



THE NAVAL ARCHITECT

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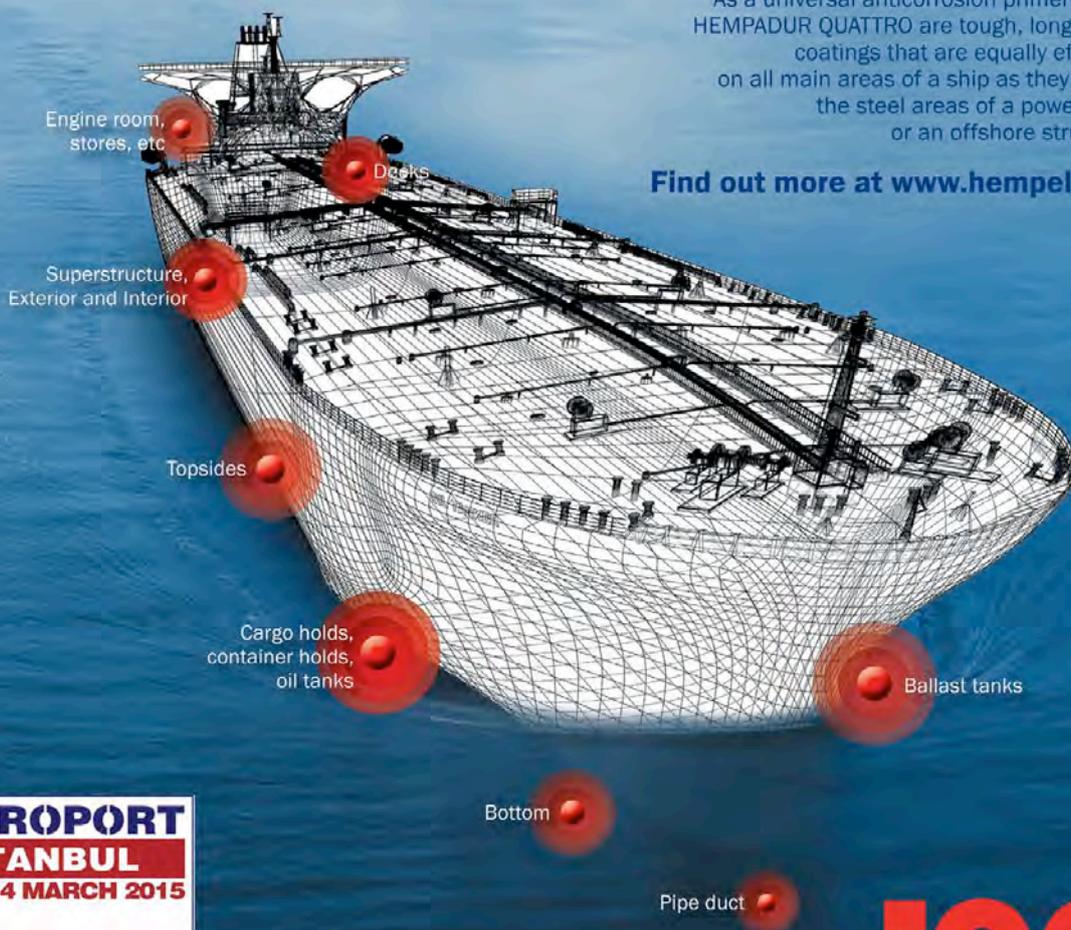


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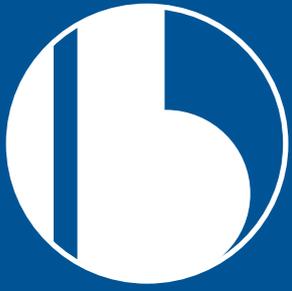


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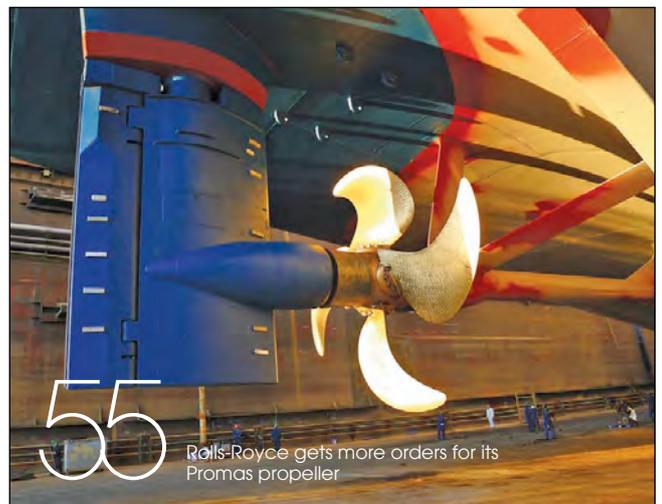
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Rolls-Royce gets more orders for its Promas propeller

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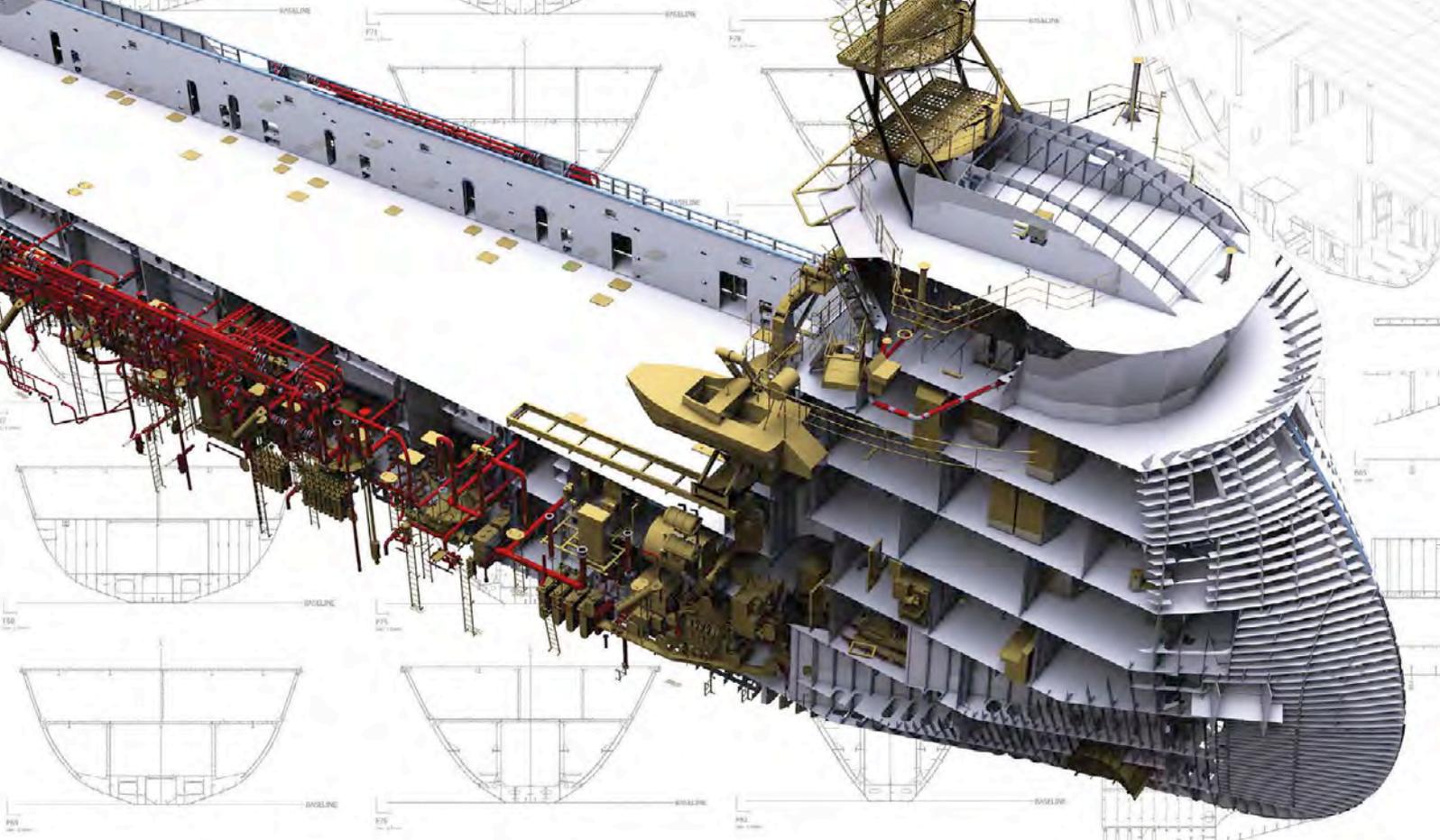


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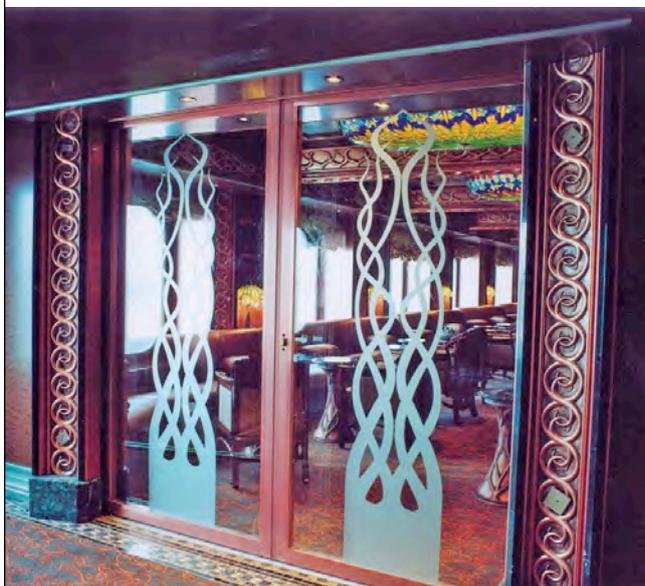
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The future of the maritime industry

Rolls-Royce foresees a future of unmanned vessels

Last month, Martin Stopford described how the maritime industry will be changed by the development of electronic systems. Electronic science will, explains the Clarkson's Research President, allow vessels to be operated remotely by trained personnel on shore. Remote operations will mean that such highly trained staff will be able to oversee up to 100 vessels each deployed globally without leaving the comfort of their office. This will mean significantly more efficient ships and far safer ships as machines are much less likely to make errors, says Stopford. This change will be also necessary if, as Stopford assumes, the demand for shipping will increase as a result of the growth in the global population, and the shortage of trained staff, such as chief engineers and masters, to operate new complex vessels continues.

This month Sarah Mander and Alice Bows-Larkin of the Tyndall Centre for Climate Change Research, School of Mechanical Aerospace and Civil Engineering, University of Manchester, have looked at the future of shipping from another angle; that is from the point of view that all industry must participate and make radical changes if global warming is to be limited to 2°C.

Whilst Stopford believes that vessel design of ships has taken us to the limit in terms of finding major efficiencies in the future vessel designs, Bows-Larkin and Mander, claim that there are signif-

icant emission reducing changes to be made by thinking radically about vessel design [See pages 20-26]. And whilst Stopford assumes that the demand for shipping will increase as a result of the growth in the global population, Bows-Larkin and Mander explore whether there is an opportunity to decrease demand for the transportation of goods by the development of manufacturing centres that are closer to their markets.

Such a move would require, not only the re-localisation of the European and US manufacturing base, but the creation of a plural manufacturing system for the world's population. Reversing globalisation is perhaps the macro view of the industry as viewed by those on the periphery, while the micro solutions offered by those that operate within the sector offer another perspective.

Another change to the maritime industry will come from the step to cleaner, more efficient shipping which was taken in late January when the second round of voting on the sea trials standard, ISO15016-2015, approved the new standard and the group now await MEPC to approve the new process.

"We have finalised the ISO document during the ISO expert meeting in London" a message announced at RINA headquarters. The second vote on the standard which was conducted between October and December of last year followed the rejection of the original revised standard in the spring of last

year prompting further discussions through the summer and a second vote on the reworked standard later in the year.

However, the question is why is a standard necessary at all? The reasoning behind the development of ISO 15016-2002 and this latest revision was that some yards were given to, what one person called, the "manual manipulation" of sea trial results. This meant that yards were able to "optimise" sea trial data, producing the results that they required.

