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The Royal Institution of Naval Architects is proud to announce that as of January this year, *Naval Architect* journal has gone digital. We are very pleased to inform the maritime industry that each issue will be published online, on the RINA website. Visit www.rina.org.uk/na and click on the issue cover you wish to view. This means that the entire publication, including all editorials and advertisements in the printed edition, can be seen in digital format and viewed by members, subscribers, and (for a limited time) any other interested individuals worldwide.

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Opportunity knocks

Designing and building tankers is not merely an exercise in economics, but a regulatory minefield that naval architects must negotiate.

The IMO is working hard to meet its climate change targets and to ensure that safety remains paramount in the industry. Newly installed secretary general Koji Sekimizu was the guest of honour at the RINA annual dinner in April, when he was introduced by RINA's president, Peter French, as a man who did not see "problems" but rather "opportunities".

The first "opportunity" that came Sekimizu's way following his appointment was to convene a meeting to discuss passenger ship safety. However, the meeting had to be postponed following the loss of *Costa Concordia*. Let's hope that is not an opportunity missed, though it seems likely that regulators will return to this issue in time.

Next opportunity was the introduction of the IMO's Energy Efficiency Design Index (EEDI). That debate has raged at the IMO for some years now and has resurfaced in the pages of this magazine recently.

Denmark's contribution to the discussion was informed by the statistical evidence supplied from the Danish Technical University (DTU) (see *The Naval Architect* in both the March and April issues).

This month Michael Osborne offers the riposte to DTU and the Danish view on EEDI. And he begins strongly with: "The first point to make is that the EEDI was not developed as a measure of hydrodynamic efficiency, which it certainly is not."

Osborne's point that crude is transported largely in cargoes of around 1 million barrels or half a million barrels and that this determines the size of a tanker along with the density of crude and the size of ports that handle the ships are a sharp reminder that these discussions are complex and there are few easy answers. In all probability the gain through finding an efficiency will see a cost, usually in dollars.

A fact that moved Osborne to write: "Kristensen also suggests that owners could design more efficient ships if they were to stick to sound design principles instead of being driven by economics. This strikes at the very heart of a naval architect's purpose in life!"

Osborne's indignation is formed from years of designing cost-efficient tankers for a major oil company. Designers design for owners within a framework set by the regulator. That principle still holds, but now new environmental regulations are being addded to the design recipe and these new ingredients will also bear a cost.

In fact during the sixties and seventies a number of major tanker accidents saw pollution of the seas and beaches giving rise to MARPOL regulations. Ships had to change to meet new safety regulations.

The focus on marine pollution has now shifted and since the 1990's there has been a growing concern about air pollution and global warming. Shipping is not exempt from these challenges and designers must look at ways to accommodate new regulations in which ships emit fewer pollutants into the atmosphere. It is fair to say that shipping has been slow to react to the challenges of air pollution. It is only since the very early part of this century that ship designers have really started to focus on designing ships that reduce emissions into the atmosphere. But, applying the best ship designers' minds we can see the opportunity has been taken through a plethora of ways to cut pollution and costs. Slow steaming, Mewis Ducts, re-designed hull forms, waste heat recovery systems, scrubbers and other systems abound.

New regulations offer engineers new opportunities and designers will be challenged to put atmospheric pollution at the forefront of their designs. That has been achieved through the introduction by regulators of economic penalties for atmospheric pollution.

Peculiarly the marine pollution debate has returned to IMO, but this time rather than sinking tankers it is the humble propeller shaft stern tubes bearing that is driving the debate. If the research is correct and oil equivalent to 137 *Exxon Valdez* disasters is spilt every year from stern tubes then this a significant opportunity that should be dealt with.

Regulators at the IMO are looking at the efficacy of sea water lubricated stern tubes as described by Craig Carter from Thordon's Bearings (page 32). According to Carter owners cannot lose with sea water bearings because no pollution can take place; there is no need to carry lubricant and stern seals cannot be damaged. They are more cost effective to install and maintain.

If the statistics are correct and the technology works this would be what one former IMO official called the "low hanging fruit" in maritime pollution terms.

At the IMO Sekimizu must surely see sea water bearings as an opportunity to make a significant, early and positive change to the maritime industry. Now there's an opportunity not to be missed. *NA*

Shipyards

STX Europe remains on the market

South Korean shipbuilder STX has said that its European subsidiary, STX Europe which is comprised of STX France and the Turku yard STX Finland, are still on the market.

Earlier this year the company released a statement confirming that the company was for sale. "STX Europe AS confirms that we as part of our ordinary course assessment of available strategies are exploring the viability of a sale of shares in the company," said the statement.

The company has appointed JP Morgan Chase Bank NA of Hong Kong and Standard Chartered Securities Korea Ltd to handle the share sale. However, the company stressed that there is no certainty that a sale of the shares in the subsidiary will take place.

STX was said by some observers to have over-extended itself when it used down payments for new vessels to invest in foreign yards, this left the company without the liquidity to build ships that were contracted.

As a further consequence of the cash flow difficulties the Dae-Gu factory that opened in 2009 to build pumps and turbochargers was also meant to have a precision casting plant attached, but "the money ran out" said an STX source.

CNG

RINa in world's first maritime CNG project

Indonesia's electricity utility PT PLN (Persero) has appointed Italian classification society Registro Italiano Navale (RINa) to help develop the world's first maritime Compressed Natural Gas (CNG) project.

The project is expected to deliver up to 6000 standard cubic feet (mscf) per day of CNG from the Indonesian island of Gresik which will then be transported to, Lombok (another Indonesian island), where it will power the Peaking power plant. The first gas is expected in 2013.

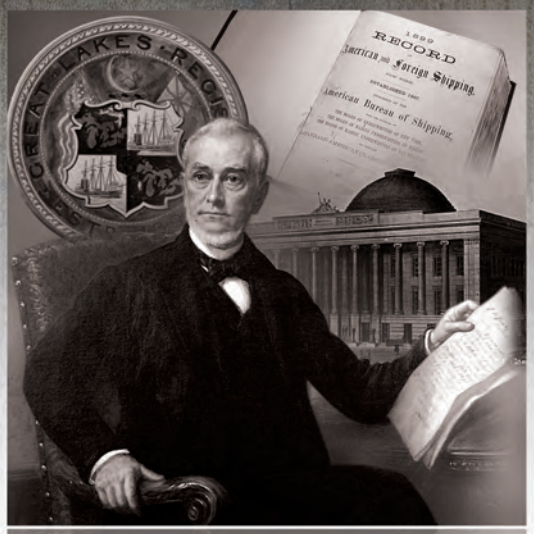
"RINa has already delivered the feasibility study, and is now developing the Front End Engineering Design [FEED]. This will be followed by support during tendering and the provision of project management support during the Engineering Procurement and Construction [EPC] phase. Tendering will open in May 2012 and a number of different technologies are being considered," said the class society.

The Gresik/ Lombok scheme is a pilot project that will allow the use of cheaper natural gas in place of liquid fuel for power production. If the pilot is successful the marine CNG technology will be applied to other power plants across the country with similar or larger capacity. PLN has mapped out potential utilisation of CNG in Indonesia. CNG will come from low-capacity gas wells, marginal gas wells, gas flare and surplus gas as a result of a fluctuating gas absorption pattern.

RINa says: "A number of technical solutions are still being considered. Sources close to the project say the most likely option is a series of barges carrying road-transport type steel pressure vessels [for the transpotation of the CNG]. It is likely two tugs and four barges will be built to carry the gas vessels. Building the pressure vessels will take time, but entry into service is set for 2013."

In addition RINa will advise on the most appropriate logistical pattern, design of the compression and decompression terminals, and

Lombok Island CNG terminal where the Gresik CNG will be delivered.



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documents for EPC tender for construction of the marine CNG facilities. The class society has developed rules for the classification of CNG ships, which are based on new technological guidelines and which take into account experience gained so far in the field.

LPG

Hyundai Mipo signs 8-ship deal

Belgian carrier EXMAR has placed an order for up to eight medium sized LPG carriers of 38,000m^3 from South Korean yard Hyundai Mipo. EXMAR already operates 16 medium sized LPG carriers ranging from 28,000m^3 to 39,270m^3. Delivery of the vessels will start in the first quarter of 2014.

"These vessels will be dedicated to strengthen EXMAR's already substantial commercial portfolio in the midsize segment and designed to stay ahead of the upcoming amendments in environmental legislation say an EXMAR statement."

The ships will have an optimised hull that will reduce drag, thereby making savings in CO_2, they will also have a ballast water treatment system fitted. Space for scrubber technology has been worked into the funnel design while the engine room and deck has been designed ready for switching to LNG or LPG as a fuel. Either fuel will reduce SOx, NOx and CO_2 emissions.

Propulsion

MAN acquires Kappel Propeller

MAN Diesel & Turbo has announced that it will buy Kappel Propeller following the signing of a contract with the propulsion company on 29 February in Copenhagen.

The two companies have collaborated on a number of projects over a period of nearly 10 years initially with the deal to supply propeller blades for the Scandlines ferries *Prins Joachim* and *Kronprins Frederik* in 2004.

"In today's market green technology, fuel-savings, energy optimisation and increased propulsion efficiency are more important than ever – for both new ship designs and for existing ships' retrofit and upgrade solutions. The energy-saving technology, which MAN Diesel & Turbo now owns - will be matured and implemented in a greater variety of customer solutions including e.g. hydrodynamic integration of rudder bulbs, high-efficiency rudders, hull's flow-guiding devices and ducts," says MAN.

Newbuilding

Viking Prince delivered to Eidesvik

Norwegian shipyard Kleven Maritime delivered *Viking Prince* to owners Eidesvik at the end of March. A second ship in the series will be delivered later this year from the same yard. The LNG powered vessel has immediately gone on charter to Lunding Norway, replacing the company's *Viking Athene*.

The 90m platform supply vessel has been built to the Wärtsilä Ship Design specifications and is powered by two Wärtsilä 6L34DF generating sets with power output of 2610kW/2510ekW and auxiliary power is provided by two Wärtsilä 6L20DF generating sets, 056kW/ 1014ekW.

A Wärtsilä statement confirmed that: "The Eidesvik orders include a unique configuration of the gas electric propulsion system. This is based on a combination comprising the Low Loss Concept for Electric Propulsion, the Wärtsilä 34DF main engines, and the recently introduced Wärtsilä 20DF engine. The dual-fuel units enable, in addition to heavy fuel oil [HFO] and marine diesel oil [MDO], the use of gas as a main fuel for marine applications."

Wärtsilä's ability to offer total concept solutions that include the design of the vessel, the propulsion plant, electrics and automation, and a host of fuel saving and environmentally sustainable options, has given the company a notable competitive edge – particularly in the area of specialty vessels such as Gas PSVs.

The 6550dwt *Viking Prince* has a beam of 21m and a deck space of more than 1050m^2. The dual fuel configuration means that the vessel will meet emissions regulations by reducing the amount of NOx emissions by 85% and CO_2 emissions by 25%. A new state of the art system for purifying ballast water has also been installed.

Viking Prince **was the first of two platform supply vessels to be delivered by Kleven Maritime to Eidesvik.**

Lubricating the engines of trade

Regulatory and commercial pressures are changing the demands made on marine lubes used in two-stroke engines, with lubricant manufacturers offering polarised advice, writes Julian Macqueen.

The use of low-sulphur fuel in Emissions Control Areas (ECAs), and the advent of slow-steaming to stave off the rising cost of fuel, have seen Castrol Marine and Total's Lubmarine come up with opposing market solutions.

Castrol Marine proposes a range of cylinder oils "in order to enable a ship to operate most efficiently, taking into account its fuel sulphur content, engine power and cylinder oil feed rate".

Total, in the opposite corner, claims its Talusia Universal (TU) lubricant "combines the performances of both a high base number [BN] and a low BN whatever the sulphur content".

But, one expert says that the arrival of slow steaming has made the job of the marine lubricant manufacturers that much harder.

Danny Shorten, lead business development specialist: Condition Monitoring at Lloyd's Register and a member of the International Council on Combustion Engines' (CIMAC) working group on marine lubricants, says that slow steaming has tipped the balance on lubricant performance for two-stroke engines.

"In slow steaming, as the residence time of the oil on the liner surface is increased, there is a greater potential for neutralisation demand and enhanced corrosion control," he says.

"It is argued that a higher base number material may be required to manage acidic build up, as, under low load operations, the time between oil injections, and thus residence time on the liner, is increased."

Castrol argues that more neutralisation of acidity is required in deep sea operations [eg while slow steaming], therefore, making the case for a higher base number (it suggests 80BN).

Total's product, on the other hand, has a base number of around 57BN and uses a slightly different chemistry which, it says, increases the neutralising capability of the material.

The science behind both arguments is not in doubt, but what has raised Castrol's hackles is Total's claim that TU can be used in all two-stroke engines whether in an ECA or not.

For Shorten, such a claim given the added complexity that slow steaming brings to the issue can only highlight the need for "unambiguous guidance and support".

"Oil maintains a fluid film on the surface of the cylinder liner for longer under slow steaming conditions and, therefore, has to neutralise more."

And he adds that evidence from the first quarter's FOBAS fuel testing reveals an increase in the average sulphur content per bunker thus making the need for clear guidance even more poignant.

Castrol argues that a generic product is fine until slow steaming increases the demand per unit on the lubricant but, equally, the Total argument is not just about the amount of the base number; it is also about efficiency.

"Why shouldn't a more efficient base number system do the same job as a higher base number that is less effective?" says Dr Holgar Gehring, chair of the same CIMAC working group.

According to Gehring, a single solution for all the cylinder applications "seems like a good approach", but he adds that "it is too early to formulate a definitive answer" to that question.

The debate is not just about chemistry as marine lubricant manufacturers have found themselves having to operate in a very different market.

In the pre-ECA days, the industry used higher sulphur fuel oil for which a base number of 70 or 80 was a "perfect solution", says Gehring.

But, ECAs ushered in a new era where two-stroke engines were operating on low sulphur fuel for longer periods of time. The first problems to emerge included excessive ash build up in the cylinder liner. One theory pointed to the too high base number, and the absence of corrosion on the cylinder liner.

"Corrosion generates a micro structure," he explains. If the surface is too smooth for oil adhesion then piston seizure could result.

As a first step, some oil companies lowered the base number from 70 to 40, but this was not sufficient because "the base number in marine lubricant is a neutraliser and a detergent". And Gehring points out that current technology combines a lower base number with a higher detergent capability comparable to a 70BN lube.

The global marine lubricant market is estimated at US$5.7 billion, according to consultant Power Systems Research. And while Castrol and Total's products both have their strengths and weaknesses, it would seem that an answer to the low sulphur fuel/slow steaming conundrum is still some way off. The companies may be pushing hard to be the solution the market wants but in the meantime, establishing the best feed rate through routine engine monitoring would seem to be good advice. *NA*

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Ancillary equipment

Japan leases to China

Mitsubishi Heavy Industries, Ltd (MHI) has signed an agreement with Jiangsu Masada Heavy Industries Co, Ltd, in Jiangsu Province, China, under which MHI is to license production and marketing of steering gear and deck machinery based on company technology to Jiangsu Masada. Previously, in 2008 MHI licensed deck crane technology to Jiangsu Masada – then known as Nangtong Masada Ship Machinery Co., Ltd. With the latest licensing agreement Jiangsu Masada will now be able to establish a structure for providing three hydraulic marine machines in combination to its customers, a move expected to enable the company to expand its share in the rapidly growing Chinese shipbuilding market.

The steering gear and deck machinery technologies to be licensed are for small and medium-sized sub-Panamax vessels. Hydraulic equipment to drive the machinery will be supplied by MHI. With the addition of these two products, Jiangsu Masada will become the only Chinese manufacturer able to provide all three products under the same brand name – Mitsubishi. The company will also be in a position to pursue marketing synergies, for example by offering a combination of products as a package. The first unit to be produced under licensing is slated for completion before year's end. Plans call for Jiangsu Masada to begin operation of a new plant having more than double the production capacity of its present factory.

www.mhi.co.jp

Ancillary equipment

Elcometer upgrades

To celebrate the first anniversary of the launch of the Elcometer 456, Elcometer has released its latest product upgrade.

Elcometer's team of engineers have developed this latest product feature update to include a new live reading trend graph, allowing users to view the last 20 measurement values as they take readings and a doubling of memory on the Elcometer 456 Model S and T gauges. Users can now store up to 150,000 readings in 2500 batches, Calibration Pin Code Lock – ensuring users do not accidentally change their calibration settings, Tap awake feature – simply tap the gauge to bring the display back to life

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www.elcometer.com

Electronics

Keeping a YachtEye on the cruise market

Oculus Technologies has announced the launch of YachtEye to the cruise ship market. Combining the latest technology with state of the art 3D graphics, YachtEye is an infotainment product that provides an onboard digital experience. Designed to operate as part of the onboard entertainment systems, guests are visually presented with all ship and cruise related information as well as details on local areas, facilities and amenities.

The onscreen graphics of YachtEye show a 3D customised animation of the ship in a realtime location linked to Google Earth. Guests can follow the ship's course, track the route taken and look up information on facilities, such as restaurants, shops and attractions, at planned destinations. Whilst following the ship on the map, local wind and ship speed, air and sea temperature and course settings can be viewed. Important onboard information can also be integrated ensuring guests are kept up to date with the activities schedule, entertainment and dining plans and all aspects of facilities available.

YachtEye is available in three interactive variants: as a television channel as part of the onboard entertainment system, as a touch screen version for an interactive experience and as a portable version for use on tablets and touch pads. All YachtEye variants provide the user with information rich exploration, customisable entertainment and graphical information sources. The variants can work as stand-alone solutions so you can choose the one most suitable or they can be combined to provide the absolute complete infotainment package.

www.oculustechnologies.nl

Propulsion

Humphree goes small

Humphree, manufacturer of Interceptor Trim Tabs, has announced the release of a new smaller interceptor size; the 350mm interceptor.

The 350mm interceptor extends the Humphree range of interceptor models downwards and the available sizes now range from 350mm up to 1500mm.

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Graphical rendering of one of the Sovcomflot newbuilding LNG carriers.

HA350 gives better control of running trim and improved maneouvring at speed is desired, but available space often is limited.

The interceptor is basically a smaller version of the popular HA500 interceptor and produced in same high quality composite material. HA350 is also asymmetric as the HA500, which means that it comes in both a right and a left version, where the shaft is offset to one or the other side. The interceptor can withstand operational speeds of up to 50knots and above.

www.humphree.com

Bridge systems

DSME and STX to install Honeywell systems

Daewoo Shipbuilding & Marine Engineering (DSME) and STX Offshore & Shipbuilding (STX) Shipbuilders have selected Honeywell to provide integrated automation systems on five new vessels. Honeywell has announced that DSME and STX will use Honeywell's Integrated Automation Systems (IAS) in five vessels commissioned by ship owners in Norway, Russia and the US. The projects are valued at more than US$8 million.

DSME and STX will use IAS in vessels under construction for the transportation of liquid natural gas (LNG).

The IAS solution uses Honeywell's Experion Process Knowledge System (PKS), and will manage the machinery and cargo areas of the vessels, including the cargo emergency shutdown system. Honeywell's solution enables the project teams to better manage and control operations and ensure that the vessels comply with strict global standards.

www.honeywell.com

Engines

MAN drives Russian gas business

Russian ship owner, Sovcomflot, has recently selected the dual-fuel MAN 51/60DF engine for an LNG carrier newbuilding programme comprising two confirmed vessels with an option for two more vessels.

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

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

www.mandieselandturbo.com

Deck equipment

Cargotec supplies mooring systems

Cargotec has received an order to supply a total of twenty 150tonne electric MacGregor winches for two pipe-laying heavy-lift offshore construction vessels (N448 & N449), which are currently being constructed at Cosco (Nantong) Shipyard Co Ltd in China. The vessels are being built for Malaysian offshore installation and maintenance specialist TL Offshore Sdn. Bhd, a wholly-owned subsidiary of SapuraCrest Petroleum Bhd. The order is booked in the first quarter of 2012.

