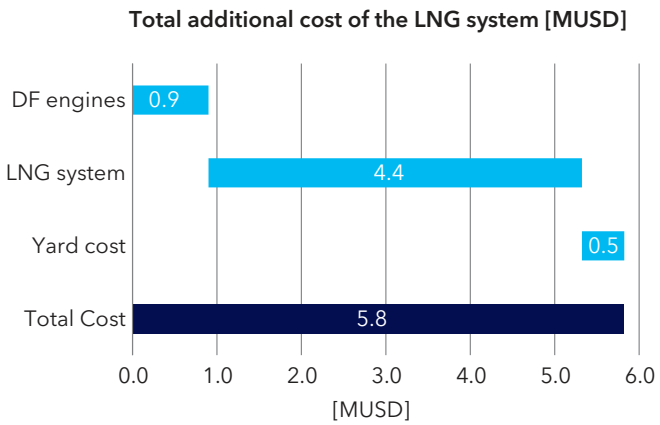


Figure 1: Total additional cost of the LNG system (MUSD)

attractiveness of LNG compared to the other main options for emission control area (ECA) compliance - fuel switch to MGO and HFO plus a scrubber - and discuss whether a LNG ready or LNG fuelled ship is ideal for this case.

But first, let's take a quick look at the status of LNG as fuel.

LNG - status today

LNG as fuel is now a proven and available solution, with gas engines covering a broad range of power outputs. Engine concepts include gas-only engines, and dual fuel 4-stroke and 2-stroke. Methane slip (contributing to GHG) during combustion is practically eliminated in modern high-pressure 2-stroke engines, and further reductions should be expected from 4-stroke engines.

The number of ships is increasing fast and infrastructure projects are planned or proposed along the main shipping lanes. There are now 48 LNG fuelled ships (excluding LNG carriers) in operation worldwide, while another 55 new buildings are confirmed. We expect LNG uptake to grow considerably in the next five to ten years. While conventional oil-based fuels will remain the main fuel option for the tanker segment in the near future, the commercial opportunities of LNG are interesting for individual new build projects.

Case – building a MR tanker to run on LNG

This case examines the commercial attractiveness of building a dual fuel 50 000 DWT medium range oil tanker.

MR tankers are usually engaged in spot trade, meaning the vessels have an unpredictable trading pattern. This has so far been one of the main arguments for not investing in LNG as fuel – industry actors consider it as too big of a risk before it is certain that LNG can be bunkered globally.

However, as charterers look for the cheapest overall cost of transportation, a dual fuel MR tanker will be an attractive choice for trades with high ECA exposure. Especially, for vessels trading to the US, charterers will realise that LNG fuelled vessels may have a lower total cost of transportation. For ship owners with a Dual Fuel MR tanker, this would mean that their vessels would be an attractive choice in the spot pool.

In this case, we have therefore looked at a cross-Atlantic trade with a high ECA exposure. The vessel will trade from Rotterdam via New York to Houston, as illustrated on the map above. This means that the vessel will operate in the North Sea SOx ECA and the North American SOx and NOx ECA. From 1 January 2015, all vessels operating in designated SOx ECAs will need to comply with the 0.1 per cent sulphur regulation. If the vessel is built after 1 January 2016, it will also have to comply with NOx Tier III regulations when operating in NOx ECAs. If the vessel runs on conventional fuels, it will then have to install additional emission abatement technologies on board.

TOTAL DISTANCE (ROUND-TRIP)	10,300 NM
Total sailing time	32 days
Speed	13.5 knots
Sailing time in ECA	38%

We assume that the vessel will use LNG for the complete voyage. If the vessel bunkers twice per roundtrip, for example in Rotterdam and in Houston/New Orleans, the vessel will need a tank capacity of 1500 m3. For only one bunkering operation during the roundtrip, the vessel requires a 3000 m3 tank. The latter case will allow the vessel to bunker all of its fuel in the US, where LNG prices are considerably lower than in Europe. LNG is expected to be available on the trade route within the next two years.

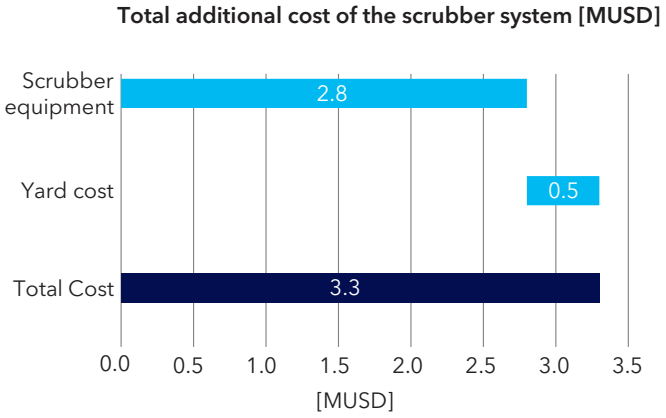


Figure 2: Total additional cost of the hybrid scrubber system (MUSD)

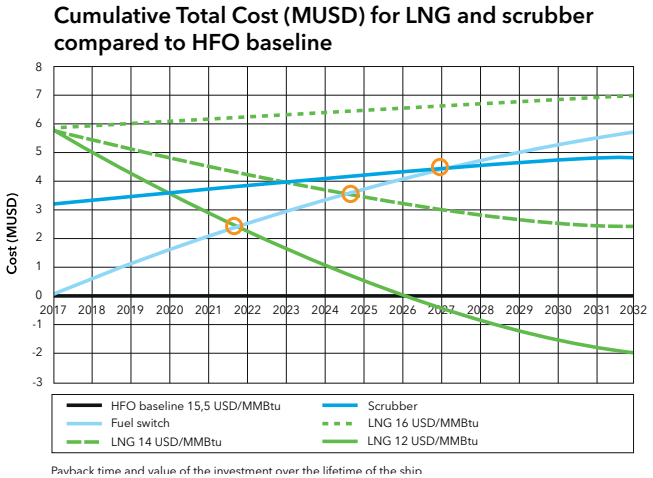


Figure 3: Cumulated discounted cost difference for different compliance options compared to HFO baseline (MUSD)

There are no technical barriers for using LNG as fuel on a MR tanker; there are now several dual fuel engines available to choose from for these vessels (both main and auxiliary), and one or more LNG fuel tanks can easily be located onboard.

Financial analysis

In order to examine the commercial attractiveness of LNG on the case vessel, we have performed a high-level financial analysis comparing LNG to fuel switch to MGO and to HFO with a scrubber:

1. LNG case: The vessel will use LNG for the whole roundtrip
2. MGO: The vessel will use MGO in the ECAs, and HFO outside the ECAs
3. HFO with a scrubber: The vessel will use HFO for the whole trip, and use the scrubber in the ECAs

In the analysis, we include both capital and operational expenditure. The figure below presents an estimate of the total additional capital cost of the LNG system, meaning the delta cost of installing dual fuel engines and the LNG system compared to a regular, diesel fuelled vessel. The cost of the LNG system is based on a 1500 m3 tank capacity. Doubling the tank capacity would only mean a moderate increase in cost. An estimate for a hybrid scrubber system is also shown in figure 2.

Figure 3 above presents the cumulative cost of the different fuel options for the new build MR tanker, compared to a HFO baseline. Although LNG has a high investment cost, operational savings can be significant, depending on the fuel price. In this case, we have applied a LNG price spread ranging from 12 USD/MMBtu (600 USD/tonne) to 16 USD/MMBtu (900 USD/tonne). In the case of a LNG price of 12 USD/MMBtu, the payback time compared to HFO with a scrubber is 2.6 years, and 4.5 years compared to fuel switch to MGO.

Conclusion

Our analysis shows that LNG can be an attractive fuel option for an MR tanker, depending on the LNG price. This is particularly promising for LNG fuelled vessels trading in the North American ECA, where access to attractively priced LNG in several relevant ports and areas is being developed. These vessels would have a competitive advantage over vessels with other, potentially more costly, ECA compliance options. Could these vessels become the preferred option by cost-conscious charterers with spot cargos and short term time charters for routes with high ECA exposure? Are there sufficient cargos available with high ECA exposure to keep a fleet of DF MR tankers busy, giving a good payback for the ship owner? We believe there could be good opportunities for ship owners today to order such DF MR tankers. Judging by the interest, the first orders are likely not far away.

The expected development of LNG bunkering possibilities in key areas makes LNG fuel a more attractive option for MR tankers as well as other tanker types trading with high ECA exposure, and the additional Capex to prepare the ship for later retrofit could prove to be a good investment.

DNV GL has to date assessed more than 20 different LNG ready cases, including both new builds and retrofits, covering all ship segments, in addition to the 65 ships that has been delivered or is on order with LNG as fuel.

The high-level analysis performed and presented in this article is part of the DNV GL LNG Ready service. The LNG Ready service has been developed in order to assist ship-owners, operators, yards and designers in identifying the most attractive compliance option for their ships. For more information regarding the service, please contact the authors. ▮

Text: Kevin Gallagher, Blue-C

SKANGASS:

AN EARLY MOVER ON LNG BUNKERING SOLUTIONS

LNG may be the marine fuel of the future, but questions about the LNG bunkering infrastructure have made some owners reluctant to embrace LNG as a fuel. However, with decades of experience in providing land-based LNG distribution infrastructure, Skangass may have the answer.

Skangass of Stavanger is ready to deliver when the ships come in. Finnish Gasum acquired a 51 per cent share in Skangass in May of this year, pushing Gasum into the lead spot in Nordic LNG. Skangass will provide a major part of the new company's LNG infrastructure, as well as assuming control of Gasum's existing distribution infrastructure.

While supply to industry has driven Skangass's expansion, the marine market is beginning to show a real upside. "This acquisition strengthens our position as a leading LNG player in the Nordic market," says Skangass CEO Tor Morten Osmundsen. "The new boost to the infrastructure will contribute to continued growth in the number of LNG-fuelled cargo and passenger vessels in the North Sea and Baltic Sea, which will result in emission cuts in maritime transport in particular."

Breakthroughs in LNG bunkering

Skangass is already breaking new ground in the LNG bunkering business, with its newly approved truck-to-ferry bunkering solution at the Risavika harbour outside Stavanger. The approval allows Fjord Line to bunker its two cruise ferries – the Stavangerfjord and Bergensfjord - in Norway, rather than trucking gas down to Denmark for bunkering there.

Two key elements in the development are the permits to deliver and bunker from trucks and to bunker while passengers are embarking and disembarking in Risavika. "The fact that the Norwegian Directorate for Civil Protection (DSB) has granted us permission for a temporary truck bunkering solution is important for us in order to maintain the delivery security for Fjord Line," says Mr Osmundsen. "We started the first bunkering in Risavika with passengers on board as early as in mid-March."

In January, Skangass received permission to establish a permanent bunkering station at Risavika and planning is expected to be completed by the summer of 2014. In connection with its LNG terminal at Lysekil, a permanent terminal for filling up the bunkering vessel is being commissioned and is scheduled to start service in June of this year.

The next step?