In part the yards were able to do this because there was no standard procedure for sea trials and it is this problem that ISO 15016-2015 will address.

According to the International Towing Tank Conference (ITTC), the Sea Trials Analysis group and ISO the latest standard is "robust" and the validation process that took place in the summer of last year, conducted by ITTC and Bureau Veritas showed that the system worked.

"It is not a perfect system," said one representative, "but we will perfect it over the next two to three years and it will improve".

The three developers of ISO 15016-2015 expect that there will be some complaints from parts of industry regarding the new rules, that they hope will be applied in the summer, but they challenge their detractors to come up with a better alternative. *NA*

Standards

Expert group set new sea trials standard

As *The Naval Architect* goes to press, news has emerged that a second vote by the expert group that was debating the standardisation of the sea trials process has passed the new standard, ISO 15016-2015.

An earlier vote in the spring of last year had rejected proposals originally put forward by the group as some members expressed concerns about the efficacy of the revised standard. In particular validation of the new iterative method was a concern for many experts.

In the summer of 2014 the validation process took place and the iterative method was then approved in a second round of voting that took place between October and December last year.

Expert groups involved in the development of the new ISO standard hope that the IMO's Maritime Environment Protection Committee 68 (MEPC 68) will approve ISO15016-2015 when the committee meets in between 11 and 15 May this year.

Sea Trials Analysis (STA) a group of 40 interested parties who were instrumental in drawing up the new

$$V_c = V_{c,c} \cos\left(\frac{2\pi}{T_c} t\right) + V_{c,s} \sin\left(\frac{2\pi}{T_c} t\right) + V_{c,T} t + V_{c,0}$$

As a counter proposal to the Mean of Means method and based on a recommendation by Professor Toki of Ehime University, the proposals to develop a method that eliminates the arbitrariness of ISO 15016:2002 and minimises the burden on speed trials. For this method, the following formula represents current changes as a function of lunar periodicity + linear term of time + constant term, in order to eliminate to manually draw current curve (data shaping using analysis results) was introduced as shown in Equation 1.

standard believe that the work to proof read the final version should be completed in time for MEPC 68 and that the hope is that MEPC will then approve the standard and ISO 15016-2015 will replace an earlier version, ISO 15016-2002, from 1 June.

STA group representative Hans Huisman told *The Naval Architect*: "Owners will prefer the new standard because it creates a level playing field, there will be no opportunity for yards to optimise results."

Under the old system yards could have a list of sea trial methods and an owner could choose which method he

would prefer; "It was like looking through a Jamie Oliver menu," explained Huisman.

Following the introduction of the new standard the system itself will be more robust, the formulas work and anybody can use them by downloading a freely available programme from the joint STA and IMO website.

A further benefit of the new sea trial standard will be that the IMO's Energy Efficiency Design Index (EEDI) measurements will be more accurate as all ships will undergo standard trials and all results under the same system should be reproducible.

The programme for calculating sea trial results conducted under the latest standard, ISO 15016-2015, is available free from: www.staimo.org

Engines

Wärtsilä and CSSC in JV deal

China State Shipbuilding Corporation (CSSC) has entered into a joint venture agreement with Finnish engine designer Wärtsilä for the take-over of Wärtsilä's two-stroke engine business, which was first announced last July, has now been finalised.

Government and merger control approvals were received last month and the company is now split with majority shareholder CSSC holding 70% with the remaining share going to the Finns.

The new company will be renamed Winterthur Gas & Diesel Ltd. (WinGD) with the head office of the new company remaining Winterthur, Switzerland. The company has subsidiaries in China, South Korea and Japan.

A company statement said: "The joint venture assumes ownership of Wärtsilä's two-stroke engine technology, and will continue to develop and promote sales of the Wärtsilä two-stroke engine portfolio with the full support of both partners. Responsibility for servicing Wärtsilä's two-stroke engines will remain with Wärtsilä via its global service network"

CSSC is the largest shipbuilding company in China; WinGD believe that the synergies provided by the joint venture will "accelerate product development, bringing critical new engine technologies to the market faster. "Wärtsilä customers will benefit from the greater market penetration and the worldwide service network that provides lifecycle support."

Shipyards

HHI launches marine centre

South Korean shipbuilder Hyundai Heavy Industries (HHI) has announced that it has launched the Hyundai

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Marine Service Center (HMSC) in Ulsan. The new entity is effectively a merger of the aftersales service units of HHI, Hyundai Samho and Hyundai Mipo and includes the overseas service offices in Rotterdam, Dubai, Singapore and Houston.

Once the merger is complete HHI says that it also intends to incorporate the service units of Engine & Machinery Division and Electro-Electric Systems Division into the centre at a later stage.

HHI says the integration of the separate units is aimed at having a single point of contact and comprehensive services for all Hyundai brand ships, both during and after the warranty period.

The company adds: "The centre is also equipped with an integrated computerised feedback system for monitoring and troubleshooting to prevent the recurrence of problems." In addition, HHI plans to offer customers an expanded range of technical, sales of spare parts services and retrofitting on demand.

Classification

NK offers new guide for gas ships

Classification society ClassNK has released version three of its Guidelines for Gas Fuelled Ships.

In the updated version there is comprehensive and up to-date information on key design features relating to bunkering, hull structure, fire safety, and explosion prevention measures.

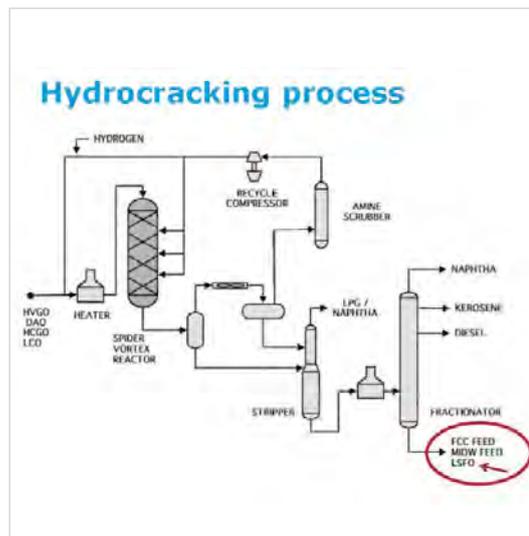
ClassNK says: "As restrictions on sulphur emissions within ECAs tightened to 0.1% on January 1, 2015 amid stronger calls for a greener shipping industry, attention has turned to the potential of natural gas as a sulphur-free, cleaner alternative to liquid fuel oil. Abundant shale gas reserves and recent developments in non-conventional energy resources have also led to an increase in gas fuelled newbuildings and projects."

As the emissions regulations are becoming more stringent the IMO has accelerated discussions of the International Code of Safety for Ships using Gases or other Low flashpoint Fuels (IGF Code) in order to extend safety regulations in this rapidly expanding industry sector. The IMO's Maritime Safety Committee (MSC) approved in principle the draft of the IGF Code during a meeting held at the IMO in November.

Fuel

New ECA fuel available

In a week in which four shipowners were fined a total of US\$150,000 for failing to meet the new Emission Control Areas (ECA), in place since 1 January, DNV GL believes there could be a new fuel that would help owners meet the regulation more comfortably.



Producing low Sulphur HFO

According to Per Holmvang, Program Director – Environmental Technologies, DNV GL Maritime Technology and R&D not only have four owners been fined but around one vessel a week in the US is breaking down, while make the switch from HFO to low sulphur fuel.

Help, however, is at hand says Holmvang. A new type of low sulphur HFO (LSHFO) is being produced by a number of oil companies, including Exxon, BP, Shell, Lukoil, Caltex and Gazprom among others.

The LSHFO is already being produced as part of the internal processes of the refineries in a process known as Hydrocracking, but the oil companies never marketed the resultant fuel. However, with the requirement for vessels to meet new low sulphur regulations of 0.1% in ECA areas the LSHFO could offer owners a significantly better way of meeting the regulations than switching to distillate.

Holmvang says that LSHFO has many useful properties including a viscosity of around 50cSt, no residuals, no catalytic fines, a high flashpoint and it has good ignition and combustion.

There may, however, be some down sides to the fuel also as pointed out by the oil companies themselves. They say that it will need heating and separation because it can produce wax as it cools; there are questions over the stability and compatibility of the fuel while the lubricity and the development of micro-biological growth could also offer some difficulties.

The LSHFO is priced at between US\$20 and US\$50 below the distillate price and will offer easier switching for crews and may be attractive to owners from this perspective. Holmvang also says that the refineries are currently saying that there is no problem with availability. *NA*

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Space invaders to the rescue

Entry into enclosed spaces continues to be a major cause of death and accidents today and incidents continue to happen on a regular basis, writes *Sandra Speares*.

Videotel, in conjunction with Mines Rescue Marine, has launched an Enclosed Space Management System, designed to help effectively assess, audit and manage the safety of enclosed spaces onboard ship and combat the number of accidents and fatalities that all too often occur when problem areas are overlooked. They have also set up virtual training for enclosed spaces which is a “gamification”.

This is currently the only computer-based system available that enables vessels and installations to comply with the IMO’s resolution on enclosed spaces as well as the latest SOLAS recommendations and costs very little to install.

It provides an auditing process to follow, allowing safety risks to be identified and solutions to be put in place. All crew members can contribute to this ‘living’ system by adding their own comments, photographs and experiential data to each space record, ensuring that knowledge is retained and the risk of safety being affected by crew changes is lowered.

It also provides ready access to all essential information needed to enter and work within an enclosed space as safely as possible. Gathered information can be viewed ashore as well as onboard and a PDF report can be sent directly to any third party by email, as required. All data entered is stored and hosted, and the system itself is updated at regular intervals to reflect changes in laws and regulations.

The Enclosed Space Management System’s auditing process allows for the assessment of internal spaces, entry points and rescue requirements, for the size of manholes; difficulty of entry; ability to rig a man riding winch for rescue purposes; availability and effectiveness of communications; dimensions of the space; internal design features; and the ability to operate whilst wearing breathing apparatus. It also prompts the user to record the manpower and equipment requirements for both entry into and potentially rescue from, a space. On completion of the audit, a simple traffic light warning system is provided, based on the degree of difficulty to get into, operate inside and rescue from each space.

According to Michael Lloyd of Mines Rescue Marine, the new enclosed management system is the first to be designed in this way. The gaming system he described as “a major first for the marine industry”. Both products were co-developed by the two companies.

The two companies came together about five years ago because the number of people dying in enclosed spaces was becoming “intolerable”, he said. They started off with a DVD series but people have continued to die.

Lloyd said that the two companies felt that culture was the problem and people going to sea for the first time were dying, but so were people who had been at sea for thirty

years. Young seafarers are “heavily into gaming”. Drinking on ships is now out and crew members tend to go to their cabins and play games, he said. “So we thought ‘give them a game here that they will learn something from’.

There are four areas contributing to the problem: equipment, training, design and culture. As far as equipment is concerned there is no SOLAS requirement to buy it, he says. As far as training is concerned this is also available. The companies wrote a paper on design pointing out that manholes were too small and “went in a circle” with owners, yards and designers each saying the others were responsible for design issues. The cultural aspect also had to be solved, he says.

Under SOLAS recommendations, enclosed spaces on ships should be identified, but the two companies found that ships could not identify enclosed spaces “No ship could tell us about those enclosed spaces and that includes the oil and gas industry”. No-one had done an audit of a space, he says. “We want to protect everybody. When you look at people dying it wasn’t just the crew onboard, it was visitors to the ship. Contractors were going down and dying.”

Visitors were particularly vulnerable because they were dependent on the crew doing everything right and the space being safe. In terms of work documentation he says many ships don’t go and check the risk assessment. “Under this system you can’t miss it because we are forcing them to do it.”

The aim is to have a simple system that everyone can follow, he says. With this system, before entering an enclosed space the crew member can go to a computer, and punch in the space and know what they are about to see.

Adam Allan, managing director of Mines Rescue Marine, said: “This is the culmination of a two-year project initiated by our realisation that one of the major problems on ships and offshore installations was the lack of detailed audited information on enclosed spaces, and a specifically designed depository for it. We felt that if we could provide a facility which shares information with not only crew members, but others working onboard, such as surveyors and contractors, it would considerably increase the safety of people entering and working in these spaces.

