DNV·GL

BULK CARRIER UPDATE

No. **01 2015**

SPECIAL ISSUE
SHIP DESIGN

Regulatory update

Operational challenges

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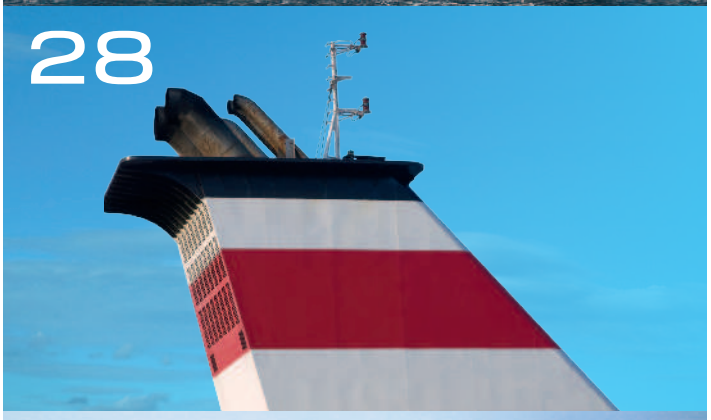

Front cover photo: © Oshima

EDITORIAL

Morten Løvstad
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Dear Reader,

This year has started with subdued expectations - the dry bulk market has been feeling the impact of China's economic slowdown in 1Q 2015; the Chinese economy grew by 7% y-o-y, which is the slowest growth rate since 2009. China's dry bulk imports have taken a dramatic dive and the trend looks set to continue. Together with the oversupply of ships across all sectors, earnings have been pushed to historically low levels. The market is cauterized by tough competition, constant pressure to enhance efficiency and many new regulations entering into force.

Despite the bleak market outlook, I have seen a lot of positive energy in the industry during my many travels around the world this year to meet with major ship owners, cargo owners, ship operators, yards and designers serving the dry bulk market. After being VP for a ship owner within the gas carrier segment for some years, I was given the opportunity to return to the position as Business Director for Bulk Carriers in DNV GL last autumn; a position I also held until 2009. I am excited to bring some of my experiences from working on the owners' side and with gas carriers into the fascinating dry bulk segment, and I am of course especially pleased to see the recent interest in LNG as fuel for Ultramax, Kamsarmax and ore carriers – will we see the first newbuilding order for a dual fuel bulk carrier placed in 2015?

In this issue of Bulk Carrier Update, I wanted to have a special focus on ship design, and we have interviewed some of the most experienced players in the bulk carrier design field over the past few years; design companies from Europe and China as well as one of the leading Japanese shipyards. In the interviews, they share their views on the current trends in bulk carrier design. Further, we have a separate section focusing on new rules and regulatory entering into force and how these will have an impact on bulk carrier designs and operations. The new emission limits will gradually transform the industry and the new Common Structural Rules (CSR) will further enhance the safety of bulk carrier designs.

As the leading classification society, DNV GL has more than 13,000 vessels in its "fleet", and more surveyors around the globe than any other class society. When it comes to operational experience, size matters, and we are in a unique position to collect, extract, analyse, benchmark and share operational experience across all ship types and within each ship segment. In the coming Bulk Carrier Updates, we will share some of this unique experience base; and we start off with one key topic in this edition: cargo liquefaction. Also read about the fascinating journey of the MV Nunavik, which in October 2014 became the first unescorted commercial vessel to sail through the Northwest Passage!

I hope you enjoy reading this magazine, which will be published twice a year (May/June and October/November) and accompanied by our Bulk Carrier Seminars around the globe – I look forward to seeing you at one of these seminars!

BULK CARRIER UPDATE

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SHIP DESIGN

SHIP DESIGN

Looking at bulk carrier deliveries from yards over the past few years and the present order books, it appears that some size groups are experiencing very strong growth, whereas others have modest or hardly any orders at all and are facing a decline in capacity.

Reasons for the new popularity of certain size groups are economy-of-scale advantages and a general tendency towards increases within size ranges, pressing sizes up towards the physical limitations of important ports and trade routes, as well as new, more efficient standard designs from shipyards.

Another trend is to use the Energy Efficiency Design Index (EEDI) score as a measure to optimize a design. Reducing the maximum installed main engine power and increasing the cargo capacity are measures to comply with the EEDI limits, but may not necessarily produce a more optimal vessel for the ship owner. The result may even conflict

CS MARINE

OSHIMA

OMT

with safe operations in heavy weather as it impacts the ship's manoeuvrability and speed reserve.

DNV GL has for many years co-operated with several design companies and yards to help verify their designs for optimal fuel performance as well as safety and operational flexibility. In this issue of Bulk Carrier Update, we have interviewed some of the most experienced bulk carrier design players over the past few years; design companies from Europe and China as well as one of the leading Japanese shipyards. In the interviews, they share their views on the current trends in bulk carrier design. In the next issue of Bulk Carrier Update, we will follow up with some recent DNV GL studies on the impact of economies of scale on bulk carrier designs, as well as the potential impact of the new Panama Canal on trading routes and patterns, and again how this may impact future bulk carrier designs.

FORESHIP BLUETEC

SDARI

DELTAMARIN

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SHIP DESIGN

CS MARINE

AIMING FOR DESIGN EXCELLENCE

Founded in 2000, CS Marine Technology Pte. Ltd (CS Marine) specializes in marine consulting, design and engineering services for the shipbuilding and offshore sectors. With more than 100 technical engineers located in the Shanghai Pudong New Area, CS Marine covers the complete field of design services - from the very beginning of concept definition to feasibility studies, basic and detailed design including class approval and production design.

SHIP DESIGN

In an interview with DNV GL Bulk Carrier Update, General Manager James Zhou talks about the company's history as a bulker designer, successful bulker types and bulk carrier trends.

Successful bulker types developed by CS Marine

CS Marine started to develop bulker types in 2006. First, it developed a Handy-size 21,000 dwt bulker and then, based on this, it developed a 76,000 dwt Panamax bulker. This was a modern, classic Panamax bulk carrier design, meeting the latest rules and regulations at that time. Compared to other bulk carrier designs of this size, the CS Marine design achieved a good balance between speed, power and load capacity. It was also one of the first of its kind in China to comply with the Common Structure Rules (CSR) for Bulker Carriers. Due to its good performance with low fuel consumption and increased load capacity while maintaining speed and power, 33 newbuilding orders were placed with Chinese shipyards for this design.

Mr Zhou attributes this success to the company's pursuit of excellence and to spending a lot of time and effort on continuous improvement in many ways, including using the CFD tool for hull optimization.

To meet the Chinese market's coastal-trade demands, the company has developed two types of coastal bulkers; a 51,000 dwt bulk carrier, the maximum size that can sail into the Yangtze River, and a 73,000 dwt bulk carrier, the maximum size that can sail into the Zhujiang River. These two specialized designs have received good recognition in the Chinese market.

Regarding the Panamax bulker design, CS Marine has spent a lot in the past two years to develop an 82,000 dwt Kamsarmax design. The company has optimized the hull form four-five times and adopted several energy-saving devices before finalizing this new design. The vessel's fuel oil consumption (SFOC) is only 27.3 mt/day at design draft and 14.3knots service speed, which according to Mr Zhou is the lowest SFOC ever for this type of vessel. Its EEDI can achieve stage II compliance. Compared to the same size of vessel from other designers, the steel weight has been reduced by more than 1,000 tonnes, the cargo hold capacity has been increased by about 800cbm and the deadweight tonnage has been increased by about 400 tonnes. The vessel complies with the latest rules and regulations, including ballast water treatment and noise level requirements (Resolution MSC 37). This modern 82,000 dwt design has already received about 60 new orders, with further options, from various owners all over the world, including Greece, the UK and South Korea. Most of these vessels are being built by Jiangsu New Yangzi Shipbuilding Co., Ltd and the first was delivered this month. The design of this vessel, which complies with the new harmonized CSR for BC&OT and SOx tier III requirements, has been approved by the class society as well.

Mr Zhou stresses the importance of good communication with key industry players, understanding the owner's demands and knowing the ship-type trend when developing a new design. As an example, he cites the 97,000 dwt bulker with self-unloading equipment which his company has tailor-made for the owner Oldendorff.

Bulk carrier trend

"There's a clear bulk-carrier trend that the size is becoming bigger and bigger," says Mr Zhou. "In addition, bulk carriers are increasingly becoming greener and more efficient due to stricter environmental regulations coming into force and the cost pressure on owners.

"All these factors are driving our designers to develop better ships to meet these challenging demands." Mr Zhou says his company has invested a lot in research and innovation to develop new bulker types. It has used different approaches in the new designs, including tank tests, energy-saving equipment evaluation, finite element calculation for structure optimization, etc. CS Marine is currently developing a 100,000 dwt bulker.

Commenting on the implementation of LNG as ship fuel in bulkers, Mr Zhou believes there is still a long way to go before bulkers use LNG as their main fuel. This is because bulkers are mainly used in the tramp trade, which makes it less likely that the necessary LNG-bunkering infrastructure will be in place. In conclusion, Mr Zhou states that dual fuel could, however, be an attractive option in some areas. ▮

CS MARINE 82K KAMSARMAX

Main dimensions:
Length overall: 229.00 m
Length between p.p.: 225.30 m
Breadth moulded at design: 32.26 m
Depth moulded: 20.00 m
Draught (design): 12.20 m
Draught (scantling): 14.45 m

Cargo capacity (at scantling draught)
82,050 MT

Fuel Consumption (at design draught of 12.20m and service speed of 14.45 knots incl. 15% SM)
28.44 MT/d

Class notation
DNV +1A1, Bulk Carrier, ESP, CSR, COAT-PSPC(B), BC-A Holds 2, 4 & 6 may be empty, GRAB[20], E0, BWM-T, BIS,TMON

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SHIP DESIGN

OSHIMA LNG-FUELLED KAMSARMAX BULK CARRIER

In collaboration with DNV GL, Oshima Shipbuilding Co., Ltd has developed a state-of-the-art LNG-fuelled Kamsarmax bulk carrier design. This provides innovative solutions to the current and upcoming sulphur emission regulations. It features a dual-fuel configuration and will comply with all known future rules and regulations, including the new emission control regulations and the IGF Code for fuel with a low flashpoint.

Future-proof design

Vessels sailing in designated emission control areas (ECAs) currently need to comply with the 0.1% sulphur limit, and after 2020 all vessels sailing in European waters must comply with the 0.5% sulphur limit. In addition, an IMO global sulphur limit will take effect from either 2020 or 2025 (still pending a final decision by IMO). All the above means that ship owners should investigate alternative compliance options for their vessels based on the operational profile, trade pattern and investment cost. The new, innovative design developed by Oshima and DNV GL can be ordered today and offers bulk carrier owners a reliable, safe, flexible and attractive option for a future-proof Kamsarmax vessel.

Operational flexibility

A DNV GL study in 2014 investigated the global bulk carrier trade routes for each vessel-size category and their exposure to the existing and upcoming environmental regulations. Based on this, the Panamax/Kamsarmax routes were selected as a pilot project and a techno-economic feasibility study for the use of LNG as a fuel was performed. As a starting point, the key trade routes connecting Europe with North America were investigated. An overview of the most popular trade routes between the US and Europe and within Europe is shown in the map below. The routes chosen are based on the number of shipments for the Panamax and Kamsarmax vessel categories. The Europe – North America route was selected due to:

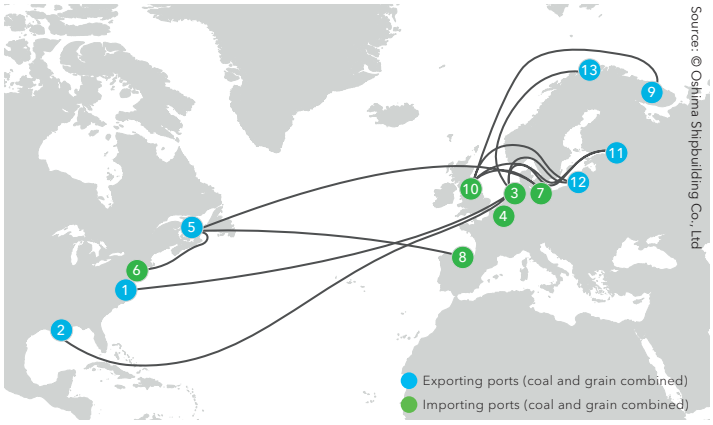
- the higher ECA and EU water exposure
- the fact that LNG costs less in the US than in Europe and may become price competitive to HFO in the future (gas prices have proven to be less volatile than those of crude oil)

The main findings of the study indicated that:

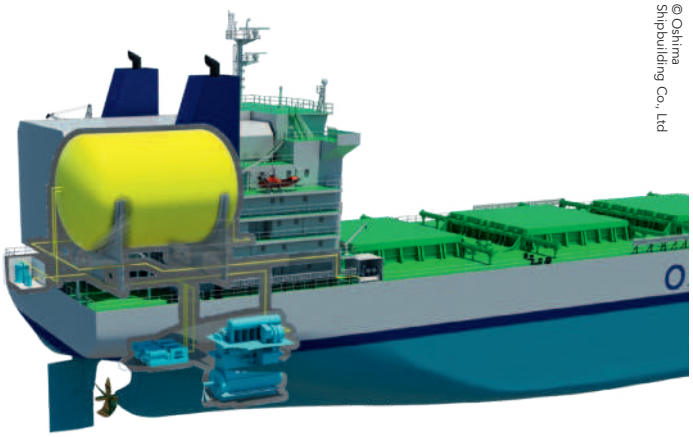
- 500-700 m^3 of LNG is sufficient to offer compliance for a roundtrip voyage with only one bunkering operation (ie, using LNG only in the emission control areas). A small LNG tank can be installed at the aft of the vessel.
- Approximately 2,000-2,500 m^3 of LNG is needed to perform a roundtrip between the US and Europe using only LNG. This option allows the operator to select the cheapest fuel supply source and hedge on the price of LNG compared to HFO and MGO.
- Approximately 3,000 m^3 of LNG is the maximum gross volume that can be accommodated on-board a Kamsarmax vessel without compromising the cargo capacity. This volume allows the vessel to trade using gas on all the identified Panamax/Kamsarmax trade routes.
- Significant daily fuel-cost savings can be achieved by using gas instead of fuel oil, based on the predicted future price differences between the various fuels. This can be translated into daily cost savings in favour of LNG.

DNV GL investigated the above alternatives with respect to operational flexibility and the potential payback times for the extra CAPEX that a dual-fuelled vessel will require compared to a 'traditional' Kamsarmax. The final recommendation was to develop

SHIP DESIGN



Global bulk carrier trade routes



Since the available space on deck is limited on a bulk carrier, major modifications were required to the superstructure in order to accommodate the LNG tank(s)

a design that could accommodate a minimum LNG fuel tank capacity of 2,000 m³. This alternative gave the best balance between the CAPEX, potential savings in future fuel costs and OPEX.

Vessel design

Oshima Shipbuilding and DNV GL had co-operated on several innovative bulk-carrier concept designs in the past and Oshima already had a Kamsarmax design which was highly optimized from a hull resistance and cargo capacity point of view, so the two parties decided to again join forces in order to develop a state-of-the-art LNG-fuelled Kamsarmax design. A Joint Development Project was initiated; with the objective to develop a commercially attractive and flexible design that:

- Can accommodate any LNG volume requirement up to about 2,500 m³ (in the case of an IMO type-C tank) and about 3,000 m³ (in the case of an IMO type-B tank).
- Can accommodate both LNG type-C and type-B tanks in the same dedicated deck space.
- Maintains the same cargo capacity as a conventional oil-fuelled bulk carrier.
- Is safe and complies with all current and known future rules and regulations, including the draft IGF Code.
- The design has received Class Approval-in-Principle for the IMO type-C tank installation and is developed to a detailing stage where a ship owner may place an order for such a vessel.

The new innovative design is a further development of the successful Oshima Panamax/Kamsarmax hull design. The most significant modifications have been made to the superstructure and engine room.

The vessel is designed with dual-fuel capabilities and will be able to use both LNG and HFO as the main fuel for the main engine, generators and boiler.

Since the available space on deck is limited on a bulk carrier, major modifications were required to the superstructure in order to accommodate the LNG tank(s). With the main priority of maintaining the existing vessel cargo capacity, Oshima Shipbuilding developed, through several iterations, the unique and innovative design shown in the figures below.

The unique U-shaped superstructure can be seen when looking at the ship from behind. The LNG tank(s) (either IMO type-C or B, depending on the required LNG volume) are located in the middle, protected by a steel cover forming a box which is part of the hull structure and provides additional safety in the case of dropped objects, gas leakage and/or fire. This arrangement allows the accommodation deckhouse to be completely separate from the LNG storage tank. The tank cover/room also adds an additional safety barrier and offers full compliance with the draft IGF Code. The bunkering stations for LNG, HFO and marine diesel oil are located at the side of the accommodation deckhouse.

In order to obtain Class Approval in Principle, the project has been supported by Mitsubishi Heavy Industries, Ltd. and the MHI-GEMS gas-handling system is used.

The vessel's main particulars are:

- Length over all (LOA): abt. 229.00m
- Length between perpendiculars (LPP): 224.50m
- Beam (B): 32.26m
- Depth (D): 20.01m

Main design benefits

The collaboration between DNV GL and Oshima Shipbuilding has resulted in a design which is flexible, safe and ready to be ordered. The main benefits can be summarized as follows:

The unique U-shaped superstructure can be seen when looking at the ship from behind

- The vessel is based on an existing, successful hull design, meaning that its fuel performance is already well documented.
- The vessel can be ordered as GAS FUELLED or GAS READY. With the DNV GL GAS READY notation, the vessel is prepared for a future retrofit of LNG equipment. This allows the owner to postpone a major part of the additional CAPEX, while still being able to install the LNG tank and gas fuel supply system at a later stage without incurring significant extra costs compared to installing these during vessel construction. Further, the innovative accommodation arrangement makes retrofit installation easier than for a conventional design and will provide a competitive advantage in the future.
- The design can accommodate any tank size and type without any further design modifications. The dedicated tank space is suitable for one IMO type-C tank that can hold up to 2,500 m^3 or one IMO type-B tank that can hold up to 3,000 m^3.
- The vessel's cargo capacity has not been affected, and with dual-fuel capabilities the vessel should be very attractive to charterers, especially for the trade routes where the price of LNG is competitive with that of HFO and substantially less than that of MGO. ∎

OSHIMA LNG FUELLED KAMSARMAX

Main particulars
Length overall: 229.0m
Breadth: 32.26m
Depth: 20.01m
Scantling draught: 14.44m
Deadweight at scantling draught: 80,000 MT
Cargo holds volume: abt. 97,000 m^3
Number of cargo holds: 7 cargo holds
Kind of cargo: Grain, Coal, Ore

Machinery
Main engine: MAN B&W 6S60ME-C8.5-GI

Speed
Service speed at design draught
and NOR (85% of MCR) with 15% sea-margin 14.3kt

Class notation
DNV GL, +1A BULKCARRIER ESP BC-A GRAB[30] CSR, Holds 2, 4 and 6 may be empty, E0, BIS, TMON, BWM-T, COAT-PSPC(B) GAS FUELLED (or GAS READY)

Design Features
DUAL FUEL SYSTEM of LNG and HFO

Dual fuel system of LNG and HFO to be applied for main engine, auxiliary engines and boiler.