"We're in the process of realising plans for a ship-to-ship dedicated bunker vessel," reports Skangass Director of Special Projects Peter Blomberg. "We are now in negotiations with a shipowner to build and operate the ship and have been granted funding through the EU pending the final decision, so there are good incentives to proceed.

"With marine LNG, it's always a question of the chicken or the egg – do you ensure supply so the customers will come, or do you wait for the customers and then build up supply?" Blomberg reflects. "But we believe it's important to take this step, to make it easier for shipowners to decide to go with LNG by being where they are, instead of them having to come to us," he concludes.

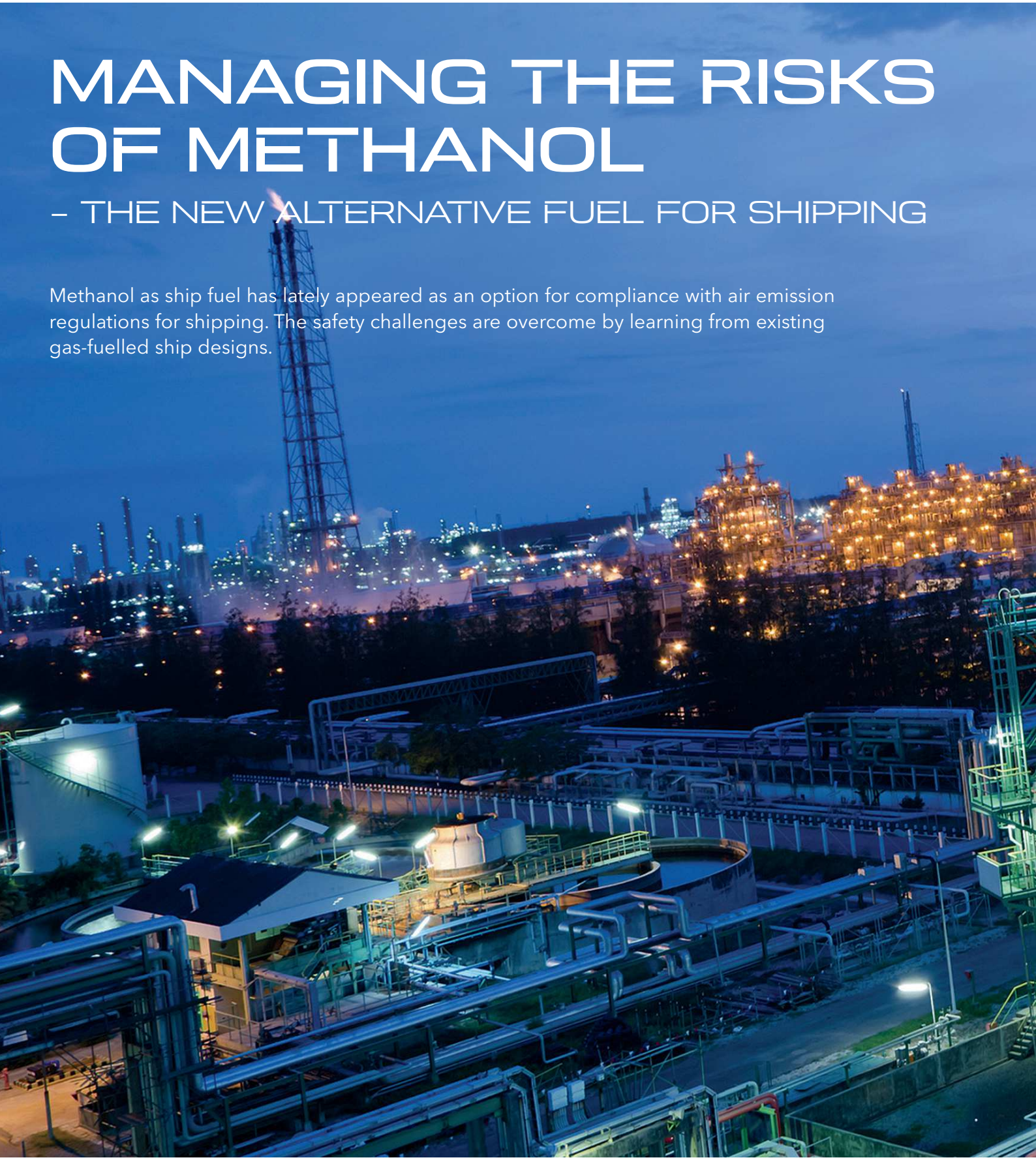
Founded in 2007, Skangass began its LNG operations in 2011 and has already come a long way towards its goals: to build up a leading position, keep up the pace and take an active role in developing the marine LNG market. Whether it is the chicken or the egg, one has to come first and Skangass is set on being a first mover in the Nordic market. ▮

Text: Tobias King
Tobias.King@dnvgl.com

MANAGING THE RISKS OF METHANOL

– THE NEW ALTERNATIVE FUEL FOR SHIPPING

Methanol as ship fuel has lately appeared as an option for compliance with air emission regulations for shipping. The safety challenges are overcome by learning from existing gas-fuelled ship designs.



Tobias King

As the first contracts for methanol-fuelled tankers were signed in December 2013, it became clear that there are opportunities for alternative shipping fuels besides LNG. It is not the first time methanol has been used as fuel in combustion engines, but its application to shipping is new and its chemical properties call for additional safety barriers compared to what the industry is accustomed to in conventional oil fuel systems.

Motivated by environmental regulations

As methanol contains no sulphur, the only SOx emissions from burning methanol will come from the pilot fuel. The NOx emissions will also be significantly lower than those from oil fuel, making compliance with air emission regulations a reason for choosing methanol. The carbon footprint will depend on the source of the methanol.

Most of the world's methanol is produced from natural gas and an estimated 35% of the energy in the natural gas is lost in the production process, making the carbon footprint of methanol ship fuel 1.08 times that of HFO (from well to propeller) according to studies by researchers at DNV GL.

The carbon footprint is significantly smaller when using natural gas to produce LNG for ship fuel, but methanol can be produced from a wide range of sources and the same studies show that biomethanol has a carbon footprint which is 0.09 times that of HFO (Source: DNV GL Position Paper 17-2014, Alternative Fuels in Shipping).

Interesting for tankers

When it comes to the technicalities, a methanol fuel system will be more complex due to the additional safety barriers - as will be discussed below. It is also worth noting that methanol's energy density is less than half that of conventional oil fuel, meaning that more than twice the amount of space is needed to produce the same amount of energy. Compared to gas-fuelled systems,

Methanol booster fuel injection valve.

MAN B&W ME-LGI for low flashpoint fuels. © MAN

PROPERTIES		METHANOL	DIESEL
Chemical formula	-	CH3OH	C8-C25
Flashpoint	°C	12	>60
Boiling temperature	°C	65	180-360
Liquid density	kg/m3	798	840
Lower heating value	MJ/kg	19,9	42,7
Auto ignition temperature	°C	470	250-450
Cetane number	-	<5	38-53
Octane number	-	109	15-25

however, a methanol fuel system will be even less complex as there are no risks connected to the handling of cryogenic liquid and boil-off.

Methanol may be stored in an integral tank at ambient temperature without any means of boil-off handling apart from safety release valves, making it an attractive option for retrofitting. Methanol is particularly interesting for tankers trading methanol because the fuel is available from the cargo supplier.

Equivalent level of safety

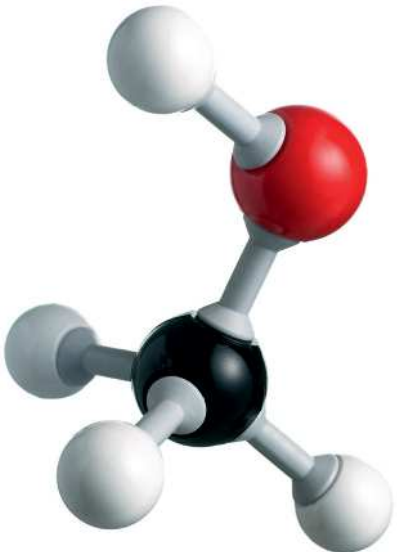
DNV GL categorises methanol as a Low Flashpoint Liquid, together with other potential ship fuels such as ethanol and low flashpoint oil fuels. Because of its low flashpoint of 12°C, methanol will be stored and handled in a liquid phase with the presence of a highly flammable vapour phase. Methanol is toxic to humans, its vapour is heavier than air (unlike e.g. methane), it burns with an invisible flame and it is not self-lubricating like oil fuels.

In order to reach a safety level equivalent to that of a conventional oil fuel system, the chemical properties of methanol mean, as mentioned above, that the fuel system must be designed with additional safety barriers, similar to the proven safety barriers on gas-fuelled ships.

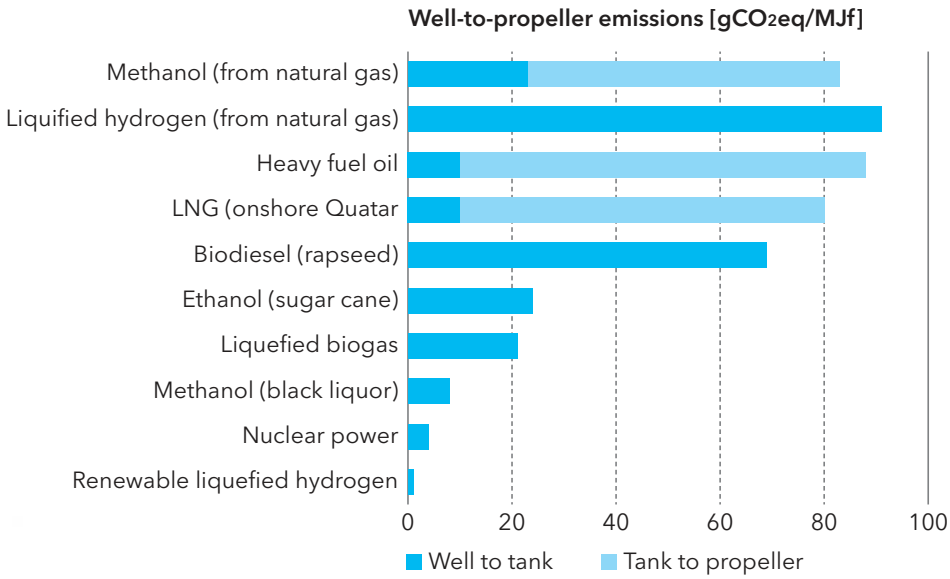
Lessons learned from gas fuel

Just as for gas-fuelled ships, the designers of a methanol fuel system face the challenge of safely supplying a fuel associated with a higher risk than conventional oil fuels to the engine room, through the combustion process and out of the engine room either by exhaust or drainage/gas-freeing. The risks associated with natural gas (methane) and methanol fuel are much the same, with fire/explosion of course being the main concern. For this reason, DNV GL's safety philosophies towards these alternative fuels are similar.