Each MacGregor mooring system includes 10 electric mooring winches, wire rope leading sheaves and accessories. "The mooring winch system is designed to maintain its designed limit of movement in all anticipated sea and weather condition," explains Ilpo Heikkilä, vice president for winches at Cargotec.

The two vessels are scheduled for delivery by the beginning of 2014 and will be deployed for marine construction contracts in Australia and regions in the Middle East and North Africa, for major oil companies. Cargotec is scheduled to deliver the mooring systems in the first quarter of 2013.

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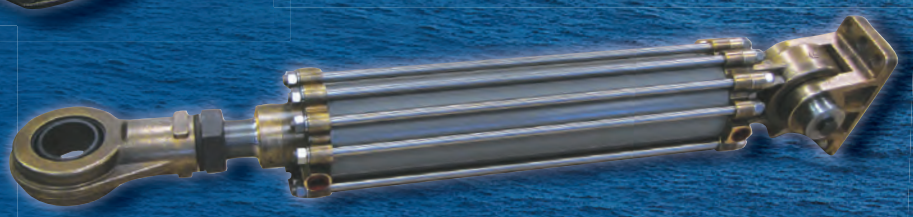

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Design constraints limit options for EEDI compliance

The debate at IMO concerning the Energy Efficiency Design Index (EEDI) for tankers and bulkers continues to foment. Over the last two months the Danish position has been defined by the Danish Technical University (DTU); this month Michael Osborne, a RINA member, offers an opposing point of view.

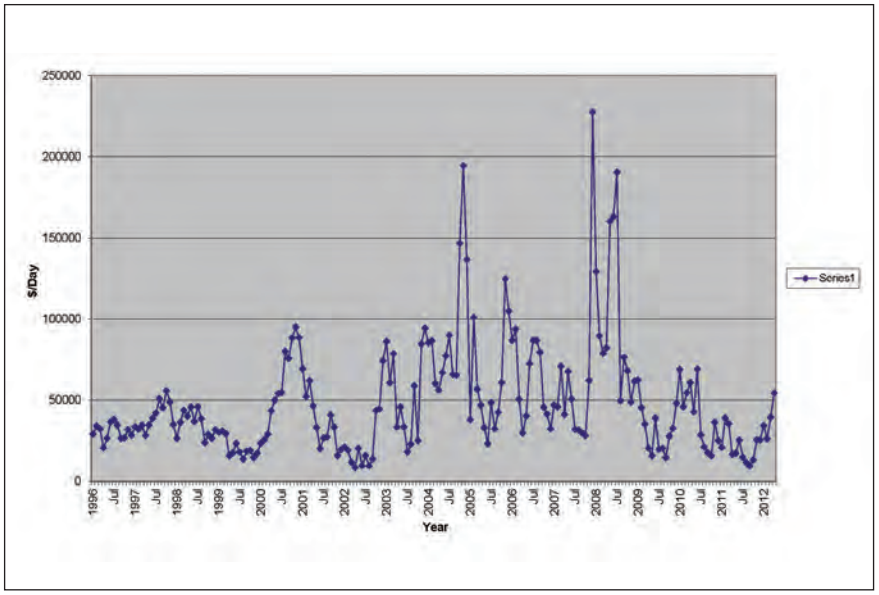
The articles "Back to basics" by Hans Kristensen in the March and April editions of *The Naval Architect* contain an interesting analysis of the trends in the design of tankers and bulk carriers over the last 20 years. The contention in the articles is that the hydrodynamic design of large tankers and bulk carriers, as measured by EEDI developed within the IMO, has become less efficient over this period. Kristensen further maintains that large tankers and bulk carriers could improve their hydrodynamic design, and EEDI, simply by increasing the ratio Length/3√(Volume of displacement) (slenderness ratio).

The first point to make is that the EEDI was not developed as a measure of hydrodynamic efficiency, which it certainly is not. Naval architects think of hydrodynamic efficiency in terms of maximum speed through the water for minimum shaft power, or minimum fuel consumption and thereby minimum cost. The relationship between speed through the water and shaft power is a complex one. The required shaft power can be a function of between approximately the second and fourth power of the speed through the water. The EEDI, on the other hand, is a measure of CO_2 emitted per tonne mile of cargo carried. Its formulation includes engine power divided by speed, both to the power of one, so it cannot possibly represent a measure of hydrodynamic efficiency.

Kristensen has carried out a retrospective analysis of EEDI values for tankers and bulk carriers over the last 20 years and is surprised to find that they have increased. He should not be surprised. The simple reason is that service speeds have increased over this period and since the required shaft power increases at a much greater rate than speed, and the formulation for the EEDI contains power/speed, the trend in EEDI values is obviously upwards.

Michael Osborne, is a retired naval architect and was Chief Naval Architect for a major oil company.

Figure 1.VLCC Spot Rates: source Richardson Lawrie.



But why have service speeds increased? Basic economics dictate that the greater the value of the cargo, and the higher the freight rate, the higher is the most economical ship speed. Figure 1 shows the enormous variation in freight rates for VLCCs over the last 20 years and the most economical VLCC service speed would probably show a similar variation.

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But, naval architects cannot design for the most economical service speed every day for the life of the ship – there has to be a compromise – so a variation of 1 or 2knots in service speed is not a surprise.

Despite this increase in service speeds, there is evidence that hull form design has indeed become more efficient. A comprehensive regression analysis by a major ship model basin, in which all the hull parameters affecting the speed-power relationship were included, established that, surprisingly, the model number was a significant variable. Since model numbers are assigned in chronological order, this demonstrated that the more recent models are more efficient, i.e, they result in better speed-power relationships.

Kristensen also suggests that owners could design more efficient ships if they were to stick to sound design principles instead of being driven by economics. This strikes at the very heart of a naval architect's purpose in life! Surely our aim is to design a ship that will maximise profits (or minimise losses) for our client, while meeting all recognised criteria for safety, structural strength and environmental protection.

Taking the design of a typical modern VLCC as an example:

Lbp	322m
Beam	58m
Depth	31m
Draught	22m
Cargo cubic	343,000m^3
Deadweight	298,000tonnes
Service speed	16knots

The reasons why these dimensions are almost standardised are many:

- Crude oil is traded and transported in lots of 1 million, or half million, barrels. A VLCC is designed to carry 2 million barrels (about 320,000m^3). This defines the required cargo capacity and hence depth.
- Crude oil generally has a density of about 0.81 – 0.85tonnes/m^3. Required cargo deadweight is therefore about 272,000tonnes in order to carry the heavier crudes.
- Many ports and berths have limits on length which are determined by berth length, turning basins and other constraints. Some offshore terminals have limits on displacement. An overall length of about 330m is usually the maximum. A tanker which is longer than this will be denied access to certain tanker terminals.
- VLCC building docks are designed to construct 2 VLCCs side by side, usually limiting the beam of each VLCC to about 58m.
- The draught limit of 22m is imposed by various ports, channels and canals.

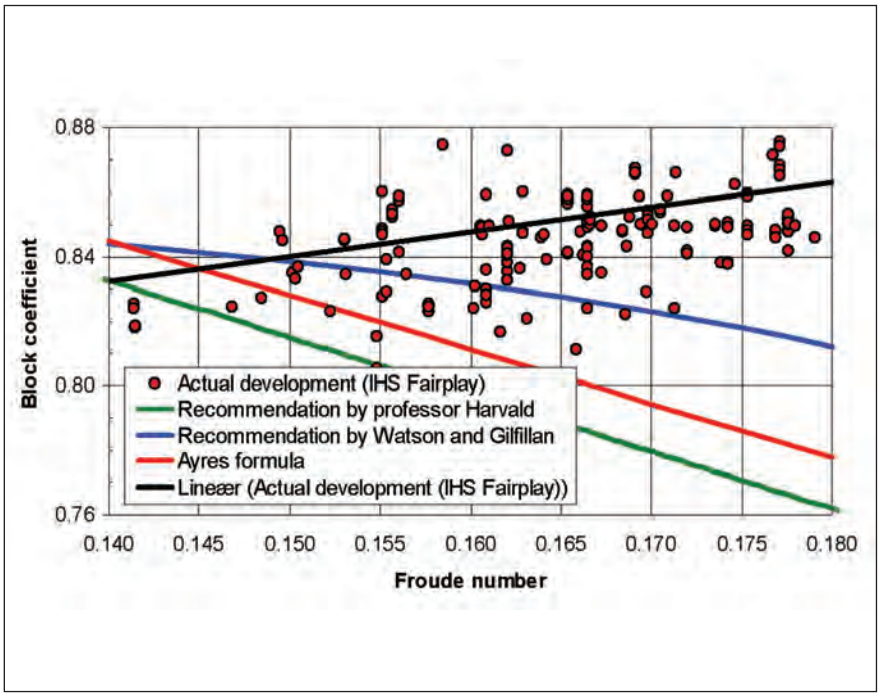

Figure 2. Block coefficient for Panamax tankers delivered between 1971 and 2010.

The designer is, therefore, constrained in the choice of dimensions and unless the VLCC is constructed entirely of very high tensile steel, the lightweight and displacement determine that the block coefficient is in the region of 0.82 - 0.84. Very high tensile steel could be used in order to reduce the lightweight and block coefficient, but it is not favoured because of its larger structural deflections and lower fatigue life than mild steel and moderately higher tensile steel.

Given these dimensions and block coefficient, the naval architect then has to decide how much propulsion power, or service speed, is needed. Nobody can see 20 years into the future to predict how freight rates will develop, nor predict how costs will change, so speed is usually chosen to be competitive with "the market", resulting in a speed at the fully loaded draught of about 16knots.

Kristensen maintains that common naval architectural knowledge and guidelines have not been followed in the design of recent VLCCs, but if we look at the "guidelines*" for Froude number as a function of block coefficient (reproduced in Figure 2 of Kristensen's article in the April edition of *The Naval Architect*), we can see that the Froude number corresponding to a block coefficient of 0.84 is about 0.148 according to Watson and Gilfillan (the most recent of the three guidelines). For a VLCC with a length of 322m, a Froude number of 0.148 corresponds to a speed of 16.04knots. Far from being driven too fast, VLCC hulls with a service speed of 16knots meet almost exactly the most recent "guidelines".

Turning to ways of reducing the EEDI of new VLCCs by 10%, Kristensen claims in his April article that a Panamax tanker can maintain its service speed and reduce its propulsion power by over 10% if the length is increased

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by 5%, reducing the block coefficient from 0.850 to 0.816 (Table 1 of the April article). However, Kristensen has assumed that the Panamax tanker's lightweight increases by only 5% when the length increases by 5%. This seems to be an over-simplification, ignoring the fact that scantlings have to be increased when length increases, due to higher bending moments.

Nevertheless, if we assume that a VLCC design could behave in a similar way and maintain a 16knot service speed through an increase in length of 5% and reduction in required propulsion power of 10%, we would end up with a Lbp of 338m and a Loa of about 350m.

Such an increase in length and displacement would render important oil terminals inaccessible. Kristensen accepts that, for Panamax tankers, a length limit is required because of certain harbour restrictions and suggests that it should be "re-evaluated", but does not explain how this could be done! Dimensional restrictions are key design criteria for any tanker or bulk carrier and naval architects give very serious consideration to the consequences of designing a ship that cannot access a particular lock, canal, offshore facility, drydock or terminal that is essential for the ship's profitable operation. It is not something that can be dismissed by re-evaluating it!

In summary, the EEDI is not a measure of hydrodynamic efficiency and there is clear evidence from comprehensive regression analysis that hull form design and propeller/hull interaction have slightly improved over time, resulting in improved hydrodynamic efficiency. Naval architects should not be slaves to parametric relationships that are usually developed in order to assist the preliminary design process. Our function is to design a ship for our client that can access all the major terminals required for profitable trading and, on present assumptions about future market conditions, is most likely to maximise his net income over its expected life. *NA*

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* The word "guidelines" is put in inverted commas since there is an issue over the basis of the "guidance". A relationship between block coefficient and Froude number can be useful as a preliminary design tool. Such a relationship can be derived simply from historical data using a least squares (or other) curve fit. It is interesting to note that the most recent of the three lines reproduced in Figure 2 of the April article (Watson, 1998) suggests a higher block coefficient (for the same Froude number) than earlier guidelines, confirming the fact that improving hydrodynamic efficiency enables the naval architect to use a fuller hull shape.

Such "guidelines" do not necessarily represent the relationship that results in the design generating the highest earnings since they cannot take into account current or future trends in revenue and costs. There is no law of naval architecture which states that the relationships between any two design parameters MUST obey certain historical criteria, but the naval architect must obviously be aware of the consequences of straying too far from the norms established by successful operational experience.

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Analysing China's shipbuilding industry

An Economic analysis of China's shipbuilding industry in 2011shows that it maintained a steady growth as economic indices kept increasing, achieving a healthy start for the 12th Five-year Plan period (2011-2015) writes The China Association of the National Shipbuilding Industry.

Hampered by the slow recovery of the world economy and as the shipbuilding market remained weak, the volume of new ship orders from Chinese yards dropped significantly in 2011.

Three major shipbuilding indices go in different directions

In 2011, China completed new vessels of 76.65 million dwt, up 16.9% year-on-year. The country received new shipbuilding orders of 36.22 million dwt in 2011, down 51.9% from the previous year and at the end of December 2011, shipbuilding orders in hand amounted to 149.91 million dwt, 23.5% lower than that at the end of 2010. Regarding the completion of new vessels, newly-received orders and orders in hand, China's global market share amounted to 45.1%, 52.2% and 43.3% in terms of dwt.

Industrial production values keep growing

In 2011, there were 1536 designated-size* marine related companies. These companies accomplished industrial production valued at RMB777.5 billion (US$123.4 billion), up 22.2% from the previous year. The percentage increase was 3% lower than the percentage growth in the previous year. Among these companies, shipbuilding firms achieved RMB598.3 billion (US$94.96 billion) turnover, representing a year-on-year growth of 22.5%, the growth was 1.4% lower than that of 2010. Ship accessory companies completed production of RMB90.9 billion (US$14.43 billion), up 30.7% from the previous year, the percentage increase was 5.2% higher than the growth in 2010. Shiprepair and ship breaking enterprises achieved RMB81.1 billion (US$12.87 billion), representing a 13.6% year-on-year growth; the percentage increase was lower than 2010s growth by 17.3%.

Ship exports continue to grow

In 2011, China exported 62.55 million dwt of ships, up 18% from the previous year. Newly-received export orders amounted to 27.67 million dwt, down 51.5% year-on-year. At the end of 2011, export orders in hand amounted to 136.72 million dwt, 17.5% lower than that as at the end of 2010. The proportions of exported vessels in the country's total shipbuilding completion volume, newly-received ship orders and orders in hand amounted to 81.6%, 76.4% and 91.2% respectively.

In 2011, China's designated-size* marine related companies have accomplished RMB319.6 billion (US$50.73 billion) worth of total export deliveries, a 13.4% increase from 2010. Among them, shipbuilding companies achieved RMB274.1 billion (US$43.5 billion), representing a 14.5% year-on-year increase; ship accessories companies completed RMB10 billion (US$1.59 billion), representing a 10.4% year-on-year growth; ship repair and ship breaking companies accomplished RMB30.8 billion (US$4.89 billion), up 6.2% from the previous year.

In the first eleven months of 2011, the total exported value of ship products exported from China amounted to US$39.78 billion, up 8% from the same period in 2010. China exported ship products to 175 countries and regions. Asia and Europe were the major export markets. The total value of ship products exported to Asia was US$19.93 billion, making up 50.1% of the total ship product export value; while the value of ship products sold to Europe amounted to US$8.81 billion, making up 22.1% of the total export value.

Economic efficiency grows steadily

In the first eleven months of 2011, China's marine companies of a designated-size* achieved total sales from core businesses of RMB622.1 billion (US$98.74 billion), up 24.9% year-on-year. Among which, shipbuilding companies achieved RMB473.2 billion (US$75.1 billion), up 25.6% year-on-year; ship accessory companies accomplished RMB76.1 billion (US$12.08 billion), an increase of 30.1% year-on-year; shiprepair and ship breaking companies achieved RMB63.3 billion (US$10.05 billion), representing a 16.3% gain from the previous year.

In the first eleven months of 2011, China's designated-size* marine related companies achieved total profits of RMB48.1 billion (US$7.63 billion), up 25.5% year-on-year. Among which, shipbuilding companies profits of RMB40.2 billion (US$6.38 billion), up 28.4% year-on-year, making up 83.6% of the profit of the whole marine related industry; ship accessory companies earned profits of RMB4.3 billion (US$682.52 million), increased 16.5% year-on-year, occupying 8.9% of the profit of the whole marine related industry; shiprepair and ship breaking companies achieved profits of RMB3.3 billion (US$523.8 million), representing a 14.9% gain from the previous year and making up 6.9% of the profit of the whole marine related industry.

Main features of the economic operations

In 2011, shipbuilding enterprises actively responded to the challenges, ensured deliveries and enhanced their resilience to risks. Completion volume continued to grow. The country's shipbuilding completion volume exceeded 70 million tonnes for the first time, reaching 76.65 million dwt, the highest ever in history.

Leveraging on their advance technology and management, Major shipbuilding enterprises pushed their ship completion volume to a new level. Among them, Shanghai Waigaoqiao Shipbuilding Co Ltd completed production of more than 8 million dwt; Dalian Shipbuilding Industry Co Ltd completed production of exceeding 6 million dwt; Jiangsu New Times Shipbuilding Co Ltd and Jiangsu Rongsheng Heavy Industries Co Ltd completed production of more than 4 million dwt. There are 22 enterprises with ship production volume

exceeding one million dwt in China last year, compared to 19 enterprises in 2010. The top 10 shipbuilding companies completed shipbuilding production of 36.54 million dwt, making up 47.7% of the total production volume in China.

Market restructuring shows effects

In 2011, shipbuilding companies have speeded up fine-tuning their structures and methods to adapt to changes of the market.

Firstly, shipbuilding companies have focused on the development of high end ship types. These major shipyards have received orders and delivered several series of new ship types. Hudong-Zhonghua Shipbuilding (Group) Co Ltd has signed contracts to build four 172,000m^3 LNG tankers and four plus two ships of 10,000TEU or more; while Jiangsu's Yangzijiang Shipbuilding (Holdings) Ltd and Dalian Shipbuilding Industry Co Ltd have been awarded contracts to build 25 10,000TEU boxships and four plus two ships of more than 10,000TEU separately.

Secondly, sizeable enterprises with technical know-how have put extra effort into developing offshore engineering equipment manufacturing. Thirdly, a number of mid-sized companies that are well positioned via accurate market segmentation and specialisation have emerged. The key products of these mid-sized companies are more competitive in the market. They include Zhejiang Shipbuilding Co Ltd's offshore support vessels; Guangzhou Shipyard International Co Ltd's product oil and chemical tankers; and Huanghai Shipbuilding Co Ltd's passenger ro/ro. Fourthly, in order to avoid the cyclical risk of the industry, shipbuilding companies in China have diversified their businesses, expanding into and raising their market shares in non-marine-related fields, such as installation of wind power equipment, coal mining machinery, railway vehicles, underground equipment and automatic logistic equipment etc.

Progress on technology research and development

China State Shipbuilding Corp (CSSC) has achieved breakthroughs in the design and development of high-tech vessels. Hudong-Zhonghua Shipbuilding has developed four models of LNG carriers. Among the four models is a 172,000m^3 LNG tanker equipped with a low-velocity diesel engine and re-liquefaction device which helped the shipyard win an order for four tankers from an LNG project between Exxon Mobil and MOL – the first LNG vessel export order won by a Chinese yard. The shipbuilding subsidiaries and research centres under CSSC has finished the design and development of a series of 10,000TEU boxships, offshore support vessels and specialised vessels; and enhanced their capability over the design and development of offshore equipment such as 3000ft drillship and geophysical survey ship with 16 cables.

