DNV·GL

TANKER UPDATE

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CONTENT

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DEAR READER,

The tanker segment has been faring much better than the rest of the shipping industry thanks to cheap crude oil flooding the market. But that does not mean there are no challenges for tanker owners and operators to overcome. In an increasingly complex regulatory environment, it is our purpose and commitment to sort things out for our customers, providing them with implementation guidance and a clear course of action. Take, for example, the maze of existing and upcoming environmental regulations or the upcoming changes of the IBC Code for product carriers. We help owners make the right decisions to ensure compliance, and we fight for better coordination among ship inspection and vetting bodies.

Great news: finally, after years of hard work, the unified, completely rewritten DNV GL rules are now available, combining the expertise of two leading classification societies. Efficient, consistent, transparent and flexible, they are the most modern rule set ever. Needless to say, DNV GL goes to great lengths to support its customers in applying them.

Innovation has always been a key strength of DNV GL. With our support, a customer developed a powerful cybersecurity management system to defend sophisticated on-board systems against cyberthreats. Taking the next step in low-emission ship fuels, DNV GL has classed the world's first methanol-powered ocean-going ship, developed jointly with industry leaders. A new DNV GL class notation allows potentially unlimited shaft withdrawal survey intervals for eco-friendly water-lubricated tail shaft systems under a condition-based maintenance scheme. And a computer platform developed by DNV GL enables owners to virtualize and simulate ship machinery systems and operation for advanced techno-economic analyses.

With so many of our clients based in Greece, DNV GL is reinforcing its local presence, expanding the range of expertise of the Piraeus office so we can respond faster to the needs of Greek owners and operators. We stand by our customers, making sure they are well prepared for every challenge.

Enjoy reading!

TANKER UPDATE

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HOW LONG DOES THE OIL FLOW?

The OPEC meeting in April ended without an agreement on a production cap to stabilize oil prices, leaving entire nations in financial distress. But consumers and tanker owners are rejoicing.

Photos: DNV GL, LovePhy - Fotolia

For the last two years, the oil tanker segment has been one of very few sources of good information in the shipping industry. While most other segments are exploring the bottom of the cycle, crude and product carriers have been consistently delivering solid earnings. It comes as no surprise that the recent bonanza is driven predominantly by low oil prices. The demand is mainly driven by two factors: vastly increased storage activity, and refineries enjoying significantly higher profit margins. Those two factors have greatly contributed to increased seaborne shipments, with crude oil and products growing in 2015 by four per cent and 6.4 per cent respectively.

As land storage facilities fill up and the utilization of refinery capacity is stretched to a maximum, one may start to wonder how much longer these two factors will push the growth of oil trade. With Iran and Saudi Arabia locked in fierce competition to grow their market shares, we see a continued increase of the oil supply without much regard to the underlying demand. A lion's share of the surplus, whether crude oil or refined products, ends up in storage, clogging up the system. One needs to remember that oil is perfectly well stored by nature and ages far better than wine! Nevertheless, once extracted from the ground, it needs to be moved and ultimately consumed. The world economy outlook, which at the beginning of the year the International Monetary Foundation (IMF) described with the title "subdued demand and diminishing prospects", certainly doesn't look like oil consumption will increase.

China picks up some slack

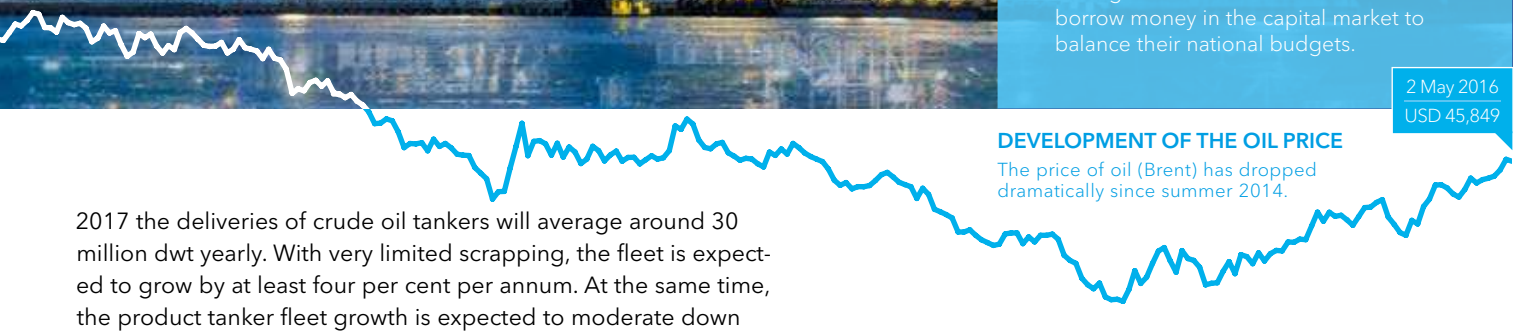
What does this mean for tankers? In general, the low-price environment contributes to an increased trade in oil. Most certainly, any significant price recovery should be considered as a threat to oil tanker earnings. While such a scenario seems unlikely following the OPEC meeting in April in Doha, other factors may impact the current strong rates. Beyond the storage and over-stretched refinery capacity utilization mentioned above, there may be a problem with substantial deliveries of new tonnage. In 2016 and

BACKGROUND: OIL PRICE

The dramatic deterioration of the oil price seems to have stopped, but the crude oil market remains tense. The International Energy Agency (IEA) sees the crude oil oversupply, which was at 1.5 million barrels per day during the first quarter of 2016, dropping slightly over the next few quarters, provided the US lowers its production rate as expected. However there is no indication of the OPEC countries cutting their production anytime soon.

Quite the reverse: their meeting in Qatar's capital Doha in mid-April was a setback. Libya and Iran did not even attend, hoping to get their national economies back on track by boosting their oil production capacity. Other geopolitical conflicts are preventing production cuts and an agreement on production quotas. Iran and Saudi Arabia are fighting in Yemen and Syria for control of the region. Saudi Arabia is actually threatening to increase production from ten to 12.5 million barrels per day.

The fight for market share is merciless, forcing both Qatar and Saudi Arabia to borrow money in the capital market to balance their national budgets.



DEVELOPMENT OF THE OIL PRICE
The price of oil (Brent) has dropped dramatically since summer 2014.

2017 the deliveries of crude oil tankers will average around 30 million dwt yearly. With very limited scrapping, the fleet is expected to grow by at least four per cent per annum. At the same time, the product tanker fleet growth is expected to moderate down to 4.6 per cent after growing by nearly six per cent in 2015. It is, however, still a substantial growth which may place further pressure on rates.

Perhaps we shouldn't worry just yet. Unless there is a sudden surge of oil prices, the long-term outlook remains positive. China is determined to increase its strategic reserves by building an additional 630 million barrels of storage capacity by 2020. It has also cut its own production by 0.4 million barrels per day (mbd) and allowed the "teapot" refineries (currently 30 per cent of the Chinese refining capacity) to source crude oil in the international markets. All this will support increased imports of crude oil to China. The long-term outlook for the clean trade is also promising, as refined products are generated further away from the end user. This will continue to boost the tonne-mile effect, driving both the number and the size of the required tonnage. Finally, the current drop in new ship orders will keep the lid on deliveries beyond 2017, thus limiting the supply of tonnage to the market.

So there you have it. Cyclicality is inevitable and softer market fundamentals should be expected. The long-term outlook will be positive for at least as long as oil remains cheap. **JW**

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The Greek port of Piraeus, famous since ancient times, is a maritime hotspot and home to numerous shipping companies.

Photos: DNV GL, milangonda - Fotolia

AT HOME IN PIRAEUS

Greek mythology brims with tales of seafarers and ship adventures, and Greek culture has been tightly interwoven with sea trade for millennia. With the Greek shipping industry more vibrant than ever, DNV GL is reinforcing its presence in Piraeus.

Greece is a shipping nation par excellence. Today the Greek shipping industry is the world's number one in terms of gross rate tonnes (GRT), and the Greek-owned commercial fleet represents roughly 16 per cent of the global fleet in deadweight tonnage. Since the late 1990s, the number of ships owned by Greek companies has doubled, and the tonnage of Greek-owned vessels has quadrupled, reflecting the continuous increase of ship sizes. About half of the Greek-owned fleet is bulk carriers, and 35 per cent are oil tankers. Substantial capital has been invested in modernizing the Greek fleet over the past 15 years, lowering the average vessel age from over 20 years in the year 2000 to just under ten years today.

Long-standing relationship

As all these facts show the Greek shipping sector is a mainstay of the global maritime industry, and all evidence indicates it will continue its 2,500-year success story far into the future. Greece in general, and its famous port of Piraeus in particular, form a unique maritime hotspot with an unmatched concentration of shipping company headquarters and offices. DNV GL has been a partner to Greek shipping companies for nearly a century and is proud of its long-standing and productive relationship with the nation's shipowners and operators. In pursuit of its long-term strategic goals and in response to the steady growth of the Greek maritime sector, DNV GL has decided to boost its range of services available locally and accelerate service delivery. This means that owners and operators based in Greece will be able to conduct even more of their business directly with the DNV GL team in Piraeus. More difficult and challenging decisions will be made locally by the Chief Surveyor, which enables us to respond even faster to the needs of local customers. What is more, the Greek DNV GL Maritime Service Center (MSC) now covers approval of all major technical disciplines within both newbuilding as well as fleet-in-service.

Furthermore, the existing research and development team will be expanded and focus its work primarily on the needs of the local maritime community. As an additional measure specifically supporting Greek shipowners and ship operators, DNV GL is building a global network of Greek-speaking surveyors operating in seven different countries around the world.