Designers will recognise safety-barrier requirements such as control and emergency-shutdown systems, secondary containment, ignition prevention, fire protection and pressure relief. The location of fuel tank and piping systems is of importance in managing the risks of external fires and of energy impact from collisions,



Methanol molecule, CH3OH. © DNV GL



Tank-to-propeller (combustion) emissions assumed to be equal to CO_2 absorbed by the plant during its lifetime.

groundings or ship/cargo operations. On tankers, special attention is paid to the separation of the cargo system and fuel system. Learning from gas-fuelled ship installations can help us manage these risks, but useful experience can also be gained from the many years of handling methanol cargoes on both tankers and offshore supply ships.

Flexible ship owners

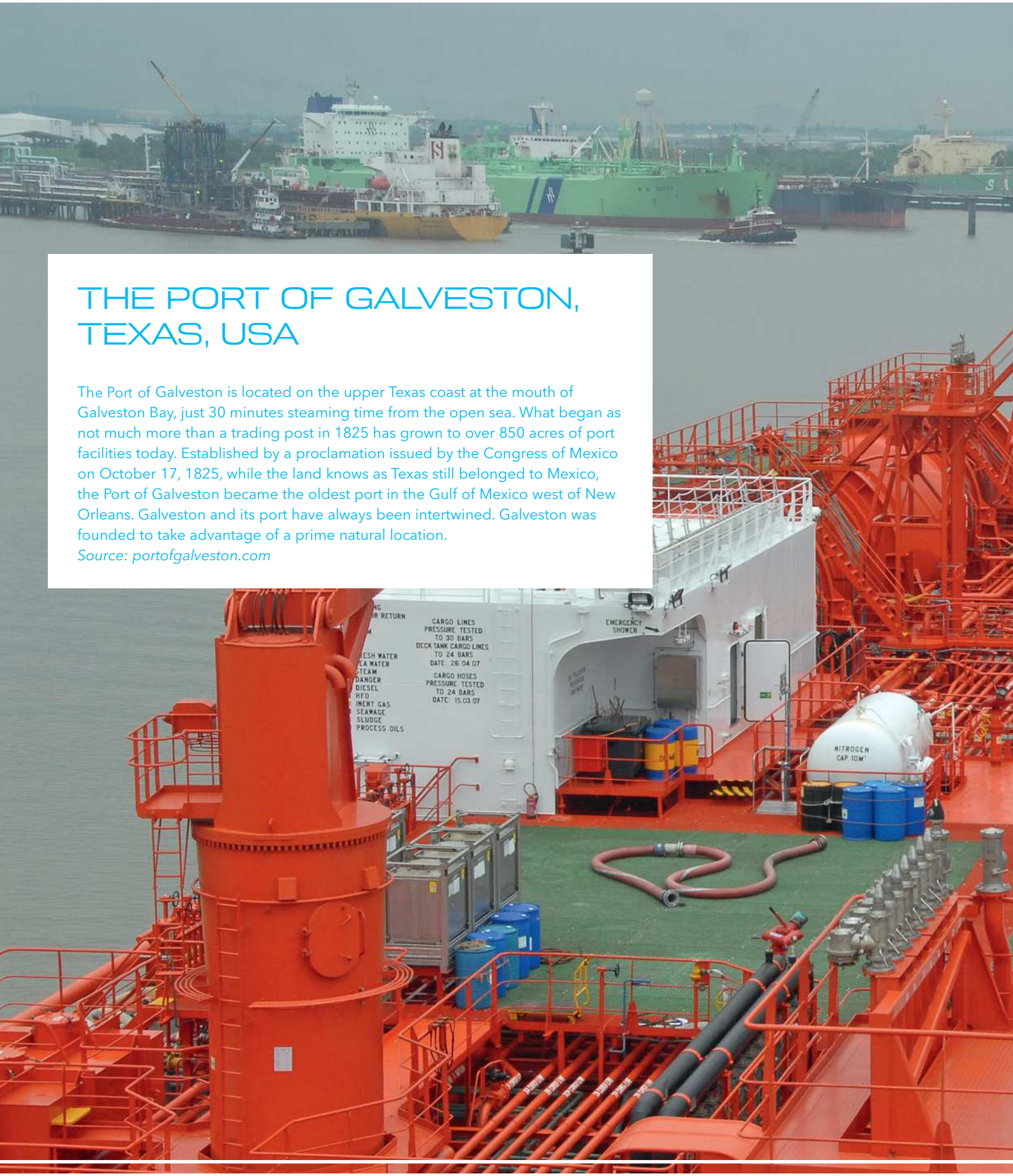
In the decades ahead, DNV GL expects to see a wider variety of fuels used in shipping, depending on the cost and availability in different parts of the world and for different trades and segments. Being smart and adapting to these opportunities when they arise may not only lead to a reduction in fuel costs, but also help the industry on the path towards greener operations and a smaller environmental footprint. ∎

Source:

- *Methanex: Technical Information & Safe Handling Guide for Methanol*
- *MAN Diesel & Turbo*

Background:

- Contracts for seven 50,000 DWT methanol-fuelled tankers have been signed by ship owners Marinvest/Skagerack, Westfal-Larsen & Co A/S and Mitsui O.S.K Lines Ltd.
- The four ships for Marinvest/Skagerack and Westfal-Larsen will be built by Hyundai Mipo Dockyard, while the three ships for Mitsui will be built by Minaminippon Shipbuilding.
- The ships will be on long-term charter to Waterfront Shipping.
- The ships will be fitted with MAN ME-LGI flexi-fuel engines which can run on methanol or conventional oil fuels.
- The ships for Marinvest/Skagerack and Westfal-Larsen will be built to DNV GL Rules for Low Flashpoint Liquid Fuelled Ship Installations and be the first to receive the class notation LFL FUELLED.
- In 2013, Stena, in cooperation with Wärtsilä, announced it was considering retrofitting its North European RoPax fleet so that it could use methanol fuel.
- A chapter about methyl/ethyl alcohol (i.e. methanol/ethanol) is included in the draft IGF Code expected to be ratified in 2016.



THE PORT OF GALVESTON, TEXAS, USA

The Port of Galveston is located on the upper Texas coast at the mouth of Galveston Bay, just 30 minutes steaming time from the open sea. What began as not much more than a trading post in 1825 has grown to over 850 acres of port facilities today. Established by a proclamation issued by the Congress of Mexico on October 17, 1825, while the land knows as Texas still belonged to Mexico, the Port of Galveston became the oldest port in the Gulf of Mexico west of New Orleans. Galveston and its port have always been intertwined. Galveston was founded to take advantage of a prime natural location.
Source: portofgalveston.com

Text: Jeffrey van der Gugten and Jakub Walenkiewicz
Jeffrey-van-der-Gugten@dnvgl.com and Jakub.Walenkiewicz@dnvgl.com

NEW DRIVERS FOR OIL TANKERS

One of the hot topics in the tanker market is the USA's transformation into a net exporter of oil products. Take this development one step further, and you will find there is a lively discussion about turning the USA into a country that exports crude oil. These developments have led to increased interest in newbuilding projects for both product and crude oil tankers.

Jeffrey van der Gugten

Jakub Walenkiewicz

USA shale oil

It has been estimated that the USA will add around 400,000 barrels/day of oil-refining capacity between now and 2018 (according to IHS Fairplay and The Wall Street Journal). USA refineries are expanding their capacity in order to take advantage of the increasing shale oil production, either to sell the petrol, diesel and other fuels domestically or to export them worldwide.

The gasoil trade from the USA to Europe and South America is showing an upward trend and mainly uses MR tankers. Last year, around 12.8 million dwt of newbuilding orders for Handysize tankers were recorded, compared to 5.4 million dwt in 2012, according to Clarksons Research. For the longer-haul oil product trades, there has been renewed interest in LR tankers in 2014, after an ordering drought for such vessels in 2013.

US refiners are, however, still cautious about expansion plans due to discussions about a possible lift of the crude oil export ban. The counter argument is that if crude oil exports are allowed, then the price of American oil is expected to increase, thus diminishing the cost advantage for local refiners. This has been the main reason why US refiners were able to withstand the competition from Asian refiners. However, there is also one technical challenge, which is that US refineries are not designed to process light shale crude.

It is difficult to predict if there will be a change of policy in the short term, but this could become an issue if the expansion of domestic oil production continues. At the moment, the US is storing large amounts of crude oil because certain grades cannot be refined locally. Not being able to export it either adds extra costs for storing the raw material.

Demand

Clarksons Research estimates that the demand for crude oil tankers will increase by 1.5% in 2014, after a decline of 2.5% in 2013. The demand for product carriers is estimated to increase by 4.7% in 2014, the same figure as in 2013. IEA estimates that the global oil demand will increase by 1.4% in 2014.

Crude oil tankers
Crude oil tanker earnings improved sharply to USD 40,000/day in late 2013 and early 2014, but fell back to around zero in late May. Leaving out these short-term fluctuations, VLCC average spot earnings have reached USD 25,000/day so far in 2014 (2013 average: USD 17,000/day). Suezmax and Aframax tankers generally show similar patterns at higher rate levels than VLCCs.

One of the factors pushing rates up was decreasing deliveries of new tanker tonnage. We expect 2014 to be yet another year with a low number of deliveries of crude oil tankers - at a level comparable to last year. At the same time, scrapping remains more or less at substantial annual levels. Combined with an expected growth in crude imports by Asian countries, this has formed the foundation for the improved outlook that can be sensed in the market.

The crude oil tanker fleet is expected to grow only marginally by 1%-2% per annum in the coming two years. Fleet growth is then expected to pick up slightly to 3% annually for 2016+2017. Last year, a strong surge in newbuilding contracting for VLCCs (+200,000 dwt) and Aframaxes (80,000-120,000 dwt) took place. This year has started in much the same way for VLCCs, with already almost 50% of last year's total tonnage contracted in the first four months of 2014. There is growing concern about the oversupply and we do not expect continued strong activity for the rest of the year. Most of the currently ordered tonnage will leave the yards in 2016.

As a result of the strong contracting activities, the order book/fleet ratio for VLCCs and Aframax tankers has increased strongly to 16% and 13% respectively.

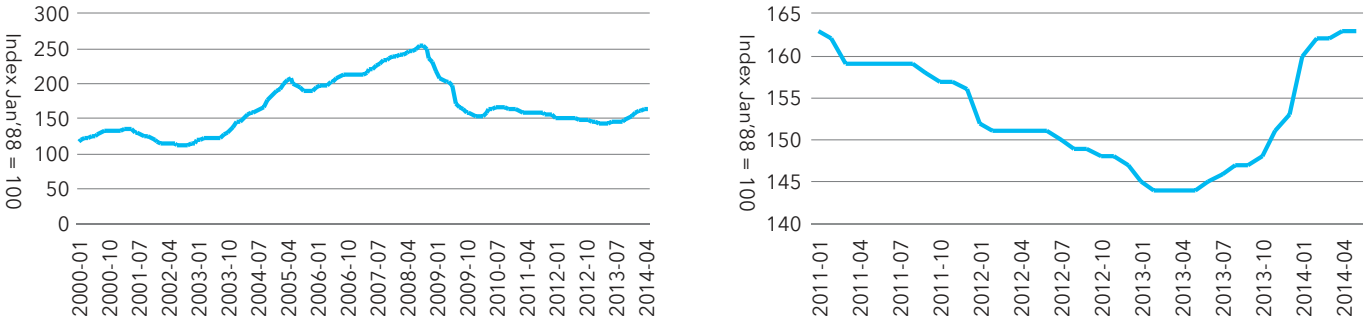
Vessel newbuilding prices have increased by 12% for a VLCC within one year. In a recent VLCC newbuilding deal, the USD 100 million mark was broken, a price level last seen in the middle of 2011.