China Shipbuilding Industry Corp (CSIC) has also achieved important progress over a series of national technology research projects. Jiaolong, a manned deep-water submersible, has successfully completed its 5000m ocean test. The new generation of CSSC's own brand 6CS21/32 marine medium-velocity diesel engines has been awarded a certificate by the China Classification Society (CCS) and launched into the market. The most advanced integrated science survey ship in China has been launched. The group's self-developed large-scale rotary vane steering gear has received certificate from the CCS. The group has also developed the largest offshore pedestal crane in China.

Jiangsu's Yangzijiang Shipbuilding together with Marine Design and Research Institute of China have developed the new generation energy-saving 10,000TEU container vessel with their own intellectual property rights over it and have already won orders for the vessel – this was also the largest shipbuilding order ever in China.

Market mechanisms prove effective

In 2011, a number of sizeable enterprises have seized the opportunity brought by the changes in the international ship market to improve their business structures via merger and acquisition and restructuring. Among them, Yangzijiang Shipbuilding has acquired 100% of Jiangsu Zhongzhou Marine Equipment Co Ltd and a 40% stake in Jiangsu Xinfu Shipbuilding Co Ltd. Zhejiang Ouhua Shipbuilding Co Ltd has taken over Dexing Shipping Co. Aviation Industry Corporation of China (AVIC) has acquired 70% shares of Shangdong Weihai Shipyard. Rongsheng Heavy Industries Co Ltd has taken over Anhui Quanchai Group. CSR Corporation Limited and Guangxi's Yuchai Group had made a joint investment to establish CSR Yuchai Sichuan Engine Co Ltd.

China's shipbuilding enterprises have also enhanced their innovation, research and development capability via acquiring overseas brands and design companies.

Weichai Group has taken over Europe's largest luxury yacht manufacturer Ferretti. Yangzijiang Shipbuilding has acquired Singapore marine technology and ship design consultancy CS Marine Technology (CSMT). China Communications Construction Co Ltd has acquired marine design firm Friede Goldman United Ltd (F&G). Hantong Heavy Industry has taken over a German design company, while Wison Heavy Industry has acquired Horton Deepwater.

In reaction to the crisis in the shipbuilding market, merger and acquisition, industry transfer and elimination have become the main contents of business fine-tuning of shipbuilding enterprises in 2011. A number of small- to mid-sized shipbuilding companies that could not adapt to the latest development of the shipping market have gradually faded away from the field.

Strengthening basic management

Falling ship prices have brought new challenges to shipyards. Major shipyards and regional key shipbuilding enterprises have actively adjusted their business strategies and kept close contacts with ship owners in order to promote strategic cooperation, look for opportunities in the market downturn, and in particular win orders for high-tech vessels and offshore equipment. These companies have analysed various potential risks and seriously reviewed their existing orders, while at the same time ensured the quality of their products and raised production efficiency, in order to mitigate the effect of the market downturn and guarantee timely deliveries.

Facing declining ship prices and rising costs, shipbuilding enterprises have strengthened their management to lower costs and increase efficiency. Companies have started doing in-depth cost analyses and improved their controlling methods. They have also standardised their debt management through strengthening their capital and internal management

comprehensively; enhanced the centralisation of capital operations; improved risk control capabilities; strived to match key production and operations benchmarks through the delicate management of production processes and to be comparable to Japanese and South Korean players; rearranged production procedures; optimised human resources management and production organisation; unveiled their potential and lowered costs.

Breakthrough achieved in offshore equipment production

China's shipbuilding companies have speeded up their development in offshore equipment manufacturing. A number of advance products have been developed and delivered. Among them are Shanghai Waigaoqiao Shipbuilding's sixth-generation 3000m deepwater semi-submersible drilling platform, the most advanced vessel of its type in the world; the first 300ft self-elevating drilling unit solely designed by a Chinese company - Dalian Shipbuilding Industry Co Ltd; COSCO (Nantong) Shipyard's self-elevating turbine installation vessel; Shanghai Shipyard Co Ltd's 3D seismic geophysical vessel; the world's first 3000m deepwater survey vessel built by CSSC Guangzhou Huangpu Shipbuilding Co Ltd; the world's first 3000m deepwater pipe-laying crane vessel constructed by Jiangsu Rongsheng Heavy Industries; and the world's first GPA696 offshore supply vessel built by Zhejiang Shipbuilding Co Ltd etc. Coslpioneer, the deepwater semi-submersible drilling platform by Yantai CIMC Raffles Offshore Ltd for COSL Drilling Europe AS has successfully drilled oil in the North Sea.

In 2011, the number of orders for offshore equipment awarded to China companies increased noticeably. According to statistics, major enterprises, including Shanghai Waigaoqiao Shipbuilding, Dalian Shipbuilding Industry, COSCO (Nantong) Shipyard, Yantai CIMC Raffles Offshore, Shanghai Shipyard Co Ltd and China Merchants Industry Holdings Co Ltd, have won orders for 18 units of offshore equipment, which were worth nearly US$5 billion (excluding offshore support vessels and supply vessels), making up 10% of the total value of offshore equipment transferred in the world. Those offshore equipment orders received by Chinese companies included mainstream products such as self-elevating drilling platforms, semi-submersible drilling platforms and drilling vessels etc.

Issues concerning economic operations

In 2011, designated-size* marine related companies in China maintained year-on-year growth of at least 10% to 20% in terms of production value, export value, turnover from core business and total profit, thanks to the booming ship market before the international financial crisis. Chinese shipyards have seized the chance to secure a large number of orders at relatively high prices. These orders have helped the sector to achieve higher growth rates in the first half of 2011. However, as production of those low-priced orders sealed after the international financial crisis have commenced in the second half of 2011, the growth rate of production and efficiency benchmarks have shown signs of weakening compared to the same period in 2010.

Monthly orders in hand fall

In 2011, Chinese shipyards received new orders of 36.22 million dwt, down 51.9% from the previous year. About one-third of the shipyards surveyed did not receive any new orders. Among the 43 key shipbuilding companies that were surveyed, two received no new order. As the completion volume has exceeded the volume of newly received orders for 12 consecutive months, companies' orders on hand shank month by month. Without adequate orders, some firms have not enough work to do and some have had no new project to start since the first quarter of 2012.

Market demand structure has changed

In 2011, the demand structure of the international ship market changed significantly. The demands and prices for bulk carriers and tankers built by Chinese shipyards have dropped rapidly. The shipbuilding sector in South Korea has leveraged on their technology, advantage of product structure and government subsidies etc and won most of the orders for ultra-large containerships, LNG carriers and large-scale offshore equipment. Shipyards in China mostly rely on the construction of standard vessels. Under the circumstances where the market of standard vessels was weak, Chinese shipyards which rely heavily on bulk vessel business was severely harmed. The issues of weak R&D capability, slow R&D process and lack of adaptability to the market facing Chinese shipyards are awaiting solutions.

At the same time, the international community has raised their awareness of environmental protection. In recent years the IMO has launched a series of new regulations and new standards, further raising the technical requirements for Chinese shipyards to compete in the international market. Many companies said during the new contract negotiations in 2011, ship owners have showed a greater interest in green ship models that can lower operational costs. Chinese shipyards should accelerate their R&D progress and put more effort into safety and environmental issues.

Proportion of first instalment falls sharply

In 2011, the global shipping market continued to be sluggish. Many shipping companies recorded losses and some ship owners had difficulty paying for existing orders. First instalments of new orders have therefore shrunk sharply which has affected the cash flow of shipbuilding companies. Many shipyards had seen their operational cash flow become negative. On the other hand, shipowners become less willing to take delivery of vessels. Requests for delivery delay, change of ship model, and postponing payment have become more common. Banks have also become more cautious when lending to the shipbuilding sector, making it more difficult for shipyards to raise funds and deliver orders.

Ship repair Volumes drop

In 2011, Chinese shiprepair yards faced great challenges due to overcapacity as the shipping market continued to decline. Both volumes and prices of normal ship repair and single ship repair businesses have continued to drop. Until the end of December 2011, the 17 major shipyards with repair business in China have only finished repairing 3780 vessels with product value

amounted to RMB14.6 billion (US$2.3 billion), down 7% and 4.1% year-on-year respectively. At the same time, the ship conversion market has become stagnant while price competition has become fiercer. According to statistics, turnover and profit from shiprepair and ship breaking in the whole year of 2011 amounted to RMB66.3 billion (US$10.52 billion) and RMB3.3 billion (US$523.8 million) respectively, up 16.3% and 14.9% respectively from the previously year. A note must be made that these income figures included turnover and profit from ship breaking and certain shipbuilding businesses of those shipyards. In fact, ship repair business earned very little and some yards have already recorded losses from their shiprepair business.

Inadequate orders for ship accessory companies

After the outbreak of the global financial crisis, China's ship accessory companies are facing even greater challenges than the shipbuilding firms in the country as Japanese and South Korean ship accessory providers have intensified competition. Some overseas marine diesel engine companies have achieved breakthrough on the limitation on sales region by production license agreement. Leveraging on their advantage of scale, these foreign companies have sold marine diesel engines to China at low prices, hampering the development of the country's diesel engine manufacturing industry. Massive imports also happened in the middle-velocity diesel engine sector, deck machinery and marine generator sectors etc. It became difficult for key enterprises in those areas to win contracts and hence these companies did not have enough work to do. The localisation of China's ship accessory industry has, therefore, progressed slowly.

As the prices of ship accessories fell, advance payments shrank and production costs climbed, companies in the sector have seen their financial status deteriorated; inventory increased; cash flow tightened and it became more difficult for these companies to repay loans.

In 2012, the global shipbuilding industry is expected to face an even more challenging environment. According to some experts the forecast for 2012's volume of global new ship orders is expected to be 70-80 million dwt, and shipbuilding completion volumes are expected to be about 150 million dwt. The imbalance between demand and supply for ships is expected to become more serious. Prices of new vessels are expected to continue going downward; but the prices of 10,000TEU containerships and LNG carriers are expected to remain stable.

China's shipbuilding completion volume is expected to fall slightly in 2012. No improvement is expected on the volume of newly-received orders and orders in hand are expected to shrink. The major economic indices of China's shipbuilding industry are expected to decline as the proportion of high-price vessels among all vessels to be delivered falls sharply, labour costs rise and the pressure of the appreciation of the Yuan mounts. On top of winning new contracts and making deliveries, making profits will become the next challenging issue faced by China's shipbuilding sector in 2012. *NA*

*Designated size = Annual sales of core business reach RMB20 million (US$ 3.17 million).

S-LASS brings findings to the table

The S-LASS network helps Swedish industry to build lightweight ferries. Dr Tommy Hertzberg, head of section, SP Fire Technology, SP Technical Research Institute of Sweden explains recent developments of the project.

SP Technical Research Institute of Sweden, department for Fire Technology, is coordinating the Swedish network S-LASS for lightweight structures at sea. The network brings together expertise, disseminates knowledge and initiates projects. During the past year the network has held the management of several vessel projects, arranged a course on how to design ships in lightweight materials and participated at the Donsö fair.

Between 2005 and 2008, the Swedish national research project LASS ("Lightweight construction applications at sea") gathered almost 30 Swedish and international industries in a study concerning the use of lightweight materials for ship structures. By demonstrating a sufficient level of fire safety, lightweight materials excluded in the prescriptive SOLAS code are allowed through SOLAS Regulation 17: "Alternative design and arrangements", which can bring large economic and ecological advantages , says Hertzberg.

Between 2008 and 2010, part of the previous LASS consortium together with the Meyer-Werft ship yard continued the lightweight ship investigation in "LASS-c"; a study concerning use of lightweight structure materials in a cruise vessel. Also this project demonstrated large economic benefits through the use of lightweight materials for ship construction.

The growing interest in lightweight materials for shipbuilding is also demonstrated in European projects such as the ongoing BESST, "Breakthrough in European Ship and Shipbuilding Technologies" where the study initiated in LASS-c on the cruise vessel *Norwegian Gem*, has continued.

"Many people from Swedish industry, research and national authorities were involved in the projects mentioned earlier and in order to continue the work and to keep the group of competences in contact the Swedish network for lightweight structures at sea, S-LASS was created in 2010", comments Hertzberg. Today, the network gathers organisations from industry, research, class and national authorities .

Figure 1: *Norwegian Gem* used as composite material design case in the

Figure 2: The object for the tanker study. Courtesy of Sirius Rederi AB.

Figure 3: Tanker with composite super structure. Designed by Tillberg Design AB, member of S-LASS.

"The outspoken purpose of S-LASS is to support its members in their work on lightweight structures through the dissemination of information, courses and initiation of projects. The network also monitors regulations (IMO, EU, national) concerning ship design and contributes proposals that can be helpful when drafting new regulations. As an example several members participated in the preparation of a Swedish response to the UK proposal put forth at the 2011 IMO meeting FP55, concerning how to include lightweight composite materials in SOLAS vessels ", says Hertzberg.

By initiating projects, the network in particular wish to provide good examples of using lightweight materials in ships. This includes not only major load carrying structures but also other areas on a ship, such as the materials used for interior design, i.e. the general idea is to investigate and to present parts of a vessel that can be made more lightweight.

Tank Light Module

A project carried out under S-LÄSS is "TankLightModule", which has investigated the feasibility of constructing the superstructure of a 9200dwt tanker in lightweight materials.

The work group produced an alternative design of a superstructure from plastic composites, together with a calculation of the expected payback time. Depending on oil revenues per kg, the payback time was estimated to be approximately 5-7 years for a lightweight superstructure saving about 100tonnes, or over 50% of the weight of a steel structure. The project also performed an investigation comparing lightweight internal fittings with existing designs, finding that about 30tonnes could be saved for a

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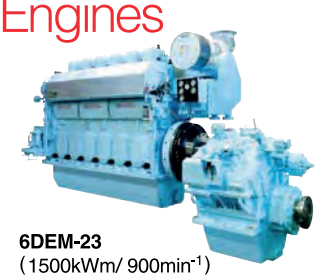

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cost that would be paid back within five years. The results of this investigation were presented in June at the 2011 Donsö Fair. As a direct result of the presentation, a commercial project was initiated that involved several of the S-LASS network members.

"One benefit of plastic composites rather than metallic materials is that it is easier to produce them in specific shapes, e.g. in order to reduce air resistance", highlights Hertzberg.

Summarising the project, it was found that the potential for both environmental and economic benefits were substantial using lightweight materials for and in superstructures, on a tanker of this size.

	Old ferry	New ferry
Regulation	EC-directive, D-area	
Capacity	200 pass. + 6 cars	
Speed	10 knots	
Machinery	588 kW	220 kW
Built	In steel 1993 at Hvidesande	Not yet
L x B x D (m)	30.5 x9.0 x 5.7	30.7 x 10.0 x 3.2
Lightweight (kg)	250 000	72 000
Deadweight		
Ballast	33 900	0
Fuel and freshwater	18 800	8 000
Stores	1 000	
Crew, 3	225	
Passenger, 200	15 000	
Luggage	2 000	
Cars	16 000	
Deck cargo	3 075	
Displacement: (full cargo)	340 000	117 300

Table 1. Comparison between the old steel ferry and the new design in carbon fibre composite.

Eco-Island-ferry

In 2010, the first fully certified plastic composite high speed craft (HSC), was put in use by the Swedish ship owner Styrsöbolaget, owned by Veolia. The use of combustible construction materials is allowed by the HSC code, but not by the European code regulating fire safety on a displacement ferry. However, the European directive 2002/25/EC for passenger vessels does permit the use of the procedure outlined in SOLAS Reg 17, "Alternative design and Arrangements", by which it is possible to demonstrate sufficient level of fire safety when using e.g. a combustible construction material. "The fleet of displacement ferries within the archipelagos of Europe is quite old and it is not uncommon to find companies owning vessels that are 25 years or more on average. They are further often built with a surplus of robustness and engine power in periods when fuel cost and environmental concern was not the main issue", highlights Hertzberg.

There is a need for ecologically and economically sound displacement ferries and wan aging fleet is the background for the "Eco-Island-ferry" project. The project involves several S-LASS companies, but also participants from Denmark through a cooperation with the ERANET-project "MARKIS" .

In this S-LASS project, naval architects together with national authorities, shipyards and fire experts are looking at the potential for building displacement passenger ferries from plastic composites. The project is financed by a Swedish fund (Västra Götalandsregionen) and a Danish fund (The Danish Maritime Fund). The Danish Tunö ferry has been chosen as the reference object for the project, and is redesigned from steel to carbon fibre based composite material.

Some preliminary weight results from the study are shown in Table 1.

The estimated displacement of the new ferry is thus only about 35% of the old steel ferry. The lightweight includes an estimated amount of fire insulation and the fire/risk analysis will have to show whether this weight should be adjusted. In any case, the project results indicate that a substantial amount of weight savings will be achievable. The fire safety level of the new design is being analysed in accordance to the EC passenger ship directive in order to show that the same degree of fire safety will be achieved as when applying prescriptive requirements.

Other S-LASS activities

The S-LASS network organises seminars and courses two to three times per year where issues relating to light weight materials in ship building are discussed. Scientific research is presented together with industrial applications and regulatory questions. The network is also involved in the organisation of the LIWEM conference (Light weight Marine Structures). Further information on the network can be found at www.s-lass.com. *NA*

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Zero oil means zero environmental impact

Seawater lubricated propeller shaft bearings use no oil-based lubricants and can bring 0-EI (zero environmental impact) below the waterline, writes Craig Carter, director of marketing at Thordon Bearings, following the company's presentation to the IMO's DE56 meeting in February.

At February's meeting of the IMO Sub-Committee on Ship Design and Equipment (DE56), a presentation was made relating to the development of a mandatory code for ships operating in polar waters. The presentation entitled, "Eliminating a source of oil pollution on ships operating in polar waters" specifically addressed oil-based propeller shaft lubricants below the waterline during the normal operation of a ship.

After the presentation, a member of the German delegation asked why seawater lubricated bearings were only being considered mandatory for ships operating in polar regions, when it appeared logical to broaden the scope of this proposed regulation to all regions? Indeed, a valid question.

Using oil-based lubricants

Currently, the majority of commercial sea-going vessels use an oil lubricated white metal propeller shaft bearing system. The lubricant used is typically a mineral oil (SAE30) and typical stern tubes contain 1500 litres (396 US Gallons) of oil. Sealed systems have been used since the 1950s. The oil is contained using shaft seals at the forward and aft end of the stern tube below the waterline. The purpose of the seals is to keep oil from leaking out into the seas and into the ship, as well as prohibit the ingress of seawater which may contaminate the oil. However, seals leak oil and some ship owners have paid heavy fines for violating oil pollution laws.

Two types of oil leakage

There are two sources of oil discharges from propeller shaft seals: operational – where oil leaks in order for the seals to work and accidental – where there is damage to the sealing elements, allowing oil to escape into the sea (or allowing seawater to contaminate the oil).

Historically, 'operational discharges' of lubricating oil have been considered normal, and as the discharges have been below the waterline in smaller quantities, in large part ship owners have not been concerned. This has changed over the past decade with better oil detection methods (such as satellite) and increasingly larger oil pollution fines.

Modern seawater bearings have been used for over 10 years without any serious issues arising says Thordon's Craig Carter.

A 142,000dwt tanker equipped with seawater lubricated propeller shaft bearings.

Operational discharges from stern tube leakage have only recently been quantified. The first authoritative study on stern tube oil operational discharges was from Dr. Dagmar Etkin in 2010. Her research was done on port oil discharges from ships, but the author estimates that if the same rates of discharge occur at sea as they do in port, the estimated worldwide annual inputs of lubricants into marine waters both in ports and at sea might amount to four times the port estimate. She estimated that total worldwide use of oil-based lubricants from operational leaks and discharges would then be about 130 million to 244 million litres (34 million to 64 million US gallons.) annually. This would be equivalent to 137 individual oil spills of equal size to the *Exxon Valdez* disaster in 1989.

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At the 11th Shafting Symposium of the Society of Naval Architects and Marine Engineers (SNAME), a large shaft seal manufacturer, Kobelco Eagle Marine Engineering Co. Ltd, stated that: "In stern tube bearings, the radial movement of the shaft is considerably larger than that of bearings for general industrial applications. In addition, external disturbances such as rough seas and vibration are considerable. It is practically impossible to seal the stern tube oil perfectly."