DATE located in Greece

The new DNV GL Direct Access to Technical Experts service (DATE), which has been established as a global service recently, likewise offers Greek-speaking experts. It provides customers with direct access to a pool of experts located in Hamburg, Oslo, Singapore, Piraeus and Houston. It is available to the fleet in service 24 hours a day, Monday through to Friday and, for urgent enquiries, even at weekends and on public holidays. All requests are normally answered within one working day, and all offices work together as a single point of contact and unified source of expertise.

To further support the high number of tanker owners in Greece, DNV GL has decided that the global Tanker Director will be spending a major portion of her time in Greece.

All these measures demonstrate the commitment of DNV GL to its Greek customers and to the principle that DNV GL is at home wherever its customers are. **CV**

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TAKING THE LEAD IN CYBERSECURITY

Sokratis Dimakopoulos, Deputy Managing Director of Tsakos Columbia Shipmanagement, explains the initiatives his company has taken to enhance cybersecurity, operational efficiency and personnel competence.

With a surge of cyberattacks across all industries, protecting shipping companies and their assets has become essential to ensuring safe operations. Recently published guidelines on marine cybersecurity by the round table of international shipping associations call upon shipping companies to enhance the security of their IT systems by developing cybersecurity management plans for their organizations and fleets. Several companies have already started to act on this with support from DNV GL – one of them is Tsakos Columbia Shipmanagement (TCM).

"We wanted to assure our charterers and customers that our systems would be adequately protected from cyberrisks by implementing the highest standards of cybersecurity on board our vessels and on shore. DNV GL's proactive attitude, its clear vision and commitment to the highest standards will assist us in achieving this," says Sokratis Dimakopoulos, Deputy Managing Director of TCM. Over the past five months, TCM has been working with DNV GL to create an information security management system which will assist in assessing cybervulnerabilities and implementing the necessary measures for mitigating risks and responding to potential system breaches.

"The results are based on a thorough risk and gap analysis and will be verified through penetration testing carried out by the DNV GL Group company Marine Cybernetics," explains Nikolaos Kakalis, Head of the DNV GL – Maritime R&D and Advisory unit in Greece. DNV GL is the first classification society to implement this kind of cybersecurity service in practice.

In addition to developing a robust information security management system, TCM has reinforced its IT department, developed in-house solutions for performance management and will be one of the first shipping companies in the world to apply for certification to the ISO 27001 standard. To be awarded this certification, companies need to demonstrate a process-driven approach for establishing, implementing, operating, monitoring, reviewing, maintaining, and improving their information security management system.

Training for 1,500 seafarers per year

TCM manages a fleet with a total of more than six million dwt, which primarily consists of tankers. In 2013, the company added two DNV GL-classed dynamic positioning DP2 shuttle tankers and a third will be delivered in 2017. "Equipped with state-of the art, technically advanced systems with sophisticated automation capabilities, these vessels require personnel with specialized skills and advanced training. We decided early on to invest in developing an in-house pool of skilled DP officers and crew to ensure safe and reliable operations," says Dimakopoulos.

"Our Maritime Training Centre, the Maria Tsakos TCM Academy, has a DP bridge simulator and is currently acquiring

TCM's highly sophisticated ships require careful crew training.

Virtual bridge. Sokratis Dimakopoulos inside the Class A bridge simulator.

FOCUS ON SKILL DEVELOPMENT

Sokratis Dimakopoulos graduated as a Chemical Engineer and holds a Master of Science degree. After his studies he joined the Hellenic Coast Guard as a Technical Officer and went on to work at the IMO as well as leading shipping companies in Greece before joining Tsakos Columbia Shipmanagement as the Deputy Managing Director in 2014.

accreditation for DP training and certification under an internationally recognized scheme," he adds. Established in 2013, the academy has been expanding rapidly, both in terms of technology and its curriculum." About 1,500 seafarers take part in TCM training courses every year and have access to a Class A bridge simulator, ECDIS simulators, cargo handling workstations, engine room simulators and a DP bridge simulator. "We consider our human resources as the key success parameter for our company. As such we are allocating significant resources to professional development projects to ensure that we attract, train and retain competent personnel," says Dimakopoulos.

Optimizing internal processes and fleet organization are also at the top of the agenda at TCM. "We have reorganized our fleet groups based on their trading areas in order to facilitate best practice sharing and enhance in-house experience for dealing with operational challenges particular to a region," states Dimakopoulos. In addition, TCM has been cooperating with DNV GL to improve the energy efficiency of cargo discharge and cargo heating operations as well as optimizing its dry-dock operations. Furthermore, DNV GL advisory experts have supported TCM in improving energy management and competence management. Later this year, TCM will work with DNV GL and several other shipping companies on an environmental benchmarking project.

Dimakopoulos is committed to reinforcing TCM's position as a leading management company, and he is confident that Greek shipping as a whole will maintain and even enhance its leading position in the industry. "The ultimate challenge for Greek companies is to maintain the seamanship and the traditional maritime values of our people. Without these elements the sustainability of our industry could be at risk." **AJO**

Photos: DNV GL (2), Tsakos Columbia Shipmanagement (4)

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"We wanted to assure our charterers and customers that our systems would be adequately protected from cyber-risks by implementing the highest standards of cybersecurity on board our vessels and on shore."

Sokratis Dimakopoulos, Deputy Managing Director, Tsakos Columbia Shipmanagement

About 1,500 seafarers take part in training courses at the Maria Tsakos TCM Academy every year.

Ballast water is among the top environmental issues addressed by new regulations.

KEEPING PACE WITH ENVIRONMENTAL REGULATIONS

The environmental impact of the shipping industry remains a topic of keen interest for regulators, with agreed regulations entering into force in the near future and new regulations being developed around the world. Understanding the evolving regulatory landscape is of strategic significance when making business decisions.

Over the past decade, shipping has seen a surge of environmental regulations. Political pressure and an increasing focus from society at large have driven the International Maritime Organization (IMO), various countries and regions such as the EU to develop steadily more stringent regulations. The consequence is a patchwork regulatory system, where numerous overlaps create challenges for operators. There are unfortunately no indications that this will change. It is important for operators to both understand the existing regulatory framework and be aware of forthcoming developments, both at IMO and elsewhere, in order to make the right business decisions.

Ballast water management

Ballast water management has been a hot topic for a number of years. At present, the Ballast Water Management (BWM) Convention is only 0.21 per cent short of the gross tonnage ratification threshold. Several states have announced imminent ratification, and DNV GL believes the threshold is likely to be crossed sometime this year. The convention will then enter into force one year later, requiring all ships to comply within the following five years. The content and interpretation of the convention are still evolving. Presumably the IMO Marine Environment Protection Committee (MEPC) 70 will finalize the revision of the technical guidelines in October. There are presently 65 IMO-approved BWM systems on the market.

The national ballast water management regulations of the United States entered into force in 2013. New ships now have to comply upon delivery, while existing ships must comply by the first scheduled dry docking after 1 January 2014 or 2016, depending on ballast water capacity. US type approval is required for the ballast water treatment systems of affected ships; so far no such approvals have been granted. To address the obviously paradoxical situation of having to install approved systems when none have obtained type approval, the US Coast Guard (USCG) has issued more than 50 so-called Alternate Management System (AMS) approvals for systems accepted by IMO. These approvals are limited to a five-year validity period. To ease the transition further the US is also liberal in granting time-limited exemptions to individual ships. We believe that once US-approved systems become available the extension policy will become significantly more stringent.

For more information on different ballast water topics such as treatment systems and approval process please visit **dnvgl.com/bwm**.

SO_X regulations

Discussions at IMO are centred on the question of whether the global 0.5 per cent sulphur content requirement should enter into force in 2020 or 2025. A fuel availability study is in progress to provide a discussion basis for an IMO decision which may be made at MEPC 70 in October 2016. A complicating factor in the discussions is the EU Sulphur Directive, which stipulates a maximum 0.5 per cent sulphur content for all EU waters by 2020, irrespective of the IMO decision. If different dates are decided by IMO and the EU, shipping will for a period face a three-tier sulphur content regime. From an operational perspective, this will be challenging.

It should also be noted that the Water Framework Directive is putting constraints on the discharge of scrubber water in certain EU countries. Belgium and Germany have in essence prohibited the discharge of scrubber water in most areas, severely constraining the operation of open-loop scrubbers. Other EU countries are following suit to a lesser or greater degree, with no common EU practice likely to be agreed. China has recently published regulations for SECA-like fuel requirements in certain coastal areas (see box next page).

More information and our updated Sulphur guideline are available at **dnvgl.com/lowsulphur**.

NO_X regulations

NO_X Tier III requirements have entered into force in the North American ECA for ships constructed on or after 1 January 2016. In essence, anyone constructing a ship today needs to consider >

Photo: Hasenpusch

> potential operation of the vessel in the North American ECA, whether upon delivery or at some time in the future. If such an operation pattern is conceivable, NO_X control technology will be needed for that ship.

In contrast to the North American ECA the ECAs in the North Sea and the Baltic do not yet include a NO_X requirement. This has been on the table for a number of years and there are now robust signals that a joint North Sea/Baltic NECA application will be made to MEPC 70. Assuming agreement at IMO these Tier III requirements are expected to apply to ships constructed on or after 1 January 2021.