Product tankers
Newbuilding orders for product tankers increased significantly in 2013, on the back of relatively low newbuilding prices, more fuel-efficient designs and trade opportunities expected from the US product exports. The order book/fleet ratio of MR tankers in the size segment of 35,000-55,000 dwt increased strongly to 25% at the end of May 2014.

Future yearly newbuilding contracts are expected to be on a relatively high level, although below the level seen in 2013.

After a period of high fleet growth rates, the tonnage expansion started to slow down to reach the lowest fleet growth in recent history at around 2% in 2012 and 2013. From 2014, yearly fleet growth is set to increase gradually to reach over 4% per annum in 2016.

Product tankers' newbuilding prices have followed a similar line as those for large crude oil carriers. Within one year, prices have increased by 10% to USD 37 million for a 47,000-51,000 dwt product tanker. A newbuilding 73,000 dwt coated Panamax tanker now costs around USD 45.5 million, compared to USD 40.5 million one year ago. Nevertheless, the newbuilding prices remain at a much lower level than they were during the boom period. ▮



Tanker newbuilding price index. Source: Clarksons Research

Text: Bror Åke Karlsson and Åge Bøe
Ake.Karlsson@dnvgl.com and Age.Boe@dnvgl.com

IACS HARMONISED COMMON STRUCTURAL RULES

FOR BULK CARRIERS AND TANKERS

In January 2014, IACS published harmonised Common Structural Rules (CSR) for Bulk Carriers and tankers. A large team of technical experts harmonised and further developed the two originally independent rule sets. The result is an improved, comprehensive and consistent rule set which will enter into force in July 2015.

The rules were developed through ten discipline-based sub-projects involving more than 70 specialists from IACS societies. Wave load, direct strength analysis, buckling, fatigue, welding, corrosion, local strength and hull girder strength were among the topics addressed in the process. In addition, comprehensive consequence assessments were conducted for tankers and bulk carriers of various sizes. Two extensive industry consultation processes were carried out in 2012 and 2013, and the comments/questions and answers have been gathered in the IACS Knowledge Centre (KC).

Implementation

The harmonised CSR will enter into force in June 2015, replacing the current CSR Tank and CSR Bulk. IMO is now auditing the new rule version to verify its compliance with IMO's Goal Based Standards (GBS) for tankers and bulk carriers, which enter into force in July 2016. To facilitate rule updates based on the latest comments from industry and the results arrived at by the development teams, there will be a limited number of rule changes in 2014. These will be ready for technical committee review by July 2014. IACS Council approval of the Rule Change Notice (RCN) will take place in December 2014 for January 2015 publication. The RCN will enter into force in July 2015.

Support and software

Changes from the current structural rules include a significant expansion in the scope of the direct strength analysis to include the finite element method (FEM), compared to the required current scope which basically covers the parallel part of the hull. The scope now covers the entire cargo hold region, including the transition to the fore body and the engine room. This makes very high demands on the software tools, which need to be significantly upgraded in order to perform the necessary design and verification analyses.

The Nauticus Hull software has been updated to support the new CSR-H rules - both prescriptive and FEM. On the prescriptive side, more criteria are now checked in the Cross Section Analysis instead of on spreadsheets. On the FEM side, there are improvements to the functionality for modelling the non-parallel fore and aft part of the cargo area, including the import of the hull shape from stability software. Ship-specific modelling features, such as adding longitudinals to the outer shell, have been significantly improved. It is also possible to reuse FE models from other software systems in order to apply CSR-H corrosion additions, loads and boundary conditions. The software fully supports the latest 1 January 2014 revision of the Rules and is continuously being updated to streamline the work process.

Impact on steel weight

The consequence assessment studies indicate that increased scantlings will be necessary in forward and aftermost cargo holds. It is expected a small increase in the total steel weight, even if this can to a high degree be compensated with improved stiffening system and better details.

For more details, see also our previous article in Tanker Update No. 1 2013. ▮

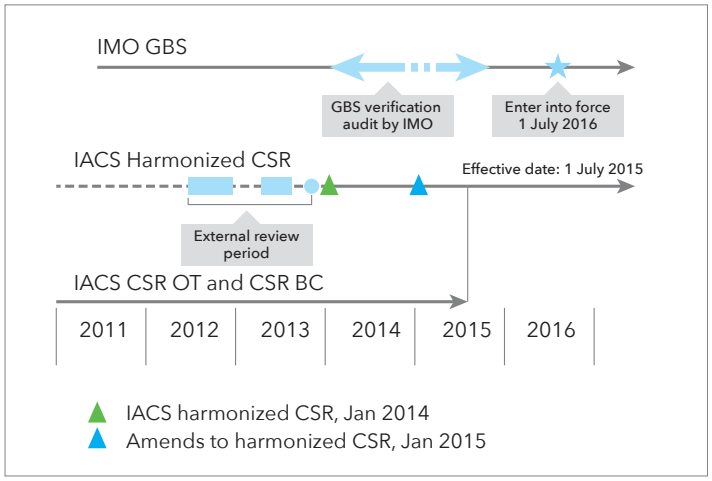
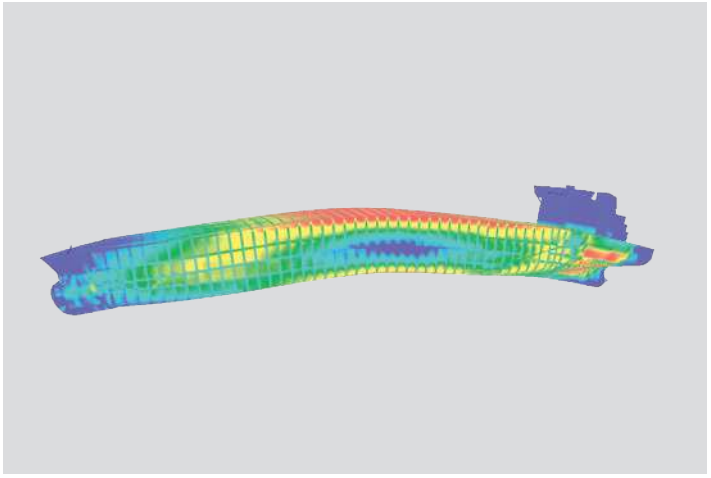


Fig 1. CSR and IMO GBS hamonization schedule



Nauticus Hull FEM model

Text: Eirik Nyhus, DNV GL
Eirik.Nyhus@dnvgl.com

NEXT-GENERATION ENVIRONMENTAL REQUIREMENTS

Managing the impact of environmental regulations now entering into force is one of the most challenging tasks facing shipping this decade. Nevertheless, the shipping community should start thinking about the potential business impact of emerging regulations.

Eirik Nyhus, Director Environment

Regulations take time – but are as inevitable as death and taxes
One of the key characteristics of developing international maritime regulations is obvious; it takes time. The timeline for a regulation is normally long, with a number of complex and time-consuming steps. There are of course exceptions. The post-9/11 International Ship and Port Facility Security Code was fast-tracked for obvious reasons, and the EEDI and SEEMP were a showcase of rapid action, taking "only" five years from inception to entry into force.

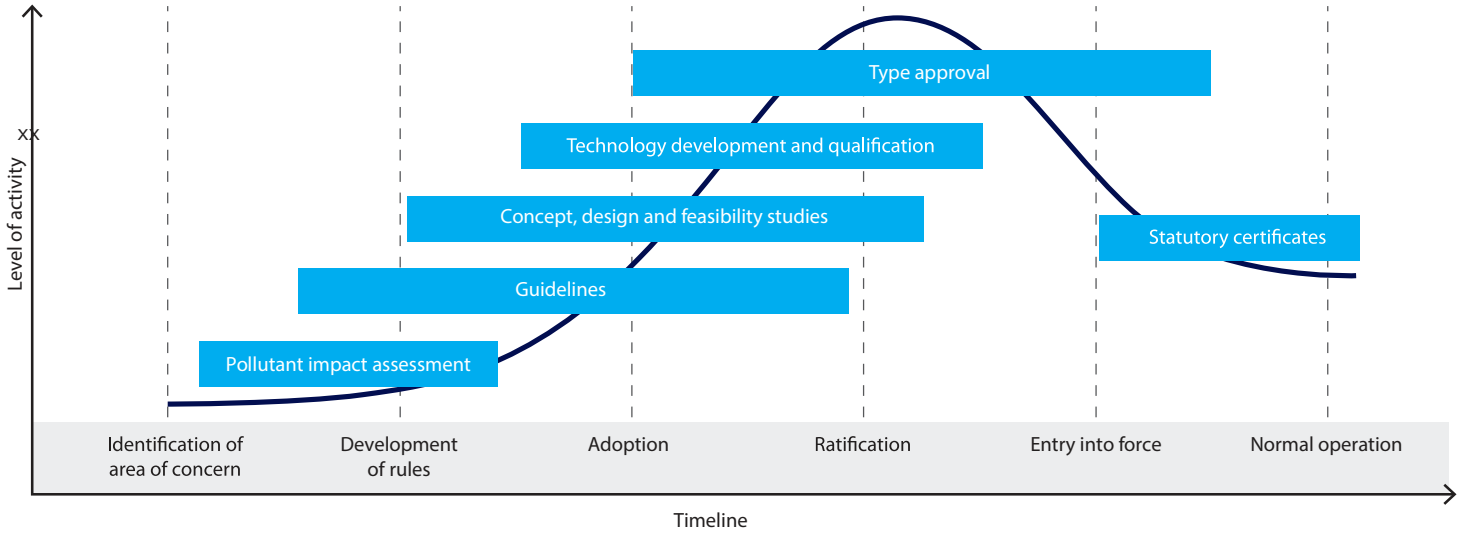
"Industry needs to engage strongly now, not later! Doing otherwise will make business needlessly difficult ten years down the road."

SOx, NOx, PM, BWMS, AMS, EEDI, SEEMP, MRV, IHM; the list of abbreviations is long and growing. What they all have in common is that they embody key pieces of environmental regulations that have recently entered into force or are likely to do so in the near future. However, it is crucial to realise that new environmental regulations entering the development pipeline will be just as challenging to respond to as anything we see today.

What are these emerging issues? The short answer is hull biofouling, soot emissions and underwater noise. While the work is still at an early stage, IMO has recognised all three as significant environmental issues and put them on the formal regulatory agenda. The time for the maritime industry to have its say is now.

The normal state of affairs is different; it is not unusual to see 10-15 years elapse from the date when an issue is introduced until the resulting regulation enters into force, see figure on the next page. The flip-side of this is that once an issue has entered the regulatory pipeline it rarely gets dropped. In practical terms, the implication is that the issues that will have developed into regulations in a decade or so are the ones that are presently recognised as concerns.