The system categorises enclosed spaces as high risk, medium risk or low risk, using a colour coding system. The system also gives the ability to build up knowledge of the space based on experience of other crew members and feedback is available over the web while reports can be printed out. If a crew member clicks on a particular space, and it is designated as red, the crew member automatically knows that it is dangerous to enter, and difficult to go in and out of. Given that the system, according to its developers, costs about the same price as a good dinner, it seems an investment that shipowners cannot afford not to make. [NA](#)

Changing fuels to meet ECA legislation is not as easy as it seems



Are you prepared for what's ahead?

If you choose to work with low-sulphur fuels when SOx Emission Control Areas (ECAs) take effect in 2015, you face potentially engine-stopping hazards when it comes to fuel viscosity and lubricity during changeover.

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Deck equipment

Palfinger Marine acquires NDM

Palfinger Marine is expanding its empire once again with the recent acquisition of Norwegian Deck Machinery AS (NDM). With this Palfinger Marine will also expand its product portfolio with winches.

Palfinger Marine has said that with NDM's position within the design and development of deck winches and handling equipment for the Oil & Gas industry as well as the marine market will be an important success factor for its future strategy.

NDM, based in Norway, has a product portfolio within winches and handling equipment for both offshore vessels and oil rigs. By integrating NDM's product range into the existing portfolio, Palfinger Marine has said that it has taken a big step forward in becoming the leading package supplier for deck equipment. The product range now includes offshore and marine cranes, launch and recovery systems, boats and deck winches. New market segments are now more easily accessible and because of this Palfinger Marine said that it can offer highly attractive package deals to customers with very heterogeneous requirements.

www.palfingermarine.com

Propulsion

GE powers KHI LNG carriers

GE's Power Conversion business has announced that it received a new order from Kawasaki Heavy Industries for electric power and propulsion systems for two LNG carriers. The gas carriers will be built for the purpose of transporting LNG from Louisiana, USA. Their construction is scheduled to be completed from 2017 through 2018.

The company has said that from the perspective of improved performance, electric propulsion technology is optimal for LNG carriers. GE's robustly simple induction-based propulsion motor technology and high output power pulse width modulation (PWM) technology improve reliability and help lower maintenance costs for vessels.

"This order is based on the result of Kawasaki Heavy Industries' evaluation of GE's induction motor technology and its extensive track record. While GE has many achievements abroad, this is the first order that we have received in Japan. We would like to seize this opportunity and deploy more proactive business initiatives in Japan," said Yoichi Yamaki, regional manager, GE Power Conversion.

www.GEpowerconversions.com

Environmental

EGCS for LPG carrier

Clean Marine has recently announced that it has successfully installed its exhaust gas cleaning system (EGCS) onboard a Dorian LPG gas carrier. The ECO VLGC Corvette was delivered from Hyundai Heavy Industries in January 2015.

Clean Marine claims that the measurements of exhaust gas emissions and washwater criteria are well below the required limits stated in the MEPC guideline 184(59). This ensures vessel compliance with the 0.1% sulphur limit in environmental control areas (ECAs), which has been in place from 1 January this year. The vessel is also compliant with the more strict US environmental protection agency (EPA) requirements of a pH above six in



Clean Marine gets onboard with Dorian LPG gas carriers

washwater, measured at the outlet.

Clean Marine's EGCS enables vessels to trade in all waters and ports well within the IMO and local regulations. The system's integrated fan and gas recirculation technology allows one EGCS unit to simultaneously serve all combustion units, including the boilers.

The system supplied to Dorian LPG is a hybrid type which can operate seamlessly in both Open Loop and in Closed Loop (zero discharge mode). Clean Marine's EGCS features a unique particulate matter trapping efficiency and meets the pH limit for washwater discharges with good margin.

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Propulsion

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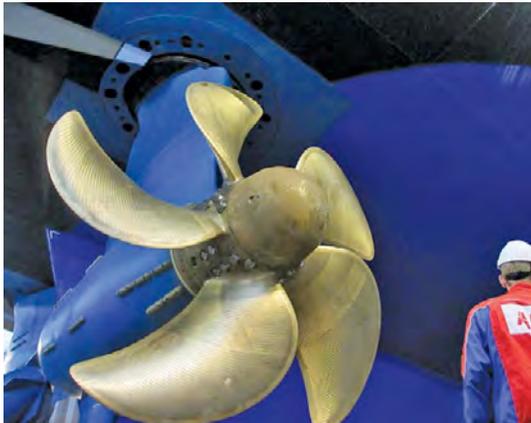


ABB will supply Star Cruises with its Azipod system

propulsion systems for two new luxury vessels for Star Cruises operated by Genting HongKong and to be built by Meyer Werft at its shipyard in Papenburg, Germany.

ABB will supply complete electrical systems for the new vessels, including power generation and distribution systems and thruster motors, as well as its latest-generation Azipod XO propulsion system, commanding power output of 20.5MW. ABB claims that its Azipod propulsion uses less fuel than traditional systems and provides greater manoeuvrability in all operating conditions. This will contribute to optimised vessel performance and a high level of passenger comfort and safety.

The 150,000gt, 330m cruise ships with 1,682 passenger cabins will be able to accommodate 4,925 passengers each and will be delivered in the autumn of 2016 and 2017.

www.abb.com

Ancillary equipment

ClassNK updates welding guidelines

Classification society ClassNK has announced that it has released Guidelines on Laser-Arc Hybrid Welding (Ver. 2). The updated version builds on the original guidelines, which were developed in December 2009.

Before manufacturers can use laser-arc hybrid welding in the construction of vessels, they must first obtain approval for the Welding Procedure Specification (WPS) and the Quality Verification Procedure Specification of production welding.

In order to support the widespread use of laser-arc hybrid welding in shipyards, ClassNK has fully revised its original guidelines and released a comprehensive summary of the requirements for welding procedure qualification tests, welding procedure specification and quality verification

procedure specification of production welding amongst other regulations.

ClassNK has said that as shipyards look to achieve higher quality and efficiency in shipbuilding methods, the future diffusion of laser-arc welding on commercial vessels is highly anticipated.

www.classnk.com

Ancillary equipment

MacGregor cruises ahead

MacGregor, part of Cargotec, has received a contract from STX France SA to deliver cargo and passenger access equipment for two cruise ships.

MacGregor's 'turnkey' delivery includes the design, production, delivery, installation and commissioning of tailor-made systems that include numerous MacGregor doors, platforms, lifting platforms, ramps, hatches and power packs; a total of 51 items of equipment per shipset.

www.macgregor.com

Environmental

Alfa Laval increases the pressure

In response to rising jacket water pressures, Alfa Laval has released a high-pressure option for the Alfa Laval AQUA Blue freshwater generator. The option's modifications will allow AQUA Blue to handle even higher jacket water pressures than those in use today.

Alfa Laval modifies its AQUA Blue freshwater generator to handle higher pressures, catering for a broader range of vessels





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Alfa Laval's 3-in-1 AQUA plates allow evaporation, separation and condensation to occur within the same plate pack, which means only half the seawater flow and pumping energy are needed. Thanks to a new option for AQUA Blue, this solution will now be available in a stronger configuration that withstands considerably higher jacket water pressures.

Jacket water cooling systems, which often provide heat for the desalination process, have changed when it comes to two-stroke engines as a result of slow steaming. The changes have been aimed at preventing cold corrosion in the engine cylinder liners, but they have also resulted in higher jacket water pressures. Where 4bar was the previous standard, pressures of 5bar or more are common today.

"Jacket water pressures will likely continue to rise," says Alex Jönsson, the Alfa Laval regional business manager responsible for marketing AQUA Blue. "When MAN increased to 5bar, many suppliers of freshwater generators assumed they could stretch the boundaries a little, and thus avoid making major changes. Since then, Wärtsilä has gone up to 6bar."

Alfa Laval, despite having the JWP-26 freshwater generator that can operate at 5bar, decided early on to create a high-pressure option for AQUA Blue. "We made the opposite assumption, that we need to be prepared for even higher jacket water pressures," says Jönsson.

The stronger configuration will simplify the design of large vessels with a deep draught, which otherwise pose challenges for the condenser section of plate-based freshwater generators.

www.alfalaval.com

Environmental

Interlake Steamship orders Belco

Belco Technologies Corporation (BELCO), a division of DuPont Sustainable Solutions, has been awarded a contract for two BELCO Marine Scrubbers by Interlake Steamship Company.

The closed loop scrubbers are to be installed on *Honorable James L. Oberstar*, a self-unloading dry bulk carrier that operates on the Great Lakes. Installation began in mid-January in Wisconsin, and testing is scheduled for April 2015. The system will allow Interlake to meet all North American ECA and IMO Annex VI sulphur requirements while continuing to operate on heavy fuel oil.

Each single-inlet, closed loop scrubber will be connected to a Rolls-Royce Marine Bergen

6-cylinder diesel engine rated at 3,000kW. BELCO said that it worked closely with Interlake to provide a system whose equipment and auxiliaries were optimised based on the vessel's operational profile. For example, the scrubbers will take advantage of a common effluent treatment system to meet all US Coast Guard, US EPA and IMO washwater emission standards.

www.dupont.com

Ship safety

Lightweight composite approved for newbuild

For the first time, combustible, fibre-reinforced, lightweight composite has been approved for use in a SOLAS ship. Panama's flag authority has accepted a design where hatches in



Nordic Bulk Carriers tries out the latest composite hatch covers

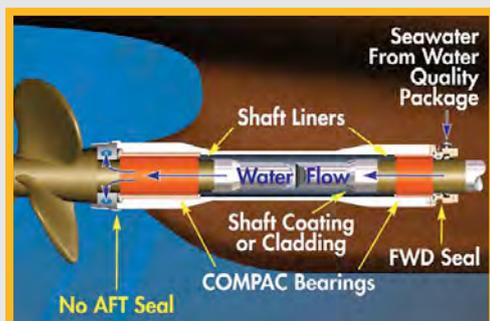
fibre-reinforced plastic composite replace steel hatches. Research and fire risk analyses at SP have helped in making this possible.

According to Tommy Hertzberg, fire researcher at SP, up to now it has been difficult to obtain approval as all regulations are based on steel. SP's experts have been involved in numerous Swedish and international projects which have had the aim of gaining approval using new materials, but prior to this no flag state had fully accepted the lightweight solution. Panama's flag authority has now accepted a conversion using composite, which is a major step forward.

The ship, a cargo vessel of 225 x 32m, which has now been approved for conversion, is owned by the Danish shipping company Nordic Bulk Carriers AS.

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Is a radical shift in shipping on the horizon?

Exploring the shifting sands in the maritime industry Sarah Mander and Alice Bows-Larkin of the Tyndall Centre for Climate Change Research, School of Mechanical Aerospace and Civil Engineering, University of Manchester, argue that meeting the 2°C limit for climate change requires all industry sectors to reduce emissions

In December 2015, Paris will host the keenly awaited United Nations Conference of the Parties (COP). It is when world leaders will gather to thrash out CO₂ targets, with an aim of preventing global temperatures rising by more than 2°C above pre-industrial levels.

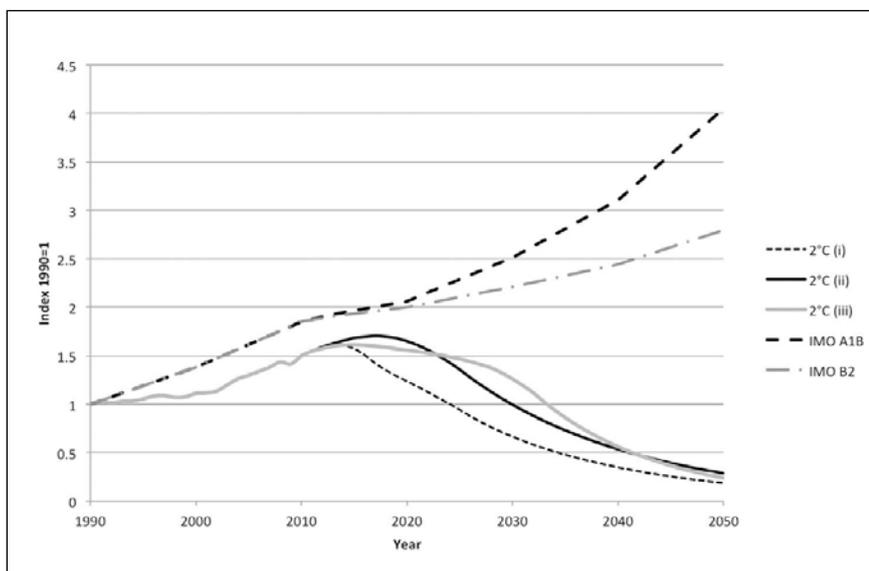
With existing carbon reduction commitments only applying to some wealthier parts of the world, the Paris meeting is expected to agree targets for all nations and sectors. If the targets set are based on the science, it means that for the first time, international shipping (and aviation) can put policies in place in line with an internationally derived greenhouse gas limit.