CO_2 and energy efficiency

Climate change remains the driving political force behind CO_2 and energy efficiency regulations. In the EU, regulations for Monitoring, Reporting and Verification (MRV) of CO_2 emissions have entered into force, requiring all ships above 5,000 GT sailing to or from European ports to comply. Ships must also report cargo data and average energy efficiency. The EU will make the data publicly available on an annual basis. Monitoring plans are to be submitted to verifiers by 31 August 2017, with 2018 being the first year of reporting. Data will be published by the EU in mid-2019. There is extensive work in progress to develop the practical framework and the EU is expected to publish practical details towards the end of 2016.

Part of the purpose behind the EU MRV regulations is to encourage IMO to work on a similar mechanism with global, not only regional, coverage. The EU has stated that if this happens it will mothball its regulation. It is therefore of great significance that MEPC 69 did agree on a global mechanism for mandatory monitoring, reporting and verification of fuel consumption data for all ships above 5,000 GT. The scheme is expected to be adopted at MEPC 70, in which case 2019 will likely be the first year of operation. However, the scheme differs from the EU MRV in several important aspects, including confidentiality of data, calculation of efficiency metrics and requirements regarding the verification of data. While the European Commission sees the IMO work as an important step forward it seems unlikely to view the mechanism as robust enough to reverse its own course on the MRV scheme. DNV GL expects that the shipping sector will have to deal with two different but overlapping reporting regimes for at least some years.

IMO is also seeing a reinvigorated discussion on long-term CO_2 emission goals following the global climate change agreement reached in Paris last year. There is as yet no agreement within IMO regarding the need to move beyond establishing a fuel data collection system, and it remains to be seen whether consensus can be reached. DNV GL sees a very real risk that unless significant progress is quickly made at IMO, other bodies outside the shipping industry may attempt to issue regulations. This would not be of benefit to anyone, least of all the shipping sector itself. **EN**

All technical and regulatory news can be found at **dnvgl.com/tecreg**.

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CHINA IMPOSES SULPHUR LIMITS AND MIGHT ESTABLISH SECA ZONES

China has published regulations to establish SECA-like sea areas outside Hong Kong/Guangzhou (Pearl River Delta) and Shanghai and in the Bohai Sea. In a staged approach, the new regulations impose an initial 0.5 per cent sulphur limit for fuel burnt in key ports within these areas, gradually expanding the coverage to finally encompass these sea areas entirely from 2019 onwards. The sulphur limit might be lowered to 0.1 per cent as of 2020, and a formal ECA application may be submitted to IMO.

Photos: DNV GL, oraziopuccio - Fotolia

Inspections can be burdensome. Improving coordination would benefit all parties.

THE NEXT SAFETY LEVEL

The maritime industry's regulatory regime has evolved over decades. Safety has improved significantly, but more needs to be done. Better coordination among regulators and inspection regimes would help.

Over the last few decades, the quality of ships and ship management and the reputation of the shipping industry in general and tanker business in particular have benefited tremendously from new IMO regulations, an enhanced class survey regime and the Oil Companies International Marine Forum (OCIMF)'s implementation of vetting through the Ship Inspection Report (SIRE) programme. But accidents still occur too often across the shipping industry, and the frequency and probability of serious tanker accidents today is similar to that of the late 90s and early 2000s.

Opportunities of risk management

There is no shortage of regulations and inspections. In fact, class and statutory inspections and OCIMF vetting add up to a complex maze of partially overlapping requirements and checks and are a growing burden to ship crews, who lose precious time they should spend on maintenance and operational safety. It would make sense to coordinate all these activities to avoid duplication. Unfortunately, there is a lack of coordination and transparency between the responsible bodies. DNV GL has created powerful big data algorithms specifically for extracting useful insight from its own survey results and findings. Combined with port state inspection and IHS Fairplay ship incident data as well as vetting data DNV GL can provide owners with meaningful information about trends and patterns in daily operation as well as data for performance benchmarking by ship type. The range of possible uses for this analytical data is virtually unlimited. What is still missing in this scenario is information from the 20,000 annual inspections conducted under the SIRE regime.

Unfortunately, this information is not made available in a dynamic way, which prevents the tanker industry from improving even further.

Dynamic risk management as practised in the aviation industry has become more common in the offshore industry since the Macondo incident and is gradually being adopted by the shipping industry as well. Companies practising Barrier Management develop preventive measures or "barriers" to avoid accidents or mitigate their consequences. DNV GL supports these efforts, for example by providing an easy-to-use tool for cruise operators to monitor their barriers over time.

Provided that all stakeholders are willing to contribute relevant information in the future, DNV GL is of the opinion that we could eventually implement a more risk-based inspection approach to replace the traditional checklist method in shipping and in the tanker business. This would streamline the inspection process and relieve ship operators from some of the tedious paperwork, allowing them to regain focus on important operation and maintenance work. DNV GL firmly believes that with an increased cooperation between all the stakeholders, OCIMF included, the tanker business would benefit tremendously and reduce its vulnerability to serious accidents. ■ **CV**

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DNV GL database	World port state inspections	IHS Fairplay ship parameters	IHS Fairplay ship incidents	SIRE database
■ **13,000** ships ■ **60,000** periodical surveys ■ **25,000** non-conformities ■ **90,000** findings	■ **88,000** inspections	■ **80,000** ships	■ **1,700** serious incidents	■ **8,100** ships ■ **20,000** inspections

DNV GL is utilizing data from different sources to support our clients on safe and efficient operations.

Photos: DNV GL

IBC CODE: SAFETY MADE FEASIBLE

Photos: DNV GL, Malcolm Fife – iStockphoto

There are new restrictions on the horizon for product carriers. With a bit of foresight, however, they are manageable.

The IBC Code is currently undergoing a revision with respect to product assessment which will eventually result in revised carriage requirements for most IBC Code cargoes. The impact on the Certificate of Fitness product list will vary depending on the design, equipment and arrangements of each individual chemical tanker.

Transport of chemicals in bulk is regulated by the IBC Code, and compliance is evidenced by the International Certificate of Fitness. The IBC Code is a set of general requirements followed by cargo-specific stipulations, such as damage stability, cargo tank location, cargo tank venting and electrical equipment. The ship's design, arrangements and equipment determines the range of products it is allowed to carry and in what cargo tanks. The Certificate of Fitness serves as the vessel's "bill of trading rights" listing all acceptable products it may carry.

No chemical may be shipped unless it is listed in Chapter 17 or Chapter 18 of the IBC Code or in the MEPC.2 Circular issued annually along with a set of carriage requirements. The latter are defined by IMO based on an evaluation of the toxicity and physical properties applying the assessment criteria which are described in Chapter 21 of the IBC Code.

Following the MARPOL Annex II revision which entered into force in 2007, the IBC Code was also revised, inter alia by changing the product assessment criteria to account for crew safety and long-term health as well as environmental aspects. However, when reassessing the list of products it was decided due to time constraints to apply the new criteria to the MARPOL/pollution-related carriage requirements only, whereas the existing safety-related requirements of the IBC code were maintained.

Restoring commercial viability

As a result there is currently a two-tiered product list where different sets of product assessment criteria were applied before and after 2007, respectively. Newer products assessed from 2007 onwards are generally subject to stricter carriage safety requirements. To eliminate this discrepancy it was eventually decided to fully reassess all products in the IBC Code pursuant to the new criteria defined in Chapter 21. In the course of this process it was soon realized that the resulting carriage requirements would be too restrictive for many conventional products.

Concerns were raised especially about products shipped in large volumes. Stricter ship design criteria, such as ship and tank types, could limit carriage capacities or even result in a lack of tonnage. This prompted a revision of the new Chapter 21 criteria to eliminate undesirable commercial effects without compromising safety. The new draft criteria are nearly completed and their approval is expected in 2017. The actual product assessment will follow but the revised Chapters 17 and 18 are unlikely to enter into effect before 2020.

This further implies that once the revised IBC Code, Chapter 17/18 enters into force, the new carriage requirements will apply to all ships, which will in advance be given a new Certificate of Fitness with a new list of products based on the new carriage requirements. The new certificate will then supersede the old certificate on the agreed date, and all cargoes loaded after this date must be in accordance with the new Certificate.

With the draft assessment criteria nearing completion, a draft IBC Code product list with proposed carriage requirements has been circulated by IMO to give the industry enough time to comment prior to adoption.

CH_4O METHANOL

C_5H_8 ISOPRENE

Examples of products which will be classified as toxic under the revised IBC Code.

C_7H_8 TOLUENE

C_8H_8 STYRENE

Few problematic cases

While the design issues seem to be more or less sorted out, there is a significant increase in the number of products that will be classified as toxic, a fact which has raised some last minutes concerns. This is mainly related to the availability of test tubes for toxic vapor detection and carriage requirements triggered by toxicity, such as the position of cargo tank exhaust vents, separation of cargo piping, restrictions on cargo tanks located adjacent to fuel tanks and opening set points for pressure-relief valves. These issues will probably be sorted out during the October session of the IMO working group tasked with the revision, possibly without compromising the agreed timeline.

Most of these requirements triggered by toxicity are relatively easy to overcome, except for cargo tanks located adjacent to fuel oil tanks. These are typically MARPOL Annex I-type slop tanks which are also used for chemicals and located next to fuel oil tanks without a cofferdam separating the cargo area from the engine room. While these tanks are normally relatively small, transporting exclusively toxic cargoes may nevertheless affect the total carriage capacity of the vessel. A few examples of products which are not classified as toxic today but will be if the proposed criteria are implemented include methanol, styrene monomer, toluene and isoprene.