SEAWORTHY BOW for energy saving in gale weather condition.

Speed loss in rough sea condition is lower than ordinary bow

ADVANCED FLIPPER FINs for energy saving and power saving. Advanced flipper fins are the most economical and effective energy saving device, composed of pre-swirl stator fitted forward of the propeller, Bilge fin fitted near aft bilge part and aft-end fin fitted on the stern end under the propeller shaft.

RUDDER BULB for improving propulsion efficiency
Rudder bulb to be provided on rudder body for improving propulsion efficiency

HIGHER EFFICIENCY PROPELLER
Higher efficiency larger diameter propeller to be applied.

More information on the DNV GL GAS READY notation can be found at https://www.dnvgl.com/maritime/lng/services.html

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SHIP DESIGN

OMT

HANDYSIZE WITH A BLOCK COEFFICIENT OF 0.82

There are different schools of thought when it comes to creating the optimum bulk carrier design to satisfy owners' needs when it comes to cargo capacity versus fuel efficiency, safe operation in heavy weather and meeting the EEDI requirements. A one-sided focus on the charter description and EEDI leads to rather bulky ships with higher block coefficients, whereas a more balanced focus that also takes into consideration safe and efficient operations in heavy weather leads to slimmer hull forms with lower block coefficients.

SHIP DESIGN

© Odense Maritime Technology

"I've been travelling the world for more than 15 years preaching a block coefficient of not more than 0.82 for Handysize bulk carriers," says Michael H. Schmidt, General Manager at Odense Maritime Technology (OMT) in Denmark.

Odense Maritime Technology can trace its history back to the proud Danish bulk carriers based on the Diamond design, which was developed jointly by Danish ship designer Carl Bro, Graig Shipping as the ship owner and DNV as the ship classification society. "The Diamond ships were built in India, Vietnam and China," says Schmidt, "and from the DNV side Andy Westwood was key to the development and success of the DIAMOND Consortium bulk carriers." Westwood is an Australian national who held several key positions in legacy DNV, including in China, but has now retired. The DIAMOND Consortium was involved in more than 80 DIAMOND 53 newbuildings and 5 DIAMOND 34. OMT began in the design office at Lindø Shipyard in Odense, Denmark, where Maersk built the world's then-largest container ships, the Emma Maersk series. OMT later bought Grontmij Marine, formerly known as Carl Bro, and this is how the Seahorse design came into its possession. The first Seahorse-design ship was ordered in 2008 by Danish ship owner Falcon Maritime, and today the order book stands at some 60 ships – 35 of these are classed by DNV GL. Owners include Falcon Maritime in Denmark, Hanzevast Shipping in the Netherlands, Bertling Reederei in Germany, Essberger in Germany, Cobelfret in Belgium, Nordic Hamburg in Germany, Aug. Bolten in Germany and Pola Maritime in Belgium.

In addition to trying to achieve a positive bottom line, the issues facing bulk carrier owners include EEDI and ECA requirements as well as other regulations, such as those issued by IMO – can you explain why the Seahorse vessels are so well suited to handle these challenges?

There's not one single answer to this", says Schmidt. "A good ship design must perform well in all operational conditions as well as complying with the Energy Efficiency Design Index (EEDI) regulations.

The EEDI was proposed in 2011 by IMO and addresses efficiency requirements for new ships. It entered into force in 2013 together with the Ship Energy Efficiency and Management Plan (SEEMP), which applies to existing ships. The EEDI score is based on a complex formula which basically measures the environmental impact (CO_2 emission) divided by the transport benefit (tonnes of cargo transported from A to B). The EEDI regulations specify an EEDI baseline and enforce the maximum allowable EEDI score related to the baseline, so in order to comply with the EEDI regulations a ship designer should develop a design with the lowest possible EEDI score.

The EEDI score can be optimized (reduced) by reducing the maximum installed main engine power and increasing the cargo capacity by increasing the vessel's block coefficient. The dilemma for the ship designer here is that the EEDI regulation is based on calm-water performance and does not take into consideration the main engine power required for safe operation in heavy weather, preventing speed loss in heavy weather, manoeuvrability, ensuring the ability to accelerate the vessel, etc, so that it is up to the ship designer to develop designs with the right balance between safe and efficient operations and compliance with the EEDI regulations.

Over the past 10 years, fuel efficiency has been the main focus for charterers, owners and designers and we have seen service speeds and the corresponding main engine power being reduced and capacities being increased by higher block coefficients to improve transport efficiency.

The way the yards and designers describe and test (tank-tests and sea trials) bulk carrier newbuildings today does not at all take account of heavy-weather performance and acceleration and, similarly, charter parties only guarantee performance up to Beaufort 4/ Sea State 2. In my opinion, this situation has led to low-powered and full-bodied (high block coefficient) bulk carrier designs with most likely poor performance in bad weather and difficult manoeuvring conditions. Ultimately, the lack of main engine power and loss of speed could pose a safety threat.

IMO has recognized the heavy-weather safety problem and is currently working on a minimum main engine power requirement.

For slow, low-powered ships like tankers and bulk carriers, the minimum installed main engine power is very important to ensure safe operation under all conditions.

Up to now, I have seen regulation proposals where the minimum main engine power requirement is related to the vessel's cargo capacity (DWT). As a ship's heavy-weather performance is very closely related to the slenderness of the hull form, I suggest considering the DWT and block coefficient when determining a ship's minimum required propulsion power.

So far, we at OMT have decided not to go beyond a block coefficient of 0.82 for our Handysize bulk carrier design in order to ensure safe operation in all weather conditions."

How can the EEDI performance be improved?

"There are four ways of doing this: firstly by reducing the installed main engine power leading to a lower maximum speed and smaller engine and sea margins. This solution requires care and due consideration to be paid to heavy-weather performance. The second way is to maintain speed with a reduced main engine power. This can be done by adopting Energy Saving Devices (ESDs) such as high-efficiency propellers, ducts, pre-swivel fins, rudder bulbs, low-friction paint, air lubrication, etc. These options should be explored in so far as possible and the ESDs should be evaluated in detail for the specific hull form and operational profile. The third way is to reduce the main engine's and auxiliary engines' specific fuel oil consumption. This can be done by using the newest and most efficient engines on the market. Fourthly, the cargo capacity can be increased by lowering the ship's lightship weight. This can be achieved by specifying lightweight equipment and machinery, increasing the high-tensile steel content of the steel structure and ensuring good building tolerances."

Where do you think that the future lies when it comes to further improving ship performance?

"For full-bodied slow vessels like bulk carriers and tankers, I believe the biggest performance improvements can be achieved in the hull, propeller and rudder interaction and by reducing the frictional resistance.

For our bulk carrier designs, we always carefully analyse the aft hull form, propeller, ESDs and rudder together in order to achieve the best possible performance. Our studies have shown good results for pre-swivel fins combined with a high-efficiency propeller design. Our strategy partner Mitsubishi Heavy Industry has developed MHI Reaction Fins (R), which have performed very well."

Back to the block coefficient – why is your figure of 0.82 so important?

Schmidt draws a rectangular box which has a BOC of 1.00. "If your ship is a rectangular box with no bow or stern, its shape will not be very good when it comes to environmental performance. Just try to send a rectangular box through water. On the other hand, a rectangular box will hold a lot of cargo. This is typically where you find the different schools of thought when it comes to ship design, with many designers working to get as close to a rectangular box as possible, with a full-bodied form and a wide bow that will have to displace a lot of water to move the ship forwards. A more 'boxy' ship will hold more cargo, but take more time to transport it. To me, we have to find the optimum equation between cargo-lifting capacity and EEDI performance and this is why we focus on what we believe is the optimum design taking everything into consideration – a Handysize bulk carrier with a BOC of 0.82," concludes Schmidt. ∎

SEAHORSE 35

Main dimensions
Length overall: 180.00 m
Length between p.p.: 176.75 m
Breadth moulded at design: 30.00 m
Depth moulded to upper deck at side: 14.70 m
Draught (scantling): 10.10 m

Cargo capacity (at scantling draught 10.10 m)
35,000 MT

Fuel Consumption at Sea (at scantling draught of 10.10m and service speed of 14.0 knots incl. 15% SM):
24.0 MT/day HFO, all incl. A/E

Class notation
DNV +1A1 Bulk Carrier ES(D), CSR, BC-A (Holds 2 and 4 maybe empty), GRAB(20), ESP, E0, DK(+), HA(+), DG-B, TMON, BIS, FUEL (700cSt, 991kg/m^3, -15deg), BWM-E(s,f)

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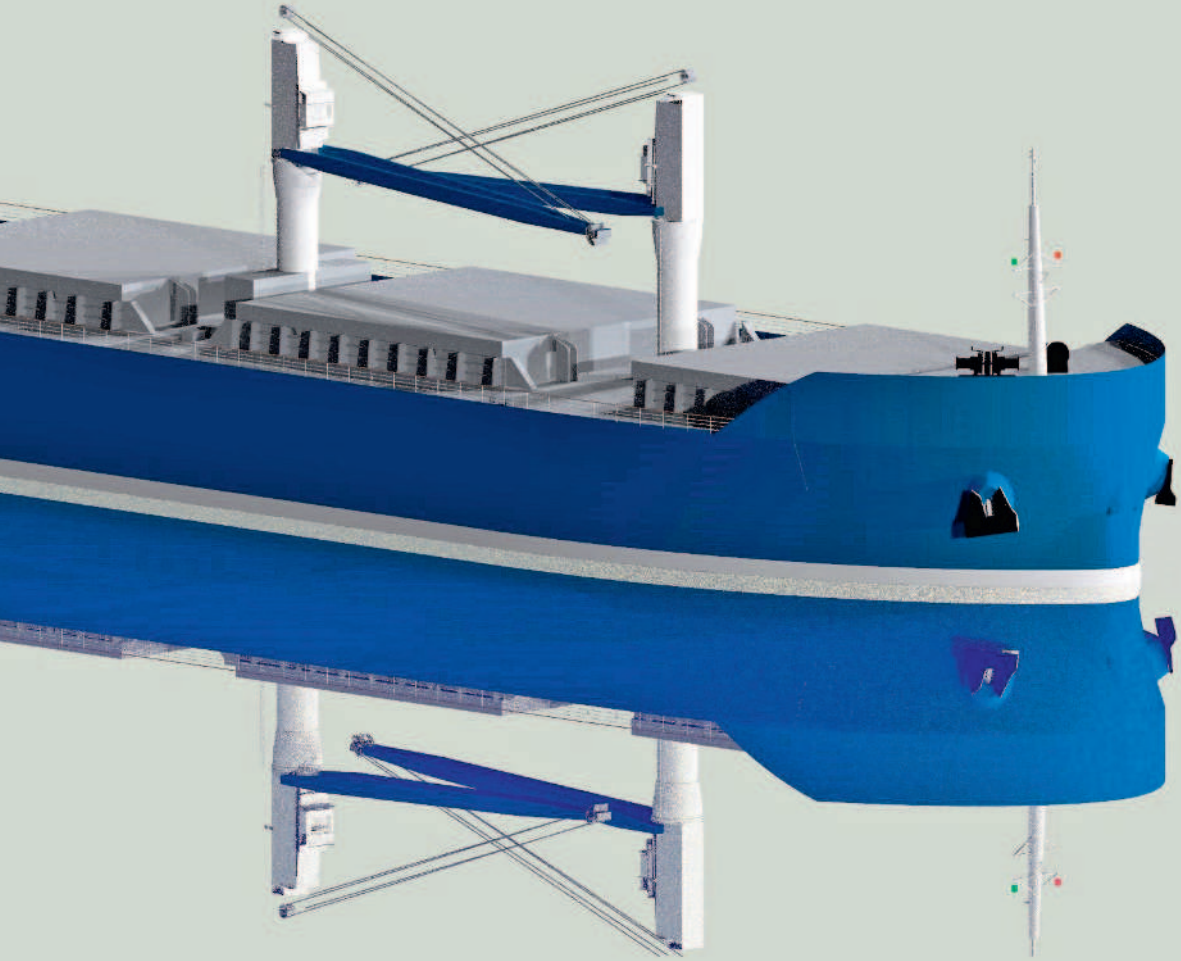
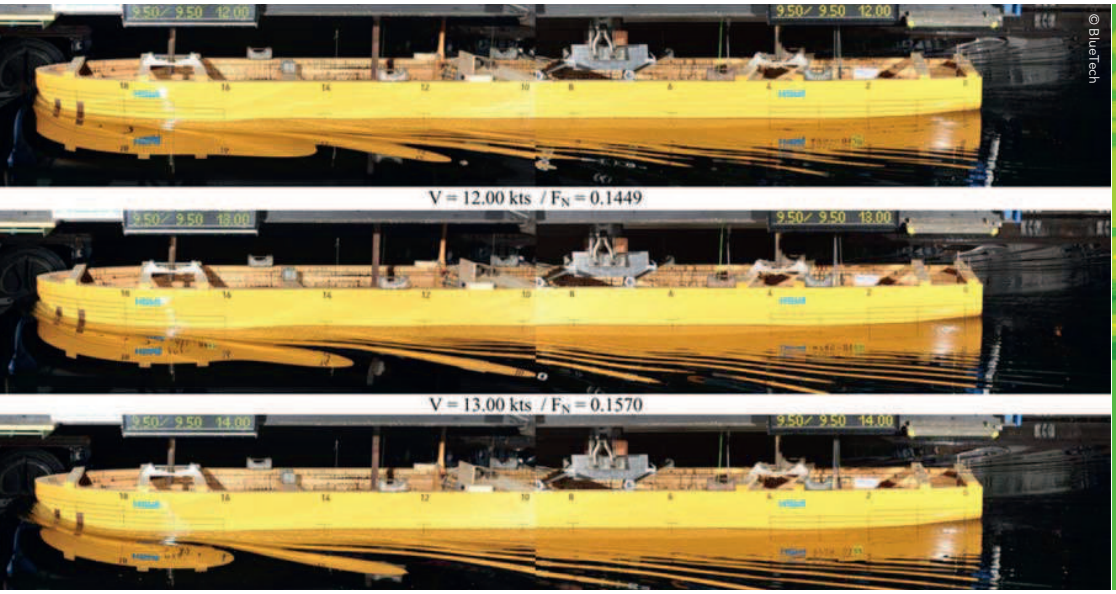
SHIP DESIGN

FORESHIP BLUETECH

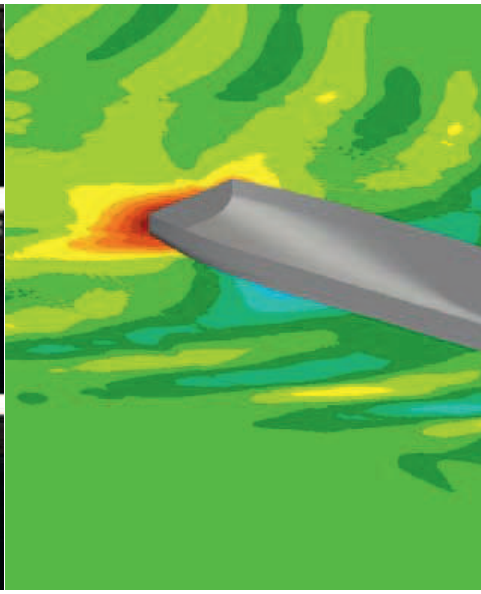
HANDYSIZE DESIGN THAT HAS A FOCUS ON BIG



SHIP DESIGN



Model test



Computational fluid dynamics

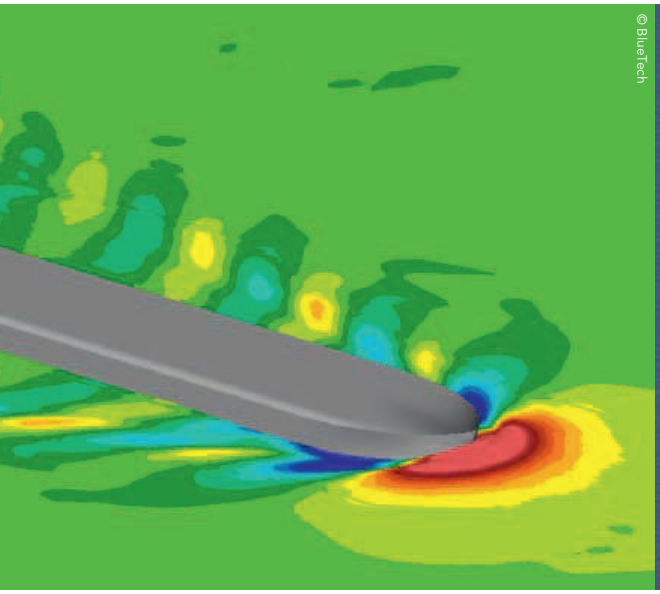
"Our ship design means a hull that is optimized to carry as much cargo as possible and that makes it rather bulky," says Petri Haukulinen, Managing Director of Foreship BlueTech in Helsinki. "The design is that of a slightly oversized 180-metre-long, 31-metre-wide Handysize bulk carrier. Four ships have been ordered to this design, with an option of an additional two. The 42.3 dwt ships will be owned by Bulgarian owner Navibulgar and are now being built in China, with the first ship due to be delivered in the autumn of 2016."