Clean hulls, smokeless exhaust and quiet ships?
That is where we see hull biofouling, soot and underwater noise right now. The confluence of factors focusing attention on these three issues leads us to believe that we will see mandatory regu-



lations addressing all of them. While the timing remains unpredictable, we would not be surprised to see regulations agreed on towards the end of this decade and entering into force in 2020 – 2025.

The work on biofouling has so far led to the development of early-stage voluntary guidelines. Research indicates that biofouling is a significant mechanism for species transfer by vessels which is not sufficiently covered by the anti-fouling or ballast water management conventions. Draft guidelines were agreed by IMO in 2011. The US has also developed and implemented national regulations which could influence IMO, and the EU may be moving in the same direction.

The US raised the issue of underwater noise with IMO in 2008 as a matter of increasing public concern, with a focus on its possible impact on cetaceans. Whales have a special place in the public consciousness in a number of countries and the US has for example established a 10-knot speed limit in whale breeding grounds as a general protection measure. Underwater noise, primarily from propeller cavitation and machinery, is thought to have a detrimental effect on both whale breeding and navigation. In response, IMO has worked on the issue for a number of years and concluded by adopting guidelines in April 2014. It can be expected that these guidelines will form the basis for regulatory initiatives as experience is accumulated

The work on soot, or black carbon (BC) as it is more precisely known in technical jargon, is less mature, but is attracting a great deal of attention, including from outside IMO. Black carbon can be described as "*a strongly light-absorbing carbonaceous aerosol produced by the incomplete combustion of fuel oil*". It is recognised as contributing significantly to both global warming and accelerated Arctic ice melting, and as such is deemed to be a significant problem. Shipping's contribution to it remains unclear, but IMO is presently working on appropriate definitions and measurement methods and is likely to eventually consider potential control measures and regulations.

All three issues, hull biofouling, soot and underwater noise, could be subject to regulation as early as in 2020. The regulatory response and attendant mandatory measures are obviously not clear at this time. However, educated guessing nevertheless points towards soot being handled by either fuel change or smoke-stack particle filters, biofouling by mandatory hull cleaning under controlled circumstances, and underwater noise by changes in propeller design and acoustically insulating noisy equipment from the hull. It goes without saying that all of these will represent significant operational and technical challenges for the shipping industry.

What price silence?

The shipping community is presently struggling to cope with what is perceived as a veritable "tsunami of regulation", while also keeping their ships running in a highly challenging business environment. Needless to say, lifting their eyes from the day-to-day concerns and trying to think strategically about what is going to happen in ten years' time can seem like a waste of time and energy. As a result, the general industry response tends towards an "I'll deal with it when I see it" attitude. Obviously, as most influence on regulations can be wielded at the early stages, this is not the best response when it comes to either shaping the final outcome or preparing for its business impact.

Industry needs to engage strongly and constructively now, not later, if it wants to ensure that what emerges from the regulatory pipeline has the desired environmental effect, is operationally practicable, technically feasible, reasonable from a cost/benefit perspective and safe. Owners and operators need to start thinking strategically about the potential business impact. Doing otherwise will make business needlessly difficult ten years down the road. ∎

Text: Kevin Gallagher, Blue-C

CALMING THE TROUBLED BALLAST WATERS

Few issues have caused as much turbulence in shipping over the last few years as the implementation of ballast water treatment regulations. Now DNV GL and Höegh LNG have teamed up to demonstrate a solution to bring peace of mind to troubled owners.


© Statoil

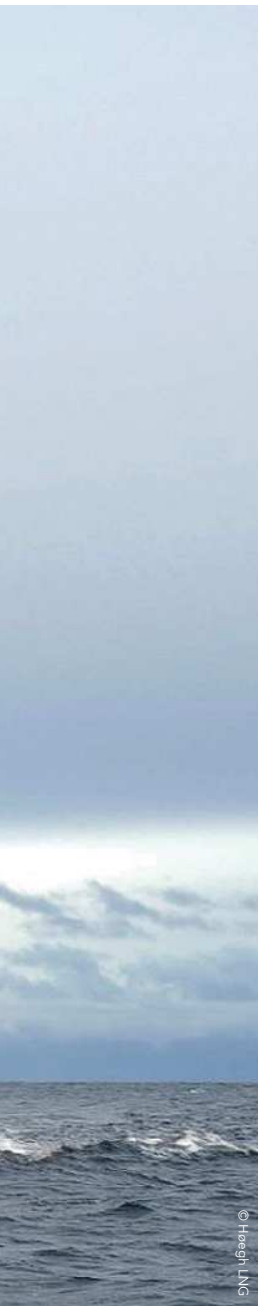
The implementation of an IMO Ballast Water Management Convention (BWM) is still adrift with no land in sight and, to complicate matters, the United States has introduced its own BWM programme, effective at the first drydocking after 2016, with none of the presently available BWM systems in compliance.

An Alternative Management System (AMS) has been introduced to allow foreign-approved systems to be installed while waiting for US approval, but there is an element of risk involved: a ship may operate for up to five years with an AMS, but it will have to comply by the end of the grace period – and so far, no systems are formally approved by the US Coast Guard.

Making mission-critical decisions based on limited experience and in an uncertain regulatory environment is by itself enough to ruin the sleep of top management, but throw in the vast variations in operating conditions that affect the efficiency of BWM systems – including particle density, debris, temperature, salinity and ice – and finding the optimal BWM solution might seem simply out of reach for most operators.

Working with DNV GL
DNV GL has developed a BWM procedure for selecting the optimal system for any given vessel or operation.

Using a combination of selection criteria and weighting, DNV GL assesses each customer's requirements for an individual ship and calculates the risk for each criterion. Installation, operational, maintenance, technical, HSE and financial issues are all considered and the outcome is used to select the system that provides the best match for the owner and vessel.



"We are a relatively small organisation with limited resources and a full slate of activities, so for us it was natural to enlist DNV GL as a technical partner to assist in the BWM vetting process,"

Pål Gunnulfsen, Vice President and Head of Fleet Management in Höegh LNG

Höegh LNG makes a move
While many owners are stymied by the uncertainty surrounding BWM, Oslo-based Höegh LNG decided to beat the rush and go ahead with evaluation and technology selection. "We realised that IMO ratification was only a matter of time and that the US programme is inevitable, so we wanted to get started before the market is swamped with orders," says Head of Fleet Management Pål Gunnulfsen.

"We are a relatively small organisation with limited resources and a full slate of activities, so for us it was natural to enlist DNV GL as a technical partner to assist in the BWM vetting process," Gunnulfsen relates. "In addition to systems evaluation, they have researched our ports of call to collect in situ data from the various harbours. This was an important feature of the study for us."

DNV GL's expert vetting does not mitigate the regulations dilemma, though, and Höegh LNG is beholden to the AMS-approved systems list, but Gunnulfsen is cautiously optimistic: "There are some 35-40 temporarily approved systems on the list, so we feel confident that, if we choose from that list, the system will eventually be approved by the US Coast Guard," he says.

Necessary evil?
While parallel BWM requirements pose a problem for owners, Gunnulfsen is sympathetic to the US position: "It's understandable that they would move to protect their marine environment, given the problems that ballast water discharge has caused them in the past." He even sees reason for optimism in an eventual harmonising of regulations. "The gap between IMO and US requirements is nowhere near as big as it was," he says, giving hope to those who fear having to comply with disparate but mandatory requirements.

In addition to compliance, customer satisfaction is another reason for Höegh LNG to move on BWM. "Quality requirements from cargo owners in the LNG segment are higher than in any other segment, not just relating to spill avoidance, but for anything that could damage the environment. They are extremely averse to bad press and they have inquired specifically as to our plans for handling ballast water," says Gunnulfsen.

Help is at hand
The take-away lesson seems to be that the BWM situation may not be as bleak as it seems at first glance. Though it is only a matter of time before operators will have to comply with new regulations in one form or another, there are trustworthy options available.

The solution lies in leveraging the necessary competence, the kind of which DNV GL offers in its BWM evaluation process. "We are very satisfied with the results of our study," Gunnulfsen concludes. "We feel comfortable that we now have the basis for making the best possible selection." ▮

Text: Damian Devlin, Blue-C

BUILDING ON TRADITION, FOSTERING INNOVATION

Those who know shipping know that George Livanos left a legacy of innovative management in Ceres Hellenic Shipping, a legacy that his son Peter has carried on as chairman of Ceres and of GasLog.

The senior Livanos was born in New Orleans, Louisiana, but received his degree from the University of Athens and started Ceres in 1949. Shipping has deep roots in the Livanos family, and George eventually inherited his father's fleet of 30 ships, including the five largest supertankers of the day. From there, he grew Ceres into the biggest shipper in Greece, with a fleet of more than 100 vessels.

Today, Peter Livanos is continuing to grow Ceres and its subsidiaries GasLog, DryLog and TankLog. GasLog joined the Ceres family in 2001.

The LNG growth strategy

The story of GasLog is one of rapid expansion and innovation, but the company started out modestly, managing LNG ships for BG, the British Gas spin-off. This task was essential for building up LNG experience in the company, and in 2003-4 GasLog assumed management of BG's newbuilding process as well.

"The rapid growth we've achieved is the result of a combination of factors, primarily our very close relationship with major LNG charterers and the strong technical platform we've developed," says Innovation & Technology Manager Theofanis Sallis. "Although our offshore and office staff didn't have experience with LNG when we entered the sector in 2001, they had a lot of experience in other shipping segments, and especially of chemical tankers, which are of course complex in their own right." By 2008, GasLog had gained sufficient knowledge of the segment to feel comfortable about purchasing its first LNG vessels.

Since then, the race has been on and GasLog has expanded its fleet to 23 vessels, of which nine are newbuildings, while managing an additional six ships.

Moving first

The new ships are scheduled for delivery from 2014 up to 2017, and there is a story there as well. On the last two newbuildings, GasLog has an option to convert to LP-2S, a two-stroke engine with low-pressure gas injection expected to be more efficient than other propulsion systems for LNG carriers.

If the ships are delivered with LP-2S engines, they would be the first in the LNG segment to have them. Two-stroke gas injection technology was developed to reduce particulate generation in the combustion cycle and GasLog is considering being a first mover on this environment-friendly and commercially attractive technology.

> "As we continued to grow as a leading LNG shipping company, we determined that it was important to create a group focused on innovation and technology to ensure a safe, effective and efficient service for our customers."
>
> Innovation & Technology Manager Theofanis Sallis.

Balancing innovation and stability

But being a first mover presents challenges. There is always a risk when pioneering a new engine type, as experience in building and operating is limited, and GasLog will have to convince its customers that the technology is safe and the risk low. However, as the LP-2S technology has many aspects that are more proven than the already ordered ME-GI, GasLog believes that it is this prudent approach that will keep it attractive to charterers. Sallis affirmed this, saying: "We will only exercise this option if we are absolutely sure it meets our rigorous technical demands as well as those of our potential charterers.

"We foresee a market move to LP-2S," says Sallis. "We believe that adopting the technology now will increase our long-term competitiveness, and efficiency is always a good thing, even if the price of fuel goes down. Eastern gas prices are forecast to remain high, though, and boil-off gas is the primary fuel for LNG vessels."