The special case of international transport

What has set international shipping (and aviation) apart from other sectors to date, is the climate governance around their activity, which occurs in international waters (and airspace). This left them exempt from national CO₂ commitments under the Kyoto Protocol. Instead, for the shipping sector the IMO was charged with implementing mitigation efforts.

It is well known, however, that gaining agreement at the IMO on adequately stringent targets faced significant challenges. This is in part due to a clash between the UN Framework Convention on Climate Change's principal of 'common but differentiated responsibilities' – where nations less economically developed historically take on low or no emission targets, and the maritime principal of 'no more favourable treatment' – meaning that all shipping activity should be treated equally.

As a consequence, while other sectors within more developed economies have faced policies to cut CO₂ since the 1990s, only in the last few years has the shipping sector started to implement mitigation measures.



Comparison of typical 2°C scenarios for all sectors and anticipated future scenarios for shipping, based on data published in Anderson and Bows, 2012.¹



Alice Bows-Larkin says no industry will do more than is necessary to meet carbon targets

The slow mitigation progress made by the industry prompted some to question future trends in emissions from international shipping. In doing

so, scenarios for future shipping activity and associated CO₂ emissions can be compared with global commitments to avoid 2°C. The picture is stark (see Figure 1) – for any reasonable probability of avoiding 2°C, substantial cuts to CO₂ are needed across all sectors. Moreover, with no sector currently suggesting that they will do more than is necessary to avoid 2°C, no sector can commit to do less, for any given carbon commitment.

Taking the average effort to avoid 2°C, analysis indicates that the shipping sector would need to cut CO₂ by at least 40% by 2030, 85% by 2050 compared with 2010 levels¹. Contrasting this with the future scenarios developed for the recent 3rd IMO Greenhouse Gas Study² highlights a major clash in expectations. Only two of the 16 scenarios published have emissions falling back towards 2005 levels. None illustrate reductions of the scale discussed above – the rest show absolute increases.



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So, this raises a question– is it possible to close this gap?

As stated by Martin Stopford last month, technical efficiency has already been pushed hard within the shipping sector. Nevertheless, in contrast to his view that “The industry’s design and engineering technology...can no longer deliver major hardware improvements to deal with the challenges of higher fuel costs, climate change....”, our research suggests that by thinking beyond incremental efficiency measures, there are radical changes to be harnessed – something that is necessary if the industry is to play its fair part in avoiding 2°C. Let’s start with the ship.

Visioning a radical ship

Compared to other transport modes, vessel size means that shipping is blessed with a wide range of technologies to either reduce energy consumption, or provide low carbon propulsion. For instance, although commercial shipping moved away from sails over the course of the industrial revolution, modern technologies to harness the wind offer a means to cut the energy required to power a ship, while at the same time reducing other pollutants such as SOx and NOx.³

Wind propulsion is not restricted to one technology; a variety of modern wind propulsion systems are suitable for different vessel types. Firstly, and perhaps most obviously, there are sails. With particular application for bulkers, and using technology from the aerospace and ocean racing yacht industries, modern sails are made of high tech materials and designed for very efficient use of wind energy. Coupled with sophisticated weather and wave forecasting technologies, energy reduction beyond the incremental is feasible.

Another wind-based technology, invented in the 1920s but then unable to compete with steam and diesel power, is the Flettner rotor. This is a spinning cylinder harnessing the Magnus Force to convert wind energy into propulsion (see *The Naval Architect* January 2015 pages 28-30). Whilst this may not be suitable for some ships, particularly given deck space requirements, the emission savings potential is promising; according to one study, three Flettner rotors installed on

a 5,500dwt general cargo carrier could provide more than half of the main engine requirements under a typical slow-steaming regime⁴.

The last example is the towing kite. This can be retro-fitted to many ship types. Launched from the ship’s bow, it harnesses the power of the wind at high altitude, taking advantage of higher wind speeds to pull a ship along. Interest in wind propulsion is primarily driven by oil prices, thus when oil prices have been high, such as during the 1980s, wind propulsion technologies have been on the radar, but interest drops off once the crisis has past. Perhaps the additional carbon driver will bring these new wind technologies to the fore.

It is not only wind power that offers opportunities. Looking a little further ahead, shipping could benefit from developments in land-based transport, through using batteries or fuel cells to supply propulsive and auxiliary power. Batteries are particularly suitable for small vessels such as ferries where engines are subject to frequent load changes, while fuels cells are suited to auxiliary power. For both these options the carbon reduction achieved depends on the source of the fuel or electricity.

Visioning radical shipping

On the operational side, shipping can benefit from innovations in other sectors, particularly digital technology. Last month, Martin Stopford put forward the case for smart shipping to harness the digital revolution; such innovations have a clear role to play within shipping operations. In recent years, much has been made of the benefits of reducing speed – slow steaming.

Sailing vessels at lower speeds started around 2007 in response to pressures on shippers, namely over capacity, high oil prices and global economic conditions. Emerging originally for container routes, where speeds are highest and starting with trades between Europe and the Far East, the practice soon spread to other routes and to a lesser extent, bulk shipping. Given the cube relationship between speed and fuel consumption, slow steaming significantly reduces fuel use, while service frequency can be

maintained by putting additional ships on routes, making use of over capacity within the fleet.

Engineering ships for a slower regime could add further cuts to CO₂. On the other hand, slow steaming, needs to be accommodated within the logistical operations of the shippers who use shipping services. More stock can become tied up onboard ship, for example, making market forecasting more challenging. ICT is a key enabler for slow steaming. Shippers have been able to accommodate slow steaming, but service reliability is key. With longer transit times, a vessel must be able to dock when it arrives, as opposed to sailing as quickly as possible to get its place in a queue.

Furthermore, reserve speed may be required to ensure that a vessel arrives on schedule, in the event of delay. Other operational measures that improve ship efficiency include reducing the proportion of time a vessel sails in ballast, or increasing the load factor in the case of a container ship. Digital technology again has a role to play here in improving the management of logistics.

Visioning a radical shipping system

Having set out some step-change technologies and operational practices that can cut CO₂, the role of demand for shipping services also warrants consideration. Shipping has been the enabler of globalisation, facilitating ever-expanding supply chains and supporting economic development. Around 90% of goods, by volume, are transported by sea. Transport work, and therefore energy demand and ultimately carbon emissions, are the product of the quantity and distance travelled of goods shipped.

Whilst shipping responds to demand for its services, changing demand alters environmental impact. Take the origin of products, differences in the cost of goods and low freight costs has led to out-sourcing where it is more cost effective for companies to manufacture goods away from markets, and then transport them.

Convergence in production costs, or policies to bring production closer to markets, would reduce the benefits of overseas production, and potentially reduce the distance component of



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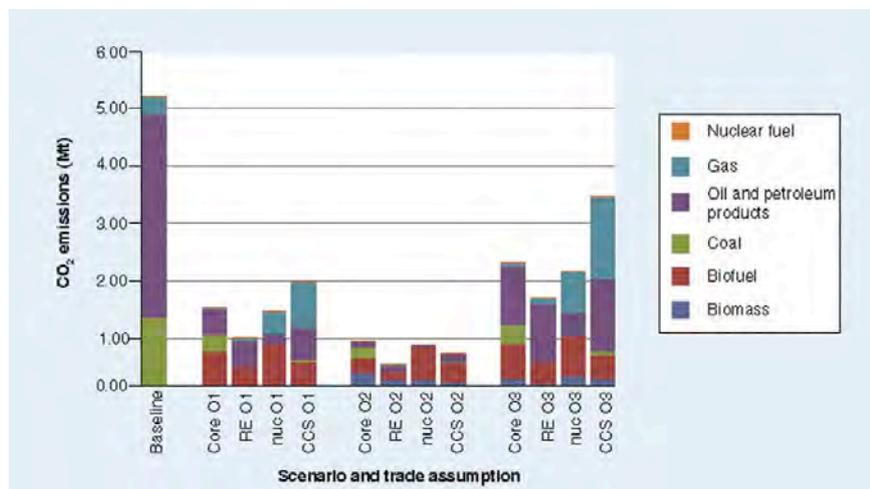
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CO₂ emissions arising from fuel imports in 2050 for each trade assumption.

CCS: Higher CCS, more bioenergy scenario; Core: Core Market scenario; nuc: Higher nuclear, less energy efficiency scenario; RE: Higher renewable, more energy efficiency scenario; O1: Option 1; O2: Option 2; O3: Option 3;

Figure taken from 'Decarbonising the UK energy system and the implications for UK shipping', Mander, S., Walsh, C., Gilbert, P., Traut, M., and Bows, A., Carbon Management, reprinted by permission of Taylor & Francis Ltd, www.tandfonline.com. Different options refer to assumptions around trading partners as well as technical and operational measures to cut CO₂.



interesting because the opportunities appear considerably greater than they are frequently given credit for. For example, compared with other modes of transport, shipping is less bounded by weight constraints. Additional kit suitable for improving engine efficiency faces a major trade-off when cutting CO₂ in aero engines for example.

Another advantage is that there are fewer issues over public perceptions, which can be a major barrier to change. There are expectations around an individual's right to fly where they wish, or drive a particular type of car, but people are much less interested in how their food arrives on supermarket shelves. Many will not even associate shipping with their daily lives and they will almost certainly not think about the ship type or technology, or how fast it is travelling.

The shipping sector has the potential to change many facets of the system – from alternative methods of propulsion or fuels such as biofuel, to slower modes of operation and high tech routing. The many intervention points for mitigation will involve multiple actors. For example, stakeholders influence ship operations, such as ports authorities, or those customers of the shipping industry wishing to drive down supply chain emissions, all have a role to play.

While slow-steaming has been one mechanism that has cut CO₂ recently², maintaining and building on this will be challenged if oil prices continue to fall⁶. And whilst technological interventions may be plentiful, it is essential that

emissions are driven down in the short-term – long-lived greenhouse gases are cumulative, so the less they are cut in the short-term, the greater the cuts required later. This points towards pushing retrofit options up the agenda; if all of this wasn't enough of a big ask, the industry is reluctant to take risks, wishing to see full scale demonstration of radically different technologies before investing⁷, but in a world succeeding in its goal to avert dangerous climate change, all barriers to innovate will need to be overcome.

Conclusions

Avoiding 2°C of climate change is a huge challenge for us all and what it means in practice is a far cry from expected future emission trajectories in most sectors; and shipping is a clear example. The gap between the scale of cuts in CO₂ commensurate with 2°C and current industry expectations is enormous.

The question raised here, asks how feasible it is to close this gap. Our analysis shows that while there are clearly many barriers to a dramatic low-carbon transformation in the shipping sector, there is room for optimism. Unlike some sectors, there are interventions across technology and operations that in combination can offer a step-change cut in CO₂.