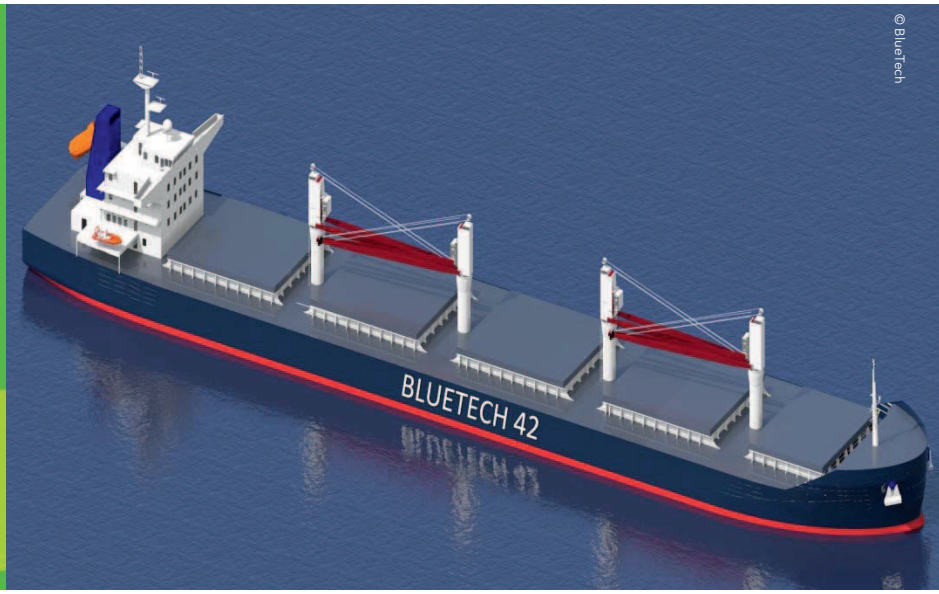
What sets your design apart from others?

Haukulinen starts a short video showing tank tests of one of the company's models. "Look, no wake from the stern of the ship." The test actually shows no wake. "We've worked hard on the aft ship design as this is where there is a large potential for saving fuel. But we have also worked hard on finding the optimum solution for our customers. Like the fact that our cargo hold has a capacity of 58,000 cubic metres, compared to the 50.5 and 46.0 cubic metres of other current designs of similar-sized ships. This makes our ships very EEDI compatible, with a good energy use to transport benefit ratio. For ship owners, that's a good argument for buying our design. We've created a very full hull design, with a high block coefficient (BOC), actually higher than ever seen. The trick is to achieve a high BOC while also making the ships as EEDI compatible as possible, and we've accomplished this."

You mentioned the aft ship – what else have you done to achieve a good design?

"The ship has three fins at the aft in addition to a slim design and efficient rudder solution. The rudder is also oversized which gives excellent course stability. There are basically four design elements we have worked hard on; the rudder as mentioned, then there are our in-house designed pre-swirl fins on the hull, the high cargo volume and finally the engine. We work closely with MAN and the engines installed will be their G-type engines featuring a longer stroke and reduced RPMs. Add to this the 6.4-metre propeller. The propeller has been put as far aft on the ship as possible and there are no vibrations on the hull from our design. Finally, we have also created a bulky but efficient bow design."





The installed power must be a challenge in such a bulky design?

"There is the issue of crew and vessel safety. If underpowered, the lack of power to comply with EEDI requirements may of course be an issue. Due to the bigger dwt and cargo hold and bulky ship in general terms, the installed power in these ships will be 7,500kW and this gives a speed of 14 knots at 6,650kW. There is enough safety built in with this power output, even in adverse sea conditions. At this speed, the fuel consumption is 18.4 knots a day. The range is some 30,000 nautical miles, which also gives the owner good flexibility in terms of where to bunker at the best available price. Owners want a large fuel-oil storing capacity on board."

Where will bulk carrier ship designs go in the future, in your view, based on the ECA, EEDI and other requirements that have entered into force or will do so in the future?

"Dual fuel solutions will come. By this I mean using distillate fuels as well as LNG. Engine manufacturers like Wärtsilä are working on new and innovative solutions. We have the challenge of where to find space for LNG tanks on board. In the short-term horizon, scrubbers may be a preferred solution and we have a 'scrubber-ready' design if a ship should need a retrofit. There are also other areas where performance can be improved, like friction and the introduction of air bubbles under the water line to create an air cushion to reduce the friction. But for bulk carriers, I have concluded that this may be a bit too expensive to install and run from a cost-benefit point of view." ▮

BLUETECH 42

Main particulars:
Length overall: 185.00 m
Length between p.p.: 181.70 m
Breadth: 31.00 m
Depth at side (at CL): 15.90m (16.30m)
Draught (scantling): 10.50 m
Draught (design): 9.50 m

Cargo capacity (at scantling draught 10.50 m)
42,600 MT

Fuel Consumption (at scantling draught of 10.50m and service speed of 14.0 knots incl. 15% SM)
19.7 MT/d HFO

Class notation
DNV +1A1, E0, BULK CARRIER CSR, BC-A (holds 2 and 4 may be empty), ESP, TMON, BIS, GRAB (25), BWM-T, COAT-PSPC(B)

Text: Cathy Zhang
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SHIP DESIGN

SDARI

CHINESE DESIGN POWERHOUSE

Established in 1964, the Shanghai Merchant Ship Design and Research Institute (SDARI) is today a leading Chinese ship design house under the CSSC group. It has a full suite of bulk carrier designs, with its Green Dolphin series being the most successful over the past few years. Recent developments include a new-generation 400,000 dwt VLOC for Brazilian mining company Vale.

The new-generation 400,000 dwt very large ore carrier (VLOC) is the most advanced and biggest bulk carrier developed to date. Compared with the last generation of VLOCs, this ship is more environment-friendly - its fuel consumption has decreased by 18.8% and it meets existing and future EEDI requirements. The loading flexibility is significantly improved and the vessel is designed for extra safety as a "specially constructed cargo ship" which can transport cargo that has a high moisture content and may experience partial or full liquefaction. The new design also includes the "LNG Ready" concept and "GAS READY" notation from DNV GL, which means the ship can be easily converted to LNG-fuelled installation at a later stage. This design is tailor-made for the Brazilian mining company Vale and its Chinese partners to ship iron ore from Brazil to China.

History

In the early 1980s, the main type of bulker designed by SDARI was a 35,000 dwt coastal bulk carrier for transporting coal from the north to the south of China. In the late 1990s, China's shipbuilding industry started to develop fast and SDARI began to design bulkers to be built for export, such as a 48,000 dwt vessel. Over the past 10 years, SDARI has developed a comprehensive ability to design all types of bulkers, such as Handy, Handymax, Panamax, Kamsarmax, post-Panamax, Minicape, Cape, Newcastlemax and VLOCs.

According to Mr Wang Gangyi, SDARI's Deputy Chief Engineer, to date more than 1,000 bulkers have been delivered to the shipping industry based on a SDARI design. In 2008, SDARI started to once again optimize the already optimized bulker types. Its 38,000 dwt, 64,000 dwt and 82,000 dwt bulkers were especially subject to further optimization. These new, optimized bulker designs, with lower fuel oil consumption than any previous design in these sizes, are now the market leaders and have won more than 400 orders already. The optimized 64,000 dwt bulker received 300 orders alone, due to its good design features and operational flexibility.

Mr Wang says that the bulk carrier is one of the main ship types that the institute focuses on and it generates 60-70% of the design house's revenue. "80% of our designed bulkers are built for export," he says.

"Our design is characterized by relatively low fuel consumption,

Mr Wang Gangyi, Deputy Chief Engineer, SDARI

good control of the lightweight and low construction costs. In addition, we know the Chinese shipyards' construction procedures very well and have a very cooperative relationship with them. So our design is very competitive in the market," says Mr Wang, citing the 57,000 dwt bulker design as an example. This design received 450 orders and so far 420 vessels have been delivered.

Bulk development trend

As Mr Wang points out, bulkers are continuously growing in size. He explains that the Handymax was increased from 48,000 dwt to 58,000 dwt, and then the Supermax grew in size to 64,000 dwt. In the same way, the traditional Capesize developed from 160,000 dwt to 180,000 dwt and further into the Newcastlemax of 206-210,000 dwt.

Another trend is the demand for more energy-efficient and environment-friendly ships to meet cost controls and increasingly strict environmental regulations. To reduce fuel consumption, the institute has introduced integrated methods such as hull optimization, better control of the weight of the vessel and a better layout for maximizing the loading and installing energy-efficiency equipment.

As for LNG fuel, Mr Wang indicates that the current lack of worldwide infrastructure limits the use of LNG as fuel for bulkers, since bulkers often do not operate on fixed routes. For bulker owners and operators, economy is key and LNG is currently not the only way to meet the emission regulatory requirements. He does not predict any large-scale use of LNG as fuel in bulkers in the near future. But he says that, if the owners want this, it is not a problem to design a ship to use LNG as fuel. He cites the example of the institute's latest design of a 400,000 dwt very large ore carrier, which is LNG-ready.

JDP project–Green Dolphin series

DNV GL and SDARI have been cooperating on two Joint Development Projects (JDP). One is the Green Dolphin 38, a concept design developed by SDARI and DNV GL together. About 100 orders including options have so far been placed for the Green Dolphin 38 at Chinese shipyards. The first Green Dolphin 38 vessel built to DNV GL class has just finished sea trial and took delivery mid May. It demonstrated a good performance that met all the design specifications. Based on the Green Dolphin 38, SDARI and DNV GL also cooperated on developing the Green Dolphin 575, a 190m-long Common Structural Rules-compliant Handymax bulk carrier with five cargo holds.

Mr Wang appreciates SDARI's good cooperation with DNV GL and hopes the two parties will further enhance their relationship for the benefit of the maritime industry. ▮

GREEN DOLPHIN 38

Main particulars
Length overall: 180.00 m
Length between p.p.: 177.00 m
Breadth: 32.00 m
Depth: 15.00m
Draught (scantling): 10.50 m
Draught (design): 9.50 m

Cargo capacity (at design draught 9.50 m)
33,400 MT

Fuel Consumption (at design draught of 9.50m and service speed of 14.0 knots incl. 15% SM)
17.7 MT/d HFO

Class notation
DNV +1A1 Bulk Carrier ESP, CSR, BC-A (CH 2&4 empty), GRAB(20), DG-B, BIS, TMON, BWM-T, CLEAN,E0, COAT-PSPC(B,D), Recyclable

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SHIP DESIGN

DELTAMARIN

THE SUCCESSFUL B.DELTA SERIES

More than 120 contracts have been closed on Deltamarin's successful B.Delta design since 2010. "The whole design concept is based on optimizing hydrodynamic performance," says Konstantinos Fakiolas, Sales Director, Ship Design at Deltamarin. "We started developing this design back in 2005/06, but our work 'took off' after the financial crisis in 2008. Before that, energy efficiency was not really a hot topic – fuel costs were rather low and bulk carriers were in high demand. But the scene changed more or less overnight and we started our programme to design the bulk carrier of the future."

B.DELTA37 Mark II

Main dimensions
Length overall: 179.99 m
Length between p.p.: 176.65 m
Breadth moulded at design: 30.00 m
Depth moulded: 15.00 m
Draught (design): 9.50 m
Draught (scantling): 10.50 m

Cargo capacity (at design draught 9.50 m)
34,500 MT

Fuel Consumption (at design draught of 9.50m and service speed of 14.0 knots incl. 15% SM)
17.2 MT/d MDO

Class notation
DNV +1A1 Bulk Carrier ESP CSR BC-A Hold nos. 2 and 4 may be empty GRAB[25] E0 BIS TMON BWM-T

Deltamarin is located in Turku, Finland. The company is a powerhouse of designs and maritime solutions for any type of ship. "We're involved in anything that floats," says Mika Laurilehto, Managing Director. Working with the entire maritime industry and with customers from basically all corners of the world, Deltamarin has developed expertise in all ship types. "Our customers demand future-oriented solutions to ensure that the new ships they order will be the ships of the future in terms of operational efficiency when they are delivered. Equally important, they must be in compliance with or exceed future regulations, like those for ECAs and the EEDI," says Jarmo Valtonen, Director, Ship Design.

"The future will have a strong focus on energy efficiency," continues Fakiolas. "We've designed the B.Delta to be efficient in all operational aspects. The ships range from capacities of 28,000 dwt (B.Delta 25) to 210,000 dwt (B.Delta210), while tailor-fit derivatives are possible. They represent the best in bulk carrier fuel efficiency and we call them the first true eco designs. The ships combine low fuel consumption in all operational drafts with high deadweight,

Fakiolas Konstantinos with B.Delta bulk carrier

while their compact designs allow flexible cargo configurations. These features, plus the wide beam - shallow draft concept, make this an efficient design ordered by many owners.

"Our most popular design is the Handysize version, the 40,700 dwt capacity B.Delta37, which can also be extended by just 10 m to become a 43,500 dwt B.Delta43 design with only 0.2 t/day added fuel consumption. From our market research, we concluded there would be a need to replace old Handysize tonnage and here the EEDI also played a central role in terms of meeting future regulations. Right now, there are some 90 Handysize ships on order, all to be built in China. Then we expanded the design to respond to a demand for modern Ultramax ships, Kamsarmaxes, as well as Capes up to 210,000 dwt. Indeed, the design philosophy and techniques have been so successful that we now also design oil and chemical tankers based on similar hull geometry and optimization principles, while we've applied the lessons learned to the development of container feeder ships too," says Fakiolas.

"Diving a bit into the technology used, state-of-the-art, advanced Computational Fluid Dynamics (CFD) analysis, tools and techniques have been used to achieve the optimum water flow around the submerged body of the ship. We've used CFD analysis in Deltamarin since the 1990s, so we had a team of very experienced hydrodynamic specialists that could utilise their knowledge of bulk carrier and cargo ship designs. The improvement in CFD tools during recent years, combined with our expertise, has helped us to become one of the first designers worldwide to efficiently implement these techniques. Actually, optimizing the hull is a never-ending story. It takes considerable time and resources to develop optimal hull designs and accurately interpret the results of the CFD analysis. However, based on our experience and competence, we always get the results we're looking for," explains Fakiolas.

"In addition to energy optimization, the future also holds LNG," he continues. "LNG will be the fuel of the future, especially for ships operating in the US and the Baltic and North Seas. This again creates a need for LNG bunkering terminals world-wide. I think the industry will move in the direction of LNG and we already have experience of this propulsion solution in, for instance, Fjord Lines' Stavanger Fjord passenger car ferry. So my guess is that you will see LNG used for propulsion not only in small Handysize bulk carriers of up to 40,000 dwt but also in larger Capes. To make the LNG solution attractive, it is essential that the LNG tanks don't take up a lot of cargo space. The other aspect is to ensure the safety of the crew, cargo and ship. After all, safety is the key factor. We are therefore looking at locating LNG tanks in such ways as to maintain operational and trade advantages, but without compromising safety or ship sustainability.

"Other trends in bulk carrier design include space for more cargo and a shallower draft. Another shift in the market is towards the so-called 210,000 dwt Newcastle-size ship, which is specially designed to be the maximum size possible for entering Newcastle, a mostly coal, but also iron-ore, loading port in Australia. Another question will be the new Panama Canal, where 'everybody' is looking for answers. The new Canal allows for a wider 'post-Panamax' beam of 36-40 metres, while the max beam is 49 metres, and this means typically post-Panamax-sized bulk carriers of 82,000 – 120,000 tons, which might benefit the most from the wider canal. New trends will also include wide-beam Handys getting longer - towards 180 to 190 metres, and I also believe in the small Handys for Baltic and intra-Asia short-haul trades, using LNG as fuel.

"Turning towards eco solutions – these will continue to be the main focus. New bulk carriers of today are up to 30% more fuel efficient than those built in 2010. They can probably be made even 10-15% more fuel efficient in the future but this may require thinking outside the box, introducing not only more innovative CFD optimization techniques, but also new technologies, such as wind rotors and air-lubrication systems," concludes Fakiolas. ▮

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SHIP DESIGN

NEWBUILDING SPECIFICATION REVIEW

Regulatory and third-party requirements are constantly developing, resulting in the emergence of the term «future proofing» of bulk carrier newbuildings. This implies that, for a bulk carrier owner, it is essential that the newbuilding specifications cover regulatory and third-party requirements that enter into force in the course of the building period and in the foreseeable future after delivery. DNV GL can assist owners with the above through reviews of technical specifications, as part of our free of charge pre-contract service.

Håvard Helling, Bulk Carrier Ship Type Expert

It is also useful for the owner to be informed of technical issues that have been found to cause difficulties in the newbuilding process or have resulted in operational limitations on previous projects. Lastly, it is useful for an owner to be informed of experiences related to, for example, the choice of technical solutions or materials which have proven to cause problems or limitations in operation, as well as possible solutions.

DNV GL can assist owners with the above through reviews of technical specifications. These can either be a review of the owner's outline specifications or a review of the shipyard's or designer's outline specifications or detailed technical specifications. Such reviews do include a check of compliance with rules and requirements, but emphasis is put on guidance to make the specification clearer and to improve the ship. A typical specification review report includes:

- Class & statutory requirements in force and relevant regional requirements (EU & USCG)
- Future known requirements

- Recommended class notations
- Evaluation of design and general arrangement
- Evaluation of technical specifications, capacities, choice of equipment, etc. based on experience from previous newbuilding project execution and in-service experience.
- New technology such as alternative fuels
- Equivalent levels of safety for novel designs.

A typical issue that has been addressed in recent reviews is the implementation of the IACS Common Structural Rules for Bulk Carriers and Oil Tankers, which enter into force for new ships constructed after 1 July 2015. Other hot topics have been related to air-emission legislation for SOx and NOx and associated technologies, as well as the future ballast water treatment requirements, where the choice of technology and location and USCG compliance issues are important.

In terms of new technology, alternative fuels are of course an important issue. DNV GL has significant experience with gas-fuelled installations and can assist owners in assessing the feasibility of the proposed solutions and highlight potential challenges that need to be addressed in the specifications. ▮

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REGULATORY UPDATE

EMISSION LIMITS: TIME TO ACT

The challenges for the shipping industry are not getting any easier. New emission limits, while not coming unexpectedly, require substantial investments in technology; and time is running out.