Innovation has always been part of the Ceres organisation's culture and Gas Log is carrying on that tradition. Ceres was the first maritime company in the world to be ISO 50001 certified and now GasLog has started its own R&D department with four employees. "As we continued to grow and position GasLog as a leading LNG shipping company, we determined that it was important to create a group focused on innovation and technology to ensure that our assets are designed and equipped to provide a safe, effective and efficient service for our customers," Sallis reports.

Maintaining quality in a growth environment

Ensuring responsible stewardship of safety and the environment in a growth-oriented organisation also presents challenges and GasLog has a systematic approach to the task.

"In our efforts to promote safety as our number one priority, we've launched an innovative safety programme for both onshore and onboard personnel," says Sallis. In cooperation with BST, pioneers in behavioural-based risk management, GasLog assesses the company's status with regard to behavioural-based safety, organisational culture and leadership development. The results are analysed and appropriate measures implemented. "This is actually an ongoing process in terms of feedback, analysis and the company's status assessment," Sallis relates.

The challenges cross over into personnel and company identity as well. One of GasLog's main issues was manning, on shore and on board. The company has retrained officers from Ceres' chemical tankers and places great emphasis on training and the corporate culture. "When you grow rapidly, there are always new people, so it's important to emphasise continuous training and help new employees to understand the company culture," Sallis confirms.

Adding to the overall quality in the organisation is a good balance of top new talent and experienced professionals, ensuring a high level of both theoretical and practical knowledge. GasLog's strong corporate culture is demonstrated by the company's 95% employee retention rate.

Good relationships bring good results

GasLog also places great emphasis on good supplier relationships. Examples are GTT, specialists in the design of membrane containment systems for the maritime transportation and storage of LNG, and engine manufacturer Wärtsilä, with which GasLog has always had close ties, ensuring optimal power plant selection and steady uptime.

There are also joint industry projects, one developing systems for sloshing measurements in actual size and real time, and one looking at the "LNG Carrier of Tomorrow." GasLog implements projects such as these to keep ahead of the competition when it comes to the vessel specification demands of potential charterers.

From its early relationship with BG to the strong corporate culture of safety and innovation that it inherited from Ceres, GasLog has a respected and solid presence in the LNG market and is one of the most experienced operators of LNG vessels among independent owners. The latest fleet additions, coupled with attention to engine technology, safety management and technological innovation, show the company's continued dedication to quality in growth.

Commercial outlook

While the LNG transport market has been very good in recent years, it has dropped off in 2014. GasLog joins many in the market in attributing this downturn to a lack of available LNG cargoes in the Atlantic and Mediterranean region, reducing demand for short-term LNG charters as more newbuilds join the fleet.

GasLog believes this softening of short-term rates is likely to continue into the summer of 2014. However, recent weeks have seen a new production facility come on line at the 6.9mtpa Papua New Guinea LNG project, new LNG production is expected from Algeria this year and BG's first production at Curtis LNG, Queensland, reportedly remains on track for 2014.

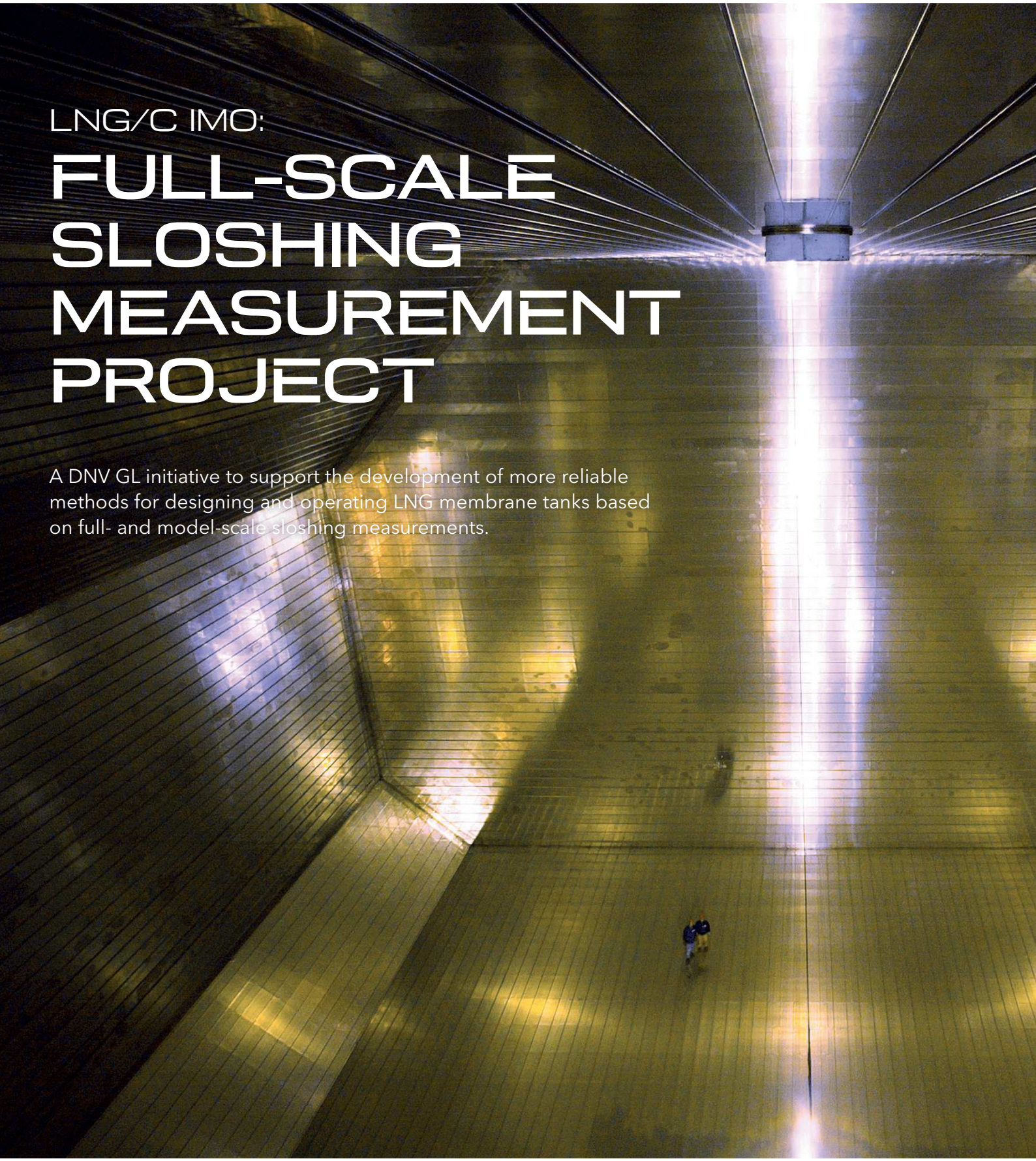
This will be followed by additional production from other new projects in Australia, South East Asia and North America in 2015 and beyond. These and other promising developments support GasLog's view that the medium to long-term outlook for LNG shipping is very positive.

Building expertise for the future

As the LNG market grows, there are of course a number of opportunities for companies with a high level of expertise in the sector to diversify into other business ventures. GasLog sees small-scale LNG shipping, LNG bunkering, LNG trucking and FSRUs as possible new segments. "We're keeping an eye on all these sectors. We will look to move into a new space if it is somewhere we feel our expertise can bring value and where we believe we can generate attractive returns," says Sallis

GasLog has also employed DNV GL to help it see its way into the future. "Through our cooperation, we have verified in practice DNV GL's good reputation," says Theofanis Sallis. "In addition to the standard services provided and increased operational reliability for a specific vessel, cooperation with DNV GL has also given us the opportunity to gain additional feedback and develop a broader view on several topics of strong interest in LNG shipping. It seems that DNV GL values innovation too and this is certainly matches GasLog's philosophy very well," Sallis concludes. ▮

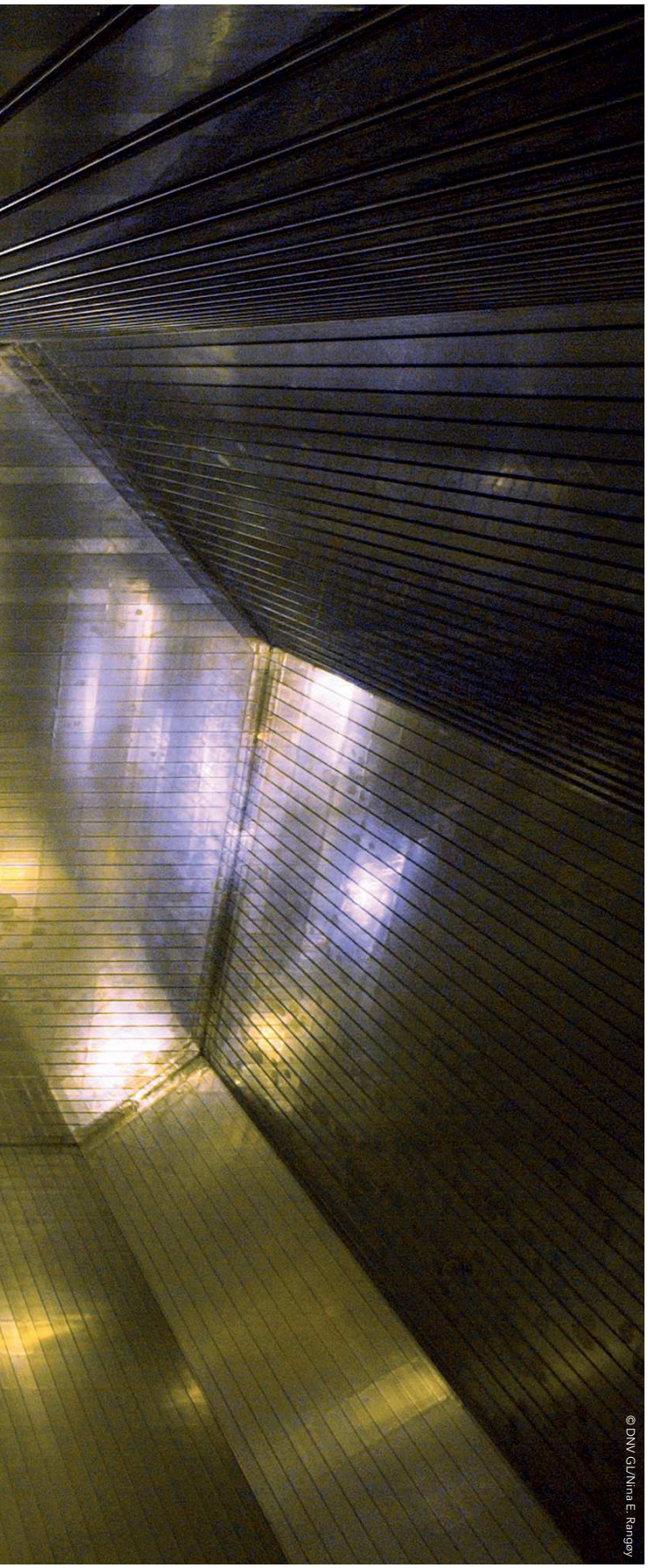
Text: Tom Klungseth Østvold and Ørjan Fredriksen
Tom.Klungseth.Oestvold@dnvgl.com and Orjan.Fredriksen@dnvgl.com

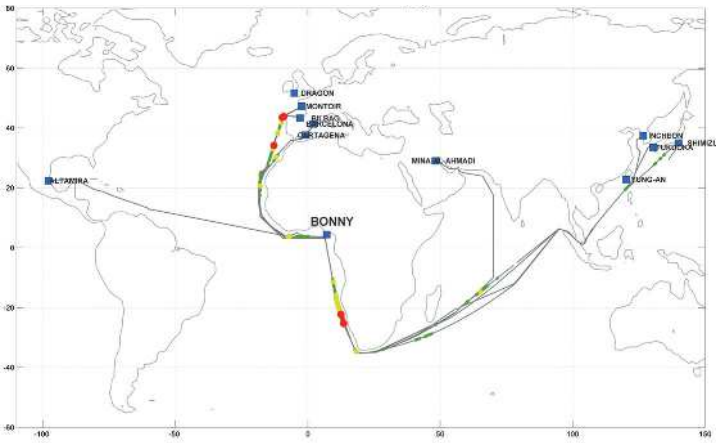


LNG/C IMO:

FULL-SCALE SLOSHING MEASUREMENT PROJECT

A DNV GL initiative to support the development of more reliable methods for designing and operating LNG membrane tanks based on full- and model-scale sloshing measurements.