Upon request, DNV GL will run a gap analysis on DNV GL-certified chemical tankers to determine the effects of the proposed carriage requirements on the given ship's certificate, and advise the owner on how to keep the desired range of cargoes on the certificate after 2020. This will enable DNV GL customers to better prepare and position themselves for the new reality in due time. **KJ**

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A NEW, FUTURE-READY STANDARD FOR SHIPPING

Since DNV and GL joined forces, a huge effort has been made to consolidate our existing knowledge and further enhance our standards to serve as a reference for the maritime industry. The know-how and experience of both legacy companies have been incorporated into the new DNV GL rules which are now available to support state-of-the-art ship newbuilding and operation.

The new rules, which represent the best of the combined expertise and experience of two leading classification societies, have been evaluated for critical issues and improvement potential by our most experienced technical experts. The rule set was scrutinized with respect to clarity, practical application and its positive contribution to the overall safety and reliability of vessels. The process involved more than 200 technical experts at DNV GL and the rule set was improved by extensive input from more than 800 shipyards, designers, shipowners and managers. The review resulted in the most modern rule set published by any class society, which is efficient, future-ready, consistent, transparent, modern and adaptable.

Harvesting operational experience

With around 13,000 ships classed by DNV GL, the experience we gain through supporting our customers in their day-to-day operations constitutes an unrivalled knowledge database.

In connection with the development of the new DNV GL rules, we launched a research project to perform a thorough statistical review of our fleet. The aim was to identify possible areas where the rules could be further improved. More than 3,000 ships in service were closely monitored, looking for design-related defects. Typical defects and their frequency of occurrence were studied and the know-how achieved was incorporated into the new rules.

IACS CSR and DNV GL rules for hull structure

The IACS Common Structural Rules (CSR) apply to the hull structures of oil and products carriers from a length of 150 metres. However, for the DNV GL rules the methodology as applied by the CSR was developed further to cover tankers shorter than 150 metres as well as all other ship types. This gives ship designers and shipyards the benefit of having to base their structural

The rewritten DNV GL rules for tankers provide designers with greater flexibility in terms of implementation.

design work on a single set of general principles while ensuring that the special operational conditions for each ship type are fully accounted for.

A new and improved technical foundation

The incorporation of equivalent design waves (EDW) into the DNV GL rules marks a significant change in the way dynamic loads are calculated. The advanced load concept is a major step towards a more realistic and accurate representation of environmental loads. Along with the state-of-the-art DNV GL capacity models, this concept improves the consistency of the safety level applied to the entire hull structure. It will also help overcome challenges related to the development of innovative designs. This provides a basis for achieving an ideal distribution of structural strength, ensuring every ton of steel is used efficiently.

With more precise load-related requirements and more advanced capacity formulations, the new DNV GL rules call for more extensive computational capabilities and are supported by powerful software tools ensuring an efficient design process.

New and enhanced notations

To enable owners to efficiently customize vessels to suit their needs, the new rules offer a variety of additional class notations. These are tailored towards ship types and additional features, and ensure that vessels are designed and equipped for their intended operation. In addition, they are continuously developed to support the application of latest technology. As for example drone surveys. First surveys are planned and an initial guidance for performing and accepting drone-based surveys is in preparation.

Gas ready and Scrubber ready

As the development of regulations and technologies can be unpredictable and complex, DNV GL offers "Ready" notations to owners who want to prepare new vessels for the future installation of new technology. By obtaining such a notation, owners can postpone initial investment costs while ensuring that the necessary preparations are in place for a smooth and cost-efficient retrofit at a later stage. In addition, they may benefit from a higher degree of technology maturity (and possibly lower prices) by investing at a later time.

TMON (closed-loop water) and TMON (open-loop water)

The revised class notations for water-lubricated tail shafts are another example of the enhanced flexibility DNV GL now offers to shipowners. These two notations allow shipowners and operators potentially unlimited intervals between tail shaft withdrawal surveys of water-lubricated systems. With these two voluntary class notations, DNV GL is the first classification society to use a condition monitoring-based survey process that eliminates the requirement for tail shaft withdrawal surveys at predetermined intervals. The notations can be assigned to both newbuilds and ships in service.

Further details about these and the other 70 additional notations can be found in DNV GL Rules for Ships, Part 6.

The maritime industry welcomes the new rules

"We have no doubt that the maritime industry will benefit from the new DNV GL rules," says Business Director Tankers Catrine Vestereng. "The rules are based on our unrivalled tanker experience accumulated over decades, which makes them spot on what is needed to operate a tanker in a safe and efficient way. All our experts around the world are eager to support the industry in the application of the new rules." **SS**

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Photos: DNV GL, momentscatcher – Fotolia

CALCULATION TOOLS – FREE OF CHARGE IN 2016!

Calculation tools are essential for developing modern ship designs. The new DNV GL rules for hull structures are supported by both the POSEIDON and Nauticus Hull software tools. The DNV GL integrated calculation tools have been updated to include the CSR rules. All tools already enjoy a strong reputation among designers and yards and will, with the latest major updates, provide even more efficient support for the design process, making it easier to apply the new rules. Please contact your local DNV GL Software representative for details.

For more information and access to the new DNV GL rules, please visit: **www.dnvgl.com/dnvglrules**

Western Queen is the first vessel to use the TMON notation.

DEFER WATER-LUBRICATED TAIL SHAFT WITHDRAWAL

DNV GL offers potentially unlimited survey intervals for water-lubricated tail shaft systems by introducing optional class notations TMON (closed-loop water) and TMON (open-loop water). This eco-friendly technology benefits all parties involved, provided it is coupled with an effective condition monitoring system capable of detecting deterioration at an early stage.

Water-lubricated tail shaft systems have assumed prominence recently with the increasing global focus on the environment and the stringent requirements for oil-to-sea interfaces in the US Environmental Protection Agency's Vessel General Permit. Operators are expected to make an informed choice when selecting the type of stern tube lubrication system and the associated classification follow-up intervals for water-lubricated systems as opposed to oil-lubricated systems.

DNV GL therefore now offers two notations for water-lubricated tail shafts – TMON (closed-loop water) and TMON (open-loop water) – allowing unlimited intervals between tail shaft withdrawal surveys provided that the condition of the tail shaft, bearings and lubricant system is monitored continuously. The new notations are the result of extensive internal research, risk assessments to identify the relevant failure mechanisms, historic experience and an evaluation of evolving industry designs and monitoring systems. Discussions with leading designers and manufacturers were an integral part of the evaluation of the practicability and feasibility of the requirements.

As long as the monitoring and the periodical DNV GL surveys do not reveal any unacceptable deterioration in the condition of the tail shaft, bearings or lubricant system, a tail shaft withdrawal survey will not be required at a predetermined interval. The propeller connection survey, however, is carried out independently.

Tail shaft withdrawal can be deferred based on a condition monitoring regime.

Photos: DNV GL, P&O Maritime

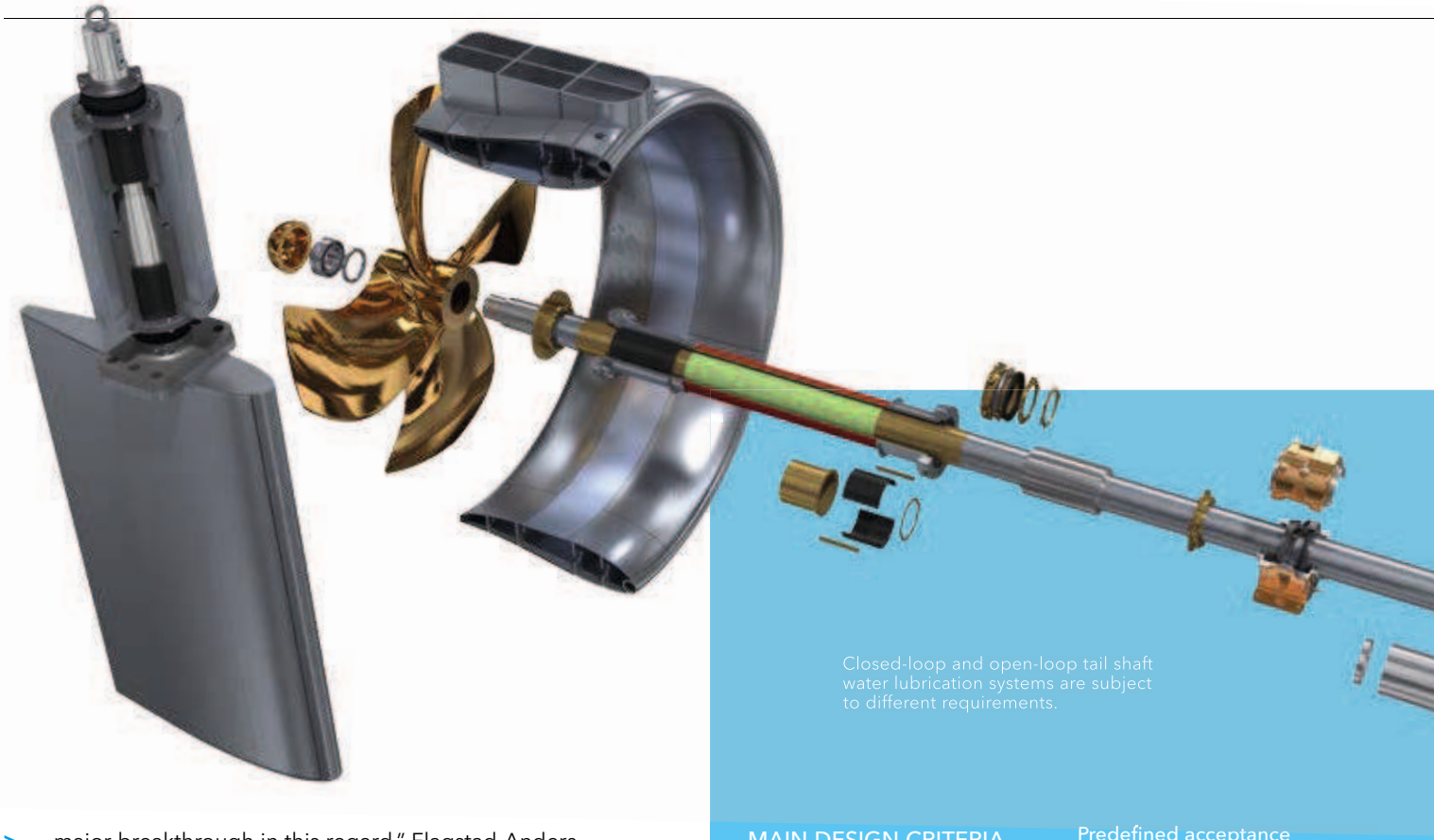
Its interval depends on the type of connection – every five years for keyed connections and every 15 years for keyless and flanged connections.