The shipping industry has been going through turbulent times. For a sector accustomed to planning decades ahead, the sequence of unexpected major events, from the financial crisis to depressed freight and charter rates, and from dropping fossil fuel prices to new international tensions, has certainly added plenty of headache to investment decisions. Many shipowners delayed investing in new anti-pollution technology hoping for a clearer field of vision, while others took action early to gain competitive advantage. With new sulphur limits now in force for European Emission Control Areas (ECAs), and the North American and US Caribbean Sea ECAs also regulating NOx and PM, those who chose to wait must act now. Further regulations will take effect soon, and additional regional and national regimes are emerging around the globe (refer to info box). Investing now will save shipowners money and protect their reputation. However, the substantial capital requirement, a lack of mature technology and uncertainty regarding compliance documentation add to the complexity of this decision.

The IMO's new ECA regulations, in effect for Northern Europe and North America since 1 January 2015, were announced as far back as 2008. As the year advances, the majority of shipowners will without doubt take the required steps since full compliance has to be substantiated now. Shipowners and operators hammering out their ECA strategies have to find answers to a number of difficult

The international shipping community is committed to cleaner air and a greener public image.

Lower noxious emissions will benefit both the environment and human health.

questions, and DNV GL is ready to help them devise the right compliance and technology strategy.

More than 40% of the ships trading in the Baltic Sea are general cargo vessels which typically do not cross larger oceans; they either sail within the Baltic Sea only, or within Northern European waters. Bulk carriers also operate frequently in the Baltic Sea. The age of these ships is fairly evenly distributed from new to about 40 years old, which means that old vessels are being replaced at a steady pace. In other words, it takes about ten years to replace 25% of the fleet.

Low sulphur destillates

The most obvious choice to ensure compliance with ECA regulations is switching to low-sulphur distillate fuel. The investment requirement is moderate, but detailed guidelines for the fuel changeover should be prepared, and the crews must be trained properly to understand the technical implications of the switchover procedure. The following special considerations should be made to avoid engine failure:

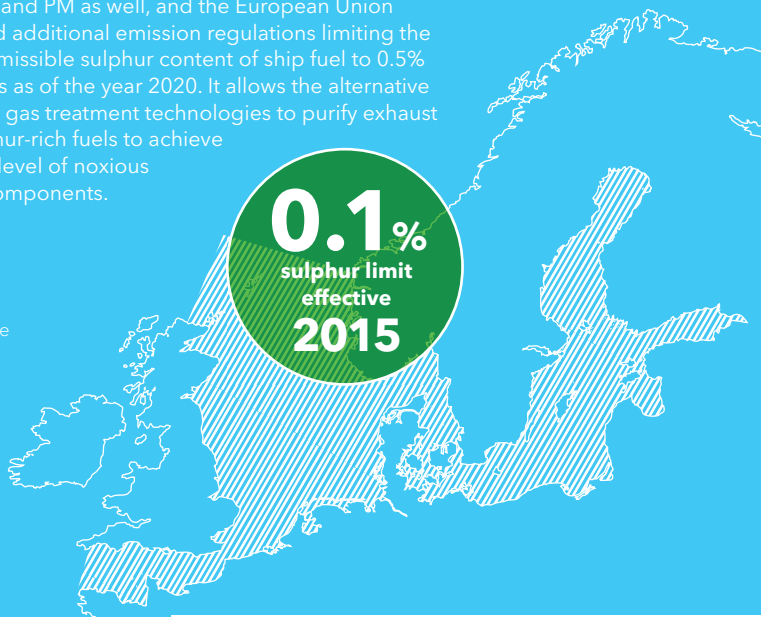
Temperature: As the operating temperatures of the two fuels differ by about 100°, special care must be taken.

REGULATIONS AND TECHNOLOGIES: HOW THE SHIPPING INDUSTRY IS CLEANING UP ITS ACT

Sulphur oxides (SO_x), nitrous oxides (NO_x), particulate matter (PM) and carbon dioxide (CO_2) are emission components originating from combustion of marine fuels. They can severely damage ecosystems and human health. IMO MARPOL Annex VI defines a combination of general maximum global emission levels and more stringent emission limits applicable to designated Emission Control Areas (ECAs). Typical abatement alternatives include exhaust gas cleaning systems known as scrubbers for ships continuing to burn HFO; using LNG as a ship fuel; or switching to low-sulphur fuel when operating in an ECA. There are also new solutions emerging which either focus on avoiding sulphur from entering the engine or on removing SO_x from the exhaust gas.

In 2020 or 2025, pending an IMO decision in 2018, a global 0.5% sulphur cap will enter into force. A study group led by the USA has now been established to assess the availability of low-sulphur fuels before the 2018 IMO meeting.

The North American and US Caribbean Sea ECAs impose limits on NOX and PM as well, and the European Union has introduced additional emission regulations limiting the maximum permissible sulphur content of ship fuel to 0.5% in all EU waters as of the year 2020. It allows the alternative use of exhaust gas treatment technologies to purify exhaust gas from sulphur-rich fuels to achieve an equivalent level of noxious exhaust gas components.

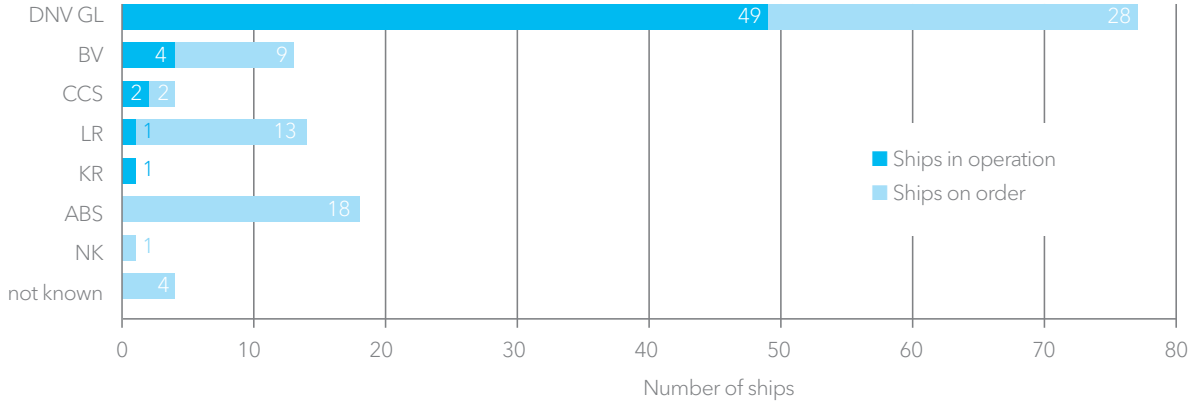


The ECAs in the North Sea and Baltic Sea.

REGULATORY UPDATE

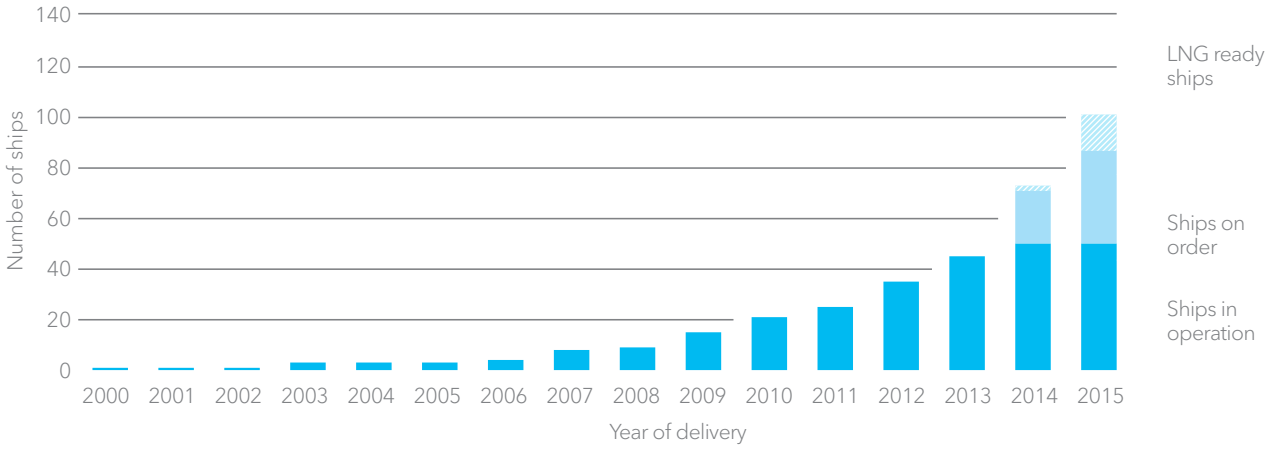
LNG-FUELLED FLEET BY CLASS

The current picture shows DNV GL-classed ships leading the industry by a wide margin.



DEVELOPMENT OF THE LNG-FUELLED FLEET

The LNG-powered fleet saw a steady growth over the last decade. DNV GL expects this trend to continue during the next years.



Viscosity/lubricity: Heavy fuel oil (HFO) and marine gas oil (MGO) have very different viscosities, which may cause fuel pump failure.

Fuel incompatibilities: HFO and MGO are mixed in various ratios during the changeover procedure, which may clog filters and cause engine shut-down.

Cylinder lubrication – acidity: Decreasing the sulphur content affects fuel acidity so another type of cylinder oil must be used.

Contamination: Tanks formerly used for HFO need to be cleaned thoroughly before switching to MGO. The solution is often dedicated fuel tanks and separate tanks for different lubrication oils.

Scrubber installation

An alternative solution is to use a scrubber while continuing to burn HFO. A scrubber washes the SOx out of the exhaust gas by spraying either seawater on it or a freshwater solution with chemicals added. Seawater scrubbers are simpler to install since the water is not recirculated but used once in a so-called open-loop system before being treated, neutralized and discharged to the sea. To achieve the right efficiency levels, seawater scrubbers rely on high-capacity pumps, which consume significant amounts of energy.

A more sophisticated installation is a closed loop scrubber, which dissolves chemicals in freshwater and recirculates this solution after each use, partially replacing it. The spent part of the solution is purified and released to sea. These scrubbers consume less electrical power but rely on chemicals. All scrubbers produce a hazardous sludge which must be properly disposed of in ports. One scrubber can treat exhaust fumes from several engines; some can switch between closed and open-loop operation, depending on the shipmaster's preference. In general, scrubbers increase fuel consumption by one or two per cent, thereby raising the overall fuel costs and CO_2 emissions. Many ships have been retrofitted with scrubbers to ensure ECA compliance. For example, the US-based cruise ship fleet has adopted scrubbers as its preferred means of complying with ECA regulations. Globally more than 160 ships have installed or ordered scrubbers.

The cleanest option – LNG fuel
The third alternative is to fuel the ship with LNG. Natural gas is the cleanest fossil fuel available, and when fuelling a ship with LNG no additional abatement measures are required to meet the ECA SOX requirements. The additional cost of the on-board LNG equipment can be recovered in three to six years, depending on the LNG fuel price and the extent of ECA exposure. An LNG-fuelled ship requires purpose-built or modified engines and special fuel tanks, a vaporizer, and double-insulated piping. Accommodating the LNG fuel tanks can be challenging and will reduce cargo space, but with new prismatic tanks entering the market the negative effects can be minimized.

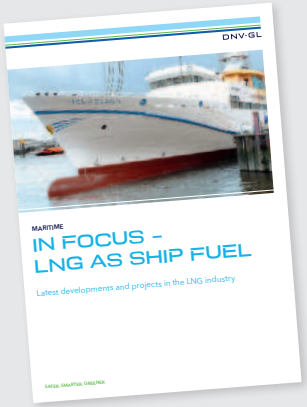
DNV GL estimates see the fleet of LNG-fuelled ships increasing over the coming decade, forming a diversified fleet of smaller coastal vessels and large ocean-going ships.

More than 50 LNG-equipped vessels are currently in service (refer to graphic), and more than 75 LNG-fuelled newbuilds have been ordered. New technical solutions are under development, and work on the new International Code of Safety for Ships Using Gases or Other Low Flashpoint Fuels (IMO IGF Code) is practically finalized. The code will create a common platform for LNG-fuelled ships. Vessels currently in service or under construction are covered by the IMO interim guidelines for LNG as a ship fuel (MSC-285(86)) and related class rules, which together form the basis for flag administrations to issue the required SOLAS certificates.

LNG fuel practically eliminates SOX and PM emissions and reduces NOX emissions by 40 to 90% depending on engine type. Release of unburnt natural gas has been an issue ("methane slip") but new engines have more or less solved this problem, giving LNG-fuelled engines a clear greenhouse gas (GHG) advantage over conventionally fuelled engines.

What is hampering the widespread adoption of LNG is the limited network of LNG bunkering stations, but many potential suppliers are seriously considering entering this market. Along with new initiatives to develop long-range LNG-fuelled ships, this may be the game changer needed to boost LNG-fuelled shipping globally. The ISO is developing an LNG bunkering guideline to support the development of local LNG infrastructure. Moreover, DNV GL released a Recommended Practice (RP) for LNG bunkering in 2014 to fill the regulatory gap between legislation/standards and local LNG bunkering procedures. In addition, DNV GL's LNG Ready service assesses the additional components needed to use LNG fuel, the associated costs as well as ship safety, stability and strength issues. DNV GL also offers evaluation of LNG bunkering facilities for ports and terminals in both the planning and execution stages. Key elements include safety, service strategy, stakeholders, capacities and feasibility. ▮

Download the new report for extensive information on LNG as ship fuel at dnvgl.com/lngreport



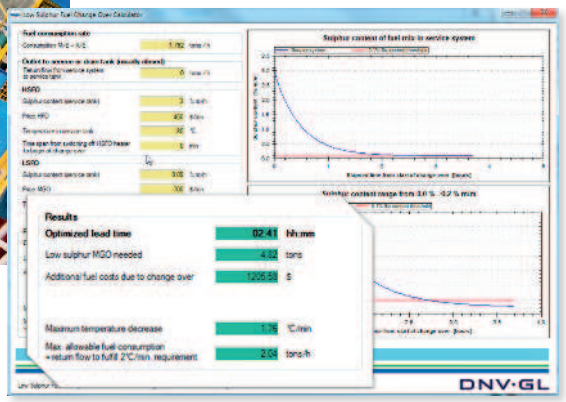
New report: LNG as ship fuel
LNG as fuel is now a proven and available solution. While conventional oil-based fuels will remain the main fuel option for most existing vessels in the near future, the commercial opportunities of LNG are interesting for many newbuild and conversion projects. But taking the leap to LNG can only be made on the basis of the best possible information and a thorough analysis of your needs, both today and in the future.

DNV GL's new report has been developed to assist you in working with all the relevant factors that come into play, based on our experience with this young technology in newbuilding, conversion projects and advisory services related to the design, construction and operation of LNG-fuelled vessels. The new report provides extensive information on the most important topics in the sector, including:

- LNG today and tomorrow
- Alternative fuels for shipping
- LNG – The right option?
- LNG as fuel on a newbuild MR tanker
- Retrofitting cruise ships to LNG by elongation
- LNG fuel tank concept for large vessels
- Innovating for safer and sustainable shipping
- Gas as ship fuel
- 2014 – Status for LNG as ship fuel
- Making sense of LNG containment system innovations
- Engines for gas-fuelled ships
- LNG in the US

DNV GL believes that the groundwork has been laid for LNG to thrive in the shipping and transport sectors – and invites their customers and business partners to come and take the next steps together with DNV GL.

REGULATORY UPDATE



FCO Calculator's Windows-based user interface delivers clear, precise information to ensure a smooth switchover.

FUEL CHANGEOVER MADE EASY

DNV GL software helps crews to master the tricky fuel changeover process and avoid costly errors.

The shipping industry is making great strides towards a more eco-friendly future. New standards and technologies must be adopted in rapid succession. With the new sulphur limit for Emission Control Areas (ECAs) in force, ships operating on heavy fuel oils must switch over to ultra-low sulphur fuel oil before entering these areas. Marine gas oil (MGO) is currently the most viable option.

However, fuel changeover is a much more complex operation than one might expect. It is a gradual process that must be carefully prepared, timed, controlled and monitored to avoid costly equipment damage or fines for non-compliance. DNV GL has issued guidelines to help the industry plan and implement the fuel changeover process with confidence. In addition, DNV GL offers a new software application which guides crews through the changeover process: the Fuel Change-Over (FCO) Calculator.

On-board guide for a smooth transition

The tool runs under Microsoft Windows and is configured for each individual ship. It helps mitigate the risks associated with switching to marine gas oil by supplying operators with the best parameters for the procedure. DNV GL provides configuration assistance to the customer to establish the ideal fuel changeover parameters.

The software takes into account variables, such as the ship's fuel system layout, any constraints on temperature and the variable sulphur content of fuels, as mixing occurs in the service system and can significantly reduce the risk of human error during preparation of the changeover procedure. The software uses a complex numerical simulation that is more accurate than previous linear models. It calculates the optimal lead time for changeover, the resulting costs and the maximum hourly consumption based on various constraints. The application allows the crew to make solid, data-driven decisions, ensures cost-efficient, reliable fuel changeovers and helps demonstrate compliance with the new sulphur directive vis-à-vis the authorities. By mitigating risks, it gives owners and operators peace of mind.

DNV GL FCO CALCULATOR TAKES INTO ACCOUNT:

- Ship-specific fuel system layout
- Constraints on temperature
- Continuously variable sulphur content of fuels
- Continuously variable temperature of fuels
- Continuously variable fuel oil consumption
- Return flow from service system to service tank
- Price of respective fuels

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REGULATORY UPDATE

CSR BC & OT COMING INTO FORCE ON 1 JULY 2015

The new Rules will be replacing the existing Common Structural Rules for Double Hull Oil Tankers (CSR-OT) and Common Structural Rules for Bulk Carriers (CSR-BC), and provide an improved, comprehensive and consistent rule set which will set the standard for oil tankers and bulk carriers.


Morten Løvstad, Business Director Bulk Carriers


Åge Bøe, Vice President


Håvard Helling, Bulk Carrier Ship Type Expert

What is CSR BC & OT?
The IACS Common Structural Rules for Bulk Carriers and Oil Tankers (CSR BC & OT) enter into force on 1 July 2015, replacing the existing Common Structural Rules for Double Hull Oil Tankers (CSR-OT) and Common Structural Rules for Bulk Carriers (CSR-BC).