● Significant sloshing ● Moderate sloshing ● Low sloshing

Overview of LNG-IMO loaded voyages since 2008.

Over the past five years, DNV GL has together with industry partners carried out successful measurements of forces and structural responses caused by liquid sloshing in a membrane LNG tank. With a large amount of data available, DNV GL recently joined forces with containment system designer GTT to analyse the measurement data and carry out a comparison with state-of-the-art model test predictions.

This is the first project of its kind and it has gathered a unique operational database which gives insight into the loads experienced by the containment system and the supporting inner hull structure. The data allows an evaluation of the test and simulation methods used in the design of membrane-type LNG cargo tanks and thus backs up good design practice and safe operations in general.

In 2007, legacy DNV launched a Joint Industry Project (JIP) to measure sloshing forces and structural responses in a membrane LNG tank. The project was initiated as part of a long-term effort to develop more reliable methods for designing membrane LNG tanks. The other project partners are BW Gas, Teekay, DSME, GTT, Light Structures and Lloyd´s Register. A new DSME-built 148,300m^3 LNG/C was fitted with a prototype fibre-optic sloshing measurement system designed by Light Structures and DNV. The measurement system was put into operation in the second half of 2009. Since then, the vessel has been trading from Nigeria to Europe and Nigeria to Asia, with some occasional crossings of the Atlantic to America.

The measurement system records a number of parameters continuously. These parameters include environmental conditions, ship operational data, ship motions, sloshing forces and structural responses due to sloshing impacts. The sensors measuring the

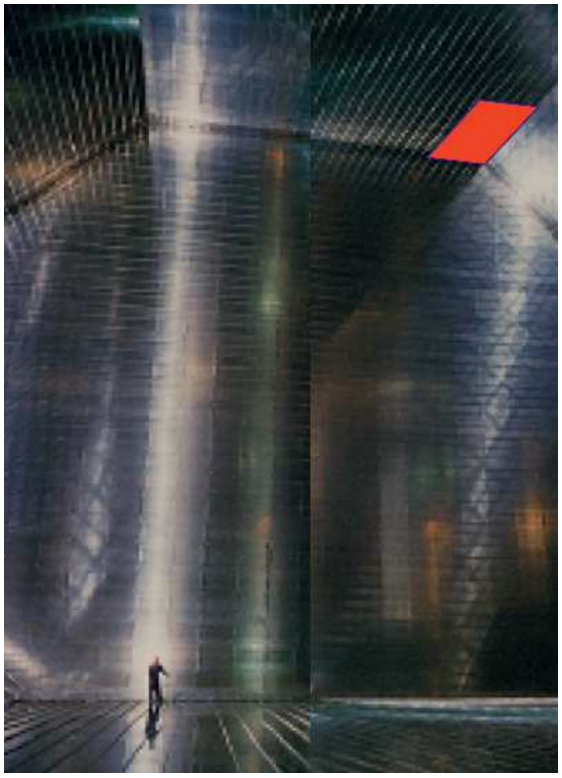


Fig. 1: Tank fully equipped with membrane. Insulation boxes fitted with pressure sensors and indication-of-strain gauges in a corner box

sloshing responses are mounted in the forward top (deck) corners of cargo tank no. 2 and are continuously sampled at 20 kHz. Fig.1 shows the specially designed pressure sensors fitted on the top of the primary insulation boxes behind the gas-tight primary membrane. Strain gauges are installed on inner hull plates and stiffeners in the same corners of the tank to measure the structural response of the inner hull structure.

As the measurement results from the LNG IMO have become available, GTT has carried out model tests in its state-of-the-art facilities. The tank model at scale 1:40 has been exposed to the ship motions measured on board. Motion sequences during periods with measured sloshing on board and sometimes adjacent periods without sloshing measurements have been selected for testing - the latter to evaluate the model test's ability to predict the motion levels when sloshing starts. Impact pressures have been recorded in the same corner locations to enable comparison with onboard measurements. A total of 3,600 model tests have been carried out at a scale of 1:40 for motion series taken from 32 voyages. This is equivalent to 10,800 hours' duration at full scale. Some of the tests have been repeated at a scale of 1:25 to evaluate the effect of the scale. Filled with water, the mass of the 1:25 test tank is six tons and a very powerful motion platform is required to achieve accurate tank motions. Fig.2 shows the model test platforms used in the study.

The main objective of the JIP is to gather and deliver full-scale measurement data to the participants. In addition, GTT has carried out and shared model tests for selected voyage sequences as mentioned above. It is up to each individual participant to take the necessary steps to make use of the data.

DNV GL recently joined forces with GTT to study and conclude on the data gathered to date. A huge effort was put into processing large amounts of available raw data to validate the measurements and extract the information of interest into more condensed formats suitable for studies. The refined data set has been studied to establish the loads encountered during the measurement period and to understand the nature of the impacts. In addition, the data has been compared with model test predictions.

It has been found that the maximum local impact pressure encountered in the corner of the tank is of the order of 10 bar, which is significantly lower than the resistance of the insulation at the considered location. Maximum pressures are found to decrease rapidly as the distance from the tank corner increases. It is also

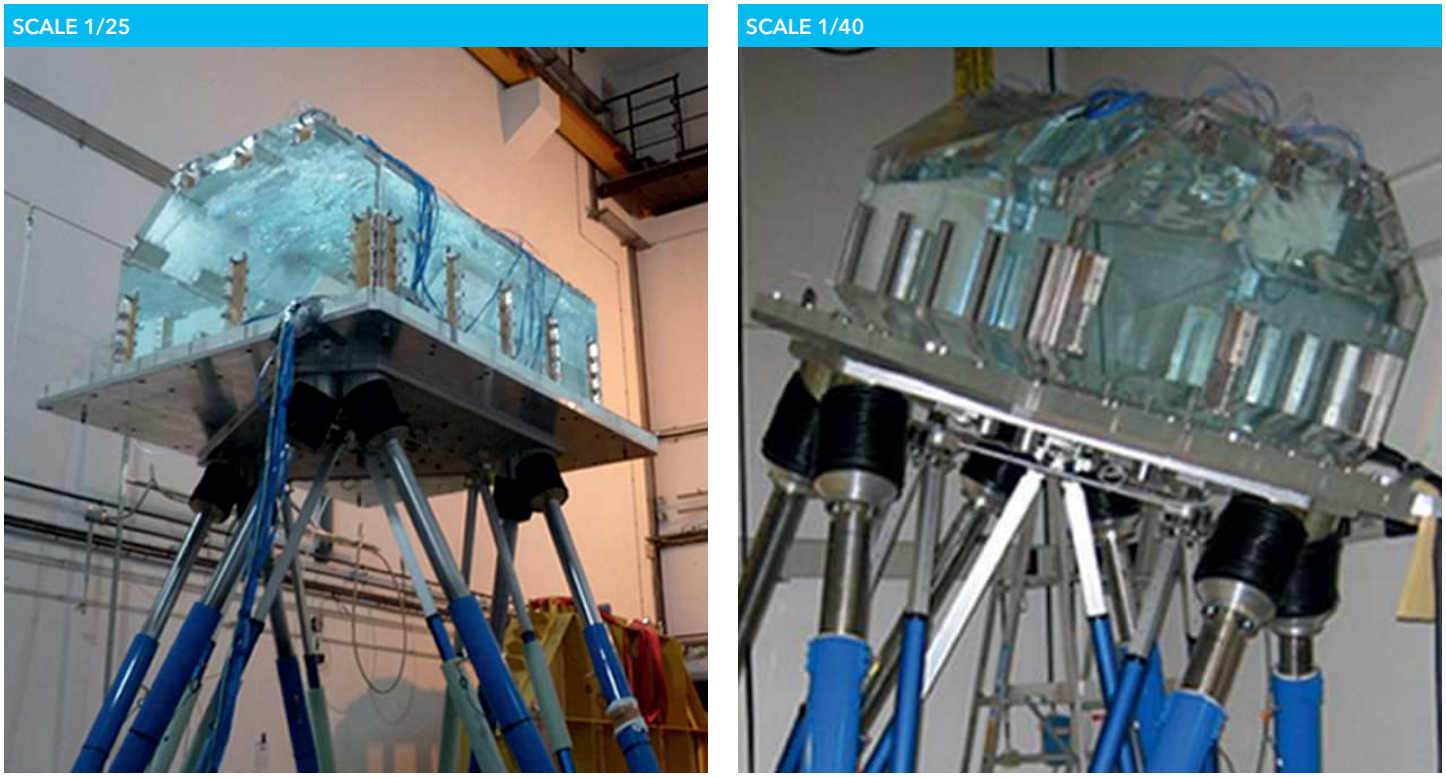


Fig. 2: Model test platforms

evident that the pressure field acting on the tank wall is random between impacts and that the peak pressure is normally very localised. The findings are qualitatively fully in line with findings from model tests and hence confirm elements of the current design practice for membrane tanks.

Valuable results have been obtained from the measurements on the inner hull. First of all, the results show that the sloshing-induced stress in the supporting inner hull plates and stiffeners is small but not insignificant. This confirms that it is relevant to consider the sloshing-induced stress when dimensioning the inner hull. Further, it is confirmed that the inner hull measurement system detects sloshing impacts in the tank, which implies that measurements in the inner hull may be used as input to Decision Support Systems (DSS) or simply to provide reliable information to the bridge when sloshing takes place in the cargo tank.