Maintaining the recent fall in energy consumption through slow-steaming is not only core to sustaining a CO₂ reduction in the short term, but is a key enabler of novel low carbon technologies such as wind propulsion. To avoid 2°C, a

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step change towards carbon reduction will be part and parcel of our future. Now is the time for sectors to step up to the challenge – but only by embracing the emerging innovation in the present can sectors hope to reap the benefits down the line. **NA**

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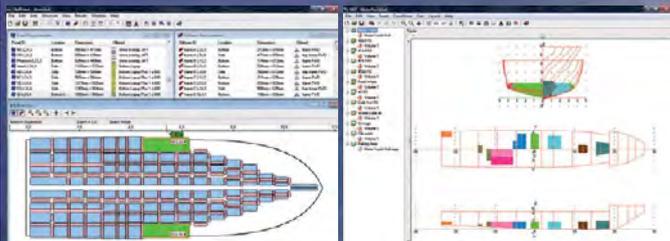
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Meeting the standards

The appropriate methodology to be adopted for standardisation of sea trials is subject to an on-going controversial debate. (see pages 86-92, *The Naval Architect* September 2014 and pages 26-27, *The Naval Architect* November 2014) Emeritus professor YJ Kwon of the University of Ulsan takes the debate one step further

The International Standards Organisation's (ISO) 15016-2002 standard on sea trials was the result of the work of ISO members and came to fruition after nine years of discussions¹.

The methodology is particularly welcomed within the shipping industry; in particular, the world's leading ship yards, namely Hyundai Heavy Industries (HHI) and Daewoo Shipbuilding and Marine Engineering (DSME). However, the development of the standard is at a crisis point and is in danger of disappearing into the shadows due to methods which may not be fully verified for the Energy Efficiency Design Index (EEDI).

To properly apply the index all uncertainties must be clarified to simplify the analysis of speed trials. However it is virtually impossible to achieve this position.

For instance, since 1975, many researchers (such as the 15th and 16th International Towing Tank Conference (ITTC)) have emphasised that, "wave diffraction does seem to have a significant effect on added resistance in waves with speed losses being registered as high as 1.5knots". Furthermore, it has been suggested that additional systematic work should be performed in this area².

However, it is difficult to determine the wave diffraction with ship speed trial analysis either by theoretical or experimental means due to its property of nonlinearity (high order effect) and irregularity^{3,4}. For instance Figure 1, 3-b and 3-d demonstrate the inaccuracy of experimental data⁴.

The purpose of this article is to present some simple methods to determine, the added resistance, speed loss and power increase at sea using Kwon's method for added resistance due to wave reflection

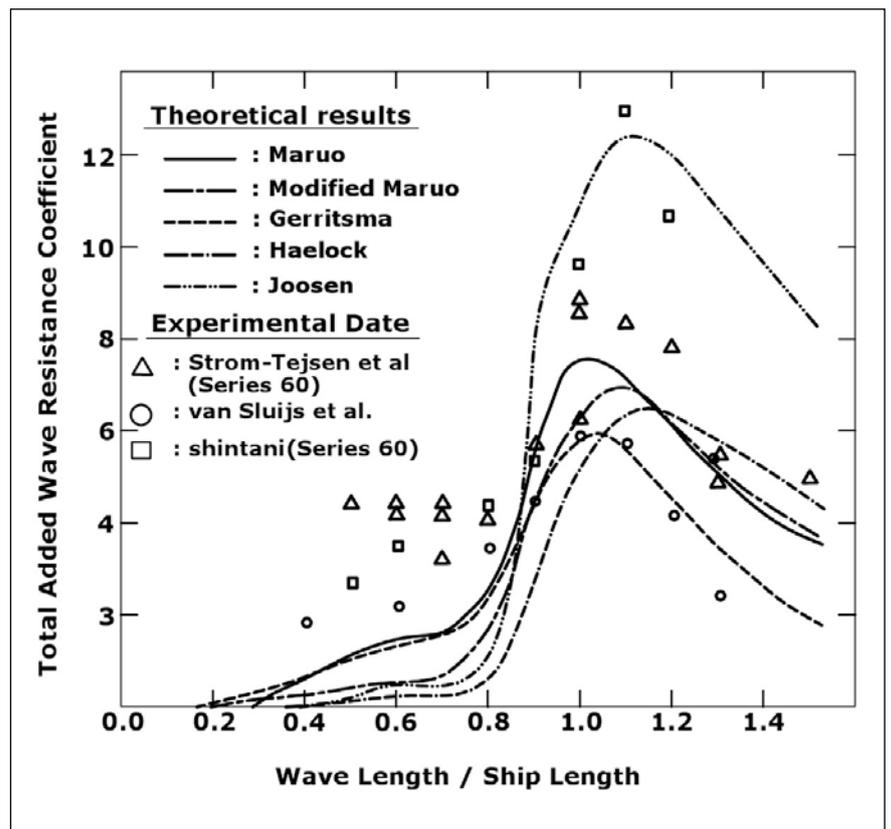


Figure 1: Comparison of measured and computed added resistance coefficients using available theories in regular head waves ($C_b=0.8$, $F_n=0.15$), (13, 14, 15)

(including diffraction) which was recommended by ISO 15016-2002.

Simple methods

A semi-empirical method devised by Kwon [4], and recommended by ISO 15016-2002[1], may be useful^{4, 5, 6, 7, 8} for added wave resistance due to wave reflection (including diffraction). However, the method is somewhat complicated to put into practice. To combat these difficulties the following work has been carried out:

The original Townsin-Kwon formulae⁵ for added resistance

in wind and waves, adopted by MARIN-'STAP⁹, was adapted to apply to most speeds and block coefficients.

The percentage of speed loss is given by

$$\alpha \mu \frac{\Delta V}{V} 100\%$$

Where

$\frac{\Delta V}{V}$ is the speed loss in head weather given by equations 1. α is the correction factor for the block coefficient (C_b) and Froude number (F_n) given in Table 1, μ is the weather direction reduction factor given by equation 2.

$C_b=0.75, 0.80 \text{ \& } 0.85$, Laden condition 1(a)

$$\frac{\Delta V}{V} 100\% = 0.5 \text{ BN} + \frac{\text{BN}^{6.5}}{2.7 \nabla^{2/3}}$$

$C_b=0.75, 0.80 \text{ \& } 0.85$, Ballast condition 1(b)

$$\frac{\Delta V}{V} 100\% = 0.7 \text{ BN} + \frac{\text{BN}^{6.5}}{2.7 \nabla^{2/3}}$$

$C_b=0.55, 0.60, 0.65 \text{ \& } 0.70$, Normal condition 1(a)

$$\frac{\Delta V}{V} 100\% = 0.7 \text{ BN} + \frac{\text{BN}^{6.5}}{2.2 \nabla^{2/3}}$$

BN is Beaufort Number and ∇ is volume of displacement in m^3

Table 1: α values

C_b (condition)	α (where F_n : Froude Number)
0.55(Normal)	$1.7 - 1.4 F_n - 7.4 (F_n)^2$
0.60(Normal)	$2.2 - 2.5 F_n - 9.7 (F_n)^2$
0.65(Normal)	$2.6 - 3.7 F_n - 11.6 (F_n)^2$
0.70(Normal)	$3.1 - 5.3 F_n - 12.4 (F_n)^2$
0.75(Laden or Normal)	$2.4 - 10.6 F_n - 9.5 (F_n)^2$
0.80 (Laden or Normal)	$2.6 - 13.1 F_n - 15.1 (F_n)^2$
0.85(Laden or Normal)	$3.1 - 18.7 F_n + 28 (F_n)^2$
0.75(Ballast)	$2.6 - 12.5 F_n - 13.5 (F_n)^2$
0.80(Ballast)	$3.0 - 16.3 F_n - 21.6 (F_n)^2$
0.85(Ballast)	$3.4 - 20.9 F_n + 31.8 (F_n)^2$

$2\mu_{\text{bow}} = 1.7 - 0.03 (\text{BN} - 4)^2 \dots 30^\circ - 60^\circ$ 2(a)

$2\mu_{\text{beam}} = 0.9 - 0.06 (\text{BN} - 6)^2 \dots 60^\circ - 150^\circ$ 2(b)

$2\mu_{\text{following}} = 0.4 - 0.03 (\text{BN} - 8)^2 \dots 150^\circ - 180^\circ$ 2(c)

Standard graphic methods for added resistance⁷

Standard Graphs were presented for an easy method to find added resistance at sea, also recommended by ISO 15016-2002¹. Using the graphs, the ratio of (added wave resistance) / (added wave resistance + added wind resistance) can be found in Froude numbers 0.10, 0.15, 0.20, 0.25 and 0.30. Block coefficients 0.6, 0.65, 0.70, 0.75 and 0.8 for ballast and laden conditions, lengths from 100m to 400m and BN from zero to 7 in head irregular sea. On the other hand, a wind added resistance (R_{wind}) in head wind could be easily estimated by the formula 4 or 3 and then the added wave resistance can be determined using the ratio read in the graph without any calculation.

Moreover using the weather direction reduction factor given in equation 2, the ratio can be easily changed to the

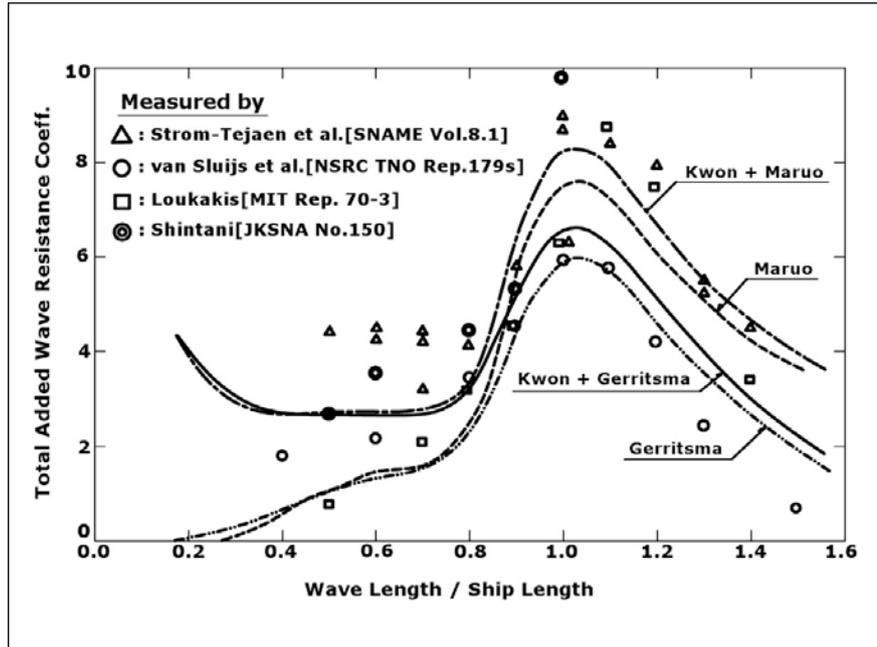


Figure 2: Comparison of measured and Kwon's (Author's) computed total added wave resistance in regular waves ($C_b=0.8, F_n=0.15$)

oblique weather. Alternately, another wind direction correction factor can be found in Reference 7 which was also recommended by ISO 15016-2002.

$$R_{\text{wind}} = 0.5 \times C_g \rho_a \times A \times V_r^2$$

Where, C is the wind resistance coefficient, ρ_a is the density of air, A is the effective area for R_{wind} , V_r is the wind speed relative to ships.

	Fujii-Takahashi's Method	Kwon's Method
Keynote	Assum. of geometric optics + Drift force($v=0, T=\infty$) + Correction	Same as Fujii-Takahashi's
Formula for drift force	Used Havelock's formula(49) for head sea $D = \frac{1}{2} \rho g c_b^2 \int_{-\frac{B}{2}}^{\frac{B}{2}} \sin^2 \theta dy$	Used Bessho's formula(50) for oblique sea $D = \frac{1}{2} \rho g c_b^2 \int_{S_1} \left(\frac{\partial y}{\partial s} \right)^2 ds$
Ship assumed for drift force	Only considered bow form of water plane, assuming a vertical axis cylindrical body having infinite draft	Considered whole form of water plane for a vertical axis cylindrical body having infinite draft, using the mathematical formula $Y = A_1 + A_2 X + A_3 X^2 + A_4 X^3 + A_5 X^4$ where, $A_1 \sim A_5$; evaluate by a minimax polynomial fit method
Correction for wave scattering	Wehausen & Laitone's(60) reflection coeff.(Cr) for a vertical flat barrier with finite draft $C_r = \pi I_1 / \sqrt{\pi^2 I_1^2 + k_1^2}$ where I_1, k_1 : modified Bessel functions the 1st & 2nd kinds	Jones & Whitham's wave scattering Coeff.(σ_s) for a vertical axis cylindrical body and on arbitrary form. $\sigma_s = \sigma_2 / \sigma_1$ where $\sigma_s = 2 - 0.985 (ka)^{-2/3}$ for vert. cyl. $\sigma_s = 2 - 0.985 (R_1^{1/3} + R_2^{1/3}) / (k^{2/3} dy)$ for a general obstacle $\sigma_1 = 2$
Correction for finite draught	No any correction except using the reflection coeff.(Cr)	Used the Smith effect of pressure attenuation with depth $C_r = 1 - e^{-2kT}$
Correction for speed	$C_v = \left(1 + \frac{2\omega}{g} v\right)^2$ or $C_v = 5 \sqrt{F_n}$ fitting to measured data	$C_v = \left(1 \pm \frac{2\omega}{g}\right)^2$ for head & following, $C_v = \left(1 \pm \frac{2\omega}{g} \cos \beta\right)^2 / \left(\frac{36\beta}{\pi}\right)$ for oblique sea[$5^\circ < \beta < 175^\circ$] by measured data & idea of encounter freq.