A large team of technical experts has from 2008 to 2014 harmonised and further developed the two originally independent rule sets – CSR-BC and CSR-OT. The result is an improved, comprehensive and consistent rule set which will set the standard for oil tankers and bulk carriers. The new rule set consists of two main parts. The first is a common part covering general hull requirements applicable to both ship types, such as wave loads, hull girder strength, buckling and fatigue requirements. The second part covers ship-type specific requirements only applicable to bulk carriers or oil tankers.

Some key features of CSR BC & OT compared with CSR-BC:
- Extended verification scope, with an FE analysis of all cargo holds including the transition to fore part and engine room
- More transparent and consistent requirements, including technical background
- Improved load model
- Enhanced fatigue standard
- Hull girder buckling, also including lateral pressure and the combination with shear stress
- Hull girder ultimate limit state assessment, including damaged condition
- Compliance with IMO Goal Based Standards (GBS)
- Increased design grab weight for Panamax and Capesize vessels

Consequences
The application of CSR BC & OT to existing designs shows that there will be some changes. Compared to CSR-BC designs, increases in the range of 1–3% may be expected. This is based on a simplified assessment without any redistribution of scantlings/design iterations. This means that, after iterations in a full design analysis, the actual impact may be reduced. The change in steel weight and scantlings also depends on the size of the vessel, structural arrangement, type of profiles used and amount of high tensile material used.

Prescriptive requirements will normally lead to scantling impact for some members, such as:

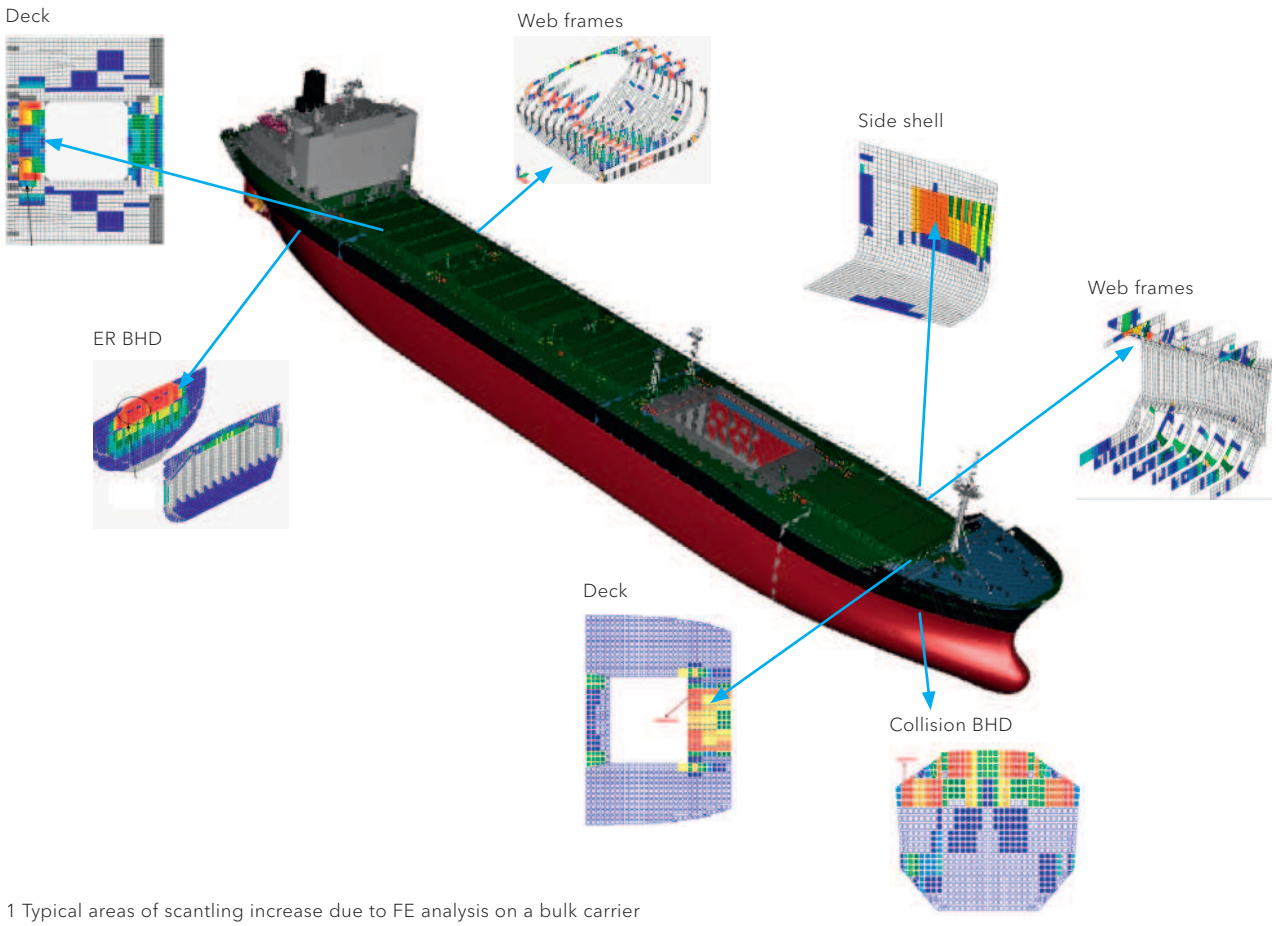

Figure 1 Typical areas of scantling increase due to FE analysis on a bulk carrier

- Bottom longitudinal girders
- Inner bottom, hopper and stool side plate due to grab loading
- Bottom plate and stiffener between 0.2L and 0.3L from F.P. due to bottom slamming

In the midship area finite element analysis, the results show small changes. However, some reinforcement due to buckling may be necessary in the side shell and for longitudinal stiffeners in the top wing tank.

Due to the increased scope of the FE analysis, a scantling increase is expected for primary supporting members, i.e., web frames, stringers and girders, for the foremost and aftmost cargo holds, including members connected to the collision bulkhead inside the forepeak tank as well as structures attached to the engine room bulkhead inside the engine room. Scantling increases have been found in local areas for the following structures (see Figure 1):

- Aftmost cargo hold region
  - Engine room bulkhead, especially upper part
  - cross deck structure
  - double bottom floors
  - top wing web frames
- Foremost cargo hold region
  - collision bulkhead, especially upper part
  - cross deck structure
  - double bottom floors
  - top wing web frames
  - side shell

DNV GL support

DNV GL has expanded its activity world-wide to assist customers in implementing CSR BC & OT. An extensive training programme has been initiated for all approval units, enabling our staff to be well prepared to provide efficient and local support to the industry. We have also been running workshops for owners, yards and designers. Together with the yards, we have performed software training resulting in extensive consequence assessments of existing designs. We want to ensure a smooth transition to CSR BC & OT for our customers. ▮

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REGULATORY UPDATE

DNV GL CALCULATION TOOLS SUPPORTING:
CSR BC & OT

In January 2014, IACS published Common Structural Rules (CSR) for Bulk Carriers and Oil Tankers. A large team of technical experts harmonized 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.

Vebjørn Guttormsen, Head of Section

The Common Structural Rules for Bulk Carriers and Oil Tankers are based on the first principles of physics instead of on empirically based models. This will provide a better answer to the conditions the ship will experience in reality. However, it also means a shift towards more computerization of the rule formulations and structural assessments and good support from rule calculation tools will be essential in the structural design process.

In response to this, DNV GL has invested heavily in its rule calculation tools to provide efficient support for the new rules. Both Nauticus Hull and GeniE have been updated to support the latest version of the CSR BC & OT rules for prescriptive and Finite Element Method calculations. The main priorities during this work were to improve efficiency and quality by introducing better modelling and FE meshing capabilities, automated calculation tasks and improved reporting functionalities. In addition, it has been important to improve the interface with other yard design and FE systems for the exchange of models.

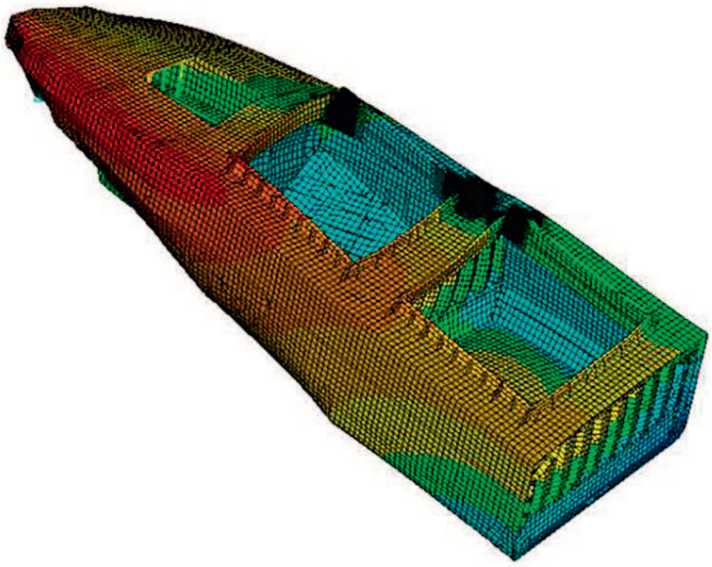
The changes in Nauticus Hull and GeniE address the needs of the designer, who will be working with new demands for an increased number of models and load cases. For prescriptive calculations, Nauticus Hull Cross Section Analysis has been updated to support the CSR BC & OT rules, including buckling, yield, fatigue and hull girder ultimate state analysis. In addition, a new rule calculator has been introduced for local scantling checks of primary supporting members and individual assessments of plates and stiffeners.

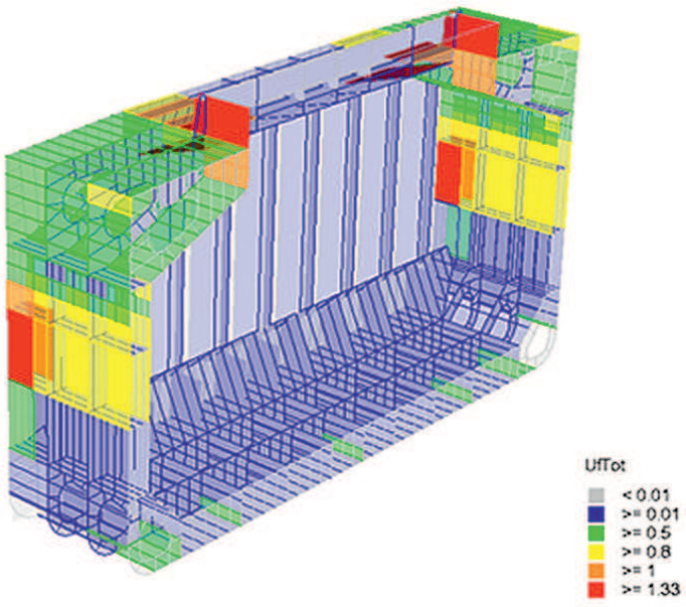
On the FEM side, there are improvements to the functionality for modelling the non-parallel fore and

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 finite element models from other software systems. GeniE includes powerful algorithms to automatically generate mesh according to various requirements. For further improved mesh control, the software has been updated with functionality for partial meshing and state-of-the-art tools for manual mesh adjustments.

Based on the GeniE model, the user can automatically apply corrosion additions, loads and boundary conditions in accordance with CSR BC & OT. In addition, the software has been updated to include tools for doing automatic yield and buckling checks in accordance with the rules. Acceptance criteria for different structural components are automatically accounted for.

The new rules also require a number of local models for assessment of critical details. GeniE has new functionality for screening the model to identify critical areas as well as improved efficiency for generating local fine mesh FE models and conducting local fatigue assessments. ▮





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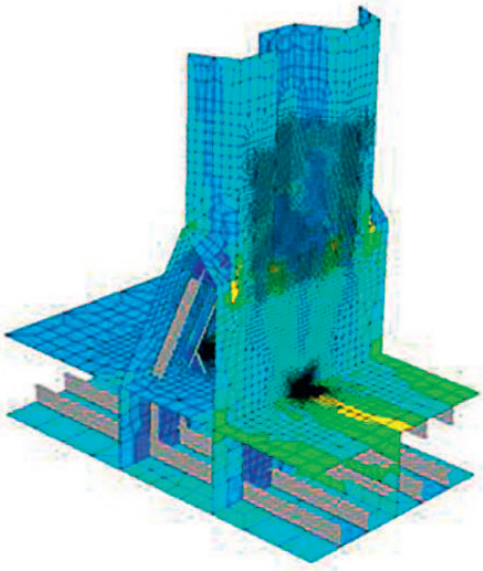

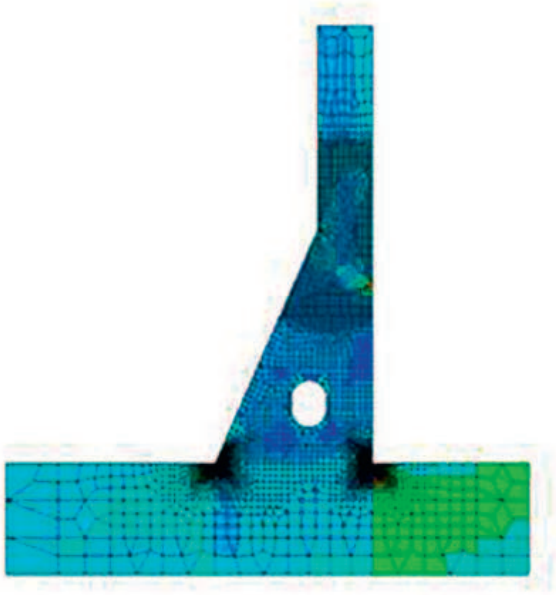

1. Aftermost cargo hold FE model yield and deformations assessment
2. FE buckling check
3. Local fine mesh model of lower stool for detailed stress assessment
4. Local fine mesh model of lower stool for detailed stress assessment

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OPERATIONAL CHALLENGES

MASTERBULK RETROFITS BULBOUS BOWS TO SAVE FUEL

Two of Masterbulk's I-Class box-shaped open-hatch Handymax ships have recently been overhauled and fitted with a new bulbous bow at Chengxi Shipyard in China. The objective was to significantly reduce bunker costs.

New bulbous bow fitted on the 45,000 dwt IKEBANA during drydocking at Chengxi Shipyard, China

Initial retrofit area in Green and final area in Red. The Blue area was modified but the original internal structure was kept.

Not only for container ships

Over the past few years, the industry has seen a large number of bulbous bow retrofits. These have primarily been carried out on slender, fast ships, such as container ships. However, this does not mean that many full-bodied ships cannot also benefit substantially from a bulbous bow retrofit.

Supported by DNV GL

Masterbulk worked together with DNV GL Maritime Advisory to design the new bulbous bow for the 45,000 dwt I-Class general cargo ships. The result is a bulbous bow that is designed for the ships' actual operational profile. Today, the ships operate for a large part of the sailing time in off-design conditions, ie, in conditions other than the design draught and contract speed for which the existing bulbous bow had been optimized.

The new bulbous bow outperforms the existing one, with predicted fuel savings in the order of 5%, which is the weighted saving over the operational profile.

Mr Sanjeev Samel, Masterbulk's Vice President Technical, who spearheaded the project, is proud of the results, stating: "We at Masterbulk have always experimented with new technologies to make our vessels more eco-friendly. It was a great experience working with DNV GL Singapore, in close coordination with DNV GL offices in Oslo, Shanghai and Jiangyin, in order to develop the new bow design which satisfied the parameters required by Masterbulk."

Operational profile

Like most Handymax open-hatch ships, the I-Class vessels operate at many different loading conditions and speeds which need to be summarized in a representative operational profile. A simplified operational profile is often used in order to reduce the analysis effort and thus time and costs.

For this project, Masterbulk and DNV GL reviewed two years of recent operational data and took into consideration future expected trades and operations. The result was an operational profile that included three loading conditions and two speeds.

The ships operate 75% of their sailing time at speeds around 13.0 knots, and only 25% of the time at around 15.5 knots, which is close to the contract speed.

DNV GL has recently extracted I-Class data for 2014 operations from the Automatic Identification System (AIS), based on DNV GL's new AIS Business Intelligence Service. The AIS Business Intelligence Service can be used to provide advice on reducing operational costs, optimizing voyage management and choosing suitable retrofit solutions. The valuable insight obtained from this data confirms that the operational profile decided in the bulbous bow retrofit project is sound. In 2014, the I-Class ships spent the majority of their sailing time at speeds in the range of 12 to 13 knots and significantly less time in the higher speed range of around 15 knots. Data collected on board the IKEBANA using DNV GL's performance management tool ECO Insight shows that in January 2015, shortly after the retrofit, the ship had an average sailing speed of 12.7 knots.

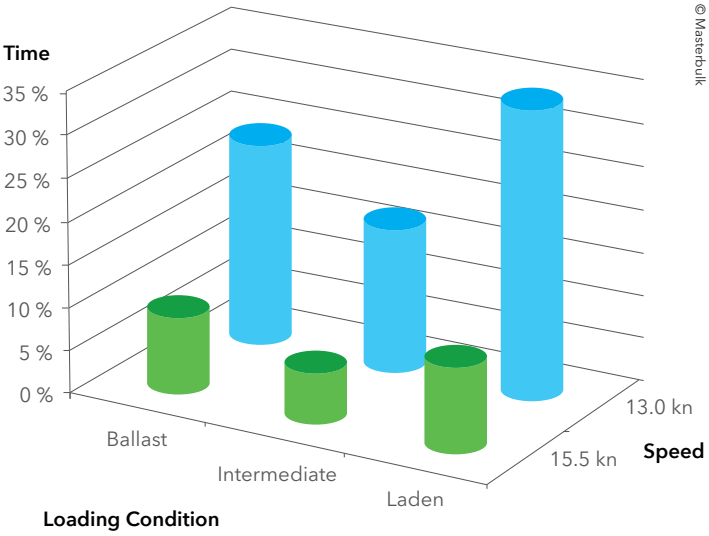
Return on investment

With a savings potential from the bulbous bow retrofit of about 5%, Masterbulk expects the annual cost savings to amount to about USD 160,000 per ship based on present bunker prices. This may increase to about USD 200,000 per ship if the ship spends more time in Emission Controlled Areas (ECAs).