Major benefits

The enhanced focus on the design and follow-up requirements for condition and performance monitoring systems offers several benefits to shipowners and operators:

- Potentially unlimited tail shaft withdrawal survey intervals;
- Condition-based maintenance to save time and costs;
- Effective management of risks;
- Optimal component and system condition ensured;
- Early identification of deterioration within safety margins; and
- Environmentally friendly systems.

Tuva Kristine Flagstad-Andersen, Head of the Machinery and Systems section at DNV GL Group headquarters in Oslo, explains: "Water-lubricated systems are here to stay and put increasing responsibility on class societies to support the industry by providing a reliable means of assessing the condition of the shafts, bearings and lubricant system while considering the impact of survey regimes on operators. The introduction of condition monitoring-assisted surveys with potentially unlimited tail shaft withdrawal survey intervals, without compromising safety, is seen as a >



Closed-loop and open-loop tail shaft water lubrication systems are subject to different requirements.

> major breakthrough in this regard." Flagstad-Andersen adds: "The optional class notation requirements focus on maintaining the integral components of the tail shaft system in an optimal condition through an effective design and in-service monitoring regime. Remedial action based on the early identification of any deterioration in condition and performance are critical supporting measures."

The TMON (closed-loop water) notation has already been requested and evaluated for *Western Queen*, a tanker owned and operated by P&O Maritime. Robin Reed, Group Technical Services Manager, P&O Maritime, Corporate (Dubai), explains that one of the main reasons his company chose this notation was that it ensures an optimal condition of the shafting system through effective monitoring while deriving the best benefits from a classification perspective.

"We expect the monitoring regimes to complement the enhanced design criteria and reflect the representative condition of the system in the operational phase to assist us in initiating subsequent preventive actions and planned maintenance," says Reed.

DNV GL has also received requests for assignment of the TMON (open-loop water) notation for newbuilding projects and has satisfactorily concluded the evaluation of respective designs.

Condition monitoring rules for propulsion shaft systems are critical to effective risk management while allowing operators to derive the best operational benefits. DNV GL rules account for shaft corrosion, consequential fatigue resistance and bearing-to-shaft interaction as the key factors in this regard. ▮ **AS**

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Photos: DNV GL, Wärtsilä (2)

MAIN DESIGN CRITERIA

Corrosion
- Approved corrosion protection of the shafting and system
- Passivating properties of the lubricant system for closed-loop systems defined
- A salinometer for closed-loop systems to warn against seawater contamination
- Alternative means of inspection for some open-loop system designs (low-grade stainless steel and liner/coating combinations)

Bearing-to-shaft interaction
- Remote sensors for trending the wear-down of the aft tail shaft bearing
- Approval requirements for bearings, shaft coatings and wear-down sensors
- Stringent lubricant quality, flow and monitoring requirements in all shaft operating conditions (including stopped mode)
- A stringent focus on shaft alignment irrespective of shaft size

Non-toxic nature of closed-loop system lubricant
- Tested pursuant to selected ISO standards for exposure to aquatic organisms

Predefined acceptance criteria
- For follow-up in service

System integrity
- In-place replacement provisions for shaft sealing elements for the respective system (closed or open)

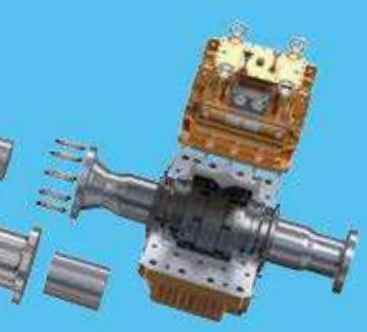
CORROSION PROTECTION, CLOSED-LOOP

The tail shaft is protected against corrosion by an approved selection of material or equivalent arrangement and is supported by a passivated lubricant system, tested periodically for quality and wear. Passivation helps minimize corrosion of the tail shaft and stern tube system.

CORROSION PROTECTION, OPEN-LOOP

The tail shaft is protected against corrosion by an approved selection of material or an equivalent arrangement.

Stainless steel shafts with a PREN (pitting resistance equivalent number, reflecting the extent and nature of alloying) of 34 or higher are considered practically immune to corrosion and have an extremely high resistance to pitting corrosion.



TECHNICAL AND OPERATIONAL CONSIDERATIONS FOR EXTENDED SURVEY INTERVALS

Arun Sethumadhavan, Principal Engineer in DNV GL's Oslo-based Machinery and Systems section for fleet in service, explains: "We intend to attract industry attention to the use of shafts with a high PREN by highlighting this distinction in the rules when the shafting material is chosen during the design stage. Shafts protected by a continuous corrosion-resistant one-piece sleeve also pose a comparatively low risk of corrosion resulting from a breach of sleeve integrity.

"In some designs with an increased risk of shaft corrosion or pitting – typically low-grade stainless steel with a PREN below 34 and shafts with a coating and/or multi-liner combination – we utilize the alternative inspection method (including inspection covers, boroscopes, etc.) to address the corrosion-related fatigue risks during a scheduled dry docking of the vessel. This also accounts for longer intervals of vessels with approved extended dry docking schemes. Designs involving A-brackets and struts with open shafts have also been given due consideration."

BEARING-TO-SHAFT INTERACTION

The design conditions, including the selection of bearings and the quality and flow of the lubricant, should ensure satisfactory shaft-to-bearing interaction. Synthetic bearings normally reveal a poor shaft-to-bearing interaction through an accelerated bearing wear pattern, accompanied by increased bearing heat generation in some cases.

The wear-down of the aft tail shaft bearing must be monitored and trended using reliable remote static sensors which provide a reading every time the shaft is stopped. Closed-loop systems should also monitor the differential lubricant temperature across the bearings.

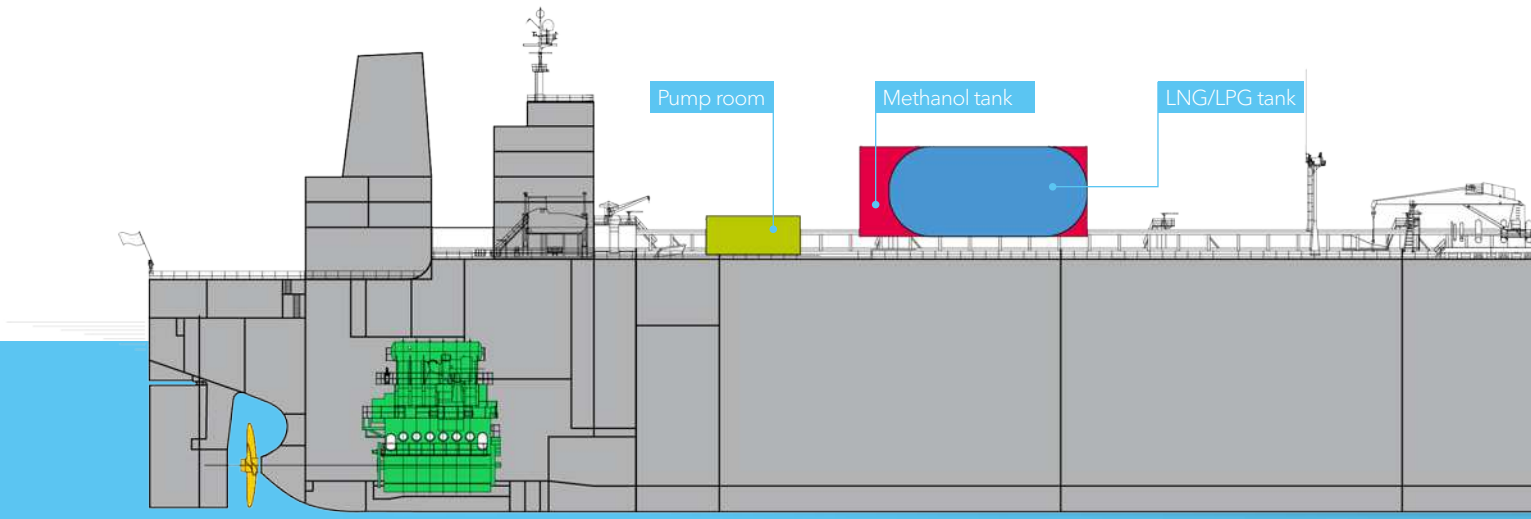
The efficacy of temperature sensors fitted to synthetic bearing materials, which are inherently poor conductors of heat, to reflect the representative bearing surface temperature, is questionable and hence not a requirement.