Table 2: comparison of Kwon's Method (4) with Fujii-Takahashi's (16)

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Figures 3a-3d: compute results by Kwon's Method and Measured data for the Added Wave Resistance Coefficient due to Wave Reflection (Increased Diffraction) in Regular Waves

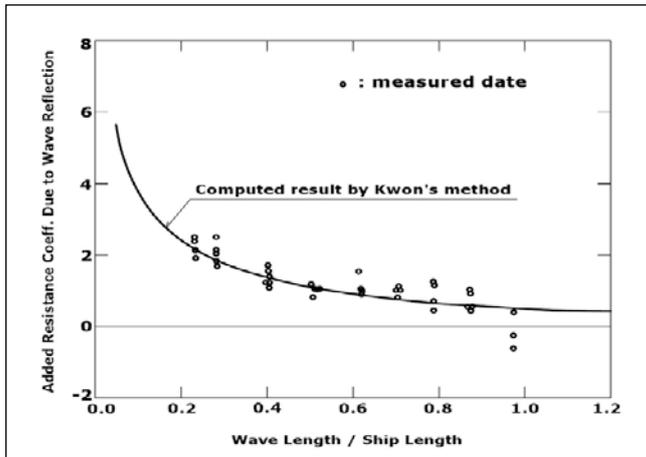


Figure 3-a: $F_n=0.10$

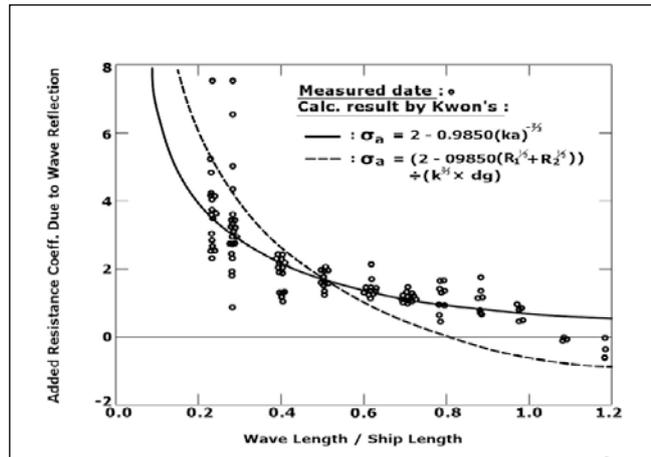


Figure 3-b: $F_n=0.15$

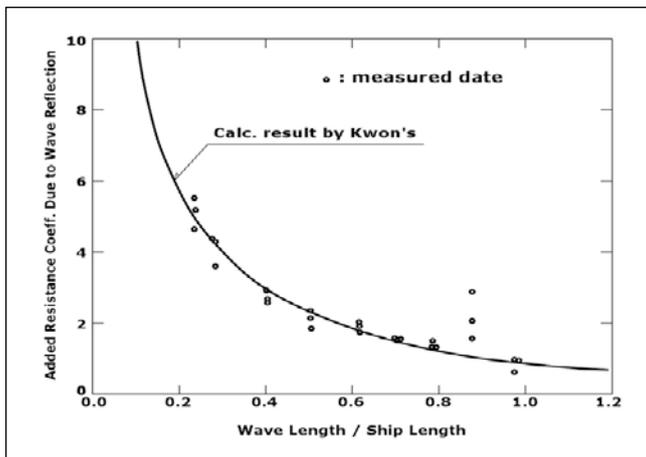


Figure 3-c: $F_n=0.20$

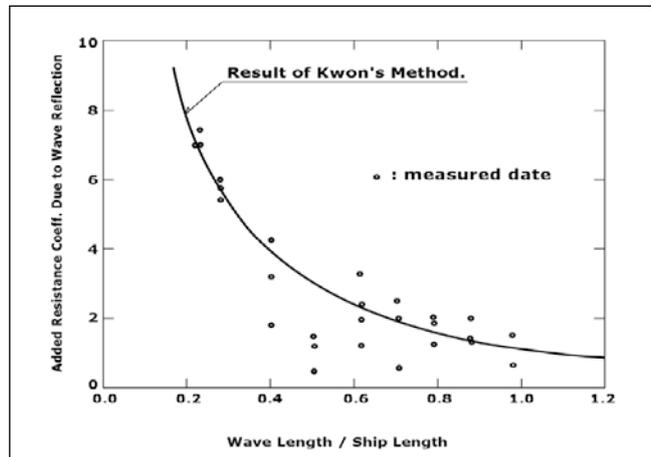


Figure 3-d: $F_n=0.25$

For instance following van Berlekom¹⁰, the head wind added resistance is given by the equation (4)

$$10^6 \Delta R_{wind} = 0.615 \times C_x \times L^2 \times V^2$$

Where

ΔR_{wind} is in MN

L is the ship length, m

V_r is the relative wind speed, m/s

C_x is the head wind coefficient, which depends upon ship type and the value of the transverse area ratio A_T/L^2

Standard tabular methods for added resistance⁶

Standard tables were presented for an easy method to find added resistance at sea⁶. Using the tables the ratio of '(added wave

resistance) / (added wave resistance + added wind resistance)' can be read for the same range of Froude numbers, block coefficients for ballast and laden conditions, ship lengths and BN in head irregular sea.

Other simple formulae⁷

Some other simple formulae in reference 7, recommended by ISO 15016-2002¹, can be found to determine for the following cases:-

- speed loss at constant thrust
- power increase for constant speed
- speed loss at constant power.

To develop the simple methods above, the following justifications were used:-

- Wind and wave condition: Pierson-Moskowitz's sea conditions for fully arisen sea
- Wave spectrum: ITTC Spectrum
- Added resistance in irregular waves using

the result of regular waves: Maruo's¹²

- Added resistance due to motion in regular waves: NSRDC computer programme¹¹
- Added resistance due to reflection (inc diffraction) in regular waves: Kwon's⁴
- Added resistance due to wind: van Berlekom¹⁰

Kwon's method for added resistance due to wave reflection including diffraction is compared with Fujii-Tkahashi's in Table 2. Further results for the comparison of Kwon's method and measured data are presented for added resistance due to wave reflection. These include diffraction in both regular waves and irregular waves as this effect has been considered to be the most fundamental and difficult effect². The comparison reveals that the results of Kwon's methods agree well with the measured data. **NA**

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Figures 4-1 to 4-4: Compare Sibul's Measured (17) and Kwon's (Author's) Computed Added Resistance in Irregular waves (Series 60, Cb=0.8)

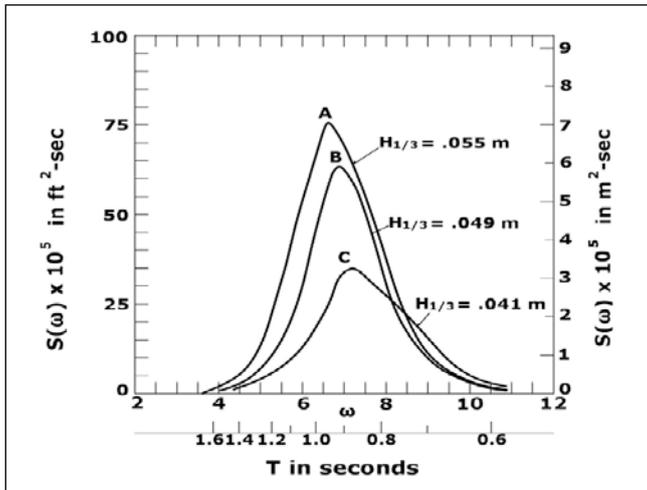


Figure 4-1: Wave Spectra for Model Test

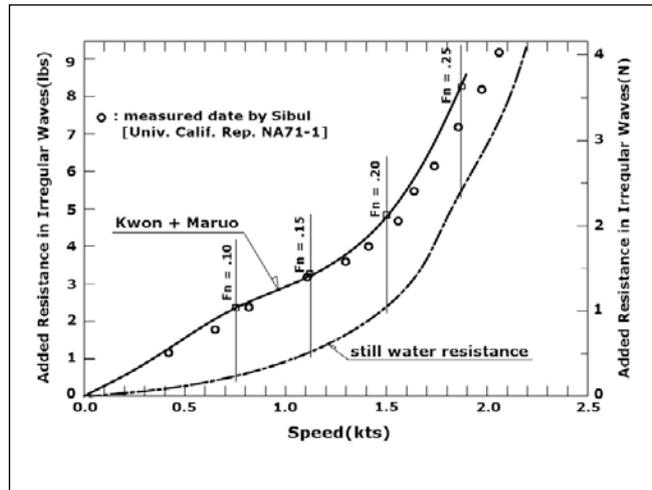


Figure 4-2: Model Test in Spectrum A

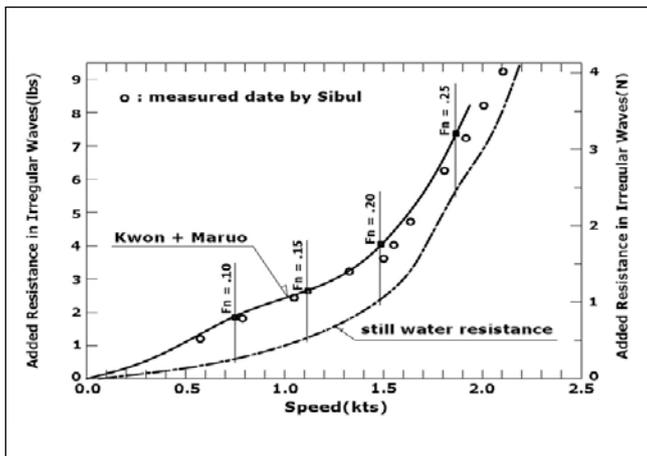


Figure 4-3: Model Test in Spectrum B

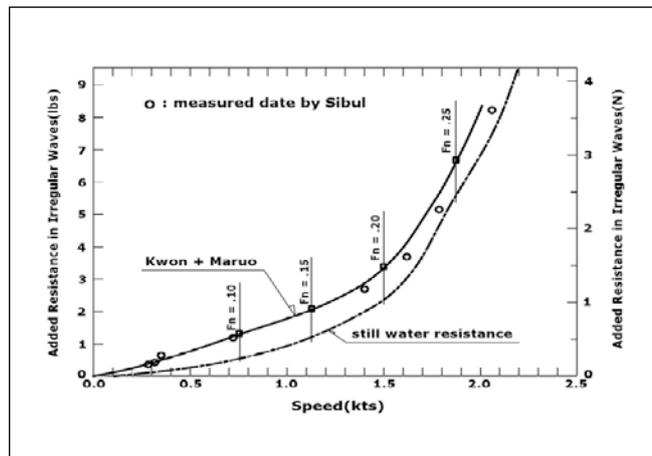


Figure 4-4: Model Test in Spectrum C

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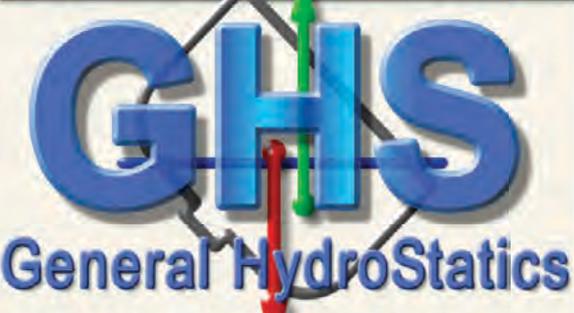
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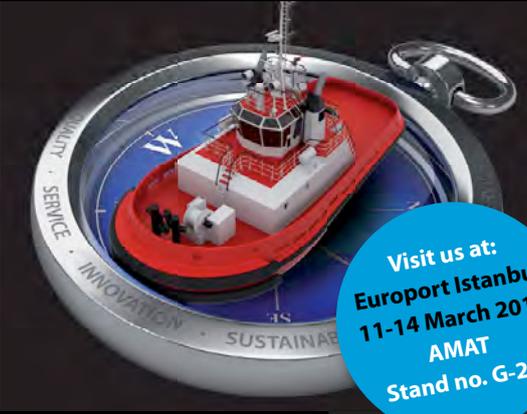
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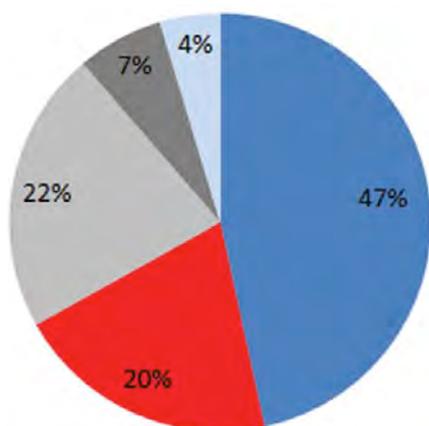