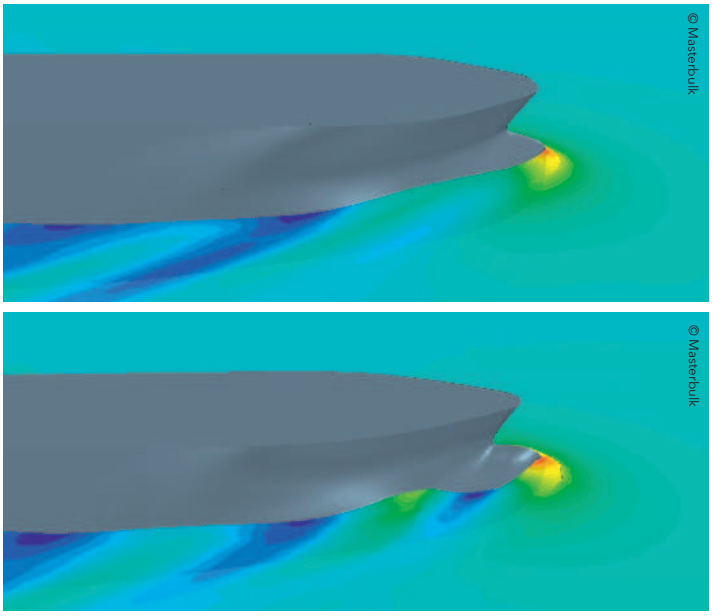
When the investment decision was made, the payback time was considerably less than the 63 months at present bunker prices. However when the Maritime Singapore Green Initiative is taken into account, the payback time is very attractive even today.

Mr Sanjeev Samel, Vice President Technical, says "Masterbulk had pledged to comply with the Green Initiative, encouraged by the Maritime and Port Authority of Singapore (MPA), which supported

OPERATIONAL CHALLENGES



I-Class operational profile



Wave pattern comparison between the existing (top) and new (bottom) bulbous bow at 13.0 knots and intermediate condition

our drive by granting partial monetary assistance upon verification of results."

Mr Nicholas Fisher, CEO of Masterbulk, continues "Maximizing design efficiency ticks a lot of boxes. Financial considerations are paramount – naturally investments like this have to make commercial sense. In this regard, the support of the Maritime and Port Authority's Green Initiative was crucial. But additionally, shipping companies have to respond to client and regulator-driven demands for lower emissions and greater fuel efficiency in the global supply chain."

Irrespective of the financial support, the CapEx for the bulbous bow retrofit is approximately USD 850,000 per ship. This includes the design of the new bulbous bow, preparation of detailed steel drawings, construction and fitting of the new bulbous bow, class drawing approval and class block inspection.

Design process

In close collaboration with Masterbulk, DNV GL evaluated the design of the new bulbous bow in two phases. In the first phase, the existing hull performance and improvement potential were evaluated in relation to the operational profile. This phase focused on a few areas but particularly revealed a significant potential for a re-design of the bulbous bow due to the large share of operations in off-design conditions. Amongst other things, the evaluation showed that hull resistance is up to 12% higher in an intermediate condition compared to a laden condition. This indicates poor performance at the intermediate condition. The resistance was shown to be higher than expected in the ballast condition too. The physical phenomena resulting in poor performance were unfavourable wave profiles from the bow region, with high breaking waves at the bulb and towards the hull shoulder region.

Based on encouraging results from the first phase, Masterbulk decided to go ahead with a second phase to re-design the bulbous bow. The advantage of executing a project like this in two phases is that the ship owner gets a better idea of what to expect and a better understanding of and increased confidence in the existing performance and the capability of the design before fully committing to a larger scope of work.

Mr Morten Løvstad, DNV GL Business Director for Bulk Carriers, says "By conducting an initial savings analysis, which has a very limited cost and can be done in a matter of a few weeks, the customer will know whether a bulbous bow retrofit is likely to produce any significant savings. We believe more companies should consider such an analysis in order to understand the savings potential, which in certain cases can be significant. This is particularly the case when they have a large series of sister vessels."

New bulbous bow

Several bulbous bow shapes were tested. The tests were performed using full-scale Computational Fluid Dynamics (CFD) simulations in in a "virtual" towing tank, based on the conditions in the operational profile. The advantage of full-scale simulations is that they avoid scaling effects and capture the dominant viscous resistance and effects such as breaking waves in the bow region and at the transom stern.

Mr Sanjeev Samel, Vice President Technical, Masterbulk

Mr Nicholas Fisher, CEO, Masterbulk

Results from the CFD simulations were used to evaluate hull performance, identify improvement potential and determine the absolute effect of the shape modifications. CFD also provides valuable information on the flow characteristics along the hull; visual observations combined with calculations of the resistance provide a sound decision basis. No towing tank tests were performed.

Mr Olav Rognebakke, Head of Section Hydrodynamics and Stability in DNV GL Maritime Advisory, says "For these types of applications, CFD is a mature and well-proven tool producing reliable results. Compared to tests in a towing tank, CFD promises results in a short time for a larger set of geometries and provides a more complete picture based on access to all flow characteristics. The visualization of large amounts of data is key. Now we are in a very interesting transition period where we are using CFD for wider applications and there is a constant trend towards lower costs and improved accuracy."

The design of the new bulbous bow focused on improving the wave pattern and wave-making resistance in ballast and intermediate conditions in particular. This is achieved by reducing the extent of concave waterlines and reducing the waterlines' entrance angles. For the laden condition, the focus was on maintaining the performance of the existing design.

The new bulbous bow has reduced the wave-making resistance in all the analysed conditions. The bulbous bow height has been increased, which particularly reduces the adverse wave system from the bow in the intermediate condition while maintaining performance in the laden condition. Another very important feature of the new design is its improved performance in waves, leading to less added resistance in actual seaways.

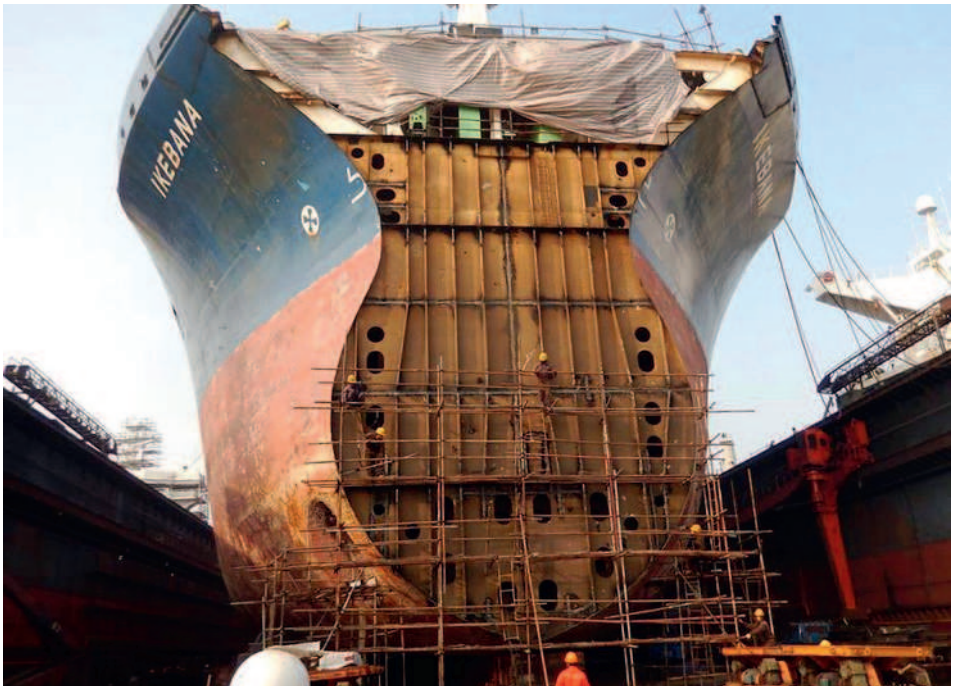
The final savings achieved in ballast, intermediate and laden conditions were up to 8%, 15% and 1% respectively. The largest savings were observed at 13.0 knots. When weighted in relation to the operational profile, the total savings amounted to a 5.3% reduction in resistance, which approximately translates into the same reduction in fuel consumption.

Mr Adam Larsson, Group Leader Hydrodynamics and Stability in DNV GL Maritime Advisory, says "Although significant savings can be seen at speeds lower than design speed, many customers are concerned that the new optimized bulbous bow will incur a penalty if speeds increase again sometime in the future. We therefore pay considerable attention to finding a new bow shape that minimizes or even eliminates any such negative effects at higher speeds. The new bulbous bow should be as flexible as possible over a large range of speeds and drafts."

DNV GL also helped Masterbulk to improve the flow across the bow thruster tunnel opening, introducing a new scallop design aft of the opening. The new scallop design combined with opening modifications contributed to additional savings of about 0.6%.

A consequence of the modifications is a slight shift forward of the stem location, but this has no implications in terms of class rules beyond the bulbous bow structure since the ship has a surplus of hull girder section modulus. A slight increase in the hull girder bending moment due to the larger rule length will not conflict

OPERATIONAL CHALLENGES



Preparing the IKEBANA for the fitting of the new bulbous bow at Chengxi Shipyard, China

with the requirements. The displacement, longitudinal centre of buoyancy and transverse metacentric height are similar to those of the original design.

Optimization challenges

The most important success factors in a retrofit project, aside from the technical know-how and expertise, are undoubtedly good and transparent communication combined with effective collaboration across organizations. In total, five different stakeholders in four different geographical locations were involved in this project. For the structural and detailed design, Masterbulk hired Chinese designer Shanghai Merchant Ship Design & Research Institute, SDARI. Class approval was carried out by DNV GL.

Mr Adam Larsson in DNV GL Maritime Advisory emphasizes the importance of communication and collaboration: "The success in projects like this is typically measured in terms of savings in percent compared to the baseline. However, success must also be measured in terms of stakeholder expectations and satisfaction, which will always be different depending on the recipient. In this project, the recipient was not only the owner but also the designer, yard and class. The expectations of all recipients must be understood and met in order for a project to run smoothly, and the likelihood of this increases dramatically when there is frequent communication and transparency in all steps of the design process and in the technical decision being made. We frequently use video conferences as an important way of getting everyone aligned."

There are several other challenges in a project like this. The savings potential largely depends on the extent of the modifications. In general, the larger the area the better, since this allows greater freedom to optimize and thus increases the probability of large savings. This is, however, a delicate balance since the retrofit cost increases with the amount of steel that needs to be replaced. There are also several other constraints, such as bulkheads, cargo holds, chain lockers, bow thrusters, etc, that should in so far as possible not be affected by the retrofit. A close dialogue with the designer and yard is required in this situation to achieve a good result while respecting design constraints and building requirements.

At first, the design of the new bulbous bow focused on an area aft of the cargo hold bulkhead and including the bow thruster. Late in the design process, however, it was decided to reduce the area aft of the collision bulkhead and to keep the existing bow thruster in order to reduce the modification area and thus cost. Hence, further design iterations had to be performed in a very critical time frame when the new bulbous bow was already being prepared by the structural designer and yard. This situation emphasizes that good communication, a known level of expectation and timely deliveries cannot be underestimated. An alternative to remove the bow thruster completely at a benefit of additional 1.5% savings was also evaluated in case this became a viable option while maintaining safe operation.

Detailed fairing of the new bulbous bow is very important for optimal hydrodynamic performance and to ensure that the new structure exactly fits the existing hull. Acceptance tolerances are very small and it is therefore critical to have accurate and reli-

able as-built construction drawings at hand. DNV GL worked on the initial fairing before passing on the new design to SDARI and Chengxi Shipyard for final fairing.

Retrofit during regular docking

The new bulbous bows were retrofitted by Chengxi Shipyard according to SDARI's structural design. The first ship, the IKEBANA, was retrofitted in November 2014. The second vessel, the INDIANA, followed in March 2015. The design development and retrofit have been completed as planned.

The bulbous bow retrofit required 196 tons of steel to be replaced. The retrofits were carried out during planned regular docking schedules, which meant there was no unplanned off-hire. The retrofits took approximately 25 days while the construction of the new bulbous bow blocks took about 45 days.

Mr Sanjeev Samel, Vice President Technical, says "The entire project was time-bound and we managed to complete it economically within the target dates. Thanks to all the stakeholders that participated in this project for making it successful. The results seen after the Ikebana's first fully laden voyage after bow modification are satisfactory and encouraging."

Operational cost-cutting

Both ships are now back in operation and the initial operational feedback indicates satisfactory results, as pointed out by Masterbulk. However, it is still too early to draw firm conclusions as the verification of retrofit measures in operation must be logged over a longer time period and with a known level of uncertainty. To support this task, Masterbulk has acquired DNV GL's performance management system ECO Insight for its I-Class vessels. ECO Insight is a unique tool that compiles and displays all the relevant ship performance data and allows in-depth data analytics and continuous fleet-performance management.

Furthermore, the I-Class vessels are equipped with DNV GL's trim optimization tool ECO Assistant. The ECO Assistant is based on an extensive RANS CFD database of resistance and power demand data, and is established on the hull together with the new bulbous bow. In combination, the bulbous bow retrofit and trim optimization comprise a very effective means to reduce the fuel consumption of a ship in operation. Add ECO Insight to the equation and Masterbulk has a very good basis to improve operational performance and cut costs for the I-Class ships.

CEO of Masterbulk Nicholas Fisher concludes "Over the last few years, there has been increased regulation and concern around shipping's CO_2, SOx and NOx emissions. New certification and reporting requirements have meant that shipping companies, down to the individual vessel level, need to have reports to prove they are reducing CO_2 and SOx/NOx emissions. The work we have done over the last 12 months will have a significant impact on our ability to benchmark our fuel use and improve performance." ▮

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OPERATIONAL CHALLENGES

FINANCING RETROFITS

To improve the energy efficiency of their fleet an increasing number of shipowners are investing in hull optimization and retrofitting. Dr Carsten Wiebers, Global Head of Maritime Industries at KfW IPEX-Bank, explains the available financial tools.

How relevant is energy efficiency for you as a maritime financier?

Carsten We are observing a two-tier shipping market development: ECO-vessels with lower fuel consumption are more competitive than vessels which are not state of the art in terms of energy efficiency and regulatory compliance. ECO-vessels have enhanced marketability, higher revenue potential and thus a more favourable risk profile for financiers as well as for shipowners. This trend is largely driven by intensified competition due to the persistently low charter rates and tightening environmental regulations.

How do you as a financier assess the energy efficiency of vessels?

We took the above-mentioned trend into account as early as 2011, asking DNV GL to develop a "CO_2 evaluation tool" for the purpose of analyzing the energy efficiency of our maritime loan portfolio, which comprises over 800 vessels, and to benchmark individual ships against the portfolio average as well as world fleet averages. Based on over 50 characteristic traffic patterns, the CO_2 tool not only allows us to benchmark vessels but also calculates actual energy and bunker cost savings compared to the portfolio and/or world fleet average. Assessing ship design and energy efficiency based on the results of the CO_2 tool is today an How relevant is energy efficiency for you as a maritime financier?

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In early 2014, we asked DNV GL for an extension to the CO_2 evaluation tool, which now also compares costs and savings of

Dr Carsten Wiebers
Global Head of Maritime Industries at KfW IPEX-Bank in Frankfurt. He joined KfW in 1992 and the shipping department in 1998. He completed his doctoral thesis in Agricultural Economics at the University of California at Berkeley and holds a Master's degree from the Technical University of Berlin.

Photo: KfW IPEX-Bank/Alexander Kempf/Thomas Klewar

specific retrofitting measures such as bow, propeller and trim optimization for a specific vessel. This helps us and our customers work jointly on the improvement of fleets and allows us to proactively initiate discussions with shipowners regarding retrofitting.

Do you see a growing demand among shipowners for retrofits increasing energy efficiency and reducing fuel consumption?

We have been seeing a growing interest and are in the advanced negotiation stages with a number of major shipowners about financing for retrofitting measures, especially propellers, bow optimization, scrubber installation and LNG-fuelled propulsion systems. Many shipowners had delayed their investment decisions until the end of last year because of rumours that the tightening of emission regulations would be postponed.

Since 1 January 2015, vessels operating in Emission Control Areas (North Sea, Baltic Sea, North American coastline and US Caribbean) are now required to burn bunker with a maximum sulphur content of 0.1 per cent. Operators who fail to comply could face penalties and detention by neighbouring states. The regulation is now in effect, and shipowners can choose between burning low-sulphur fuel oil – at a significantly higher cost compared to heavy fuel – and installing emission reduction technologies such as scrubbers, or making the switch to burning LNG. The price spread between low-sulphur fuel, LNG and heavy fuel is actually regarded by some shipowners as an opportunity to build competitive advantage through retrofitting, rather than a threat.

Generally speaking, how difficult is it to receive loans for this purpose in the seventh year of the shipping crisis? What are your prerequisites for financing?

All in all, the conditions for shipowners and financiers have improved in recent years. The world economy is recovering slowly. Many banks have cleaned up their balance sheets and are lending again. Today, well-positioned shipowners have sufficient access to financing. However, banks today differentiate more between risk categories than before 2009 while applying tougher loan requirements such as higher equity contributions by owners, corporate guarantees/structures etc.

Apart from classic vessel financing, we are observing a trend towards alternative financing sources such as equipment-based financing for retrofits and newbuildings. This approach allows shipowners to access financing from countries where they source major equipment. KfW IPEX-Bank can provide long-term ship financing of up to 80 per cent of the purchase price for a tenor of up to twelve years. The minimum financing volume should be around 30 million US dollars, which can be easily reached when ordering a specialized vessel or if shipowners consider retrofitting an entire fleet. Our financing contribution is not limited to German equipment, but it is based on European content. However, German maritime suppliers in particular are in a leading position internationally, in an industry which is strongly driven by innovation. Some leading suppliers have teamed up in the German Maritime Export Initiative (GeMaX) to provide shipowners with a more focused means of sourcing maritime equipment, which we support by financing their vessels.

What are typical retrofitting measures you have financed?

Our responsibilities mainly comprise financing of scrubbers and propeller replacements. Some initial commitments have been made in this segment. As a consequence of the new, stricter emission limits in ECAs, we did not see an increased demand for financing until a few months ago. We are in the advanced negotiation stages with a number of major shipowners about financing fleet-wide retrofits (in particular propellers, bows and trim optimization) as well as LNG-fuelled vessels. For the latter in particular, we expect a growing demand from liner companies whose vessels operate on predetermined routes where LNG bunkering facilities can be secured. We expect to team up with an engineering office offering LNG propulsion packages to cargo shipowners which could be financed by KfW IPEX-Bank. ▮

KfW IPEX-Bank
The Maritime Industries department of KfW IPEX-Bank provides financings for all maritime assets in cruise, offshore and shipping sectors. With its loan portfolio of 18.3 billion US dollars KfW IPEX-Bank is one of the leading financing institutions in the maritime sector worldwide.