In 2005, the European Maritime Safety Agency (EMSA) set up an agency called CleanSeaNet to provide a European wide operational system for oil slick detection based on satellite-sourced synthetic aperture radar (SAR) images. In 2007, an 18-month study by CleanSeaNet reported on ship pollution totally based on space -borne SAR remote sensing. It revealed for the first time the dramatic dimension of shipping pollution in European waters with 4027 oil slicks detected and reported, not as a result of accidents, but from routine unauthorised operational discharges. Aircraft or vessels verified that as much as 80% of the CleanSeaNet detections were mineral oil.

Ships do not operate in a closed environment. The propeller shaft may become entangled in rope, fishing nets or monofilament lines. The propeller may hit the ocean floor or impact with ice or other heavy objects. Accidental oil discharges have been reported in the press over the past several years from seal repair companies. These companies are hired by the ship owner to fix the seals so they do not leak oil (and prevent seawater ingress so the bearing doesn't seize) and the ship can continue to sail. Since 2008, various press articles have reported over 50 ships operating globally that required stern tube seal repair due to a damaged shaft seal (and this is only what was reported).

Sapphire Princess and *Diamond Princess* are both fitted with seawater bearings.

In 2009, Lloyd's Register reported that: "Defect statistics over the last 20 years indicate that the aft stern bush represents 10% of shaft line failures, with the forward stern bush representing 4% of total failures. Interestingly, the aft stern gland (seal) and forward stern gland [seal] represent 43% and 24% of failures respectively."

In 2010, at IMO's Sub-Committee on Ship Design and Equipment (DE54), a DNV report prepared for the Norwegian Maritime Directorate stated that: "As a potentially relatively large source of operational oil discharge, however, still not effectively regulated and of unknown exact magnitude, stern tube leakage should be addressed as a particular environmental aspect in the polar environment as well as in other areas. Of particular importance under ice operation is the potential for especially high leakage rates, and the proximity to ice with regards to deposition of oil."

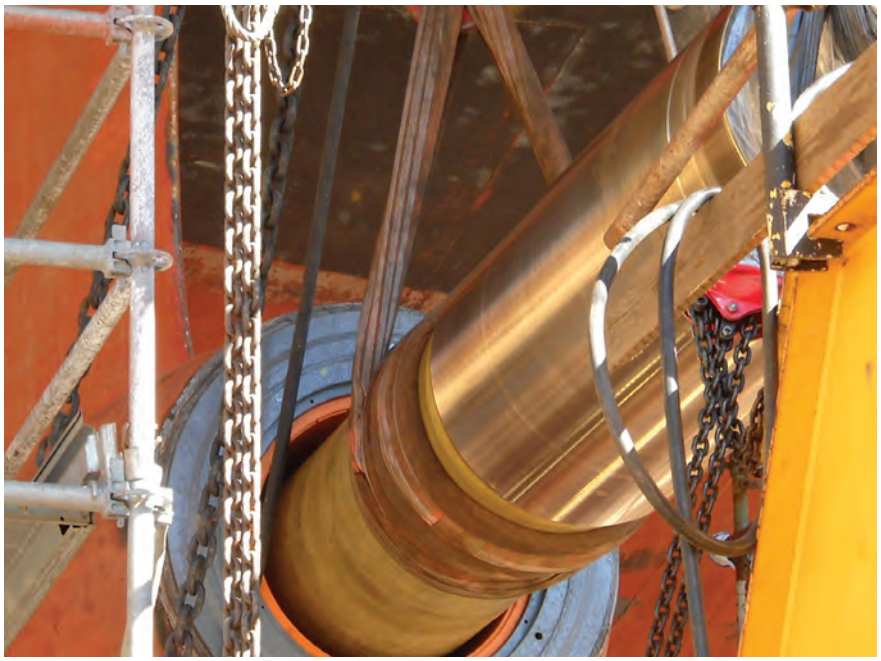
Alternatives to mineral oil

Two 'conventional' alternatives currently in use claim to reduce the impact of discharges to the environment. Seal manufacturers have developed more sophisticated multi-lip seals which reduce the amount of oil that escapes into the sea, but as the ship does not operate in a perfect environment, shaft seals can still be damaged, and oil can still escape into the sea (or seawater water ingress into the stern tube). Biodegradable oils (both vegetable and synthetic oils) are also becoming more widely used. However, the research on biodegradable oils is varied and limited typically to laboratory tests. According to research, birds do not avoid oil slicks (biodegradable oils typically have a strong smell) and may be fatal if their feathers become matted. In the US, the Clean Water Act defines any substance that leaves a sheen, emulsification, or discoloration, as a pollutant and be subject to appropriate fines and regulations governing pollutants.

Non-metallic sea water lubricated ropeller shaft bearings.

Can shaft oil discharges be eliminated?

One alternative that has been overlooked by many ship owners is a return to seawater lubricated propeller shaft bearings. Prior to the 1950s, all ships operated with a seawater lubricated propeller shaft bearing system; seawater was used as the lubricant and wood (*lignum vitae*) was used as the bearing to support the shaft. Bearings



A Seawater-lubricated bearing being installed.

were unreliable – no one knew when they would wear out, as they operated in an uncontrolled environment – wood bearings often had to be changed out after each Atlantic Ocean crossing.

However, there have been significant changes since the 1950s. First of all, the design of a seawater-lubricated system has changed. The seawater is taken from the sea and is pumped through non-metallic bearings before being returned to the sea. The seawater enters the forward section of the stern tube just aft of the seal and then passes through the forward and aft bearing prior to re-entering the sea. Seawater from the sea chest is either filtered or conditioned removing any abrasives in the water. Since the seawater is now cleaner, the non-metallic bearings will last longer.

The bearings used are non-metallic so there is no issue of bearing corrosion. The shaft and inside of the stern tube, however, does require corrosion protection from the seawater. Bronze liners are typically used in way of the bearings and a flexible, anti-corrosion shaft coating is required between the shaft liners. The bronze liners are typically the most expensive part of a ship owner's decision to switch to a seawater lubricated system at the newbuild or conversion stage. New bearing designs and materials currently available have demonstrated long life performance, which has allowed some class societies to inspect the stern tube and not withdraw the shaft. Use of seawater lubricated bearings eliminates the aft seal, as well as the storage, sampling and disposal of oil. The potential impact of stern tube oil pollution is zero, as no oil used.

Seawater-lubricated propeller shaft bearings are still used by most of the world's Navies and Coast Guards for safety reasons and non-catastrophic failure mode. The experience gained from their continuous use has now transferred to commercial ships, as new materials and designs have shown technical equivalence to oil lubricated stern tube systems. One segment of the commercial shipping industry that has adapted seawater lubricated propeller shaft bearings on many of their ships is the cruise industry. For example, Carnival Corporation owns 15 cruise ships using seawater lubricated propeller shaft bearings (all twin screw) with the first ship equipped since 1998 - and that ship is still running with the same bearings. This is quite a contrast to the original water lubricated bearing materials used in the first half of the 20th century where wood bearings lasted only a few years. Currently, there are over 750 commercial ships that use seawater lubricated propeller shaft bearing systems including large tankers, bulk carriers, dry cargo ships and ferries.

Weighing up the issues

Commercial ships have been using new design seawater lubricated propeller shaft bearing systems since the late 1990s with very few issues. Ship owners have saved money as aft seal maintenance costs are eliminated because there is no aft seal. There are no oil storage and oil disposal costs and no emergency seal repair costs. The bearings are acoustically quiet (in use by NOAA and other fisheries research vessels), so there is reduced noise impact on sea life. They pose zero risk to the ocean and sea environment as no oil-based lubricants are used. It also eliminates any risk of criminal or civil penalties and other adverse reactions such as bad public relations for the ship owner that may result from oil-based lubricant discharges into the ocean.

The cons to this type of system are related to the corrosion protection of the shaft and stern tube which may mean a higher upfront cost compared to an oil lubricated white metal bearing.

2020 – Zero ship discharges?

The regulation and elimination of global ship discharges are becoming the norm. Under the EU's directive on "Ship Source Pollution" [EU/2005/35], the OSPAR Commission called to "move towards the target of cessation of discharges, emissions and losses of hazardous substances by the year 2020. In the US, under the Clean Water Act, the EPA now regulates many ship discharges, specifically oil lubrication discharges from stern tubes. The time may be coming when discharges of oil-based lubricants may not be permitted and some ship owners are looking or have implemented other alternatives to using oil-based lubricants.

A seawater-lubricated propeller shaft bearing system offering zero pollution that operates interchangeably in the same space as an oil-lubricated stern tube system can meet the zero discharge requirement. It is not a half step towards eliminating this type of ship pollution but a realistic and existing solution to eliminate oil-based lubricant discharges from the world's oceans and seas today. *NA*

Exhaust emissions prediction and mitigation

In an extract from a paper delivered at RINA's Green Shipping conference in February Dr Alan J Murphy, lecturer in Marine Engineering, and Dr Kayvan Pazouki, teaching fellow both at Newcastle University, outline the maritime exhaust emissions conundrum.

Shipping, despite being a highly efficient form of transport has become one of the world's major air polluters. Pollution from shipping in European waters amounted to 20 – 30% of the SOx and NOx emitted from all land-based sources in the year 2000 according to an EU report.

Despite these concerns demand for global shipping has steadily increased, by 5.5% annually from 2000 to 2007. Increased shipping activity has offset the positive environmental impact of emissions regulations, resulting in a net increase in shipping emissions. Consequently, in 2008 the IMO agreed an amendment of MARPOL annex VI which applies more stringent measures on NOx and SOx emissions from ships.

Additionally shipping's contribution to climate change through CO_2 emissions has received attention from regulatory bodies with estimates suggesting around 3% of the global greenhouse gas (GHG) come from maritime activity. With an anticipated growth in international trade that figure is expected to increase by a factor of 2-3 by 2050 if no action is taken. However, the EU is committed to reducing shipping emissions by 40-50% by 2050, compared to 2005 levels, it said in a recently published transport White Paper.

The IMO has also intensified its work on regulating GHG emissions from ships and focuses on two areas. The Energy Efficiency Design Index (EEDI) sets a minimum efficiency standard for new ships and will become mandatory from 2015. Additionally the Energy Efficiency Operational Indicator (EEOI) encourages shipping to reduce CO_2 emissions by improving fuel efficiency.

Currently there are some mitigating measures and technologies available to reduce air pollution from ships. However, some technologies need further development and some may not be economically viable for installation.

Emission reduction methods

Much research has been carried out on developing technologies to reduce emissions from ships. These abatement measures and technologies can be divided into four main categories as follows:

- **Pre-combustion** measures modify either air or fuel before admission to the engine and restrict the formation of NOx and/or SOx. The use of alternative fuels as a mechanism for exhaust gas emission reduction is also included in this category.
- **During combustion** measures alter fuel combustion characteristics by either introducing water during the combustion process or through tuning engine timing. These technologies predominantly target NOx formation in the combustion chamber by lowering peak combustion temperatures. Engine modification can, in addition, reduce particulate matter (PM) emissions by improving fuel combustion conditions through better atomisation and distribution of fuel.
- **Post-combustion** technologies clean the exhaust gas using either a scrubber and/or by converting pollutants into benign elements by chemical reaction. These technologies do not prevent the formation of pollutants during combustion, instead, remove contaminants post-combustion.
- **Non-engine and non-combustion** are measures that concentrate on managing and optimising shipping activity to reduce emissions. These include optimum maintenance strategies, economic speed and weather routing. Another measure considered in this category is the provision of an onshore [electrical] power supply (OPS) to the ship, when in port. In this case, ship exhaust emissions can be entirely eliminated if all engines are shut down while connected.

These measures and technologies have been variously investigated and their reduction efficiencies have

* There can be potential reduction of CO_2 depending on the source of supplied energy.

Category	Technology/Measure	NO_x	SO_x	CO_2	PM
Pre-Combustion	Humid Air Motor	-70%	0%	0%	0%
	Air Saturation System	-60%	0%	0%	0%
	Exhaust Gas Recirculation	-35%	0%	0%	0%
	Water in Fuel (Max. 20%)	-20%	0%	0%	-40~6%
	Low Sulphur Fuel (2.7% to 0.5%)	-80%	0%	0%	-20%
	LNG	-60%	-90-100%	-25%	-72%
	Hydrogen	-20%	-100%	-100%	0%
During Combustion	Direct Water Injection	-50%	0%	0%	-50%
	Basic Engine Modification	-20%	0%	0%	0%
	Advanced Engine Modification	-30%	0%	0%	0%
Post Combustion	Selective Catalytic Reduction	-90%	0%	0%	0%
	Plasma assisted Catalytic Reduction	-90%	0%	0%	0%
	Seawater Scrubber	0%	-75%	0%	-25%
Non Engine/Combustion	Maintenance	Reduce fuel consumption by 5%			
	Economic speed	-10%	0%	-20%	-25%
	Weather Routing	Reduce fuel consumption by 10%			
	Onshore Power Supply (OPS)	97%	96%	*	96%

Table1: Reduction performances of mitigating technologies.

been published. However, some technologies are not yet ready for shipboard installation and are still at the laboratory stage. Hydrogen-fuelled engines and Plasma Assisted Catalytic Reduction (PACR) are examples of successful technologies at laboratory scale. Although laboratory results of these technologies have been successful, further research is required to prove their viability for shipboard installation. Table 3 presents an overview of reduction potentials of different technologies and measures and Figures 1 to 4 display the performance of these technologies in each category in graphical format.

Figure 1 reveals that measures which introduce water into the cylinder target mainly the reduction of NOx, but not SOx. However, hydrogen and LNG as alternative fuels offer more effective reduction potentials for all the exhaust gas pollutants. Basic engine modification (Figure 2) reduces NOx emission by exchanging conventional fuel valves with low NOx fuel valves, while advanced engine modification optimises combustion, fuel injection and charge air characteristics to gain a greater reduction. Both basic and advanced engine modification are only effective for NOx reduction whereas direct water injection claims to also reduce PM emissions. Figure 3 also shows that post-combustion methods such as selective catalytic reduction and scrubbers are effective at reducing NOx and SOx emissions. They both also reduce PM emissions, but have no effect on CO_2. With the exception of Hydrogen and LNG, none of the measures and technologies in the categories of pre-, during- and post-combustion reduce all exhaust gas pollutants as standalone methods. Interestingly, non-combustion measures, shown in Figure 4, can reduce all four pollutants from ships, the most effective one being OPS (AKA, *cold ironing*).

The reduction potentials of measures and technologies presented in the Table 1 suggest that LNG and hydrogen as alternative fuels and onshore power supply are promising measures for the reduction pollution. Hydrogen-fuelled engines, despite their emission reduction capability, are not yet ready for shipboard installation and additionally, worldwide availability, shipboard storage, handling and usability as well as economic aspects of it need further research before being considered as realistic option. A study by Levander and Sipilä evaluated the onshore power supply and alternative fuel concepts using dual-fuel auxiliary engines burning LNG at local areas for a 7300TEU container vessel. They compared the environmental and economic outcomes of the two concepts and concluded that LNG is an attractive option for reducing the total, and especially local, emissions from ships.

Regulatory authorities focus on the local reduction of exhaust gas pollutants such as NOx, SOx and PM because there is a local environmental impact from these emissions. This is not the case for CO_2 as it has a direct impact on the global warming irrespective of the point of emission. Accurate engine models that predict exhaust gas emissions when coupled with an environmental model can help understanding and measurement of the possible impact of ships emissions at any part of their commercial profile. These models can later be utilised to effectively manage the voyage profile of ships to reduce the impact of emissions.

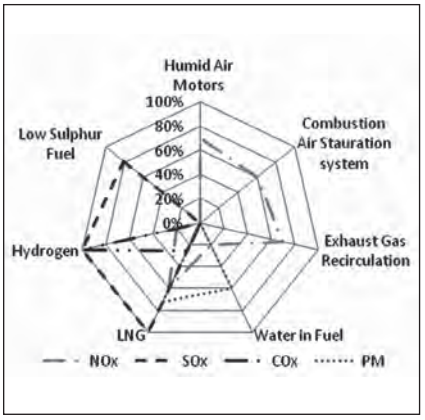


Figure 1: Reduction potential for pre-combustion measures.

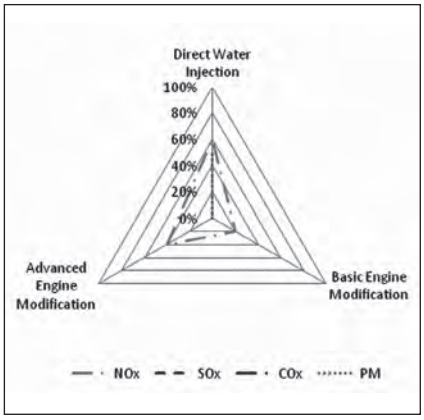


Figure 2: Reduction potential for during combustion measures.

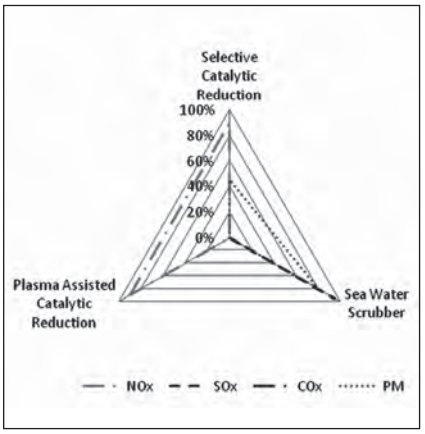


Figure 3: Reduction potential for post combustion measures.

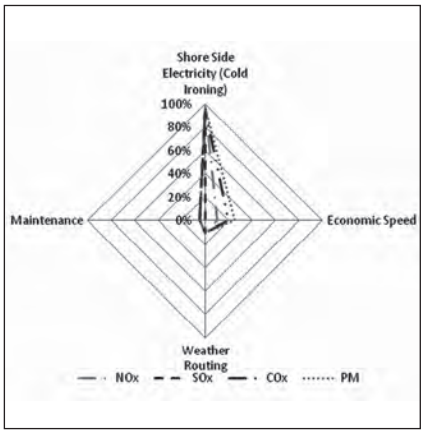


Figure 4: Reduction potential for non-engine/combustion measures.

Predicting exhaust emissions

Despite the regulations and a plethora of technologies which target the different emissions with varying degrees of effectiveness, these neglect to account for the actual operating conditions of the vessels, including engines, propeller and hull as a coupled system.

Furthermore, in order to make operational judgements, whether that be from the tactical point of view of the ship staff on a day-to-day basis, or at a fleet-level to inform strategic decisions on fleet

composition, for predicting the generation of the different emissions is another important tool for reducing emissions.

There are a variety of methods available of varying degrees of sophistication and accuracy and these can be classified into three categories:

- Base-line methods
- Intelligent methods
- First principles methods.

Base-line methods include the simplest estimation models in common use. Usually aggregated technical and emissions data is used resulting in highly aggregated predictions with low spatial and temporal resolution. Nevertheless, in the absence of large volumes of detailed data for individual ships, these methods serve to provide a first estimate, or *base-line* estimate, of the exhaust gas emissions from ships.

For example, these methods are usually used to prepare emission inventories for particular geographical regions such as ports and for making aggregated estimates of the contribution of shipping to the global, continental or national emissions. Furthermore, they are routinely used to generate input data for environmental models which predict the spread and evolution of airborne emissions throughout geographical regions.

These emission estimation methods can be divided into three tiers of increasing levels of complexity, matched with the quality and amount of ship-specific data available.

At Tier 1 the input data is simply a statistical view of fuel usage (often determined from bunker sales) coupled with highly aggregated emissions factors, based on the average technology of the global fleet.

At Tier 2 the input data requires that details of the engine technology on board individual ships is known, allowing the inclusion of technology-specific emission factors.

At Tier 3 there is a requirement that in addition to data on shipboard technology, some level of detail of individual ship activity is known. To date, ship activity data is only usually categorised in three phases. That is, over the duration of a complete voyage, ship time is spent in hotelling, manoeuvring or cursing. For each of these modes of operation and for each fuel type, a separate emission factor can be used. Therefore, using the total mass of fuel consumed per engine per activity mode in each phase of the voyage leads to a total emission estimate.