FOLLOW-UP IN OPERATION

The factors below represent the main considerations for follow-up during operation:

- Periodical trending of the aft tail shaft bearing wear-down measurements
- Periodical testing and analysis of the lubricant system quality and trending of corrosion/wear elements (for closed-loop systems)
- Annual DNV GL surveys for the TMON class notations
- Alternative inspection method during scheduled bottom surveys in dry dock (for low-grade stainless steel shafts (PREN below 34) and shafts protected by a coating and/or multi-liner combination)

Remote display of bearing wear monitoring.



FUEL ALTERNATIVES FOR LR1 PRODUCT TANKERS

In a comprehensive study, DNV GL in cooperation with MAN DT examined a set of scenarios for various versions of an LR1 product carrier to determine the most economically feasible fuel type to plan for. Considering the current volatile market situation, the conclusions are quite different depending on the development of fuel prices.

The goal of this study was to analyse costs and benefits of various fuel options for a newbuild. The alternative fuels selected included LNG, LPG and methanol and others. The costs and benefits were determined by looking at the additional investment and operating costs compared to a standard fuel variant using HFO and MGO.

An LR1 product tanker on a fixed route was selected for a financial analysis. The machinery set-up was the same for the various fuels except for the fuel system, see Figure 1. The ship was assumed to operate on a route between North America and northern Europe, see Figure 2.

Based on AIS data, the typical speed for similar-sized product tankers on comparable trades was determined to be 12.5 knots. This speed was then used as the fixed transit speed of the ship. For the selected operating pattern, 87 per cent of the time is spent in transit, three per cent in approach and ten per cent in port.

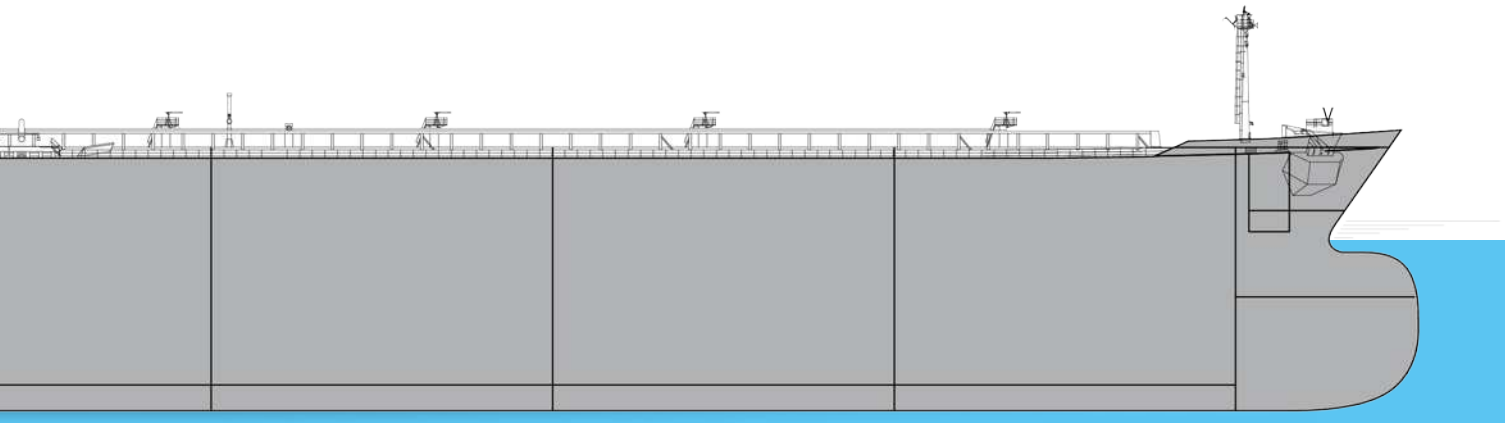
Fuel variants

The study assumed that the reduction of the global sulfur cap will be enforced as of 2020. Therefore LSFO with 0.5 per cent sulfur will be the reference fuel outside of SECAs as of 2020.

For the alternative fuels considered, one variant includes use of the alternative fuel for the entire round trip (one-fuel variant) while a second variant assumes use of the alternative fuel in the SECAs only and HFO/LSFO outside (mixed-fuel variant).

The additional investment costs relative to the reference scenario for tanks, piping and engine modification were considered in the financial analyses. Tanks were assumed to be placed on deck without reducing cargo capacity and compromising the earnings. The investment year was set to be 2017, with operations between 2018 and 2030.

Figure 2: Selected route between North America and northern Europe.



MAIN PARTICULARS OF THE SELECTED SHIP

Length overall	225 m
Breadth mld.	32.26 m
Scantling draught	14.2 m
Design draught	12.2 m
Main engine	1x MAN B&W 6G60ME-C9.5
NCR (90% SMCR)	10,390 kW at 88.8 RPM
Design speed at NCR	15 knots, incl. 15% sea margin
PTO	Fixed ratio, 778 kW
Genset	3x MAN 7L23/30H at 944 kW

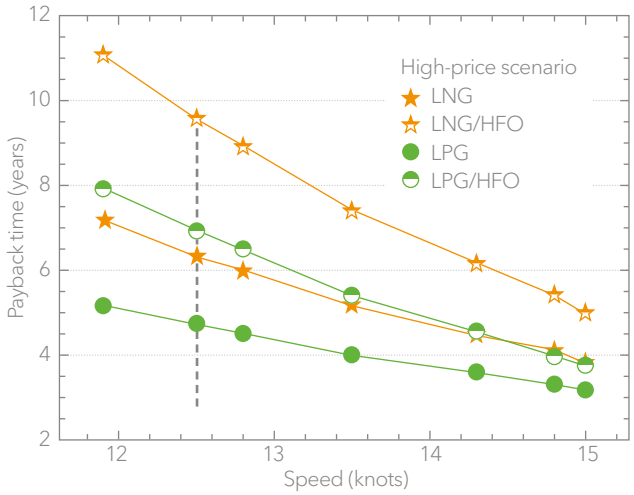


Figure 3: Payback time as a function of ship transit speed for LNG and LPG pure and combined variants in the high-price scenario. The dashed line indicates the reference speed.

Machinery

An MAN B&W 6G60ME-C9.5 was selected as the main engine, which can give the ship a design speed of 15 knots at 90 per cent engine load, including a 15 per cent sea margin. The 6G60ME-C9.5 engine is available as a standard oil-fuelled diesel engine, but also in dual-fuel versions capable of burning LNG, methanol and LPG (the ME-GI and ME-LGI types, respectively).

The propulsion system is equipped with a fixed-ratio power take-off (PTO). The capacity of the PTO is 778 kW, offering a simple and cost-effective way to supply all electric power from an alternative fuel when the ship is in transit.

The tank size for the alternative fuels was selected to give the vessel half-round-trip endurance with a 20 per cent margin.

Fuel price scenarios

The fuel price scenario is important for the financial viability of the various fuel options. Apart from the expected variations for each fuel type in concert with the crude oil prices, the relative position of fuel prices has changed over the last five-year period: MGO has become less expensive than methanol, and LNG has become as expensive as LPG.

Two price scenarios were developed: a high-price scenario based on the fuel prices in mid-2014 when the Brent oil prices were 100 to 110 dollars per barrel; and a low-price scenario based on fuel prices in mid-2015 when the Brent oil prices were about 50 dollars per barrel.

Results

In the high-price scenario, LNG and LPG both in the one-fuel variants and mixed-fuel variants, deliver a cost advantage during operation when compared to the reference vessel. There are, however, substantial investments for these alternatives related to investments for the tanks.

In the low-price scenario, both LNG and LPG are less attractive. The cost difference for LPG stays positive for all operational years, whereas LNG is estimated to be negative prior to the global sulfur cap and positive afterwards.

Selecting methanol does not give a positive cost difference compared to the reference case for any of the price scenarios so the investments needed for the engine upgrade, the gas supply system and the tanks will not pay back.

In the high-price scenario, both LNG and LPG have payback periods in the five-to-ten-year range. As expected, the payback time decreases at higher vessel speeds as shown in Figure 3. At 15 knots, the payback times are less than five years for all four variants. >

Illustrations: DNV GL, MAN

> The payback times are shorter for the single-fuel variants than for the mixed-fuel variants. Therefore the increased initial investments are more than compensated by the lower prices for LNG and LPG, compared to LSFO in the high-price scenario.

In the low-price scenario, the payback time for LNG is longer than the 13 years considered in this study, whereas LPG has a payback time of approximately 6.5 years. The payback times for LPG in both price scenarios are shown in Figure 4. Based on the fuel-price scenarios presented in this study, LPG can be understood to be at least as good as LNG based on shorter payback time, reduced sensitivity to reasonable price variations and lower initial investments.

Sensitivity of fuel prices and bunkering choice

Fuel prices with their intrinsic uncertainty are critical for the outcome of the financial analysis. To account for this uncertainty, a sensitivity analysis was carried out between LSFO and the alternative fuels. A large price spread indicates a larger driving force for a fuel switch to LNG or LPG.

As shown in Figure 5, LPG requires a smaller discount than LNG to be financially attractive. This is due to the lower investment costs. While the expected discount is lower for LPG than for LNG, the payback time is shorter. Nevertheless, with reasonable prices for LNG and LPG in the high-price scenario, the additional investment required for the alternative fuel variant pays back within the 13-year project period.

In this study, a tank capacity sufficient for half a round trip was assumed, which means that the vessel would need to bunker in both Houston and Rotterdam. However, considering the fuel price difference between these ports, the scenario was also checked for bunkering LNG and LPG at the cheapest location of the round trip only, which is Houston. When LNG is used for the entire round trip and bunkering is limited to a single location, the payback time increases from 76 to 97 months. Therefore the additional investment cost for the tank is not compensated by the lower fuel price. However, the payback time for LPG is reduced from 57 to 51 months when enough tank capacity is installed for a full round trip. The main reason for the difference is the high tank price for LNG compared to LPG. ▮ **HB**

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Figure 4: Payback time as a function of ship transit speed shown for LPG in both price scenarios, with LPG used both inside and outside SECAs. The dashed line indicates the reference speed.