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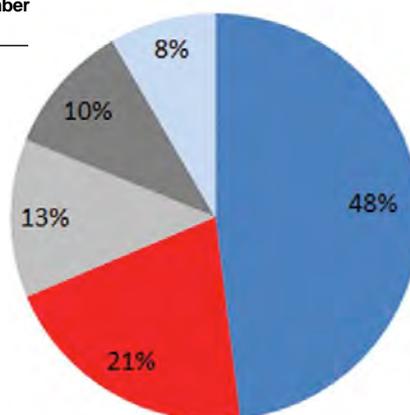
Vessel Type	2004		2005		2006		2007		2008		2009		2010	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half								
VLCC >= 200,000	15	14	15	16	5	13	15	14	18	22	33	20	30	24
Suezmax 120-200,000	16	11	17	8	14	12	15	10	9	5	23	22	26	12
Aframax 80-120,000	31	21	37	28	29	21	29	27	26	42	63	33	39	31
Panamax Tankers 60-80,000	26	11	23	22	24	20	27	15	17	26	26	12	15	16
Products 30-60,000	60	58	52	48	58	55	69	67	73	91	92	66	63	43
Products 10-30,000	3	4	3	5	2	10	9	10	9	6	5	5	7	7
Chem & Spec. 10-60,000	28	33	35	41	56	45	62	62	83	102	107	71	79	63
Tankers < 10,000	27	17	27	27	20	26	31	44	59	89	67	69	60	49
Capesize > 100,000	21	20	22	25	32	28	29	27	20	24	34	77	101	112
Panamax 80-100,000	3	3	5	11	22	23	22	16	15	17	27	21	61	60
Panamax 60-80,000	35	39	41	35	36	26	22	22	23	20	18	15	17	33
Handymax 40-60,000	37	43	52	48	53	40	50	50	66	59	86	100	168	168
Handysize 10-40,000	30	35	32	38	33	33	43	54	66	61	92	123	142	159
Combos > 10,000	0	0	0	0	0	0	0	0	0	0	0	0	3	2
LNG Carriers	11	9	7	11	12	16	16	16	25	26	22	17	15	12
LPG Carriers	6	5	4	3	9	14	16	20	27	33	25	18	18	18
Containers > 8,000 teu	5	10	14	18	34	28	20	17	25	25	22	13	30	33
Containers 3-8,000 teu	40	35	38	54	45	56	60	70	72	61	62	57	79	41
Containers < 3,000 teu	40	50	63	78	88	115	105	121	140	108	70	51	56	25
Offshore	7	4	5	6	4	5	3	18	14	14	13	15	25	25
Cruise Vessels	8	2	3	1	6	0	7	3	6	3	3	6	9	4
Ro-Ro Ferries	10	5	13	6	9	3	8	7	19	5	9	7	10	9
Other	69	63	76	81	105	126	147	136	151	150	144	154	167	181
TOTAL	528	492	584	610	696	715	805	826	963	989	1,043	972	1,220	1,127

Orderbook by builder region (number of vessels)



Orderbook by sector (number of vessels)

BuilderArea	Actual number of Vessels
China	1,969
S Korea	854
Japan	924
Others	281
Europe	195



BuilderArea	Actual number of Vessels
Bulker	2,030
Tanker	867
Other	532
Container	440
Gas	354



2011		2012		2013		2014		Scheduled Orderbook		
1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	OB2015	OB2016	OB2017
35	27	27	22	21	9	14	10	28	52	12
25	18	31	16	25	6	4	4	17	28	19
28	31	29	14	13	5	4	13	52	37	14
18	8	8	6	6	4	3	1	8	29	6
45	23	25	30	49	27	48	52	162	97	19
9	8	12	2	6	2	2	7	6	0	0
52	45	41	11	11	16	13	10	89	90	39
50	49	65	34	29	24	20	16	39	6	0
128	123	148	65	63	40	56	38	161	171	34
83	97	140	95	100	68	62	36	169	137	32
38	46	54	39	34	43	44	23	68	5	0
195	198	226	146	147	117	96	97	425	263	77
160	170	212	113	110	74	89	68	281	146	44
3	0	0	0	0	0	0	0	0	0	0
5	10	1	2	4	13	14	19	45	43	34
16	14	13	7	23	16	14	14	79	91	26
46	25	50	28	51	32	60	40	131	72	13
33	26	40	19	46	29	26	24	36	8	4
32	29	33	34	29	16	22	27	74	80	12
29	25	33	17	15	19	31	30	81	68	34
4	2	6	1	6	0	3	2	7	11	6
10	7	9	7	4	6	12	4	15	13	6
177	173	189	93	98	86	72	46	177	73	18
1,221	1,154	1,392	801	890	652	709	581	2150	1520	449

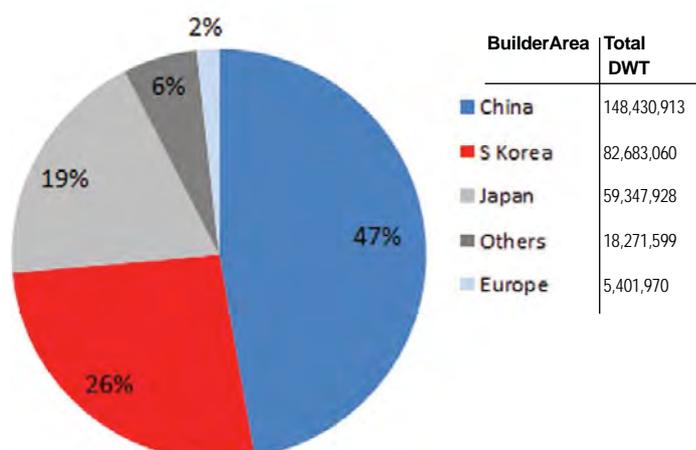
Data includes all vessels with LOA estimated at >100m

Where scheduled month of delivery is unknown an arbitrary month of build has been applied for orderbook data

The orderbook by year of delivery on this page is based on reported orders and scheduled delivery dates and do not necessarily represent the expected pattern of future deliveries

All data taken as of 1st August 2014

Orderbook (DWT) by builder region



Source: Clarkson Research Services

Predicting the rough and the smooth

In a paper presented at the International Conference on Computational and Experimental Marine Hydrodynamics, Philip Stenson, technology leader at AkzoNobel's marine coatings business, International, offers the first major re-evaluation of average hull roughness prediction methodology in almost 30 years

Frictional resistance linked to hull roughness has always been a major factor in determining ship efficiency. For many years sustained high fuel prices have given shipowners and operators cause to investigate and introduce measures to mitigate hull roughness in order to unlock heightened levels of efficiency.

Although fuel prices are dropping today, new environmental legislation has forced an increase in the use of expensive distillate fuel. This, combined with pressures from shippers and charterers to improve sustainability, has placed significant responsibility on ship owners and operators to deliver more environmental and operational efficiencies. For many it is the key to unlocking competitive advantage.

In recognition of this, International has established the principles of a new average hull

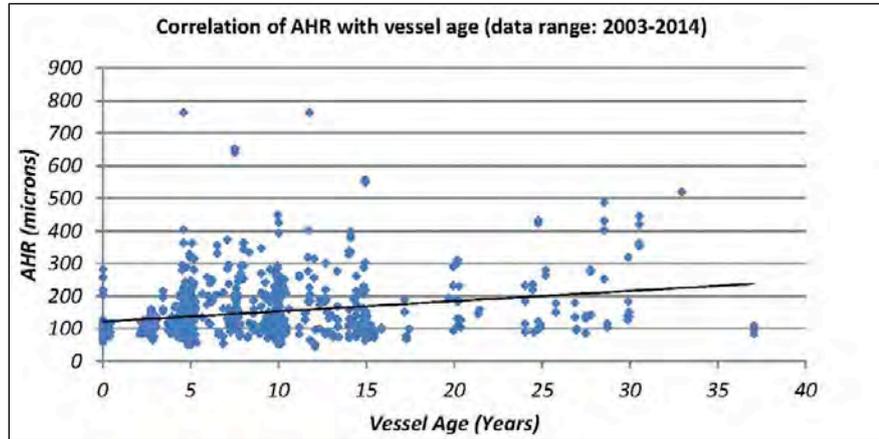


Figure 1: A plot of AHR versus vessel age

roughness (AHR) calculation, building on the landmark work of Dr Bob Townsin, the

first researcher and academic to establish the important link between hull roughness and ship powering in the 1980s.

Dr Townsin's methodology was accepted by the International Towing Tank Conference (ITTC) in 1990 and the shipping industry continues to use the methodology to estimate the AHR of a ship's hull. While Townsin's methodology offers an important foundation for future methodologies to build upon, trends in hull coatings, ship yard practices, environmental changes and regulations, vessel design and operation have altered considerably since the 1980s. Consequently, there is a real requirement for an updated model that reflects the changing dynamics of the shipping industry.

A new methodology for greater clarity

Roughness can be characterised as either biological – the widely researched attachment of marine fouling organisms to the ship's hull – or

Data subset	n	ΔAHR (µm)	Significant?
Spot Blast vs Full Blast			
<i>[AHR_{spot}] – [AHR_{full}]</i>			
Containers; FR coating	120	41.5	YES
Containers; SPC coating	84	87.6	YES
Tankers; FR coating	57	25.8	YES
Tankers; SPC coating	50	39.6	YES
Containers vs Tankers			
<i>[AHR_{cont}] – [AHR_{tanker}]</i>			
Full blast; FR coating	119	-11.0	NO
Full blast; SPC coating	52	12.4	NO
Spot blast; FR coating	58	-26.7	NO
Spot blast; SPC coating	82	-35.6	NO
SPC vs FR			
<i>[AHR_{SPC}] – [AHR_{FR}]</i>			
Containers; Fully blasted	112	10.5	NO
Containers; Spot blasted	92	56.6	YES
Tankers; Fully blasted	59	33.9	NO
Tankers; Spot blasted	48	47.7	YES

Table 2: Comparison of out-docking AHR surveys for containers and tankers coated with FR and SPC technologies. Full blast datasets also contain new build vessels. Spot blast datasets also include vessels where no blasting was carried out.

physical – the roughness elements dominated by the impact of coating formulation parameters on the surface texture. In its paper, Philip Stenson has focused on the latter; presenting the foundation of a new methodology that predicts AHR both at dry dock after a coating scheme application and during the subsequent dry docking cycle. The updated model presented is based on a raw dataset of 845 vessels gathered between 2003 and 2014.