Often while attempting to generate emissions inventories for large numbers of ships over a wide geographical area, the raw data for many of the required parameters is not directly available. Therefore, strategies are also suggested for estimating missing data. For example, it is also common practice to estimate the fuel consumption during particular activities from some level of knowledge of the engines' rated installed power and multiply this by an estimation of full-load specific fuel consumption and again by an estimated load-factor fraction that accounts fuel consumed by engines operating at part-load.

In practice, when using these methods to prepare emission inventories for large numbers of ships, the data quality across the fleet of interest can be variable, requiring a combination of this tiered approach to be used, applying, for each ship or group of ships, the most sophisticated method relevant to the available data.

The principal challenges with base-line methods lies in the lack of high quality raw data for any given calculation. Information on technology, ship movements and emissions data is often unreliable.

Nevertheless, these methods are relatively simple to use and can give aggregated estimates of emissions contributions from large numbers of ships. They are also useful for generating a base-line for emissions contributions from shipping against which, for example, comparisons to other emitters can be made and/or allows the formulation of operational and regulatory strategies to mitigate emissions.

A more complex calculation comes from using *intelligent methods*. That is those which can relate the physical causes of emissions to their rate of production beyond simply attributing a statistically derived emission factor to the mass of fuel used. These methods facilitate more refined predictions for individual ships or engines, or a subset of ships, than is possible by using a base-line approach alone. The application of these methods may eventually lead to prediction of emissions under transient engine conditions – for example, during manoeuvring.

Artificial Neural Networks (ANN) have been investigated as one modelling method which might be able to relate the causes (input layer parameters) to effects (output layer parameters). A recent study focussed on a Wartsila, RT-flex60c slow speed diesel engine. In this study nine causal parameters were used as the input to the model, including engine speed, n, mean effective pressure, P_e, injection and exhaust valve timing. Six emission components were identified; CO, CO_2, HC, NO, Soot and PM. And, while the experiments for training and subsequently testing the ANN were performed under highly controlled conditions on a test-bed, rather than under the less predictable conditions with the engine in-service, the method reportedly shows good potential for making future predictions of marine engine exhaust gas emissions.

Another approach that could be used is regression analysis techniques and response surface methodologies, similar to those used in dimensional analysis and branches of statistics.

For example, it can be supposed that production of NOx is a function of parameters such as engine speed, n, compression ratio, r_v, mean effective pressure, P_e, maximum combustion temperature, T_m, air-fuel ratio, λ, etc. i.e.

$$NOx = k_1(k_2 n^a . k_3 r_v^b . k_4 P_e^c . k_5 T_m^d . k_6 \lambda^e \ldots)$$

The unknown coefficients, k_n, and indices, $a,b,c,\ldots$, could then be resolved through a least-squares-errors fitting of sufficient measured data to the formulation.

The advantages of intelligent methods over base-line methods is that predictions of emissions for individual scenarios can be achieved – taking into account the instantaneous operating condition of the engine onboard the ship. The level of detail that could be included will be

dependent on the number of causal parameters and output exhaust species that can be associated with each other.

These methods require further investigation to fully establish the relationships between cause and effect.

Perhaps the most refined methods for predicting emissions can be described as *first principles methods* include modelling the details of the mechanical, thermodynamic and chemical processes in an engine. The interactions between the hull, the propeller and the engine, leading to the precise conditions in the combustion space and hence the constituents of the exhaust gas are highly complex. Therefore, the underlying model assumptions and level of modelling sophistication and/or supporting empirical factors in a *first principles* model needs to be carefully considered and a trade-off between computational power and time against the prediction accuracy of the exhaust gas emissions is required.

At the highest level of sophistication it is desirable to generate a model for engine operation that can predict emissions generation under steady-state full-load as well as when the ship and engine systems are operating in either part-load (e.g. slow steaming) or transient conditions (e.g. while manoeuvring). To investigate the possibility of such a tool, as part of the Clean North Sea Shipping Project at Newcastle University, a time based, first-principles simulation tool has been developed.

The time-based simulation approach has been chosen for investigation because of a number of potential advantages it can provide. This approach allows transient conditions to be modelled, which is particularly important as there is a focus and need to predict exhaust gas emissions in areas of high population density, such as in port.

In addition, a steady-state condition within the model can also be achieved, in the same way as in reality, through allowing the simulation to run for sufficient time, after the ship-propeller-engine set points have been entered. And in fact, the simulation time required to achieve a steady-state engine performance can be artificially reduced through control of the initial conditions of the integrators within the simulation.

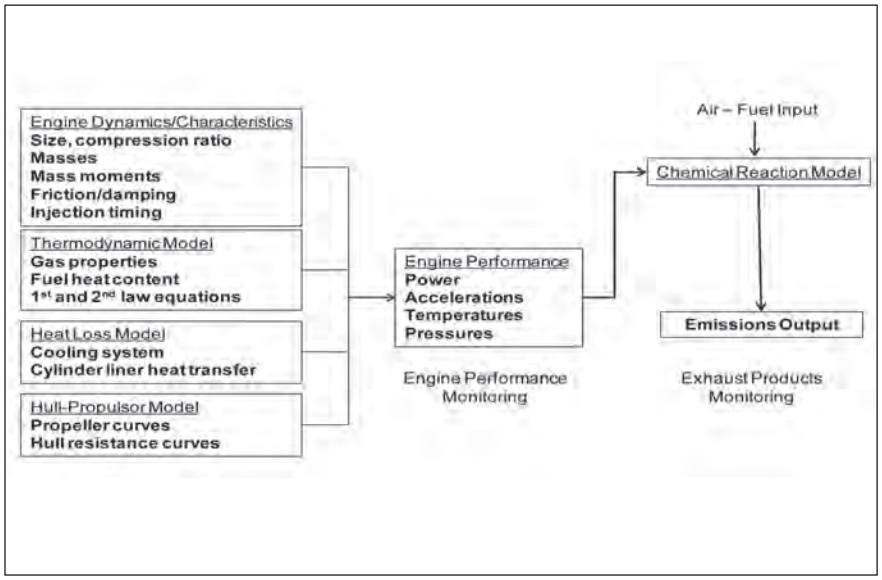


Figure 5: Reduction potential for non-engine/combustion measures.

A time-based simulation also allows its use as a training tool, in which the user can observe the effects on engine performance, in all respects, from the time-varying output of the simulation in response to initiating changes to engine control input parameters. In this way, it provides not only a tool through which higher-level operational and design decisions can be made, but also allows ship staff the opportunity to understand and predict the outcome on engine performance of day-to-day operational choices.

It also allows the precise operational condition of the coupled hull-propeller-engine system to be taken into account and therefore, not only can it show instantaneous performance levels, but can also be used to guide engine maintenance or modification strategies for improved emissions, by changing air inlet temperature, valve timing, injection timing or inlet air conditions for example.

The model under development is shown schematically in Figure 5. It assumes a lumped-mass model of the engine and propulsion chain, similar to that assumed in dynamic response models for engine vibration and torsional responses. In this case a piston and crank model are coupled through their kinematic relationships, for displacement, velocity and acceleration. A differential thermodynamic model, based on energy conservation and mass conservation, is then used to calculate the instantaneous cylinder gas pressure, and hence force, acting on the face of the piston. The total moment on the shaft is derived from the sum of the moment due to the gas pressure acting through the connecting rod, a frictional component of torque and the propeller torque, which can be specified or derived through propeller design curves. Solving the equations of motion for the piston-crank-shaft system, in response to gas-induced forces and total shaft torque, allows the time-dependent motion of the piston-crank-shaft to be resolved.

To date the fuel-addition and combustion process is modelled as a rate of heat addition per unit time between the start of injection and the completion of combustion. Heat loss is accounted for through a one-dimensional convection-conduction model and temperature-dependent instantaneous gas property, γ, is derived using published values for different elements and molecules.

As yet the model does not predict NOx or PM emissions since the simulation tool is in development and establishing that the approach can accurately model engine performance in terms of salient pressures, temperatures, power output, etc. has been the priority because it

is imperative that these pressures and temperatures can be accurately predicted since the chemical formation models, which will follow, are wholly dependent on them.

To give an example of the success of the approach to date, Figure 6, compares the predicted power card and actual power card for a cylinder of a four-stroke marine diesel engine, running at 600.5rpm, developing 369kW per cylinder. This demonstrates good agreement between the actual and simulated power cards. Once further validation studies, now being conducted, are complete, the emission predictions models, also under development, will be included.

Direct measurements of emissions

Another approach to assessing exhaust gas emission levels is to directly measure their production onboard ship. As noted in the base-line methods, there are only limited published data sets of such activities and, since regulations to mitigate ship emissions do not actually require this activity, there has been little imperative to undertake monitoring campaigns more widely.

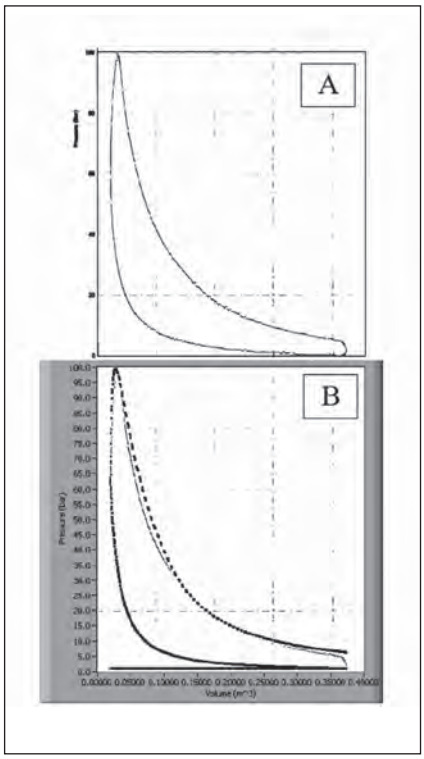


Figure 6: Comparison between a power card taken from cylinder of a four-stroke marine diesel engine, A, and the simulated power card for the same specification, overlaid on the original power card, for comparison, B.

Clearly there are a number of barriers to monitoring emissions in real-time on board ship, including the investment required in the equipment and data handling infrastructure, particularly from the perspective of associating the measured emissions values with the other causal parameters which would be required for meaningful interpretation of the data. Additionally, caution should also be exercised in interpreting the results since the equipment for monitoring and measuring exhaust gas emissions can often return results with high levels of variability.

Besides the technical and financial challenges of using direct measurements for assessing emissions factors and indices, there may be reluctance to voluntarily undertake this activity from a commercial perspective. In particular there is a risk of negative perceptions if high emission levels are revealed under realistic operational conditions, as opposed to maintaining a conservative stance of correctly meeting (or nominally exceeding) regulatory requirements, which require no subsequent reporting of actual emissions produced.

Emissions indices

To date, the principal mechanism for controlling (with the intension of reducing) exhaust gas emissions from ships is through the IMO MARPOL ANNEX VI and, where relevant, regional regulations. These regulations have set nominal rated limits on engine design (for NOx) and fuel quality limits (for SOx), but do not require measurements or monitoring of the actual emissions produced in operation and therefore, under this regime, as Figure 7 demonstrates, operational choices will ultimately dictate the actual levels of these emissions from ships. In addition, more recently, the concept of efficiency indices (EEOI and EEDI) has emerged to encourage a reduction in GHG (CO_2) emissions from ships through reducing fuel usage per unit transport effort. Although, since minimising fuel usage is already financially in the best interests of the shipping companies, one could suppose that there is limited scope for further reduction through this strategy alone and as has been shown in other studies, again, as noted in Figure 7, might actually be in conflict with other emission reductions.

While many technologies exist at differing technology readiness levels to reduce exhaust gas emissions from ships, as the issues and regulations for exhaust gas emissions control from shipping increases it will become ever more important to establish the tools, methods and strategies for predicting, measuring and controlling exhaust gas emissions.

This paper has highlighted the various alternatives and shown that the level of sophistication for applying such methods can be appropriately chosen to fit a broad spectrum of desired outcomes – from relatively simple and aggregated base-line methods, to potentially, highly sophisticated prediction methods that could be used to optimise the detail of operation or design of individual ships – which if adopted or more widely available, will no doubt have the consequence of making a net reduction in harmful emissions – particularly in regions where the emissions cause most harm. *NA*

This work was conducted within the Clean North Sea Shipping Project (CNSS), www.CNSS.no. The authors wish to thank and acknowledge the support for this work from the European Commission, Regional Development Fund, Interreg IVB North Sea Region Programme, 2007-2013.

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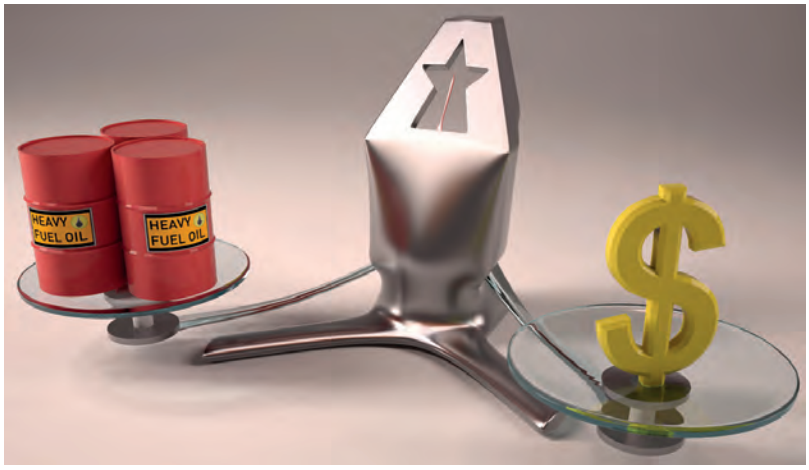
WHEN EFFICIENCY COUNTS...



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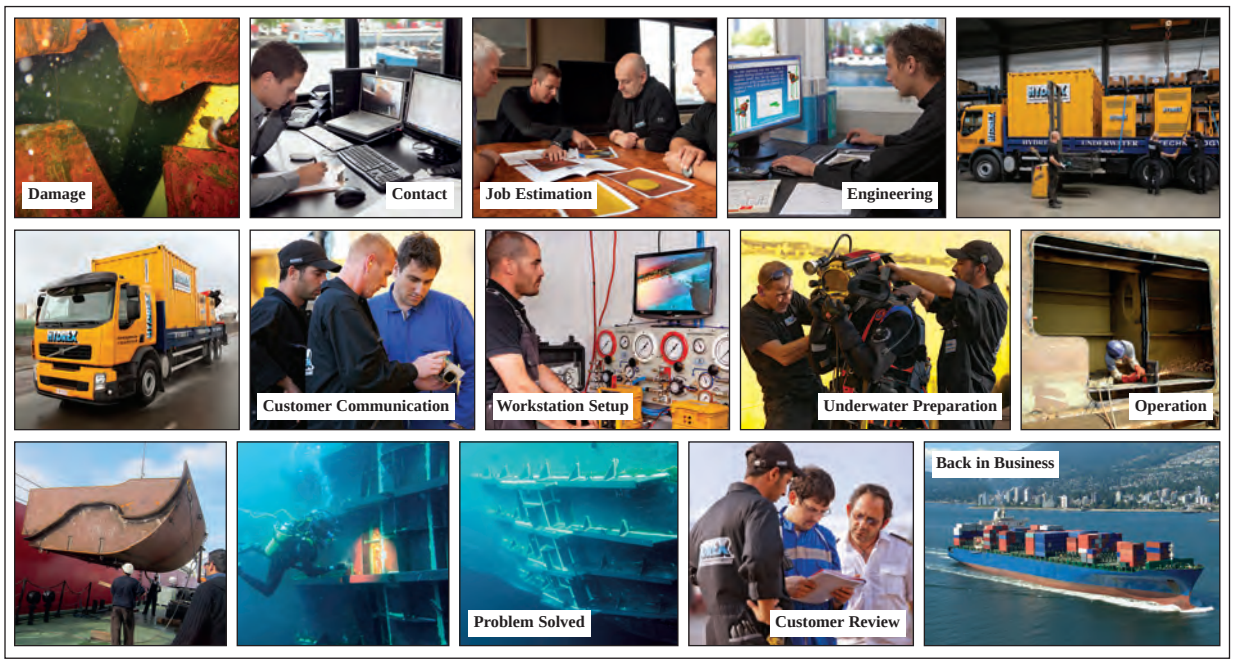

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Training key to safe operation of gas fuelled ships

Italian class society RINa (Registro Italiano Navale) says that the drive for lower emissions should not compromise safety. In the LNG industry safety is maintained through proper ship design and crew training and these important factors must be replicated in the use of LNG as a fuel on other ship types.

There is no doubt that gas-fuelled ships are one way to reduce air emissions. But gas-fuel opens up a number of safety questions and it is important to put in place the pragmatic steps needed to ensure that lower emissions do not mean less safety.

"Gas-fuelled ships are not a new technology," says Andrea Cogliolo, Head of Machinery Sector for classification society RINa. "But they bring a new mix of technology to people not familiar with the safety culture needed to manage LNG as a fuel. There is nothing new in having liquefied gas on ships, and nothing new in engines which burn gas. Gas carriers have both and gas carriers have one of the very best safety records of all ship types. But we need to take great care when we extend gas power to other ship types. Substantial changes are needed to the structure and outfit of the vessel, and the crew need to be trained to understand the new fuel and its risks. Carrying and using gas at sea requires a culture which is present on gas carriers, but which is not found on most other ship types."

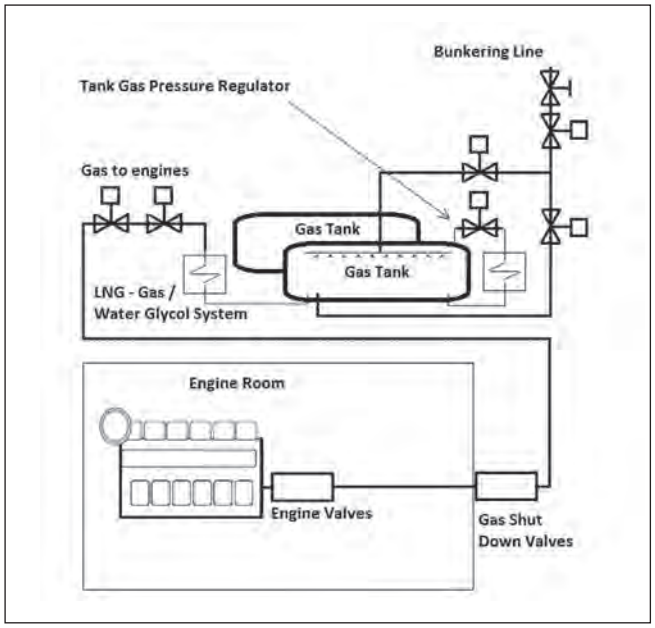
According to Cogliolo there are many advantages in the use of gas as a fuel in terms of reducing air emissions. "The use of natural gas as a fuel provides a 20% reduction in CO_2 emissions and competitive prices at current costs and estimates for the near future, along with the advantages of a total reduction in SOx emissions and a considerable reduction in NOx emissions," he says.

However, he adds: "There is nothing free in this world. Moving to gas as a fuel has a cost in terms of new outfit, new design, operational flexibility and crew training. All of these issues will be covered in a new IMO Code for Gas Fuelled Ships, but that is not going to be ready before 2014. We are working with owners and yards which need to know how to tackle gas fuel issues safely now, so we have brought out a new notation and amended our Rules to provide guidance on the requirements."

RINa has published a notation GAS FUELLED SHIPS which establishes requirements for the use of liquefied or compressed natural gas (LNG or CNG) onboard ships as an alternative to traditional fuels. It is designed to give the industry a regulatory tool to ensure that the arrangement and installation of onboard machinery using this type of fuel is such as to provide a level of integrity, from the point of view of safety and reliability, equivalent to that of a conventional installation.

Recognition that gas as a fuel has a very much lower flashpoint than marine fuel oils, and also that it is stored as a liquid at very low temperatures or as a

Schematic of engine gas flow.