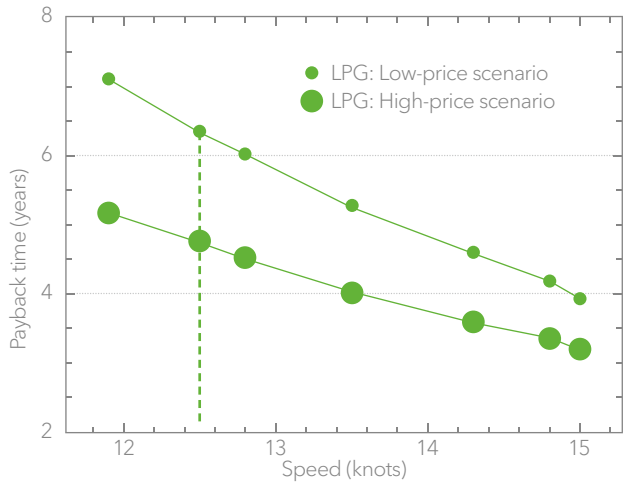
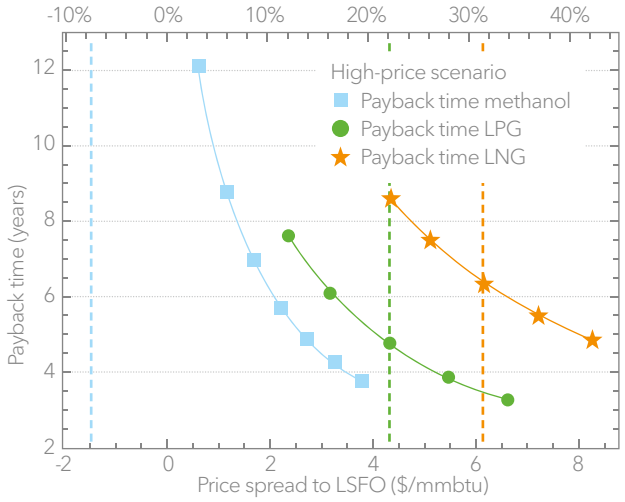


Figure 5: Payback time as a function of price difference between LSFO (at $19.55/mmbtu) and the alternative fuel. The dashed lines represent the values used in the high-price scenario for each fuel.



Illustrations: DNV GL, MAN

Tankers can be more productive by increasing their summer draught.

Photos: DNV GL ,corlaffra - Fotolia

DRAUGHT INCREASE BOOSTS INCOME

Often considered a no-brainer, existing vessels can increase their carrying capacity by increasing their maximum summer draught.

During the life cycle of a vessel a need for increasing the earning capacity of a vessel may arise. This could be achieved by increasing the maximum summer draught, which in many cases is fully possible by simple means! Imagine a medium-sized tanker for chemicals carrying caustic soda in a partially loaded condition. An increase of the maximum summer draught by 0.5 metres corresponds to an increase of approximately six per cent in the deadweight. The business case is even more attractive when there are a significant number of sister vessels in the same fleet and the same study may apply. The return of investment further improves when no structural modifications are necessary.

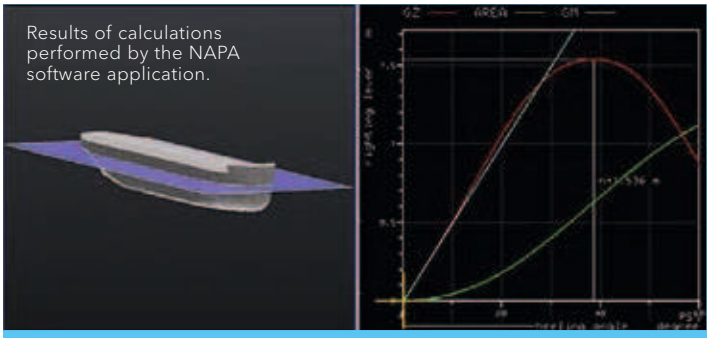
Assigning to a deeper draught is not considered a major conversion according to the unified interpretation of Annex I in the International Convention for the Prevention of Pollution from Ships (MARPOL).

However a multidisciplinary study is still needed which involves freeboard calculations according to the International Convention on Load Lines, a stability analysis according to MARPOL and the International Bulk Chemical Code (IBC), where applicable, as well as a structural evaluation. Port limitations and individual flag state requirements must also be taken into consideration.

More in detail, a draught increase feasibility study is initially carried out with respect to the load line, stability, strength and other relevant regulations to ensure safety and regulatory compliance. A satisfactory result will then be followed by preparation of the documentation required for approval. Finally the approval phase will follow to verify compliance with the statutory and class requirements and issuance of the relevant certificates. Over the last three years DNV GL has handled around 30 draught increase projects.

In one of these cases five medium-sized sister vessels of approximately 42,000 dwt capacity, operated by the same company, increased their maximum summer draught from 11.35 metres to 12.06 metres without any upgrading having to be done. This corresponds to 3,660 tonnes additional load capacity, which means additional earnings – with only a small investment cost for performing the study, preparing the drawings and running through the approval process, all taken care of by DNV GL.

Our goal is to help our customers to improve the efficiency and the earnings of their operations without any compromise on the safety standard, and indeed, evaluating the increased cargo capacity is one of them. **NV**



Results of calculations performed by the NAPA software application.

SOPHISTICATED TOOLS

In-house developed software is used for the freeboard calculations and the naval architect software package NAPA for the ship modelling and the stability calculations.

NAPA incorporates state-of-the-art hull surface and 3D model definition with advanced stability and strength tools.

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NEW KID ON THE BLOCK

DNV GL has welcomed the world's first methanol-fuelled ocean-going vessel into class. The companies involved in its development explain what makes this technology safe, cost-effective and sustainable.

Lindanger's naming ceremony at Hyundai Mipo Dockyard, South Korea.

The quest for low-emission ship propulsion concepts is driving the development of alternative solutions using a wider range of fuels. The latest entry into the fuel mix is methanol. The DNV GL-classed vessel *Lindanger*, launched at Hyundai Mipo Dockyard in South Korea, is the first of two 50,000 dwt, dual-fuel tankers worldwide. It brought together a whole consortium of companies eager to establish methanol as an alternative marine fuel.

"We are not only welcoming a new vessel but also a ground-breaking innovative technology to the shipping industry," said Rolf Westfal-Larsen, President and CEO of the Norwegian company Westfal-Larsen Management, which owns *Lindanger* and another methanol-fuelled tanker still on order. Both belong to a series of seven dual-fuel vessels which will be chartered to Waterfront Shipping. Waterfront is a wholly owned subsidiary of Methanex Corporation, the world's largest producer and supplier of methanol. Four of the vessels, including *Lindanger*, will be classed by DNV GL, and DNV GL has also carried out a hazard identification study on the remaining three ships. >

Photos: Hyundai Mipo Dockyard, Sjøfartsdirektoratet (Norwegian Maritime Authority)

Unlike other alternative fuels, methanol can be bunkered using conventional equipment with only minor modifications.

Lindanger during her final outfitting stages at the pier in Korea.

PROJECT SCOPE – SEVEN DUAL-FUEL VESSELS

Owners: Westfal-Larsen (2), Marinvest and Waterfront Shipping (2), Mitsui OSK Lines (MOL) (3).

Charterer/joint owner: Waterfront Shipping

Shipyards: Hyundai Mipo Dockyard (Korea) and Minaminippon Shipbuilding Co. (Japan).

Engine design: MAN Diesel & Turbo. The power plants were built by Hyundai-B&W.

DNV GL will class the four ships owned by Westfal-Larsen and Waterfront/Marinvest, and has carried out a hazard identification study on the remaining three MOL vessels.

> "This is the first time a dual-fuel engine with a low-flashpoint liquid (LFL) fuel system has been installed on an ocean-going vessel. It is a testament to the excellent cooperation between all the project partners that we have been able to complete this unique project and gain flag state approval," says Knut Ørbeck-Nilssen, CEO at DNV GL – Maritime.

Seamless fuel switch

The impetus to use methanol as a marine fuel came from Waterfront Shipping. "In 2012 we were looking to renew part of our fleet to meet growing market demand. So we invited Westfal Larsen, Mitsui OSK Lines and Marinvest to collaborate with us on taking the methanol dual-fuel concept to the next level," says Jone Hognestad, President at Waterfront Shipping. "It is exciting to be working with our partners to advance this new, clean technology. Investing in methanol-based marine fuel is an important step in the right direction and reinforces our commitment to sustainable proven technology that provides environmental benefits and meets emission regulations," he adds.

The engine required to operate the vessels with methanol as a ship fuel is based on the first-of-its kind MAN B&W ME-LGI two-stroke dual-fuel engine. The 6G50ME-9.3 ME-LGI dual-fuel, two-stroke engine enables *Lindanger* to run on methanol, heavy fuel oil (HFO), marine diesel oil (MDO) or marine gas oil (MGO). "We developed these two-stroke engines in response to interest from the shipping world to operate on alternatives to heavy fuel oil and meet increasingly stringent emission regulations. To hedge the risk of fuel price volatility, the vessels can switch between fuels seamlessly, and operate cost-effectively," states Ole Grøne, Senior Vice President, Head of Marketing and Sales, at MAN Diesel & Turbo. "When running on methanol the engines have the same or even a slightly better efficiency record compared to conventional heavy fuel-burning engines," he adds.