A comparison of onboard measurements with model test results is generally challenging due to the differences in instrumentation, randomness of the sloshing impacts and uncertainties about how to scale model test results to ship scale. A direct comparison of pressure measurements is not at all possible. Comparisons have to be carried out based on statistical parameters and parameters describing the global motion of the liquid in the tank. The onboard measurements and model-scale predictions are found to be in reasonable agreement. The observed differences are expected to be caused by the lack of physical similarity between the model test and full-scale application, but are most likely also caused by uncertainties in measurements on board and in model scale. The comparison nevertheless suggests that the load predictions obtained using the current state-of-the-art assessment methodology are conservative.

The measurement system is still in operation on board the LNG IMO. During its almost five years in operation, the system has demonstrated the feasibility of measuring sloshing at sea and has allowed the JIP to gather a unique database of sloshing-response parameters. The project objectives are now considered to have been successfully achieved and it has been decided that the measurement JIP will be terminated within the first half of 2014. ∎

Text: Alex. Wardwell, Blue-C

MAKING SENSE OF LNG CONTAINMENT SYSTEM INNOVATIONS

Over the past five years, dynamic market forces have generated improvements of existing and new technical solutions for LNG containment systems. DNV GL is working with a number of suppliers to get new systems approved.

Owners active in LNG transportation of large volumes are practically limited to two choices for LNG containment systems: Membrane or type B (spherical). These systems met the needs of segment characterised by stable, long-term point-to-point trades. But according to Magnus Lindgren, Principle Surveyor, Tankers & Dry Cargo for DNV GL, the LNG business is in a period of rapid change.

"Increased concerns about security, the development of floating LNG solutions, new emissions regulations and ship types using LNG as fuel and the development toward reduced boil of rates have helped create demand for new containment systems," he says.

Innovation drivers

Lindgren notes that developments of floating LNG solutions (such as LNG Floating Production, Storage and Offloading (FPSO) units and Floating Storage, Regas Units (FSRUs) have created the need for containment systems that can manage any filling level, while implementation of Environmental Control Areas (ECAs) has led to an increase in dual-fuel propulsion and LNG fuelled coastal vessels, requiring smaller LNG containment tanks. "These changes have created a growing market not only for suppliers already active in the shipping industry, but companies active in land-based containment systems," he says. "Our primary goal is to ensure that these new systems are safe and effective and for companies with no experience in the maritime industry, ensure that they have the technical support to help them manage the unique challenges of operating systems at sea."

"We are in the middle of an exciting shift in technology for containment systems which will help transform the maritime LNG. Our role is to ensure that we help suppliers and owners alike manage these new technologies safely."

Magnus Lindgren, Principle Surveyor, Tankers & Dry Cargo for DNV GL

Approvals process

DNV GL is working closely with suppliers to help guide them through the approvals process and compliance with IMO's International Code for the Construction and Equipment of Ships Carrying Liquefied Gases (IGC) and the Corresponding DNV GL Rules. First, suppliers submit designs to DNV GL to review for potential design flaws. Once the designs have been amended to comply with existing standards, DNV GL awards the company an Approval in Principal (AiP) certification. The second phase (GASA) requires full documentation, with comments from DNV GL linked to more detailed engineering.

For example, DNV GL has awarded the Korean Shipyard, DSME an AiP for their new membrane-type containment system, Solidus, which features double stainless-steel barriers and reinforced polyurethane insulation foam, with a secondary barrier secured to the hull with load bearing mastic. In addition, DNV GL has awarded a Norwegian supplier, Torgy with an GASA for a Type A containment system, featuring a stainless steel tank held in position within a space by stainless steel supports. Further we are working with a large number of other suppliers at various stages of development.

Lightweight composites

One trend in containment systems is the use of technologies and materials already in use in other industries aerospace and land-based industry. "The development of new, lightweight composites has enabled the development of innovative tank designs that are now being further developed for the application to the maritime industry," he says. "While we welcome these developments, we are mindful that the LNG segment is notable for its excellent safety record and our primary goal is to ensure that these systems not only function effectively, but also do not represent a risk to crew, cargo or the environment."

Lindgren acknowledges that the development and the approval process often include several design iterations and therefore takes time – about 18 months and more – but says that owners will soon have access to many different designs that match the operating profile of their vessel – from an FSRU to a coastal ferry. "We are in the middle of an exciting shift in technology for containment systems which will help transform the maritime LNG," he says. "Our role is to ensure that we help suppliers and owners alike manage this shift safely." ∎

COOL RUNNER

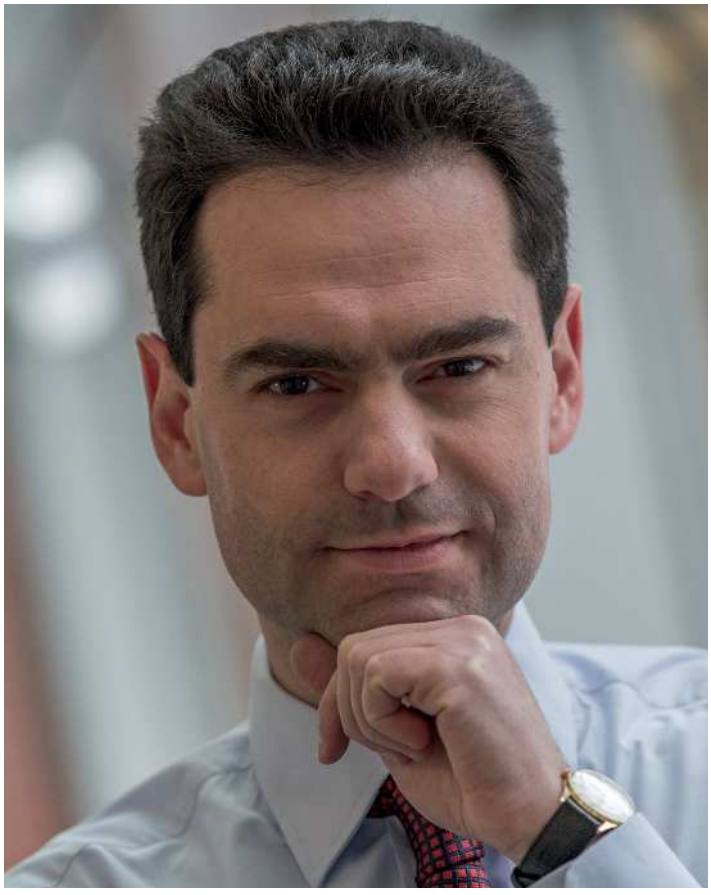
In April the LNG fleet surpassed 400 ships and Cool Runner was nominated as one of the candidates to break this milestone.

Text: Nikolaos Matthaios Kakalis
Nikolaos.Kakalis@dnvgl.com

COSSMOS

– ADVANCED COMPUTER PLATFORM TO IMPROVE ENERGY EFFICIENCY

High bunker prices, environment-focused regulations and overcapacity in certain segments create pressure on shipping companies' finances, leading to a focus on higher energy efficiency and fuel savings. These conditions also drive the development, evaluation and adoption of new technologies and alternative fuels.



Nikolaos Kakalis

Operations and new machinery configurations are thus becoming increasingly complex, and novel computer-based methods that can provide an integrated systems perspective are needed to take coherent decisions on design and operational improvements.

DNV GL Research & Innovation Greece has developed the DNV GL COSSMOS computer tool that can simulate and optimise complex ship machinery systems with respect to energy efficiency, emissions, safety and costs.

For tankers, COSSMOS is used in a variety of applications, from techno-economic design evaluations and the optimisation of waste heat recovery systems (e.g. exhaust gas economisers, steam-turbine generators) to performance assessments, the optimisation of cargo discharge operations and holistic energy management via advanced thermodynamics and exergy analysis.

One of a tanker's important and challenging daily operations is to discharge its crude oil cargo. Discharges are an energy-efficiency focus area for many operators. The COSSMOS module developed by DNV GL can simulate the discharge operations under the actual/realistic conditions. The module may serve as a performance assessment baseline for evaluating the condition of various components and the effectiveness of applied operational strategies. It may also be used to optimise the overall discharge operations (both the engine room and cargo handling side) by making the optimal selection of discharge control variables for given terminal schedules, tank capacities and operational constraints.

The module (a typical flowsheet including the discharge machinery is shown in Figure 1) is customised and calibrated based on each vessel's actual system in order to reflect the actual behaviour of the discharge system. Onboard measurements that are collected during the discharge operations (manually or automatically) are used as input in the simulations. The module can be used to execute a wide range of studies, such as an assessment of the discharge process with regard to energy efficiency and fuel consumption. Iterating this procedure for various discharges can benchmark each operation against the system's "good-as-new" performance. In addition, the findings of these studies provide a means to identify ways of improving operational and crew procedures and assess the condition of the system components. Finally, the module can be used to provide sensitivity analyses of important operational variables, which may increase the operator's system knowledge.

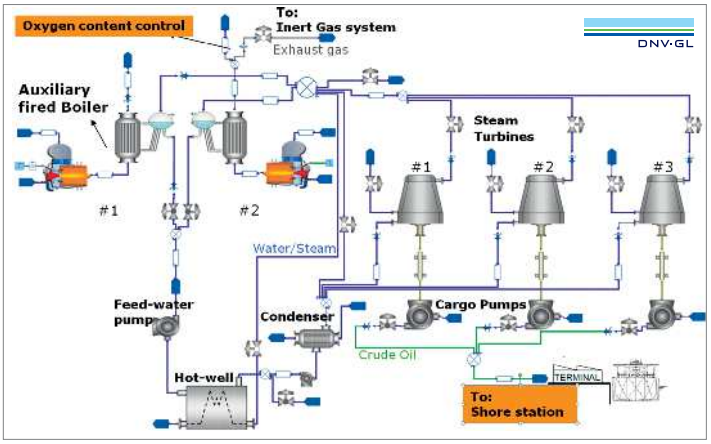


Figure 1: DNV GL COSSMOS discharge module

The potential fuel savings and other findings depend on the system's condition, on the understanding of the governing processes and interaction between components and on the crew's operational know-how and communication. The COSSMOS discharge module has been successfully applied in a series of projects and demonstrated a fuel-savings potential of up to 10%.

A series of COSSMOS projects for tankers owned by large Greek shipping companies, including Consolidated Marine Management, Minerva Marine, Samos Steamship and Thenamaris Ships Management, are showing the usefulness of COSSMOS as a next-generation platform able to support tanker owners and operators. ▮

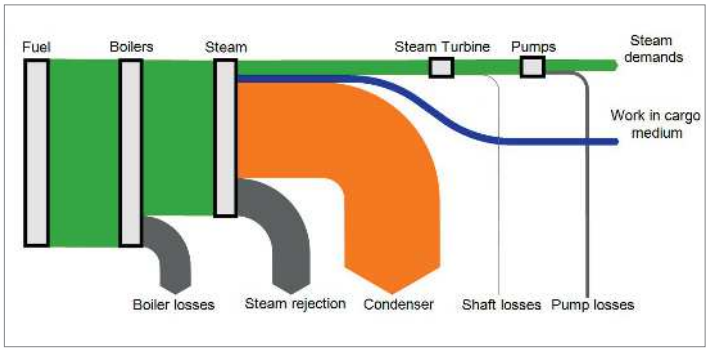


Figure 2: Power flow of the discharge system

SAFER, SMARTER, GREENER

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