Andrea Cogliolo, Head of Machinery Sector, RINa.

gas at very high pressure is taken into account by RINa. "The rules are aimed at mitigating any escape or leakage which could cause an explosion and the possibility of the extremely cold liquid gas causing structural damage," explains Cogliolo. "All materials and structure which are in gas service or could be affected by a leakage must be able to withstand the low temperatures, and the arrangement onboard of storage tanks, piping system and engine rooms must minimise the likelihood and the consequences of an accident. Tanks and gas piping must be located so as to minimise the risk of collision damage."

A key issue is to site LNG tanks in protected locations near the centre line, but this raises questions of space on board. "The type of tanks used for oil cannot withstand the pressures which build up in a tank of LNG over even a short period and LNG requires a lot more space than oil. Tanks capable to sustain gas pressure are required, and even then some gas will have to be used within two weeks if pressure is not to become too high. We see that tankers can mount cylindrical tanks on the open weather deck, but other ship types such as bulkers and ro-ro's will end up eating part of the cargo space if they want to use gas power," says Cogliolo.

Risks of gas leakage are tackled by requiring that all gas pipelines are double walled. The space in the double wall is alarmed so that any escape of gas from the inner pipe will be contained by the outer pipe and also let the crew know there is a problem. Routeing of gas pipes to avoid accommodation and explosion risk areas is also required.

"You can see how the design consequences of a decision to build in LNG as a fuel multiply," says Cogliolo. "Estimates of the space penalty vary, but depending on the ship type the amount of space needed for a liquid gas fuel installation compared to a conventional oil one is in the order of three to four times as much. Either you need extensive monitored and alarmed double wall piping, or two completely separate machinery spaces. And you have to find room for the gas process machinery, at the same time, in a dual fuel installation, as having all the normal oil outfit."

RINa is working with shipyards and owners on a possible new tanker design and retrofit of ro-ro ship with a gas fuel system, to be used to fuel the vessels in low sulphur areas and looking at the potential for gas fuel on a cruise ship.

"All those are technical issues, which can be solved by good engineering and risk assessment techniques," says Cogliolo. "But there is an equally important area where we as class have less remit, and that is the crew culture and expertise. Our notation does not address crew training, but how to keep things safe and efficient from the structural and outfit perspective. These issues are linked, because the crews of passenger ships and cargo ships are not used to handling gas, and not used to LNG ship-to-ship transfers, and both of these will become common once gas is in greater use. We expect LNG bunkering to be done from small LNG tankers, which will mean lots of LNG ship-to-ship transfers. Crews need training and a different attitude to safety for that."

Cogliolo insists that LNG is not a new technology: "But so far ship-to-ship LNG transfer is done only by experienced gas carrier crews. So we will need to see a big effort to train up the crews of other ships using gas as a fuel. The training will have to mirror that of gas carrier crews and focus strongly on ship-to-ship transfers. That will be an important part of the IMO Code when it is ready."

RINA has been heavily involved in the development of onshore, offshore fixed and the world's first offshore floating LNG terminals as Italy becomes a major gas importing and distribution hub for Europe. "We have a lot of experience with LNG, we are very keen on the environmental benefits it can offer and we see the potential of LNG as a fuel for ships," says Cogliolo. "The role of class is to enable the benefits of LNG as a fuel to be realised in a safe and practical manner." *NA*

Building a small gas carrier with cylindrical tanks.

Efficient Post-Panamaxes

With the widening of the Panama Canal a new type of vessel is making itself apparent, the Post-Panamax, claim DNV and HSVA.

Claimed as being the most modern and efficient ship design the new Post-Panamax vessels will be able to transit the widened Panama Canal, but questions remain about just how efficient this new size vessel will be? The market situation for container shipping is difficult at present, with the depression of freight rates since 2009 that is still putting pressure on charter rates today.

A seminar held in London by DNV and HSVA (Hamburgische Schiffbau-Versuchsanstalt) in March looked into the efficiency of shipping in the future, in particular Post-Panamax vessels. Jost Bergmann, business director, container ships, DNV, stated that: "New Post-Panamax vessels are more efficient, companies will pay a higher charter rate because they can have increased efficiency." He added: "The risk; more ships coming onto the market with a 30% increase in efficiency will push out older tonnage." However, Bergmann did point out that unless the vessels operate at near 100% capacity then efficiency gains are lost.

Jost Bergmann, business director, container ships, DNV highlights the pros and cons of Post-Panamax design.

Bergmann highlighted that the industry is now facing a paradigm change. Where existing vessel designs have been constructed around design speed and draught, what has not been calculated is the "off design" conditions of the vessel. With average speed now being reduced by vessels to allow them to slow steam, there is a need for vessels to operate in different conditions and at different draughts.

With ships in the future that will be operating at what is called "off design" and being heralded as the new design standard by HSVA, a profile of speed, data, operation and deadweight utilisation, will give better flexibility of operation, which will be the key to keeping these vessels as efficient as possible, say both DNV and HSVA. Today, many ship owners look to install 'green' devices on vessels to reduce emissions and to increase efficiency. DNV has looked at systems on the market and how these can be adapted into future designs.

DNV has highlighted *Emma Maersk*, with hull optimisation of the vessel being based on the actual operation of the vessel and taking into account slow steaming. Also, *Emma Maersk* has been fitted with a waste heat recovery system (WHRS), however, Bergmann claims: "WHRS on *Emma Maersk* is a waste of money because it only works at the maximum speed of the vessel." Also, DNV highlights that when the speed of a vessel is decreased then wave making at the bow is also substantially decreased, but friction on the ship increases which also needs to be taken into account.

Long stroke engines allow vessels to achieve power outputs at a significantly reduced rpm, enabling better efficiency. Bergmann says that an engine can be easily adapted to the load profile which will improve engine efficiency. Further, propeller adaptations which will also improve vessel efficiency such as the Mewis Duct are now starting to be installed.

HSVA has also been working with ship owners looking at ship designs that have smaller draughts and slower speeds, Uwe Hollenbach, director, resistance & propulsion, HSVA said that: "The Post-Panamax is shorter and wider, but the power demand of the vessels will be higher, but they will be able to carry more cargo and have less ballast water." Hollenbach also believes that vessels in future will opt for slow steaming as: "it is more efficient to run at a slower speed than a higher speed and use WHRS." *NA*

Viking's charge into a new era

New regulations limiting SOx emissions in Northern Europe leave ferry operators with three main options, find a clean fuel such as LNG, install scrubber technology or use distillate fuel. Gavin van Marle reports on the choices that some owners have made in the region.

The keel-laying ceremony of Viking Line's new state-of-the-art LNG-fuelled newbuilding took place at the beginning of March at the STX shipyard in Turku, Finland.

The event represented the next tentative step towards a new era in the ro-ro sector, the vessel type which is likely to be most adversely affected by the EU's forthcoming sulphur emissions regulation, due to come into force at the beginning of 2015.

It is no surprise then that it is in northern Europe – principally the Baltic and North Seas, and English Channel – where the cutting edge in ro-ro design is taking place. These three areas will feel the full force of the regulations first in Europe, as they have been designated as special environmental control areas (ECA).

Under IMO regulations (MARPOL Annex 6 amendment), in 2020 all vessels globally will not be allowed to burn fuel that has more than a 0.1% content of sulphur oxide (SOx). The current level is 1%, reduced from 1.5% in 2010. However, in the Channel, North and Baltic Seas, and all around the US coast, the 0.1% limit is due to be introduced on Jan 1 2015, which ship owners fear could cost so much that some will be driven to bankruptcy – one common estimate is that the cost of compliance in just one ECA is likely to be US$3.5 billion annually.

There are considerable structural problems with the introduction of the 0.1% SOx level in 2015, the foremost of which is that there is unlikely to be enough of the distillate marine fuel – which to all intents and purposes is the same fuel that the continent's haulage industry uses – that would bring ship operators under the 0.1% level available in the region.

Partly the problem is the lack of refining capacity in Europe. At the recent Marine Propulsion conference held in London in March, it was estimated that Europe will require an additional 27 million tonnes of distillate diesel per year as a result of the regulation, and the EU is already a net importer of distillate fuels.

That sort of jump in demand, with ships competing with trucks, buses, farmers and domestic heating usage for fuel is clearly going to result in a sudden hike in fuel prices, and there are additional doubts that there may not be enough global refining capacity to cope with that demand.

Tony Ohman, technical director in charge of marine operations and newbuilding at Viking Line says the company is "entering a new era of gas-electric driven operation."

As result, the hunt is on either for alternative fuels, or ways of dealing with the emissions of heavy fuel oil that mitigate the SOx emissions, and it is in this context that Viking Line chose to specify that its new vessel, which will be christened *Viking Grace*, is to be dual-fuelled, after reaching an agreement with the Finnish government that it would be partially subsidised due to the expected environmental performance of the engine.

Altogether, the company expects to receive around €36 million (US$47.13 million) from the Finnish government when the vessel is delivered. The subsidy was cleared by the EU's competition watchdog and the Finnish government on the grounds that the company was going beyond what was required of it by law in terms of environmental performance.

The 57,000gt vessel will be 288m long and have the capacity to carry 2800 passengers in over 880 cabins. There will be 1575 lane metres of cargo-carrying capacity for trucks, and another 500 lane metres for cars, with extra capacity for cars provided by hoistable decks. *Viking Grace* is due to enter service in early 2013 and will operate between Stockholm and Turku, with a stop at the Aland Islands.

Viking and STX Finland returned to its normal engine manufacturer, fellow Finnish firm Wärtsilä, for the four dual-fuel engines, of the 8L50DF type – the largest of Wärtsilä's four-stroke dual fuel range, with a 50cm bore and eight cylinders – as well as contracting the company to supply the transverse bow and stern tunnel thrusters, and two stainless steel fixed pitch, built-up main propellers with complete propeller shaft lines and environmentally sound shaft line seal systems.

Tony Ohman, technical director in charge of marine operations and newbuilding at Viking Line, explained that the decision to go with Wärtsilä was not just about the specifications of its engines: "A domestic supplier close to us, Wärtsilä offers us the opportunity to collaborate in optimal operations, engine maintenance, technical training and field testing. All this is very important now that Viking Line is entering a new era of gas-electric driven operation."

Viking has also placed a follow-up order with Wärtsilä for the supply of the LNG storage system for the vessel and the gas fuel supply systems, a product known as LNGPac, as well as an advanced compact silencer system, which minimises noise from

the engines, particularly low frequencies which can boom across the water as the vessel sails through the thousands of islands that are on the approaches to both Stockholm and Turku.

The LNGPac comprises onboard LNG bunkering, two storage tanks which will be located at the rear of the vessel, and handling equipment with related safety and automation systems. The contract also includes a cold recovery system, which utilises the latent heat of LNG for the air conditioning systems. This has the effect of reducing electrical consumption from the cooling compressors and thus bringing significant operational savings.

One of the biggest worries that ship owners and operators keen to switch to LNG have had has been over the issues around both finding adequate supply of the fuel, and the difficulties of bunkering operations themselves, given that it has to be stored at such low temperatures, below 150°C.

However, Viking Line appears to have solved these problems with an agreement in February with Swedish gas supplier AGA Gas AB, to supply the vessel from its LNG terminal in Nynäshamn, which launched operations last year. It estimated that *Viking Grace* will consume 22,500tonnes of LNG per year.

AGA Gas said that the project planning was underway and the application for permission to bunker the vessel at Stadsgarden in Stockholm had already been made, and Viking Line CEO Mikael Backman added that the project would lay down best practice models for other LNG vessel operators in the region to follow.

"The cooperation between AGA and Viking Line means that the guidelines for the management of a new fuel will be developed. This paves the way for a new infrastructure for Swedish shipping where LNG is of great future importance," he said.

In fact, Sweden's largest oil company, Preem, recently said that it intends to build an LNG terminal on the country's west coast.

It has brought LNG into the spotlight in a region which has always been at the cutting edge of ship design. Towards the end of March Norway's Color Line announced that it too had decided to order an LNG-powered ferry to replace the ageing, 40-year old *Bohus*, which operates the company's service between the Norwegian port of Sandefjord and the Swedish port of Stromstad, in conjunction with the relatively younger *Color Viking*.

An order for two vessels has not yet been placed with a yard, although the vessels are expected to be around 160m in length, with a capacity of 2000 passengers and 500 cars, with the intention for the first one to enter service by 2014.

That would place Color Line slightly behind its fierce rival Fjord Line, although the construction of the first in a series of two dual-fuel ferries, with type C LNG tanks installed, ordered from Bergen Group is behind the original schedule. When the pair were first ordered in early 2010 the expected delivery dates were Spring and Autumn of this year, but that appears to have slipped somewhat and the new dates for launch are set to be Autumn this year and Spring of next. The hulls are being fabricated at the Polish shipyard of Stocznia Gdansk, and will be outfitted at the Bergen Group's yard at Fosen, in Norway.

Dubbed the *Stavangerfjord* and *Bergensfjord*, the sister ships will have an

The yard is lifting down block that covers the engine room seen in top picture.

overall length of 170m and weighing in at 4000dwt and 20,000gt. They will be able to carry 1500 passengers and have 300 cabins, and also able to carry 600 cars.

The vessels will open up two new routes for the company, between Bergen and Stavanger in Norway and the Danish ports of Hirtshals, and between the Norwegian port of Langesund and Hirtshals.

As well as Norway, Sweden and Finland, the use of LNG has also attracted considerable interest in Denmark, and the Danish Maritime Authority completed an in-depth report into its potential as a fuel type late last year.

The focus of the study was how to create an adequate network of LNG bunkering facilities that could support a marked increase in the number of vessels running off it, after concluding that the payback time and amount of fitting a newbuild with LNG capability was much the same as fitting it with a scrubber system.

"The difference is so small that the key issue instead ought to be the availability of LNG, rather than the difference in pay-back time between the LNG and HFO/scrubber strategy. This means that for LNG to become an important fuel, availability is the key issue for the near term future," the report said.

In conclusion the report considered that the one major issue facing the development of a wide scale LNG bunkering network is the development of safety guidelines for handling the fuel in terminals; and secondly the commercial problem that since the initial amounts of vessels using the fuel would be comparatively low, start-up costs would very likely be high, which would probably lead to the fuel being relatively expensive.

"Since investments in terminals take place stepwise (a tank or bunker vessel cannot be expanded continuously) the capacity utilisation will often be low in the beginning. Therefore, the studied terminals have a high specific cost. Consequently, the terminal owner/operator will have to charge very high prices, make losses, or need support until the capacity utilisation (i.e. the demand) increases," concluded the report. *NA*

Construction of the Forward engine room can be seen at the STX shipyard in Turku, Finland. The engines and other equipment are covered with blue protective covers.

RINA - Lloyd's Register
Maritime Safety Award

The Institution believes that the safety of both the seafarer and the maritime environment begins with good design, followed by sound construction and efficient operation. Whilst naval architects and other engineers' involved in the design, construction and operation of maritime vessels and structures do not have a patent on such issues, nonetheless their work can make a significant contribution.

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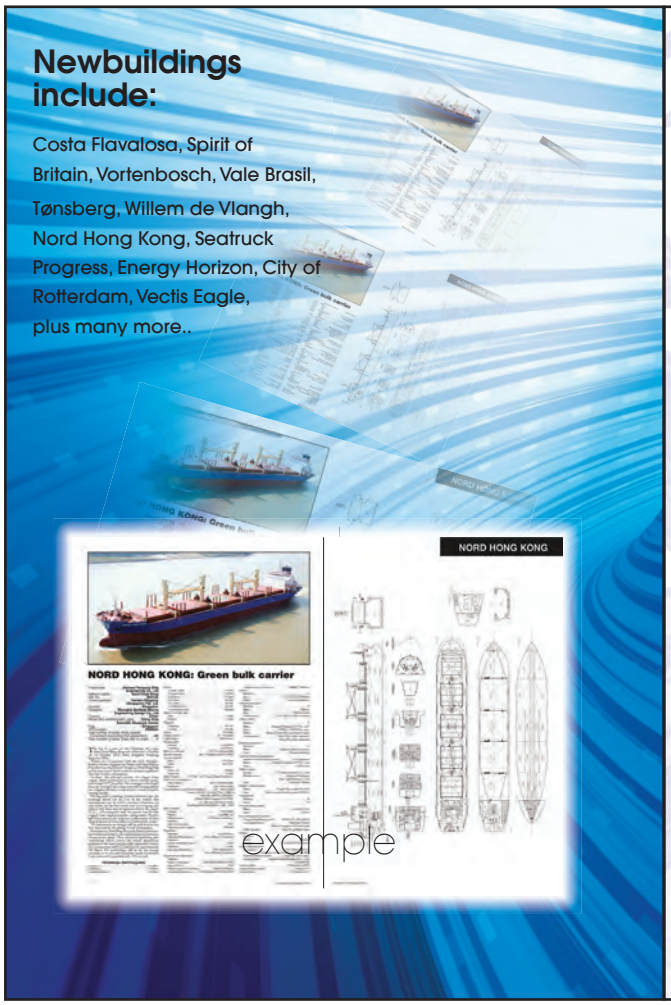

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Taxing emissions

In mulling over alternative technologies for complying with new regulations limiting sulphur emissions to 0.1% from January 2015 P&O Ferries rejected all the new technological fixes in favour of distillate fuel. Gavin van Marle reports.

The unpredictability of LNG fuel supply was one of the chief reasons that P&O Ferries decided against installing a dual-fuel capability when it designed its two new mega-sized ferries that recently began operating on the company's core cross-Channel route between Dover and Calais.

The 49,000gt vessels, *Spirit of Britain* and *Sprit of France*, are the largest to run on the route – each costing US$250 million and able to carry 2000 passengers, they are 213m long and 31m wide.

In terms of complying with the 2015 regulations, Mike Langley, P&O Ferries' new business technical development manager, says that the company had neither sufficient confidence in the availability of LNG supply, or in the proficiency in the technical capabilities of existing scrubber technology, to employ either at the design phase.

"We investigated fitting exhaust gas scrubbers at the design stage as an option, but because we were not confident that they were reliable, or would be capable of operating continuously and meeting compliance we decided not to fit.

"We also looked at dual fuel, but potential supply problems in the operating ports and uncertainty of bunkering requirements resulted in the conventional heavy fuel oil approach," he tells *The Naval Architect*.

As result, when the new regulations come into force the company will be faced with a straight choice between paying vastly higher fuel costs for distillate fuel or retrofitting scrubbers – and at the moment the company is dubious the technology will be ready.

"The choice for 2015 is 0.1% sulphur fuel or exhaust gas scrubbing which in our view is not proven reliable yet," he says.

The vessels have four MAN 7L48/60CR engines, and Langley says that it is a "straight" choice between those and four Wärtsilä 8L46F, both common rail.

"On a through life model including initial capital costs and developing the required power, the MAN engines were chosen, other engines required too many cylinders which resulted in higher maintenance costs," he says.

The main engines were chosen based on the power required for design speed and manoeuvring requirements, with three 3000kW bow thrusters being taken by the propulsion train, he said that there had to be enough power left for power from the main propellers.

However, the first ship to enter service, *Spirit of Britain*, which launched in January 2011, has had a few teething problems, the most problematic of which was unexpected vibrations, which Langley admits could have been identified and prevented given the right investigations and modelling during the design phase. The vessel was built at STX Finland's Rauma shipyard.

"The vibration was caused by the natural frequencies of typical structural elements coinciding with the excitation frequencies of the main engines.

"The builders solved the problem by modifying the hull structure so vibration of the structure occurs at frequencies, which the main engines cannot reach.

"Additionally, two synchronised phasing systems were also fitted to ensure favourable phasing, one system for each side – one for the two port engines, and one for the two starboard engines," he explains.

Mike Langley, P&O Ferries' new business technical development manager.

Main engine fuel pump and viscoheater plant on *Spirit of Britain*.

Spirit of Britain and *Spirit of France* pass in The Channel.

But, the experience was at least put to good use while *Spirit of France* was under construction, and it finally met the full design specification for vibration on sea trials in early January 2012, with the ship being delivered later that month.