"Methanol will reduce sulphur emissions (SO_x) by about 95 per cent and nitrogen oxide emissions (NO_x) by about 30 per cent compared to conventional marine diesel oil, and therefore could become one of the popular alternative marine fuels in the future. We are so privileged to become the first shipyard in the world to deliver a methanol-fuelled vessel," adds Man Choon Kim, Vice President, Contract Management Department, Hyundai Mipo Dockyard.

Ensuring safe operation

The shipping industry has a long history of handling methanol safely. As is the case for all marine fuels, the risks associated with

> "We are not only welcoming a new vessel but also a groundbreaking innovative technology to the shipping industry."
>
> **Rolf Westfal-Larsen**, President and CEO Westfal-Larsen Management

Photos: Sjøfartsdirektoratet (Norwegian Maritime Authority), Methanex, Waterfront Shipping

Lowering the gigantic dual-fuel engine designed by MAN Diesel & Turbo into the hull is high-precision work.

LINDANGER MAIN PARTICULARS

Tanker for chemicals and oil products with LFL-fuelled engine

LOA	186 m
LBP	177 m
Breadth	32.2 m
Depth	19.1 m
Draught	12.85 m
Deadweight	49,999 dwt
Speed	15.8 knots
Main engine	Type: Hyundai-B&W 6G50ME-9.3 LGI (Tier II) Output : 10,320 kW @100 rpm

methanol include toxicity and flammability. The properties and toxicity of methanol are well understood, and safety features that minimize risk to the crew, such as double-walled piping, are technically simple to implement and support the safe use of methanol as a marine fuel.

DNV GL was one of the class societies that verified the engine concept: "The classes have played a very important role in supporting the development of these engines. They have been involved from the design stage, through HAZOP, testing and sea trials through to notation for using methanol as a marine fuel," says Hognestad from Waterfront Shipping. The DNV GL-classed vessels have been assigned the additional notation LFL FUELLED to demonstrate compliance with the DNV GL rules for low-flash-point liquid fuels (LFL). DNV GL was the first classification society to publish rules covering LFL marine fuels in July 2013, to ensure that the arrangement and installation of these systems have an equivalent integrity level in terms of safety and availability as a conventional system.

When the ME-LGI engine operates on methanol, it uses HFO, MDO, or MGO as a pilot fuel, significantly reducing CO_2, NO_X and SO_X emissions while eliminating methanol slip.

Clean, cost-effective and globally available

According to Methanex, by the end of 2016 there will be eight large vessels in commercial operation capable of running on methanol, and interest from the industry is growing. Methanol is produced from natural gas or renewable sources, such as biomass, recycled CO_2, or agricultural and timber waste. Its energy content is roughly half that of standard heavy fuel oil, but as it is a liquid, methanol can be handled using conventional bunkering and storage solutions without having to make extensive modifications. Sulphur-free and with lower particulate and nitrogen oxide emissions, methanol is also a promising option for vessels operating in emission control areas (ECAs) and for meeting both current and future regulations covering sulphur emissions.

As one of the top five chemical commodities shipped around the world, methanol is available globally through existing infrastructure. "This makes it a more feasible fuel option in remote areas, as the infrastructure required to make it available is far less costly than for comparable fuels," explains Ben Iosefa, Methanex Vice President, Global Market Development and Stakeholder Relations.

The cost to build new and convert existing vessels to run on methanol is significantly less than for other alternative fuels. "The technology significantly reduces emissions while giving shipowners a viable, efficient and convenient fuel alternative," says Waterfront's Jone Hognestad. "With this investment in sustainable marine technology, we have demonstrated and verified the potential for methanol to move the shipping industry forward." **KG/SA**

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COSSMOS – IMPROVING ENERGY EFFICIENCY

A DNV GL developed, state-of-the-art computer platform virtualizes integrated ship systems and their operation, opening up a wide range of simulation applications for both the planning stage of newbuilding projects and the monitoring and control of systems and operations.

Market volatility and environmental regulations drive maritime industry towards more cost-effective and environmentally friendly operations. This has a significant impact on ship machinery, which is often pushed to the design limit, imposing higher degrees of sophistication both in the configuration and in the operation of vessels. Advanced computer-aided methods today can successfully manage this increasing complexity of integrated marine systems.

DNV GL Research & Development Piraeus has developed COSSMOS, a state-of-the-art computer platform that enables the analysis and optimization of the design, operation and control of any ship machinery system at integrated-systems level. Standing for Complex Ship Systems Modelling & Simulation, COSSMOS has the ability to represent all governing phenomena of ship machinery and energy systems (thermodynamics, transport, mechanics, electrical) in a realistic manner. In essence, we use COSSMOS to build virtual engine rooms, digital twins of the vessel machinery either to be built or operated. The virtual engine room is then coupled with the entire operational profile of the ship together with cost data to perform advanced techno-economic analyses of practical use.

COSSMOS is thus an innovative technology that we use to assist shipowners at the pre-contract phase of newbuildings, for performance assessment and optimization of machinery and operations for fleets in service, and it is also DNV GL's main application in analysing the potential of new ship machinery/energy technologies and concept designs.

Simulating operational processes

For tankers, COSSMOS supports a variety of applications, from techno-economic evaluations and optimization of machinery, propulsion and waste heat recovery configurations to performance assessments, optimization of cargo operations and holistic energy management. In particular, a key part of tankers' operations is cargo handling. Cargo loading, cargo heating (when relevant cargo is shipped) and discharging are complex and often challenging operations. They involve complex machinery, operation from different officers at different locations on the vessel, and they are affected by the terminals, cargo specifications and environmental conditions. COSSMOS can assist in managing such complexity in an effective way. Figure 1, for instance, shows a typical COSSMOS model for cargo discharge systems, and Figure 2 shows a typical cargo heating model.

Discharging, more specifically, is a focus area for many operators. The COSSMOS module developed by DNV GL can simulate the discharge operations under actual/realistic conditions. The module can serve as a performance assessment baseline for evaluating the condition of various components and the effectiveness

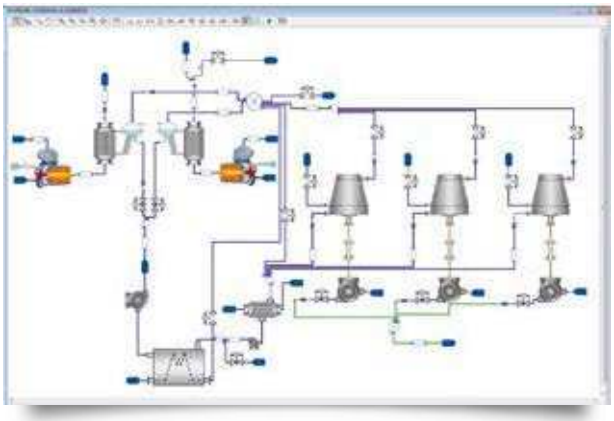

Figure 1. Typical COSSMOS model of a cargo discharge system.

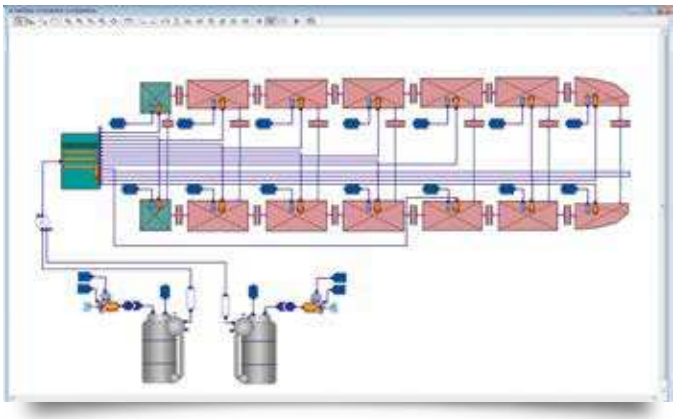

Figure 2. Typical COSSMOS cargo heating model.

Comprehensive modelling simulation and monitoring enable efficient discharging operations.

of applied operational strategies. It may also be used to optimize 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 (see Figure 1) is customized and calibrated based on each vessel's actual system in order to reflect its actual behaviour. On-board 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, COSSMOS can be used to provide sensitivity analyses of important operational variables and has shown to improve the operator's system knowledge and awareness. 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.

Real-life benefits

A series of projects have successfully demonstrated the practical benefits of COSSMOS for tankers. Key value-adding features include systematic assessment and understanding of equipment and crew performance during cargo discharging, improved efficiency and fuel savings (currently up to ten per cent), as well as better crew awareness.

With these benefits in mind, Minerva Marine Inc., an Athens-based owner and operator of a fleet of 56 crude oil and chemical product carriers (VLCC, Suezmax, Aframax, MR) signed up its entire fleet for the COSSMOS service for cargo discharge operations in April 2016. "Over the last two years we have been using COSSMOS to monitor and improve the energy efficiency of cargo operations of an Aframax and a Suezmax tanker," reports Meropi Mantzouranides, Energy Efficiency Engineer at Minerva. "After implementing COSSMOS successfully in collaboration with R&D Piraeus, we were able to thoroughly monitor the operation, fuel savings and crew awareness. To fully realize these benefits, we decided to proceed with a roll-out of the service across our entire fleet," Meropi Mantzouranides concludes.

Further tanker owners profiting from the COSSMOS service include Consolidated Marine Management, Eastern Mediterranean Shipping, Euronav, Mideast Ship Management, Samos Steamship, SK Shipping, Thenamaris Ships Management, Tsakos Columbia Shipmanagement, and Unicom. **NK**

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DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry – across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

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