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OPERATIONAL CHALLENGES

PACIFIC BASIN ADOPTS DNV GL's SHIPMANAGER

Pacific Basin, one of the world's largest owners and operators of Handysize bulk carriers, will implement the DNV GL's ShipManager fleet management system on its owned fleet within the next two years.

The teams from Pacific Basin and DNV GL at the signing ceremony in Hong Kong.

From left:
Patrick Fong Yiu Fai, Area Manager, Maritime HK & Taiwan, DNV GL

Capt. Jay K. Pillai – Fleet Director, PB,

Are Føllesdal Tjønn, Managing Director, DNV GL - Software

Charlie Kocherla, Chief Technical Officer, PB

Kitty Mok, Director, Risk Dept. & Group company secretary, PB

Kaveh Mansoorian, Senior Customer Service Manager, DNV GL

Eric Tan, Director, Division Asia Pacific, Software, DNV GL

Ivan Tam, Regional Sales Manager, Software Greater China, DNV GL

Suresh Moganti, IT Director, PB

Raghvendra Lavania, Project Manager, Ship Management, PB

Shipping companies often have various IT systems that cover different aspects of their operations, and therefore have challenges in aligning data input and output for efficient decision-making, reporting and ship-shore communication. The implementation of the ShipManager system in Pacific Basin will simplify and optimize their ship management, allowing extensive fleet-wide data collection, integration and analysis, thereby improving performance.

"With this strategic partnership, we are strengthening our technical and customer services capacity in the Asia-Pacific region. DNV GL's value proposition is unique and we are positioned as a leading provider of fleet management software and services worldwide," says Are Føllesdal Tjønn, Managing Director, DNV GL - Software. "

"DNV GL has instilled confidence during our selection process and we look forward to developing long term partnership and friendship during the implementation process," adds Captain Jay K. Pillai, Fleet Director of Pacific Basin.

"Through in-depth discussions and workshops we demonstrated our domain expertise and how our software and best practice approaches can increase safety and improve operational efficiency," says Torsten Kappel, Director of Operations for Maritime and Class solutions at DNV GL.

Pacific Basin will be using six integrated ShipManager modules: Technical, Procurement, Project, Crewing, QHSE and Analyzer. The modules will support Pacific Basin in generating dynamic OPEX (Operational Expenditure) reports and in monitoring KPIs. ShipManager Analyzer provides exceptional decision-making support, as it extracts data from all of the ShipManager modules for data mining and analysis. "This is expected to reduce a lot of manual work and give our fleet managers all information in one place for management of data and trends. The system also allows the integration of data from previous solutions," says Raghvendra Lavania, project manager of Pacific Basin.

At Pacific Basin there is a constant focus on the crew, and ShipManager will be a central part of the communication between ship and shore. "The system is easy to learn, user-friendly and technically innovative," says Mr Lavania. "ShipManager will integrate to our new accounting system and provide customized reports to manage our fleet efficiently," he says. ▮

About Pacific Basin
Pacific Basin Shipping Limited (www.pacificbasin.com) is one of the world's leading owners and operators of modern Handysize and Handymax dry bulk vessels. The company is listed and headquartered in Hong Kong, and currently operates in two main maritime sectors under the banners of Pacific Basin Dry Bulk and PB Towage. Our dry bulk fleet (including newbuildings on order) comprises over 250 vessels directly servicing blue chip industrial customers. Pacific Basin provides a quality service to a wide range of customers, with approximately 3,000 seafarers and 370 shore-based staff in 16 offices in key locations around the world.

About DNV GL – Software
DNV GL is the world-leading provider of software for a safer, smarter and greener future in the energy, design and engineering, risk assessment, asset integrity and optimization, QHSE, and ship management. Our worldwide presence facilitates a strong customer focus and efficient sharing of industry best practice and standards.

OPERATIONAL CHALLENGES

Advanced analytics applied to data from multiple sources can deliver enormous economic benefits to all participants in the maritime value chain.

NEW AIS BUSINESS INTELLIGENCE SERVICE

AIS and other maritime data can have a profound impact on the way ship operators and owners monitor ship safety, sustainability and performance.

DNV GL's new AIS Business Intelligence Service delivers valuable information. Maritime experts from the advisory division at DNV GL interlink various types of data, such as ship positions, OPEX models, geographical port information, ship schedules, etc. to create a holistic view of vessel performance. Using advanced models and analytic schemes, they analyze information about voyage management, port and bunker operations as well as benchmarking data from other market players. DNV GL can tailor the analysis to each customer's needs, providing advice on reducing operational costs, optimizing voyage management and finding the best retrofitting solutions for a given operational profile.

Ship operators and owners, port operators and authorities, insurance companies as well as commodity traders and maritime service providers can all benefit from AIS Business Intelligence data, be it for identifying the causes of vessel delays or advising on a switch to ports with shorter anchorage times or for finding the right dry dock. third-party view. ▮

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DNV GL's NEW PERFORMANCE MANAGEMENT PORTAL ECO INSIGHT

Even at the current low oil price, fuel cost is the single biggest cost element of a vessel. Market leading container liners claim to have cut down their fuel consumption by 50% over the last 6 years, and only half of this effect came from simple slow steaming. The other 25% come from a well orchestrated bundle of technical and non-technical measures to cut down consumption. If we compare all sailing bulker carriers, the difference between the market average and the worst in each segment shows the same magnitude; 25-30% difference. (Source: DNV GL AIS benchmarking database, global bulk carrier fleet).

While many shipping companies have implemented single technical measures in the past, such as trim optimisation or weather routing, many now look into the benefits of orchestrating them and look at the behavioural aspect of it.

Fleet Performance Management is the next wave in energy management, which does three things:

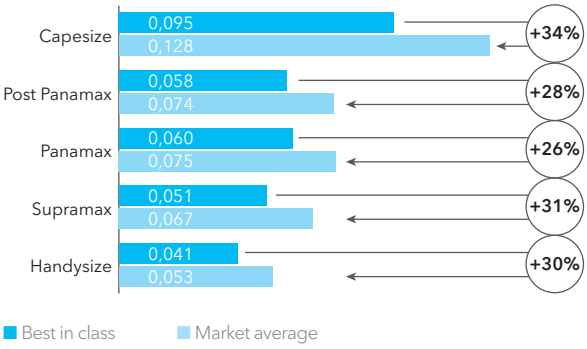
- It sets a performance baseline and decide which measures to take for which parts of the fleet
- It immediately changes behaviour of shore and vessel teams towards more efficient operations (sometimes against "seafarers tradition")
- It demonstrate control and transparency to customers and other industry stakeholders

The benefits are significant. A well implemented fleet performance management system shall provide explanations for why comparable vessels of your fleet perform differently, like the 6 bulkers mentioned in the introduction. To understand the causes of performance differences you need to get a comprehensive picture of how the vessel did the voyage, how the engine & system condition is, whether your hull and propeller give added resistance and what part of the performance gap is due to fuel quality.

From our experience looking at a lot of bulker vessels performance we see that:

- Speed is recognized as an important lever. However, whereas speed management has a potential, at current slow steaming mode the additional saving potential is limited.
- Many companies do not collect proper engine performance data, which need to have a "snapshot" nature (taking values at its ambient conditions at the same point in time), so engine & systems performance is overlooked.
- Slow vessels like bulkers are prone to hull degradation, a lever which is widely overlooked as the computation on hull degradation is complicated and coating is more chemistry than engineers home turf.

DNV GL's performance management portal ECO Insight provides a comprehensive and easily accessible way to manage the performance of a fleet, including voyage, hull & propeller, engine & systems performance. It enriches customers' own fleet reports with industry data, such as Automatic Identification System (AIS), weather, or fuel, and provides unique benchmarking capabilities. Advanced engineering methods, for example hull fouling prediction based on CFD, are also packaged into the portal. Navigator Insight, due to a lot of smart plausibility checks against specific vessel particulars, will ensure high quality data collection onboard. ∎



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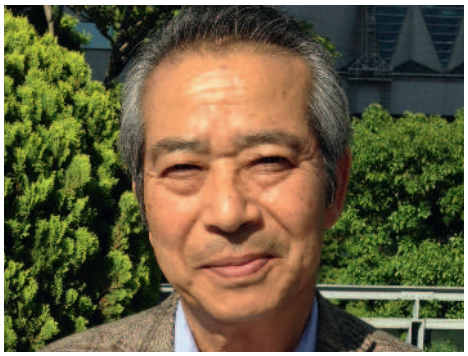
OPERATIONAL CHALLENGES

ASKING THE DNV GL EXPERTS


Sönke Pohl


Dimitris Dedepsidis


Fumio Yoshida

Based in more than 100 countries around the world, DNV GL experts work as part of a global network to find proactive solutions for our customers. To find out how shipowners and operators in different regions are preparing for upcoming regulations and which new projects DNV GL is currently working on around the globe, Bulk Carrier Update spoke to three of our specialists and ship type experts for bulk carriers based in Japan, Germany and Greece.

Carrying dry bulk cargo is one of the oldest operations in shipping. But as the world fleet continues to grow in capacity, increased loading rates and the cargo itself create additional risks that crews need to be prepared for. "Cargo liquefaction was recently detected as one of the major risks for ships carrying mineral ores or concentrates, and it has not yet been properly accounted for by international regulations. Many shipowners are concerned and are asking for our support in preventing or dealing with this problem," says Dimitris Dedepsidis, Team Leader for Plan Approval and Ship Type Expert for bulk carriers at DNV GL in Greece.

Some of the terminals that handle mineral ores such as nickel ore and iron ore fines, are located in tropical areas. Especially during the rainy season, the cargo's moisture level can therefore be significant, and may be close to or even exceed the transportable moisture limit (TML) of the specific cargo. If such cargo is loaded, it significantly increases the risk of cargo liquefaction during the ship voyage, which may eventually lead to a serious stability problem or affecting the structural integrity of the ship. "An ore carrier's tank boundaries are not always assessed for the possibility of cargo liquefaction. If it does occur, the pressure on the non-horizontal cargo hold boundaries can increase by a factor of two or even three," explains Sönke Pohl, Key Account Manager and Ship Type Expert for bulk carriers at DNV GL in Germany. To help customers tackle this issue, we have developed a new guideline for the design and operation of vessels with dry bulk cargo that may liquefy. The guideline helps customers assess the structural strength of their vessels (e.g. ore carriers) to avoid complications arising from cargo liquefaction by taking preventative measures at the design stage. The publication also sets out circumstances which call for third-party assessments to check the condition of the cargo prior to loading (see the article on page 50 for more details).

DNV GL and Oshima present LNG fuelled bulk carrier concept
The beginning of the year saw the introduction of stricter emissions regulations in the European and North American and U.S. Caribbean Emission Control Areas (ECAs). Now Asia too may see its first ECA, with the Hong Kong government expected to implement a sulphur emissions limit of 0.5% from 1 July. "Shipowners previously unaffected by the sulphur cap may have to respond and equip their vessels for low-sulphur operation very quickly. This could be a challenge, both in terms of costs and adapting to the technical issues that can arise during operation," says Fumio Yoshida, Senior Advisor at DNV GL in Japan. "There have also been discussions on the possibility of implementing MARPOL Tier III emissions regulations in Tokyo Bay," he adds.

Japan is one of the countries most affected by the global surplus of tonnage in the bulk segment, as roughly 70% of the country's maritime sector is made up of bulk carriers. Therefore, Japanese shipbuilding companies have to be more efficient and innovative than ever to remain competitive. Oshima Shipbuilding Company

has been working closely with DNV GL to be ahead of the game. "In light of current and upcoming emission control regulations and an increased interest in alternative fuels, DNV GL and Oshima have just finished creating a state-of-the-art LNG-fuelled Kamsarmax bulk carrier concept vessel," Yoshida explains. The concept vessel's design parameters are based on data generated in a 2014 DNV GL feasibility study that examined the use of LNG on a trade route between Europe and North America from a technological and economic perspective. The innovative new design is based on the successful Oshima Panamax hull design, with significant modifications made to the superstructure (for more information, see the article on page 10). LNG is considered one of the most important alternative fuels to help the shipping industry reduce its environmental impact over the next few years, as vessels operating on LNG have greatly reduced SOx, NOx and particulate emissions while emitting less CO_2.

Ship owners and operators are also investing in increasing their fleet's overall efficiency to stay competitive in the market. A significant number of customers, who use the DNV GL ECO Insight solution to monitor the voyage, hull & propeller and engine and systems performance of their fleets, are bulker owners and operators. "Many owners are also improving the design of their vessels, reducing operational costs through hull form optimization, or are replacing hydraulic systems on deck with electrically powered alternatives," says Sönke Pohl.

All three experts agree that the industry has a long way to go in preparing for the introduction of the Ballast Water Management Convention, which may come into force as early as next year. "At the moment, treatment systems using ultraviolet light are very popular. But what kind of system suits a particular vessel best very much depends on the ship's operational profile, the budget and a number of other factors", says Dimitris Dedepsidis. For example, treatment systems using UV light have been found to be less effective with murky water. DNV GL is currently testing or approving 25 different ballast water treatment systems and is consulting with customers from different shipping segments on such systems. "There is no single treatment system that fits all bulk carriers," he adds. "The best solutions are the result of parametric analysis based on customized demands and preferences."

DNV GL will continue to work with partners from across the maritime industry and beyond. Experts such as Sönke Pohl, Fumio Yoshida and Dimitris Dedepsidis translate these insights and solutions for the bulk sector – preparing customers for future challenges and helping them improve their business. ▮

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CARGO LIQUEFACTION

Traditionally, the phenomenon of dry bulk cargo liquefaction has not received much media attention, but it is now seen as one of the major hazards for bulk carriers. All the stakeholders in the industry, and the media, are increasingly focusing on this issue. To address this important safety issue, DNV GL has prepared a guideline for the design and operation of vessels with bulk cargoes that may liquefy.

Vessel	DWT	Built	Lives lost	When	Cargo type	Cargo origin
Asian Forest	14k	2007	0	17.07.2009	Iron ore fines	India
Black Rose	39k	1977	1	09.09.2009	Iron ore fines	India
Jian Fu Star	45k	1983	13	27.10.2010	Nickel ore	Indonesia
Nasco Diamond	57k	2009	21	10.11.2010	Nickel ore	Indonesia
Hong Wei	50k	2001	10	03.12.2010	Nickel ore	Indonesia
Vinalines Queen	56k	2005	22	25.12.2011	Nickel ore	Philippines
Sun Spirits	11k	2007	0	22.01.2012	Iron ore fines	Philippines
Harita Bauxite	50k	1983	15	16.02.2013	Nickel ore	Indonesia
Trans Summer	57k	2012	0	14.08.2013	Nickel ore	Philippines

Table 1: Liquefaction accidents

Liquefaction is a phenomenon in which a soil-like material is abruptly transformed from a solid dry state to an almost fluid state. Many common bulk cargoes, such as iron ore fines, nickel ore and various mineral concentrates, are examples of materials that may liquefy.

If liquefaction occurs on board a vessel, the stability will be reduced due to the free surface effect and cargo shift, possibly resulting in the vessel capsizing. The ship structure may also be damaged due to increased cargo pressures.

Accidents caused by cargo liquefaction

There are some distinct and disturbing features of accidents caused by cargo liquefaction. Firstly, the accidents happen very fast. The time that elapses between liquefaction being detected, if it is detected at all, and the vessel capsizing is in some cases only a few minutes. This leaves very little time for remedial measures. It also leaves very little time for the safe evacuation of the ship, and such accidents are often associated with tragic losses of crew members.

Secondly, it has been observed that an accident on one vessel is followed by a new accident or near-accident on other vessels that have loaded cargo at terminals in the same area and in same period of time. The best known example of this is the loss of the bulk carriers Jian Fu Star, Nasco Diamond and Hong Wei during six weeks in the rainy season during the autumn of 2010. All of them were carrying nickel ore from Indonesia, which is a cargo known to be prone to liquefaction. In total 44 lives were lost.

Table 1 lists ships of more than 10,000dwt lost since 2009 where it is suspected that cargo liquefaction is the cause of the casualty. It is worth noting that six of the nine vessels were less than 10 years old and presumably in good condition. It is also noticeable that there is a strong link to the rainy season in Southeast Asia.

Liquefaction of granular materials

The liquefaction of granular materials, such as iron ore fines, is a well-known phenomenon. There are two prerequisites for liquefaction to occur. First, you need a cargo material with at least some fine particles. Second, you need a minimum moisture level. If one or both of these ingredients are missing, liquefaction is not possible.