In the meantime, *Spirit of Britain* is to go back to the shipyard in April for rectification work to meet the same status as *Spirit of France*, and is due to resume service on 25 April, although prior to this a temporary solution was found, by operating the first ship at reduced power the company was able to provide reduced vibrations and yet still run to schedule.

As a result of the work that is scheduled to be done to *Spirit of Britain*, P&O Ferries has decided to keep the 26,500gt *Pride of Calais* running on the cross-channel route, rather than put the vessel into lay-up, which it had been scheduled to do.

There have also been other challenges facing the new vessels including more stringent regulations that were introduced by the IMO through its Safety of Life at Sea (SOLAS) regulations as passenger vessel sizes have ballooned in recent years. The Safe Return to Port programme, which officially came into force in mind-2010, posed numerous challenges, says Langley.

"The engine configuration, with the port prop shaft going through the aft engine room in an A60 tunnel, meant a new type of water tight seal on the shaft bearings [and] early designs caused local overheating of the shaft bearings, which has now been solved with a new seal design."

He also says that the commissioning of the first vessel proved to be very challenging, "Quite often when the system was tested for real, we discovered some issues".

He also confirms that the process of training crews and checking routines to be compliant with the new regulations is ongoing.

"With both ships now in service, we are drilling each Safe Return to Port scenario and discovering more information.

"We are also investigating how individual machinery failures may impact on Safe Return to Port capability, and drawing up a matrix to assist the management of a Safe Return to Port ship."

Starboard engine of *Spirit of Britain* seen from the top level.

He adds that a further challenge is where existing SOLAS requirements are enhanced, thus making the previous SOLAS requirement redundant.

But, perhaps the greatest challenge that P&O Ferries faced with the deployment of the new vessels was their sheer size, and the fact that they are the largest possible to operate in the existing ports of Dover and Calais, both ports also have ambitious expansion plans. It was a case of deigning a vessel that would provide the maximum economies of scale in the present port dimensions, but also future-proofing them so they would continue to be commercially viable after the expansion projects have been completed.

"The ship had to fit both existing and future port infrastructure, which meant that for existing berths the bow and stern fit would have to be offset, for future wider berths the offset arrangement could be removed and centre line alignment of ship and link span restored, this offset meant wider cargo doors.

"The longer length required a tighter swing within Calais harbour, to minimise the associated risk, we ensured the design incorporated the manoeuvring requirement a 50knot wind force capability.

"The larger vehicle decks and the additional deck for tourist cars and caravans, provided a challenge to achieve a similar turnaround time as our current fleet, this was achieved by moving the storing process down to deck two, wide freight lanes, and wider cargo doors," he says, adding that the company has used a simulator to familiarise its captains in manoeuvring, and also used the same model to verify the 50knot wind capability.

But, his assertion that scrubber technology is not able to make ships emissions compliant with the 2015 regulations might be disputed by manufacturer Hamworthy Krystallon, which was acquired by Wärtsilä at the end of January.

A month earlier it had delivered the world's first commercial scrubber system to Italian owner Ignazio Messina & Co, which had ordered the systems for four of its 45,000dwt ro-ro vessels. The first was successfully launched on the *Linea Messina* in December.

The ship now has five scrubbers – four 2MW units for the auxiliary engines and one for the auxiliary boiler. All are housed within the ship funnel casings, and the delivery also includes a control system, combined wash-water treatment plant and a new range of super duplex stainless steel pumps.

Installation took place over last year and was approved by classification society DNV, while RINa has given it its first Green Plus notation.

Hamworthy managing director Sigurd Jenssen claims: "By 2015, ship owners and operators operating in ECAs will have a simple choice - either pay the US$300 to US$400 price differential for costly distillate fuel or install a scrubber, which typically has a payback of less than two years." ***NA***

The Royal Institution of Naval Architects
International Seminar

Education and Professional Development of Engineers in the Maritime Industry

14-15 November 2012, Southampton, UK

First Announcement

The key to the future success of the maritime industry will be innovation in all aspects and sectors whether it is in research, design, construction or operations. And in an industry which is technologically led, such innovation will be provided by engineers who have the professional skills to meet the future demands and challenges.

Such engineers will achieve the knowledge and understanding which underpins those professional skills while at university, and develop them through training and experience after graduation. But what are the particular skills required by different sectors of the maritime industry – commercial, naval, recreational, offshore, renewable energy? What are the interpersonal skills which engineers of the future will require to complement their technical skills? Are the universities and colleges adapting to deliver these skills? And what is the role of industry in enabling those skills to be developed?

The Seminar will build on the success of the International Conference on the Education and Professional Development of Engineers in the Maritime Industry, held in 2011, and provide an interactive, but less formal forum for representatives of both industry and academia to present and discuss how those engineers of the future will achieve the knowledge, understanding and professional skills which the industry will need. The Seminar will examine the differences in the requirement and delivery of education, training and professional development in different sectors of the industry and in different countries, seeking to both learn and benefit from such differences. Given the lead time to provide professional engineers, the Seminar will also seek to identify the changes needed now to provide the engineers of the future.

The value of such a Seminar lies in the exchange of experience, views and discussion between the stakeholders of this vitally important subject. Therefore, in order to involve as many participants as possible, the Seminar will consist of a number of presentations and panel discussions.

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Raising the standard

Even before the investigation into *Costa Concordia's* accident in Italy in January is complete questions over the efficacy of the regulatory regime are already being asked.

Costa Concordia's accident is still under investigation but questions are already being raised regarding safety management, and whether further changes to issues like safe return to port requirements or damage stability and ship design need to be considered in the light of the report's findings.

While the passenger ship safety regulatory developments have reflected the lessons learned from casualties, starting with the development of SOLAS following the sinking of *Titanic* 100 years ago, what will be the impact of the *Costa Concordia* incident?

Lloyd's Register's (LR) vice president for passenger ships John Hicks says: "The lessons from casualties are vital, but science and technology advance constantly, as do the statutory requirements. Analysis techniques and other investigations, which were not possible to be calculated many years ago, are now possible, hence the move to so called 'goal based' approaches and away from prescriptive rules. This has also prompted the move from deterministic to probabilistic requirements."

However, Hicks believes that any conclusions about *Costa Concordia* that are made now would be premature. "We need to wait for the conclusions of authoritative investigations into *Costa Concordia* before making any decisions about the regulatory regime."

Nevertheless, Hicks says: "LR will support the implementation of any further changes to international safety regulation. Through IACS [International Association of Classification Societies], we will support the development of an appropriate implementation method for any new policy, and an appropriate assessment regime."

He went on to point out: "The EU has funded several research projects in recent years to contribute to the consideration of the various systems and components involved in the safety of passenger ships. LR has contributed to many of these projects. Examples include GOALDS, SAFEDOR, SAFECRAFTS, SAFEGUARD, MONALISA, FLOODSTAND, and HARDER.

"From these studies and others, two likely future areas of concentrated effort will include: the goal based standard model and how this can be developed and used in creating the regulatory framework of the future and human element studies to further understand this complex yet key component in overall operation and function of all ships."

Built in 2006, *Costa Concordia*, unlike those ships built from 2010 onwards, was built to prescriptive rules, so one argument could be that new regulations have already been put into force.

Hicks points to probabilistic damage stability and safe return to port which are innovations that have recently entered into force to further reduce the risks involved in operating passenger ships.

"How ships are operated is as important as how they are designed and constructed – perhaps more so."

The International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management (ISM Code) is a key piece of regulation.

According to Hicks: "Lloyd's Register believes that the most significant reductions in risk at sea will now be found in managing the human element – across ship operations but also in design. This is an area of increased importance to LR and we have considerable capabilities in human factors. Technological and regulatory approaches to improving safety will continue – and they should."

Helping ensure that there are properly trained and experienced seafarers in place, as well as professional and experienced managers with external verification of performance coupled with the existence of an effective management culture with common understanding and goals shared between ship and shore are vital, he believes.

Ships, such as *Queen Elizabeth* below, that were built from 2010 onwards used the probabilistic rather than deterministic rules for their design (see GA Plan).

As for potential changes following *Costa Concordia*: "The safety and evacuation of all passenger ships, large and small, are governed by the regulatory framework set forth by IMO, but the industry is always looking for ways to understand the complexities of safety and evacuation better.

"We can expect a renewed regulatory scrutiny on the safety performance of large passenger ships. Whether this focuses on design issues or operational issues, or both, will depend on the outcome of investigations into the loss of *Costa Concordia*."

The major operating lines are carrying out their own comprehensive safety reviews and this, coupled with the conclusions from the authoritative investigations into *Costa Concordia*, will dictate the direction of the changes for the industry.

"The Cruise Lines International Association (CLIA) announced a review of operational safety in January, which includes an internal review by CLIA members of their own operational safety practices and procedures concerning issues of navigation, evacuation, emergency training, and related practices and procedures.

Other components of the review include: consultation with independent external experts, identification and sharing of industry best practices and policies, as well as possible recommendations to the IMO for substantive regulatory changes to further improve the industry's operational safety and collaboration with the IMO, governments and regulatory bodies to implement any necessary regulatory changes.

According to Hicks: "LR is also undertaking a review of areas which may be affected. This includes our processes, policies and practices in a number of areas to ensure that we remain well-placed to support the industry as the events from the incident investigation unfold. Given that a passenger ship is a complex system and one where the crew are a vital factor in the system operating efficiently and effectively, one early area of concentrated effort is in the human element/human factors realm across all stages of the asset lifecycle."

According to Robert Ashdown of the European Cruise Council (ECC) while the causes of the incident will only be known once the report has been released "every indication is that the people failed the ship rather than the ship failing the people". The ECC he said retained full confidence in the current design and building regime, and unless the report indicated otherwise, it saw no reason to go back on that stance.

Design and construction of ships was reviewed on an ongoing basis, he said and the ECC had "full confidence that the current regime was fit for purpose".

The cruise lines' operational safety review and its four stages will clearly take some time, but Ashdown said that as soon as an improvement in best practice was identified, it would be implemented by the cruise industry ahead of any mandatory requirements coming from any new regulation. An example of this is new mustering requirements, which have already been put into force since the review was first announced in January.

Responding to the *Costa Concordia* accident the International Chamber of Shipping (ICS) put out an information sheet on progress that has been made since *Titanic* as regards to passenger shipping. A number of areas are the subject of ongoing work at the IMO, according to the ICS's James Langley. The FP Sub-Committee is reviewing the interim recommendations on evacuation analysis for new and existing passenger ships and the SLF Sub-Committee is revising, in the context of its work on subdivision and damage stability, the guidelines on safe return to port for passenger ships and revising SOLAS chapter II-1 subdivision and damage stability regulations.

Nautilus International senior national secretary Allan Graveson says that he believes that the safe return to port concept is a modern version of "unsinkable" and "brings about a false sense of security".

One major concern that he raises is the rate of heel in a turn. This should be no more than 10deg when the wheel is put hard over, and Graveson cites one of the most prominent occurrences of large angles of heel as being *Crown Princess* in 2006.

He points to RINA's recent paper presented to the Sub-Committee on Stability Loadlines and Fishing Vessels proposing changes to the Intact Stability Code 2008, since the formula used takes no account of the vessel's turning ability - hence no guarantee of minimum stability margin in full-helm turns.

As far as cruise ships are concerned: "Some of the ships are on a knife-edge stability wise, not all of them, but some of them. This is typified by the fact that they are putting a lot of aluminium up top on these ships to reduce the weight." That in itself brings with it a risk of fire, he adds. Although he says in *Crown Princess* it was possible to blame the officer of the watch or the autopilot for the ship taking on a large angle of heel, "the fact is the ship should not heel over that far. It is OK to say that the wheel should be applied in a timely fashion to alter course, but what happens if the officer of the watch is faced with a yacht and has to put the wheel over?"

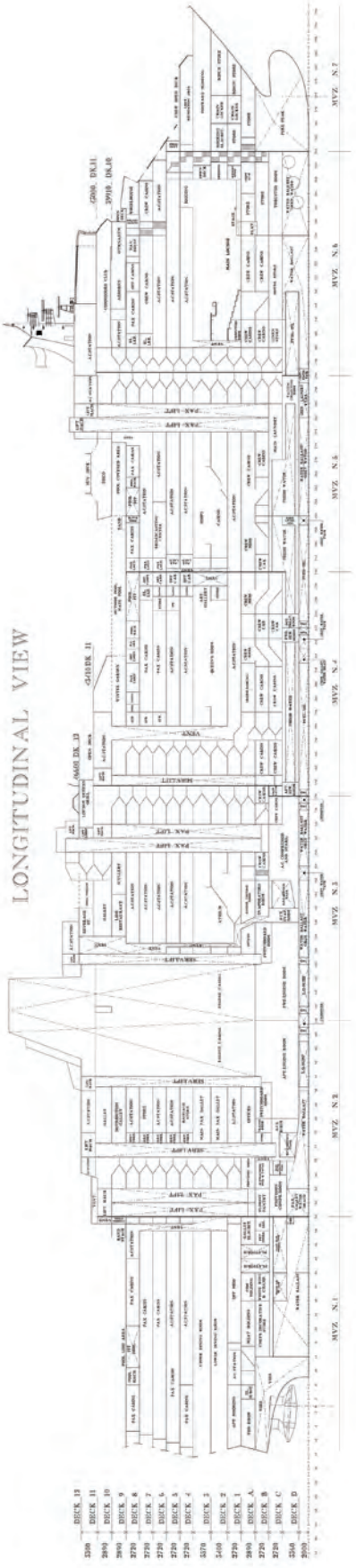
Turning to the situation of when the hull is breeched, Graveson says ships are only being built to two compartment survivability, which he states is no better than *Titanic*, "in fact it is worse".

Compartments on the ships go from one side of the ship to the other, he explains. One of the recommendations in Lord Mersey's report following the sinking of *Titanic* was a longitudinal, vertical, watertight bulkhead on each side of the ship as a means of preventing water flooding from one side of the vessel to the other. Turning to the present Graveson says: "You can look at a centre line bulkhead; you can look at double side skin and certainly more transverse subdivision. More transverse subdivision and two longitudinal bulkheads – it's all there in Lord Mersey's report."

With today's technology it can be achieved, he believes. It is not size that matters, he stresses: "it is how we apply the rules of construction". You are never going to get an unsinkable ship, he argues: "what you hope to do is get the ship to sink gracefully. It must not capsize or plunge. If you have two longitudinal bulkheads you can counter-flood from port to starboard, starboard to port and along the length of the vessel as well".

One thing, he stresses, is that the report on *Costa Concordia* must be as comprehensive as possible as, he says, there are "whispers" that it will be narrowly focused.

"So what are we looking for? Simply, a safe and sustainable cruise industry. In order to achieve this it needs to be acknowledged that there are problems and owners and regulators need to respond positively and, where possible, anticipate and mitigate the consequences of incidents. Firstly, acknowledge that humans make mistakes. While we can and must do a great deal to minimise this, something else is required. A good start would be to implement in full the recommendations of the *Titanic* inquiry. It is not too premature to implement the recommendations of Lord Mersey." ***NA***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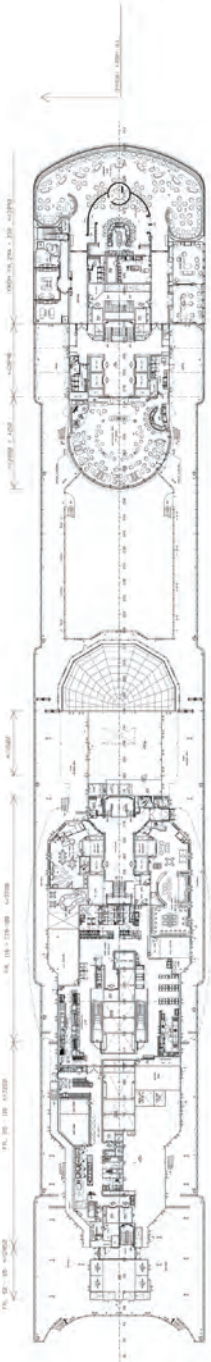

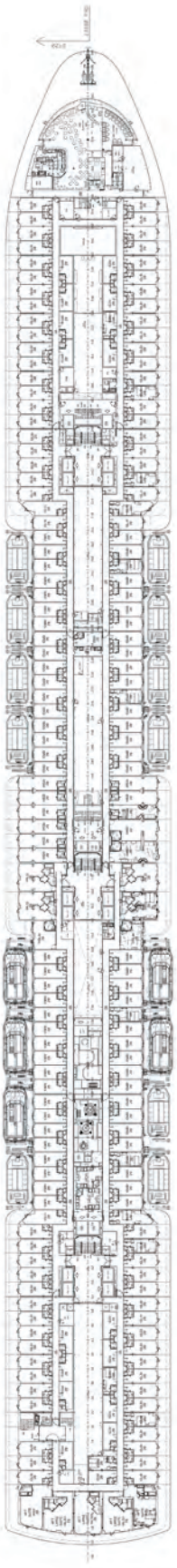

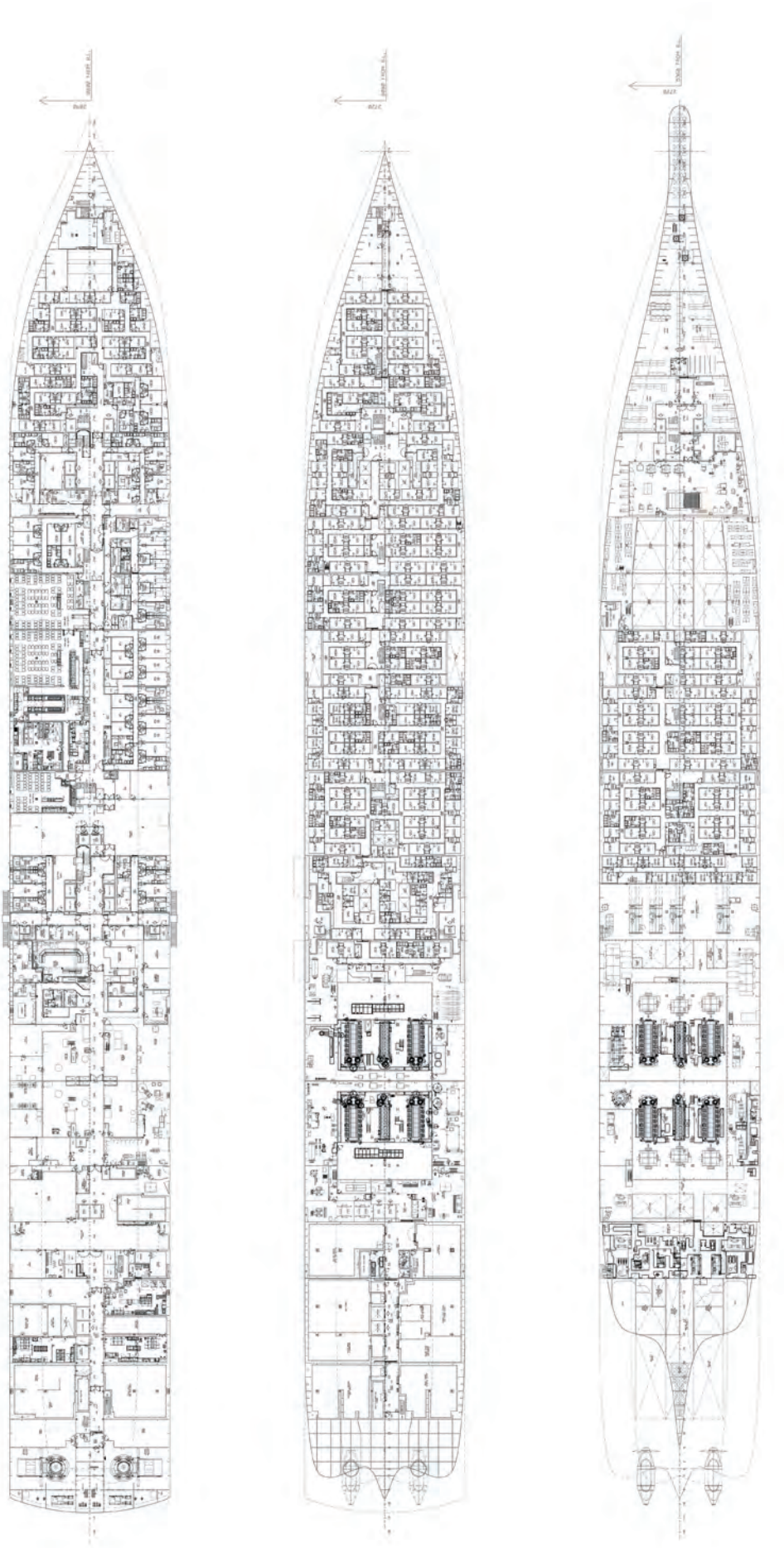

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Miami launch for Eniram's OSA

Some 70 large cruise ships have already installed Eniram's systems says the company, but the system, which is a modular add-on to Eniram's Dynamic Trimming Assistant, can work on any vessel types.

Finnish provider of real time decision support systems Eniram launched its new Optimum Speed Assistant (OSA) at Cruise Shipping Miami in March which the company says could save operators up to 3% a year in fuel-related costs.

The software analyses real time data about current sea conditions alongside historical information about a vessel's performance to determine its optimum speed, ensuring just-in-time arrival in port.

Eniram claims that its latest software tool will radically change the way the shipping industry manages speed, engine use and fuel consumption.

The OSA is an onboard decision support tool that enables a ship's crew to attain the optimum speed profile for each voyage, allowing vessels to maintain a constant performance and arrive into ports just in time.

The software, which builds on Eniram's existing Dynamic Trimming Assistant, combines real-time information about prevailing sea conditions with historical data giving operators the facts they need to be able to sail constantly at the optimum speed profile. This reduces the need for a crew to build in 'buffer' time and vary engine speed to ensure on-time arrival in port, a practice which is not fuel efficient.

Calculations are served up to the crew via an easy-to-use dashboard and colour-coded 'traffic light' system. This coordinates all of the information in one place, in a form that can be readily interpreted without the need for any manual input.

"OSA shows quick gains in efficiency," says Eniram chief technology officer Henrik Dahl. "For a typical vessel such as a cruise ship, payback time is significantly less than a year. We see that our OSA together with Dynamic Trimming Assistant will be key elements of any vessel's energy efficiency plan [SEEMP]. These tools coupled with Eniram Performance Management reporting and follow-up tools will guide our customers to achieve best performance and reporting of emissions and follow up of EEOI," he added.

> "If you optimise speed, but you don't optimise the engine you might be gaining two to three percent on the speed side but you might be losing two to three percent on the engine side"

"The OSA shows quick gains in efficiency," says Eniram chief technology officer Henrik Dahl.

Eniram expects OSA to also lead to a change in behaviour for ships' crews in the way they use a ship's engines, Dahl adds. "It is not enough simply to optimise the engine loads for each engine, as the ship might end up consuming more energy. Obtaining the best efficiency on a passenger vessel usually means operating at a constant speed and therefore using the engines at less optimal loads than those for which they are designed."

According to Dahl the company started developing the OSA product about six months ago. The company has 140 vessels sailing with its data collection platform around the world. The platforms were first introduced with the Dynamic Trimming Assistant product which was rolled out in 2007.

Some 700 million signals are collected daily from the 140 vessels which means that Eniram has a huge data repository of signals which "pretty much describes how vessels operate globally," Dahl explains. "We analysed 50,000 sea days from the data repository. From that actual vessel data, we could see there is a 2-3% saving on average regardless of whether a voyage optimisation system or a route optimisation system is in use".

He says that there is a big opportunity for customers to make further savings and so Eniram developed the OSA product. Eniram has recorded a vast amount of dynamic data and has developed the technology in recent years to measure what happens on the vessel.

"We have the dynamic data to tell how much the wind, weather and currents are actually affecting the performance of the vessel". The company needed to collect this data to optimise trim, and has now

developed its use further to achieve speed optimisation.

Dahl says there are a lot of other companies out there offering speed and trim optimisation products, Eniram's approach he maintains is different as the company is not starting from a theory-based approach and relying on forecasts, but is using real time data.

Eniram has a number of master mariners on the team and they have identified the problem that there are so many changing factors like currents and weather conditions which make forecasting difficult.

"Forecasts are good, but they are not precise enough to enable you to plan all your operations around them. If the weather changes the forecast changes and everything changes. With our technology we can adapt to that," Dahl explains. Updates take place three times per minute, he says. However, he explains this does not mean the vessel will adapt to any changes fully because changing speed constantly would prove expensive. It is more about establishing the optimum economical speed, which should be fairly constant. However, he adds, you need to have dynamic measurements of the impact of weather, wind, currents, trim, and fouling on the vessel in order to give the client optimum guidance. Eniram has identified that more savings can be made, and the reason why they have not been made so far is that systems in operation are not dynamic enough to provide optimum guidance.

Another key issue he mentions is ease of use. The crew is not required to input a lot of information about planning, routes and forecasts. The Eniram tool takes the information required from the ship's existing systems and adapts it in real time. Although there is little need for training in using the system, Dahl says there is a need to support the crew so that they can change procedures to follow the advice provided. It is also useful to ensure the crew understands the reasons behind having a good speed profile - how the system reacts when a vessel is in hurricane conditions, for example.

Eniram does follow up sessions with the customer to show the potential to be saved and how much has been saved so far.

The company's work has focused on the cruise industry because they operate short leg voyages, which means the results are easier to demonstrate. The same holds true of liner trades.

Dahl says that he does not wish to identify individual cruise lines with whom the company is operating, but 70 systems, out of the total 140, are on cruise ships, he says. As far as the cruise ship market is concerned, he says, the bigger the ship, the more there is to save.

The aim is to optimise across the board, and not just individual components like speed or trim. If you add up savings earned by optimisation of speed, trim or engine, savings are not a question of "two plus two plus two equals six", Dahl says. Cost savings with one component result in gains with another. "If you optimise speed, but you don't optimise the engine you might be gaining 2% to 3% on the speed side but you might be losing 2% to 3% on the engine side".

Eniram started with trim optimisation and Dahl says that on some vessels there was no change in the fuel budget, because by optimising trim the vessels got 2-3% gains in speed, resulting in the vessel arriving early into port and the corresponding gain would not be seen in the fuel budget. The issue was to reduce the speed to get the actual fuel saving. Potentially, 3-5% savings could be made optimising speed, trim and engine, he estimates and at an individual level between 2% and 5%.

Eniram is launching an engine optimisation product which will be an add-on to existing equipment on the vessel. "The Eniram Vessel Platform is built and designed to be modular," Dahl says. More applications will be considered for the future including work on the route side, although the company may seek partners to develop this.

If you optimise speed, but you don't optimise the engine you might be gaining two to three percent on the speed side but you might be losing two to three percent on the engine side.

Dahl says that the system takes into account the issue of virtual arrival. "As long as we have a schedule, whether physical or virtual, we can make sure the client gets that. A virtual arrival scheme might work without speed optimisation but the combined effect means you will have greater savings". In the case of slow steaming, it is even more essential to keep the speed under control.

The main issue, he says is to make the industry more dynamic "so that you can do things like slow steaming as a concept, and when you can do that you need to have the tools to make sure you get the best out of it". That, he says, is what Eniram is all about. *NA*

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The EU-funded SAFEGUARD research project brings together nine international companies and research institutes based in the UK, France, Canada, Norway and Greece to perform a series of full-scale ship passenger evacuation trials to gather data for calibration and validation of ship based evacuation simulation models.

Data collected from real sea trials on three passenger ships and five semi-unannounced evacuation assemblies will be used by the SAFEGUARD partners to create a large data base of passenger response times and assembly times of a sufficient depth and detail to permit simulation model calibration, verification and validation. It is also hoped that this data will serve as the basis for improved evacuation analysis protocols beyond the International Maritime Organisations (IMO) MSC circular 1238.

- Background on ship evacuation, presenting the partners
- Introduction to the SAFEGUARD project, methodology, description of the three shipping companies and the ships.
- Enhanced Benchmark Scenarios and model performance and the recommendations to IMO MSC.
- Response time data set: data collection, the data sets, implications for IMO MSC.
- Validation data set: data collection, the data sets, the model performances and the recommendations to IMO MSC.
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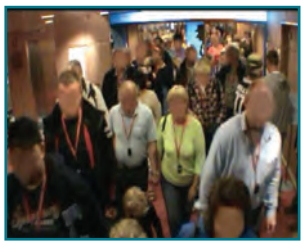
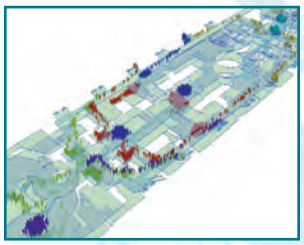
- Fire Benchmark: Rationale, the benchmark, the model performances, and the recommendations to IMO MSC.

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Adding ballast to the convention

The ballast water treatment (BWT) convention is sailing into its eighth year of not being ratified, while some still hold out hope that it will be ratified by the end of 2012, what impact has the delay had on the market?

Currently, the BWT convention stands with 33 States that have ratified the convention, fulfilling the 30 states needed, but only representing 26.46% of the Worlds tonnage leaving a further 8.54% still needed for the convention to be ratified.

Other large owner led flag state countries that have larger tonnage have held back on ratifying the convention due to the growing list of outstanding issues that need to be resolved, such as how the convention will be enforced, how useful the Type Approval process is from the owner's perspective and where the US stands with it regulations for ballast water treatment systems.

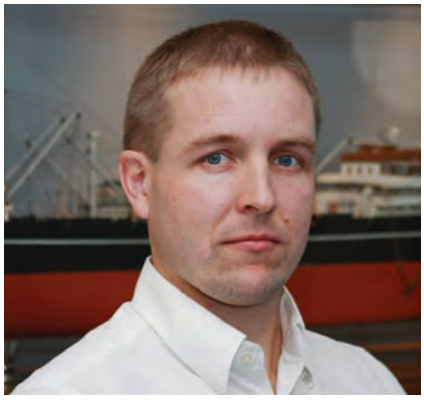
The outcome of the IMO bulk liquids and gases (BLG) 16th session meeting in February this year stated that further work was needed on how the convention would be enforced. It stated that: "The Sub-Committee continued its work on developing a draft circular on ballast water sampling and analysis protocols, intended to provide general recommendations on methodologies and approaches to sampling and analysis to test for compliance with standards set out in the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention). The work will continue at the next session, in particular, to address the concerns of some delegations regarding the manner of confirming compliance in accordance with the sampling and analysis protocols, with the view to its finalisation."

Sampling has been a subject of debate over the past number of years, as to how it would actually work and be implemented. Martyn Ayris, managing director, RWO GmbH Marine Water Technology comments: "There have been comments and concerns around testing and how this would be carried out. There are a number of different views; that of a tiered system is one. This will come down to what is reasonable and what's enforceable and stands up in a court of law."

The US Coast Guard (USCG) published its guidelines at the end of March saying that it will move in line with the IMO. Commander Ryan Allain, Chief, Environmental Standards Division, US Coast Guard says: "That we have used a discharge standard along with the IMO's." As to how the USCG will treat non US ballast systems that enter US waters, Allain explains: "There are systems that have been type approved by foreign states. We have recognised this through the alternative management system." He further explained that systems in the future will need to have not only a classification/state approval, but also a USCG approval for the ballast system installed. He added that: "We look to take a holistic approach [to enforcement guidelines], same as we do for oily water separators."

In March this year withdrew its ballast water system from the market after concluding that the system, although Type Approved, might not offer the level of compliance required by a vessel engaged in international trade. This has been an unfortunate situation for the market, as Ayris comments: "You can view this as good or bad news. If you're an owner then it's bad. It has also created concern in the market for other manufacturers. It is also not good from a competitor's side as you need the competition."

Alfa Laval has also said that some ship owners are starting to question Type Approval, as it only tests for certain types of waters, highlighting that a vessel in its lifetime may sail in many different types of water and the equipment onboard will need to handle this. Ayris adds that the test process is very prescriptive, in that you



Roger Strevens, solutions development manager, Wilhelmsen Technical Solutions, highlights the ship owner's perspective.

Wilhelmsen Technical Solutions bows out of BWTS market

Norwegian-based Wilhelmsen Technical Solutions (WTS) has announced that it has taken its Unitor ballast water treatment system off the market and recalled the units which have already been sold. It took the decision based on verification testing that it took on its own itiative.

"The verification programme showed that the system at this stage of development will not, in our opinion, provide our customers with an effective, fully compliant solution for the varied and dynamic water conditions encountered by a vessel engaged in global trade," says Petter Traaholt, president of Wilhelmsen Technical Solutions.

WTS's solutions development manager, Roger Strevens also highlights that Wilhelmsen has gained from these tests and that it will return to the ballast market in the future when it will be acting upon what it has learnt.

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"have to jump through hoops" to achieve the Type Approval.

"Type Approval represents a minimum standard, however, it tends to be mistaken to mean more than that", says Roger Strevens, solutions development manager, Wilhelmsen Technical Solutions. He points out, systems are tested with certain types of waters as laid down by the IMO guidelines and that Type Approval confirms that a system is compliant with those specific conditions. What the boundaries of a systems efficacy are not established by type approval testing.

However, not everyone has seen the delay in the ratification of the convention as a bad thing as Tore Andersen, sales and marketing director, Optimarin points out: "We're glad that the convention hasn't been ratified, as it gives people more time to develop their systems."

Strevens also says: "With the scale of the investment that BWT represents, especially for fleets, the kind of company that the BWT vendor is becomes important. BWT systems will be operationally critical and, therefore, service and support globally and it's availability over the lifetime of the vessel is essential. That raises questions about the likelihood of whether a vendor can survive long term and provide that support."

Ayris also adds that ballast water treatment system manufacturers spend millions on creating systems, but they need a return. The longer that the convention goes unratified the longer the manufacturers have to wait for that return.

Many ship owners are still waiting for the convention to be ratified before acting, but whilst they are waiting time is running out for them to fit out vessels in the time given in the convention as it stands to date. Ayris likens the ratification of the convention to the chicken and egg scenario with owners waiting, but people needing act to make the convention happen. "When the convention comes into force, then it can change, there will be a change in timescale for retrofits as can't see whole fleets getting done in time", says Ayris.

Strevens points out that it is an interesting time as ship owners are increasingly aware of what questions to ask and what standard of answer to expect". As for when the convention will be ratified Ayris says that he is quietly confident that it will happen this year and will come into force in 2013. Others are waiting with baited breath, waiting to see what happens with the market, as each year gone past it was expected that the convention would have been ratified. *NA*

Martyn Ayris, managing director, RWO GmbH Marine Water Technology believes that the convention will be ratified this year.

Optimarin seals the deal

Norwegian-based Optimarin has recently announced that it has received a contract to install its ballast water treatment systems (BWTS) onboard 10 Evergreen container ships.

The contract will see the BWTS fitted onboard the vessels that are currently under construction at CSBC in Taiwan.

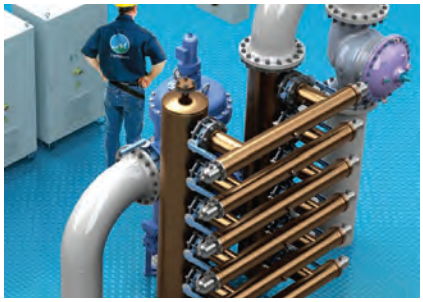
Tore Andersen, sales and marketing director, Optimarin says: "It's a nice order, worth quite a lot of money." The order is worth NOK23 million (US$3.9 million).

Optimarin's ballast water solution utilises filtration and high doses of UV irradiation to kill marine organisms, viruses and bacteria. During ballasting, water flows through a 40-micron MicroKill filter, which removes larger organisms and particles and back flushes them overboard at the ballasting location.

After passing the filter, the ballast water continues through the MicroKill UV chambers on its way to the ballast tanks. The UV light kills or inactivates organisms, viruses and bacteria in the ballast water. The filter is automatically bypassed during de-ballasting, and the ballast water receives a second UV-treatment during discharge as a safeguard to ensure compliance.

The system has almost no moving parts and uses only three UV lamps for a typical 500m^3 system. It can fit almost anywhere on a ship, thanks to its modular design, highlights Optimarin. "Our system is self-cleaning and environmentally friendly – using no chemicals – and does not harm a vessel's ballast water tanks," Andersen states: "The lack of moving parts means there's less to go wrong, ensuring reliability that is second to none and minimal maintenance costs. *NA*

Optimarin gets Evergreen contract.



Alfa Laval ups the standards

Swedish shipboard water treatment supplier Alfa Laval has recently announced that its bilge water system, PureBilge, can now achieve 5ppm filtration and has also been certified at this level by DNV.

The DNV Clean Design class notation is a voluntary newbuilding specification, which covers most aspects of ship design and operation. For bilge water, Clean Design stipulates a maximum of 5ppm of oil remaining in the water after treatment, prior to pumping overboard. MARPOL regulations stipulate 15ppm. In 2011, DNV introduced a 5ppm type approval process for marine bilge water separators.

Alfa Laval's PureBilge is claimed to be the first system to obtain the new 5ppm DNV type approval certificate. The system has also been granted the US Coast Guard Certificate of Approval. In May 2011, the DNV 5ppm Type Approval Programme No. 771.60 became available for certification for Oily Water Separators (OWS) for the first time.

Alfa Laval's PureBilge achieves 5ppm.

Alfa Laval's PureBilge system was tested according to this procedure and in December 2011 Alfa Laval obtained Type Approval Certificate No. P-13965 for PureBilge 2005 and 5005 (2.5m3/h and 5.0m3/h).

The development of the 5ppm approval has been driven by cargo owners and their customers, say Alfa Laval. It also claims that since its release on the market in June 2009, PureBilge had been tested onboard ships under real life conditions and consistently achieved results below 5ppm. *NA*

Korean's top-up the BWTS market

With the Ballast Water Convention ratification getting nearer, more ballast water treatment solutions have come on to the market in the last couple of years. Further development of those treatment systems will cater for more vessel types.

Korean-based Techcross and Panasia offer ship owners two different solutions for the ballast water convention conundrum, but both claim that their ballast water treatment system can meet ship owner's requirements.

NK, also a Korean ballast water treatment manufacturer, highlighted the financial issue faced by the ballast water market as the convention lingers on without being ratified. "According to IMO MEPC 55/2/4 document, there will be 1740 new build vessels in 2012 and all existing vessels by 2017 will be expected to have ballast water treatment systems installed. In addition, in June 2007, according to data released in the UK by class society Lloyd's Register, the system and installation cost shows a difference from US$250,000 to US$2.3 million. If the average price is US$500,000 including installation costs, we expect the size of ballast water treatment market to be worth US$870 million in 2012, US$3.37 billion in 2015 and US$8.97 billion in 2017", says N J Lee of NK.

However, the pressure is still building on ship owners to adapt to the new regulations and to come to a decision on what type of ballast water treatment system to install. Techcross has highlighted the features of an electrolysis system. "Regarding UV technology, it's very safe, compared to the other systems using chemicals. It's not dangerous to the environment, ship, crew, and ballast tank. And what's more, its sterilising power has already been proved through various experiments", states Ahmi Mun of Techcross.

NK's ballast water treatment for ships.

Techcross opts for an electrolysis system.

With concerns over certain forms of treatment systems that use filters as Wilhelmsen withdraws its Unitor system, Panasia still believes that the technology can still work. Its latest product the GloEn patrol GII has a large capacity Multi-cage type filter that has a patent and PCT applications, which has been completed for 14 different countries. It has a reduced footprint and will take up less space in a vessel. Techcross also claims that it is highly efficient at back flushing by increasing the working pressure of individual parts and reducing the loss of pressure within a vessel, allowing for minimum back flushing discharge.

Techcross has also highlighted that: "Type Approval demonstrates a system's suitability and efficacy, not a performance guarantee. Therefore, the owner and operator are responsible for compliance of the performance standard defined by the IMO (International Maritime Organization) throughout the vessel's life because Type Approval should not be considered as an indication that a given system will work on all vessels in all situations", says Mun. *NA*

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