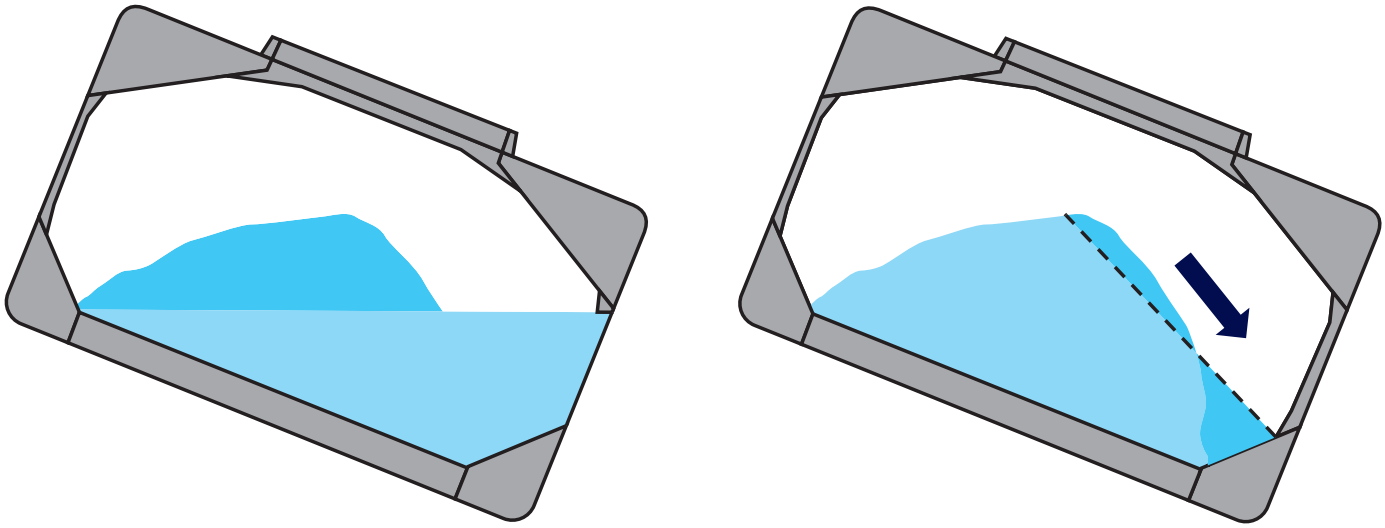


Figure: Liquefaction (left) and sliding (right)

In a typical cargo that may liquefy, there will be a mix of fine particles and larger particles or grains. In between the particles, there will be a mix of moisture/water and air. When the cargo is in a solid dry state, ie, not liquefied, the particles will be in contact with each other. The frictional force between the particles gives the cargo some physical shear strength. The cargo may be formed into a pile and appear dry. During the voyage, the cargo may be compacted due to the ship motions, wave impacts and other vibrations. This means that the space between the individual "grains" of cargo is reduced. The reduced space will lead to increased pressure in the water between the grains, since the limited permeability of the cargo due to its fine particles prevents water drainage. After the compaction, if the amount of water is larger than the space between the particles, the increased pore water pressure will press the particles apart and the frictional force between the grains will be lost. As a result, the shear strength of the material will also be lost and the pile of cargo will flow out to create an almost flat surface; ie, the cargo is transformed into a fluid state.

The liquefied state of granular material is a transient state that lasts for a limited time. After a while, the cargo settles in a more compact state and is less likely to be liquefied. Due to this, liquefaction problems are most likely to occur shortly after loading. Normally, only parts of the cargo will be liquefied at the same time, so in most cases it will be a partial liquefaction.

Liquefaction of very fine (non-granular) materials

The liquefaction of very fine, clay-like materials, such as nickel ore, is principally different from that of granular materials. Nevertheless, the results in terms of the danger to the vessel are comparable.

Unlike the liquefaction of granular materials, where increased pore water pressure is the trigger, the liquefaction of clay-like materials can be seen as a sort of fatigue of the material. After a number of stress cycles due to ship motions, wave impacts and other vibrations, the cohesion and strength of the material are suddenly significantly reduced. Since a number of stress cycles are required, liquefaction problems may occur several days or weeks after loading.

Another difference from the liquefaction of granular materials is that liquefaction may take place in all the cargo on board simultaneously. It is also very difficult to stabilize the cargo after liquefaction.

It is important to be aware of the recent amendments to the IMSBC Code for these cargoes. Up until 2015, the code stated that liquefaction does not occur when the cargo contains very small particles. This sentence was removed on 1 January 2015.

Consequences of cargo liquefaction

The main risk for a vessel carrying cargo that may liquefy is that the cargo may shift. The shifting may be caused by liquefaction or by the cargo sliding. The two processes are different, but the possible consequences are the same; listing, capsizing and structural damage.

The cargo will act as a dense, viscous fluid when liquefied. For standard bulk carriers, the stability now becomes critical due to the free surface effect. Most cargoes that may liquefy are relatively dense, so normally only a small part of the cargo hold volume is occupied by cargo. Combined with the relatively wide holds of standard bulk carriers, this leaves a lot of space for the liquefied cargo to move around in. The destabilizing effect of the free surface may put the vessel in jeopardy. Another possible scenario is that the cargo flows to one side of the cargo hold with a roll, but does not completely flow back to the starting point with the next roll. The vessel may then experience a progressively increasing heel angle, which may result in it capsizing suddenly.

OPERATIONAL CHALLENGES

The possible structural damage is related to the fact that the pressures exerted on non-horizontal cargo hold boundaries, for instance transverse bulkheads, are higher for a liquid than for a dry bulk cargo. Typically, the pressures are increased by a factor of two or three.

On ore carriers, stability is normally not critical, since the longitudinal bulkheads limit the width of the cargo hold. The structural strength, on the other hand, may be more critical than on conventional bulk carriers due to the higher filling level in the cargo hold and because the cargo hold boundaries are not designed to withstand flooding.

The sliding of cargo is not exactly the same as liquefaction, but could be considered as a related phenomenon. Sliding may occur in untrimmed cargo holds during heavy rolling if the inherent cohesion, or "stickiness", of the cargo is too low. We can use sand to illustrate the concept of cohesion. Damp sand is quite cohesive and can be used to make sandcastles with steep or even vertical sides. Dry or very wet sand has almost no cohesion and cannot be used for sandcastles, as any steep slopes will collapse.

Which cargoes are susceptible to liquefaction?
In the International Maritime Solid Bulk Cargoes (IMSBC) Code, the cargoes have been divided into three groups. Group A consists of cargoes that may liquefy, Group B are cargoes with a chemical hazard, while Group C cargoes are considered neither liable to liquefy nor to possess chemical hazards.

The majority of the Group A cargoes are various types of mineral concentrates. There have fortunately not been many incidents related to these cargoes in recent years, most likely because the cargoes are uniform in nature and their properties and condition are well controlled.

Several types of unprocessed ore cargoes are also classed in Group A. Such cargoes have been linked to a number of tragic accidents:

Trans Summer after capsizing.

- Nickel ore is arguably the most dangerous of all bulk cargoes, suspected of claiming the lives of 81 seafarers since 2010.
- Iron ore fines are iron ore with a large proportion of small particles (10% smaller than 1mm and 50% smaller than 10mm). Iron concentrate (sinter feed) is iron ore that has been processed to increase its iron content. Both these iron ore qualities may liquefy if the moisture content is high.

Bauxite is an aluminium ore and is listed as a Group C cargo in the IMSBC Code. However, it should be noted that in some cases the ore is sieved before shipping to remove large lumps. Sieving involves using high-pressure water to force the ore into rotary sieves. In addition to increasing the portion of fines, this adds water to the cargo. Both these factors increase the risk of liquefaction for bauxite too.

DNV GL guideline

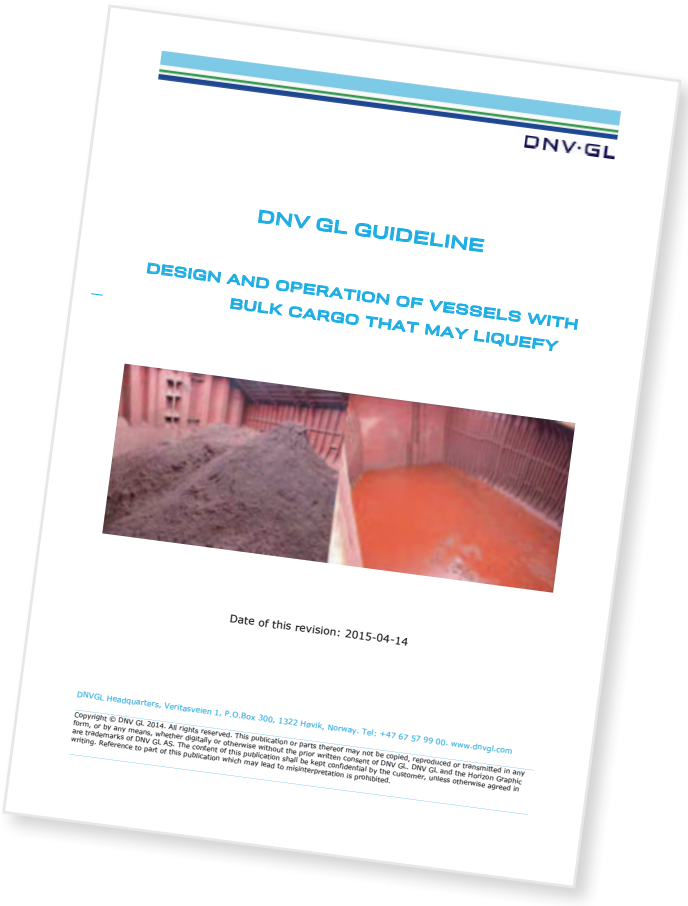
To address the safety risk entailed in transporting cargo that may liquefy, DNV GL has, in co-operation with several shipping companies involved in the transportation of such cargoes, prepared a guideline for the design and operation of vessels with bulk cargoes that may liquefy.

The intention of this guideline is to raise the awareness of the risks of cargo liquefaction on ships, and to describe what mitigating actions may be taken to reduce such risks. The target group is ship designers, yards, ship owners and other stakeholders in the shipping industry.

This guideline focuses on what mitigating actions may be taken at the design stage, as well as highlighting conditions that may call for independent, third-party tests to be conducted to check and report the actual cargo condition prior to loading. The guideline is out for wider review by the industry and is expected to be issued in June 2015. ▮

Dry cargo

Cargo that has liquefied



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OPERATIONAL CHALLENGES

A FANTASTIC VOYAGE

Fednav's Nunavik makes historic, unescorted journey through the Northwest Passage

In October 2014 Canadian shipping company Fednav became the first to send an unescorted commercial vessel through the Northwest Passage. The MV Nunavik travelled from Quebec's Deception Bay to its destination in northern China in just 27 days.

"Favourable weather conditions played a key role in the success of the Nunavik's travels," says Thomas H. Paterson, Fednav's Senior Vice President, Ship Owning, Arctic and Projects. "And the fact that we managed to go via the Prince of Wales Strait shaved an additional 400 miles off the journey."

Overall, the route through the Northwest Passage added up to a total of 6,700 miles – just over half the distance of the traditional 12,500-mile journey through the Panama Canal. This dramatic cut in mileage also resulted in substantial fuel savings and reduced greenhouse gas emissions by more than 1,300 tonnes.

The journey made economic sense

The Nunavik's trip to China is not only the first unescorted journey through the Northwest Passage, but more importantly the first commercially viable voyage.

"Of course we're very happy about being the first to make the journey – but what is more important for us and for our clients is the fact that the journey made sense from a financial perspective," says Paterson.

The Chinese mining company Jilin Jien Nickel Industry Co. Ltd. was both the shipper and receiver transferring 23,000 tonnes of nickel concentrate from its mine in Deception Bay to its facility in Bayuquan, northern China.

Proper timing was one of the factors that made the journey possible. The relatively mild weather conditions in October even allowed the ship's 30,000 horsepower engine to operate at a mere 24% of its capacity while still letting the ship travel at a comfortable (and fuel-efficient) 12 knots.

Arctic experience and high-tech support

Fednav is based in Canada and has a vast amount of experience in shipping bulk and container cargo through Canada's icy straits to Europe and was keen to be the first to make this historic voyage.

"We have shipped two million tonnes of cargo every year in the Arctic for quite some time," Paterson says. The MV Nunavik was

Captain Thomas Grandy

built in 2014 to DNV GL Polar Class 4 and is the most powerful conventional (non-nuclear) icebreaking bulk carrier in the world.

The vessel's hull is designed to be the shipbuilder's equivalent of a suit of armour, protecting the Nunavik as she cuts through up to 1.5 metres of solid ice. Ice navigation specialists on shore and on the ship ensured that the vessel never collided with any glacial ice it couldn't overcome.

Captain Thomas Grandy was one of these specialists and navigated the vessel through the first 1,500 miles of the trip. "The Nunavik is perfectly equipped to operate in very adverse conditions. In the past the vessel has even managed to make its way through ridges of up to 10 metres of fresh ice by ramming and backing away again, so we were not worried about the conditions we were going to face in early autumn. The area where the ship operates has no permanent ice coverage, so most of the ice we encountered was relatively young and therefore easier to break," says the 40-year-old Captain from Gooseberry Cove in Newfoundland.

Grandy received regular ice charts, including real-time satellite imagery via Enfotec's onboard ice-navigation system IcenavTM, to manoeuvre the ship through the icy waters. "This system takes an average of a pre-set number of scans and gives us a much clearer image of ice formation, the flows are more defined and it allows us to find the cracks and leaks. It's much better than conventional radar," Grandy explains. Different ice thicknesses are displayed in different colours. "An iceberg that is made of strong, old ice would show up as bright white, for instance," he adds.

"It's through the extraordinary capabilities of the Fednav team, the ship's crew, and its world-leading technology that we were able to undertake this journey with confidence," Paul Pathy, President and co-CEO of Fednav said in a statement.

Paterson also gives credit to DNV GL, Fednav's longstanding classification and advisory partner.

DNV GL is always in the forefront of technology for ice and Arctic shipping," he says. "Through our many years with DNV GL, we have met frequently, strengthening our relationship and learning from each other. The senior management and senior technical experts at DNV GL promote and support out-of-the-box thinking – and they always have the research, technical knowledge and experience to back it up."

TECHNICAL DETAILS ABOUT NUNAVIK

General information

22 crew members on voyage to China
Maximum speed: 18,1 knots, average speed: 13,5 knots
Journey dates: 19 September - 15 October 2014

Icenav TM

The *MV Nunavik* uses a specialized ice navigation system called IcenavTM to spot glacial ice formations. IcenavTM uses a combination of ice and weather information uploaded by Fednav and a virtual marine radar to provide so-called "egg code charts", which show the amount and thickness of ice coverage in a particular area, and high-resolution satellite images. This specialised information helps the crew manoeuvre through Arctic waters.

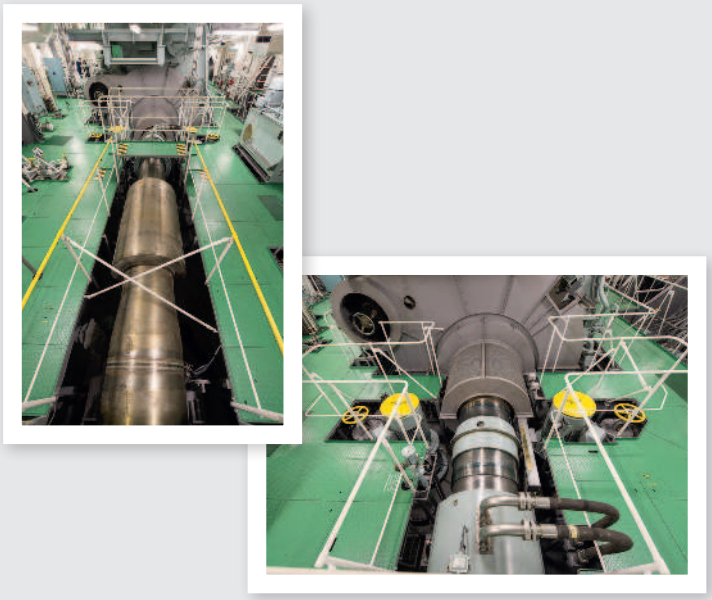
Lights help the crew manoeuvre through Arctic waters.

Three sets of powerful XENON searchlights mounted on the bow, the stern and above the bridge help the crew detect dangerous ice formations lower in the water. "The lights are the only way you can spot so-called growlers, which are weathered bits of old and very hard ice that only just break the surface of the water. The radar often misses these," Captain Grandy explains. In the future, Fednav's ships are set to use drones for ice reconnaissance as well. The Canadian shipping company is currently testing drones on three of its vessels.

Images: © Fednav

Engine and propeller

With an engine that has close to 30,000 horsepower to move almost 32,000 deadweight tonnes, the ship is very powerful – a conventional bulk carrier of the same size only needs an engine with up to 9,000 horsepower. The Man B&W 7S70ME-C engine is electronically controlled and powers a 6.5m-diameter controllable pitch propeller (CPP) that enables the Nunavik to change direction very quickly. Conventional vessels have to stop their engine, then reverse the propeller before they go backwards, but the Nunavik can reverse propeller pitch in one motion and it only takes her 40 to 50 seconds to do so. This is crucial to the vessel's icebreaking capabilities, as it often has to ram its way out of heavy ice coverage. Powerful steering gear enables the ship to go from hard-over to hard-over in ten seconds – significantly undercutting the SOLAS requirement for this manoeuvre (28 seconds).



Structure

The vessel's hull is reinforced to arm it against collisions with ice. While a conventional bulk carrier's hull is about 10 to 12 mm thick, the Nunavik's bow is reinforced with up to 47.5 mm of high-tensile steel and the stern is up to 31 mm thick. In addition, both sides of the ship are strengthened with a 33.5 mm ice belt. The ship can also flood the ice area ahead with warm water to reduce friction using the ballast water system. The system's pipes lead up to a ring of holes in the bow and can pump out up to 3,000 cubic metres of warm, ozone-treated ballast water per hour – roughly the equivalent of 12 million cups of coffee.

Bumpy ride

The vessel's high level of stability allows it to roll much more than other ship types. At times on its way to China the Nunavik rolled up to 45 degrees.

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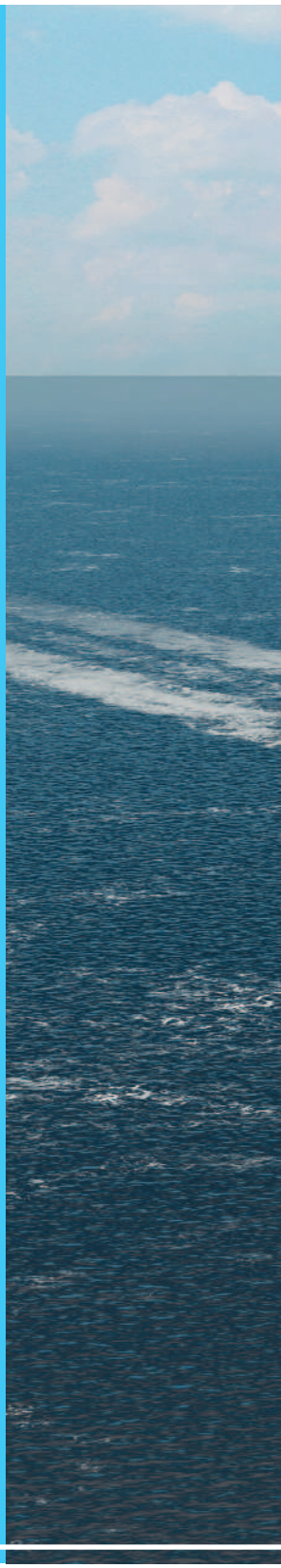

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