New findings

International's study reached new conclusions based on the dynamics of today's shipping industry, which questioned the validity of some existing principles upheld previously. Importantly, the study found the strong correlation between vessel age and increased hull roughness is no longer a key parameter in triggering hull degradation. Conversely, vessels over the age of 25 can still achieve low AHR, as shown in Figure 1.

First stage analysis of a statistical investigation into the parameters that influence initial AHR revealed the two key parameters that have the

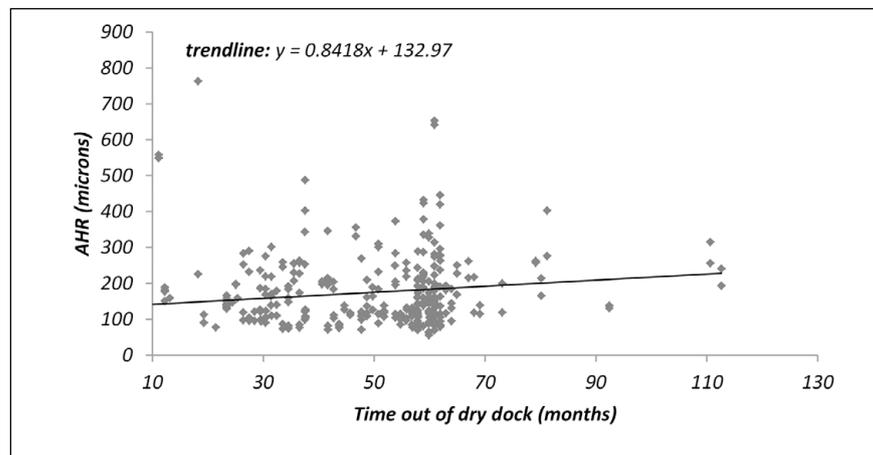


Figure 3: Plot of AHR versus time since dry dock for 2003 – 2014 surveys. A mean AHR increase of 0.84µm per month (~10µm per year) is observed

greatest impact on AHR at dry dock: Substrate preparation and coating technology; with high degrees of correlation between the parameters that requires a more detailed examination of the data.

The size and quality of the study's dataset enables further filtering of the raw data to yield

subsets of surveys able to examine the container and tanker vessel datasets in more detail. Specifically, researchers were able to measure the spread of foul release (FR), self-polishing co-polymer (SPC) and controlled depletion polymer (CDP) coatings in fully blasted, spot blasted and not blasted scenarios.

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As shown in Table 2, the impact of vessel type has no significant impact on initial AHR, although the vessel type and operation is likely to have a significant impact on the expected increase in AHR over a dry dock cycle.

In terms of the impact of coating on AHR, a lower AHR is typically obtained from application of a FR than an SPC coating scheme. In particular the coating technology type (i.e. whether or not a FR coating is applied) is most significant in scenarios whereby the vessel was only spot blasted (or not blasted at all).

A significant impact of coating technology is not always seen when the vessel is fully blasted and this suggests that some coating schemes (for example, silicone based FR) may be able to level out and mask macro-physical roughness elements of the substrate better than others.

In the fully blasted scenario where macro-physical roughness elements are minimised there is less of an impact. It is proposed that initial AHR prediction should reflect the observation that application of a FR coating in a scenario where the vessel is not fully blasted is likely to result in a lower AHR than for a non-FR coating. For fully blasted scenarios a more modest difference in AHR between FR and non-FR coatings is expected.

Prediction of AHR degradation

Figure 1 illustrated the modest impact of vessel age on AHR in the 2003 - 2014 dataset; therefore it is expected that the increase in AHR over a dry dock cycle will also be lower than predicted previously, a trend confirmed in Figure 3.

The effect of coating technology type on AHR over time is likely to be highly correlated with other factors included in the linear regression analysis. Acknowledging this unresolved feature, it is reasonable that the coating scheme be used to predict the magnitude of AHR increase as a proxy for more

Coating Technology	Typical AHR Increase*	HRPC
FR	2.3 µm/y	5 µm/y
SPC	9.7 µm/y	20 µm/y
CDP	12.8 µm/y	40 µm/y

Table 3: Predictions of AHR increase over a dry dock cycle obtained from linear regression analysis. Comparison with values that were assumed for the HRPC is provided. *Note that due to the scatter associated with AHR data the standard error in these values is large (SE ~0.5). The AHR increases are therefore presented as typical guideline values only

complex, hidden correlations. A summary of the results from this analysis is provided in Table 3. As expected, the predicted increases in AHR are significantly lower than the round number estimates adopted for the Hull Roughness Penalty Calculator (HRPC), created by International in 2003 to estimate the impact of ship powering on the degradation in AHR as a function of the fouling control coating type (dataset based on the work by Townsin).

A new model for AHR prediction

A methodology for modelling hull roughness requires a reliable prediction of the initial AHR as well as a description of the magnitude of AHR increase over the dry dock cycle.

International's initial AHR predictions are based on the following terms:

S_{AHR} : Expected AHRs based on the peak values derived from histogram distributions of data from fully and part blasted AHR surveys are used as the starting point for initial AHR prediction. SAHR takes the values 90 and 135µm for fully blasted / new build and spot blasted / not blasted scenarios respectively.

C_{AHR} : Based on coating technology type and introduced to modify the initial AHR estimate based on substrate preparation, SAHR. The value of CAHR is negative for FR coatings (i.e. AHR will be lower than non-FR coatings) and

positive for non-FR. Lower absolute values of CAHR (-5 and 5µm for FR and non-FR respectively) for full blast / new build scenarios reflect the observation that coating technology has less of an impact here than for spot blasted / not blasted scenarios.

I_{AHR} : The change in AHR over the dry dock cycle is modelled as a linear increase, termed here IAHR, based on the values proposed in Table 3. Proposed guideline values for SAHR, CAHR, and IAHR are also presented in Table 4.

The overall model for average hull roughness prediction is Equation 1 where SAHR, CAHR and IAHR are constants (see Table 4) t is time in months.

Equation 1:

$$AHR = S_{AHR} + C_{AHR} + t(I_{AHR})$$

Conclusion

Following the introduction of the 2015 IMO MARPOL Annex VI regulations, every ship operating within Emission Control Areas (ECAs) must use higher quality fuels with a maximum sulphur content of no more than 0.1%. Generating greater efficiencies will prove instrumental in helping shipowners and operators offset the costs of compliance triggered by the use of more costly distillate fuels. Frictional resistance associated with hull roughness is a major factor in determining ship efficiency and it is therefore of fundamental importance that reliable estimations on hull roughness are available. This study represents a provisional step towards this aim. Further input into AHR calculations can play an important role in supporting efforts by the shipping industry to adopt transparent and accurate methodologies that measure fuel savings generated by eco-efficient technologies, including hull coatings, helping to build trust between manufacturers and owners and driving shipping efficiency and sustainability. **NA**

Table 4: Typical guideline values of SAHR, CAHR, and IAHR, required for the modelling of average hull roughness

Coating Technology	Substrate Preparation	S_{AHR} (µm)	C_{AHR} (µm)	I_{AHR} (µm)
FR	Full Blast	90	-5	0.19
SPC	Full Blast	90	5	0.81
CDP	Full Blast	90	5	1.07
FR	Spot/No Blast	135	-25	0.19
SPC	Spot/No Blast	135	25	0.81
CDP	Spot/No Blast	135	25	1.07

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Cruise lines move to meet new emissions regulations

There have been many developments in the cruise ship arena in recent times with a spate of newbuildings on order and moves by cruise lines to tackle the issue of emissions following the introduction of emission control areas in January. Sandra Speares reports

Carnival announced plans to significantly increase installations of its industry-first exhaust gas cleaning technology to more than 70 vessels last year to cover over 70% of its entire fleet. Investing as much as US\$400 million to design, build and install the systems being used for the first time in the restricted space found on cruise ships.

The system is called ECO Exhaust Gas Cleaning (ECO-EGC) for its ability to remove major pollutants from the exhaust gases at any operating condition of a ship.

Carnival's system combines two established technologies that have been successfully used in shore applications like power plants, factories and vehicles to scrub the exhaust from high-sulphur fuel. For the first time this combination is being developed to accommodate restricted spaces on existing ships.

Its plan incorporates a two-pronged system – one to reduce particulates from the ship's engine emissions, and another to use seawater to scrub sulphur compounds from the exhaust gases.

Royal Caribbean also announced in December that it would retrofit 13 of its cruise ships with advanced emissions purification (AEP) systems to meet the new ECA requirements.

These new scrubbers will remove more than 97% of the sulphur dioxide emissions generated by the ships' diesel engines.

The installation of the scrubbers will take place during scheduled dry-dockings and while ships are in service. While preliminary work has begun on several of the ships receiving AEP systems, most will take place between 2015 and 2017. Each installation will take approximately eight months.

Quantum of the Seas was among the first cruise ships to be built with AEP systems



Harri Kulovaara says the complexity of the AEP project is "unprecedented"

installed during initial construction. *Liberty of the Seas* has been operating one of its six engines with a retrofitted AEP system for two years.

"AEP technology for maritime vessels is very new, and we expect that by utilising multiple technological solutions to accommodate the differences among our ships, additional development will ultimately help industrialise AEP technology even more, which will benefit not only RCL but also the larger maritime industry," Adam Goldstein, President and COO of Royal Caribbean Cruises commented on making the announcement.

To ensure the right systems are available for each ship's unique requirements, RCL contracted two different AEP technology suppliers, Swedish company Alfa Laval and Finnish company Wärtsilä and additional companies are being hired to execute the installations.

The company faced significant challenges in order to accommodate the AEP systems on its existing ships – some pieces of which can be as large as

a school bus, an entire system having an operational weight of several hundred tonnes of equipment and liquids.

"A retrofit project of this size and complexity – and the scale and intricacy of the research, planning, and design required – is unprecedented for our company, and has required a very systematic process and involved the world's leading expertise in this field," said Harri Kulovaara, executive vice president, maritime.

Royal Caribbean introduced other energy saving measures when building *Quantum of the Seas*, including a full-hull air lubrication system that reduces friction between the ship and the water, which can result in up to 7% energy savings depending on ship speed and itinerary; a keycard-operated master switch for lights and air-conditioning in guest staterooms that reduces unnecessary energy usage; and the use of only LED or fluorescent lights.

Fresh water systems

Meyer Werft, Meyer Turku, STX France, and Fincantieri shipyards have all placed orders in recent months with Wärtsilä for the supply of fresh water generators to a total of seven cruise ships. The orders were placed between September and November 2014. Delivery of the Wärtsilä systems is scheduled to commence in May 2015 and will be completed by autumn 2017.

Wärtsilä's delivery comprises a total of 10 large MSF distillation systems with unit capacities spanning from 115tonnes/day to 900tonnes/day, and four Single Stage Desalination systems (SSD) with unit capacities of 30tonnes/day.

The Wärtsilä Serck Como fresh water generators produce the fresh water needed onboard a cruise ship for deck washing, laundry, cabins, swimming pools, and

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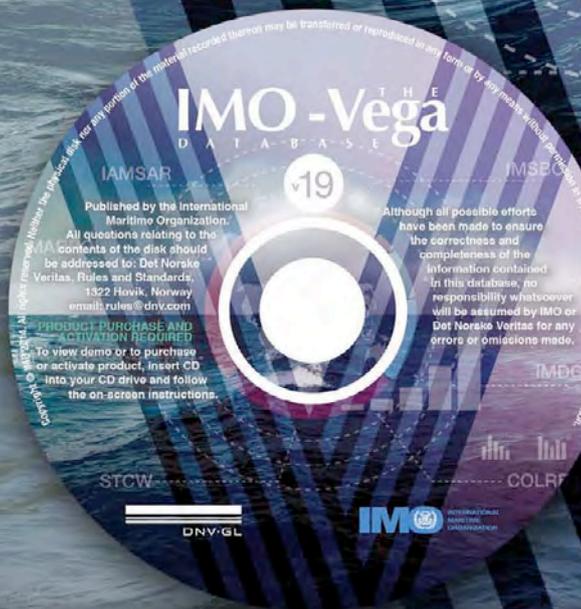
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technical applications that need high quality water. The evaporators employ the multi-stage flash (MSF) principle and use the waste heat from the ship's main engine in order to evaporate seawater in multiple stages under vacuum. Every consecutive stage has a slightly lower pressure, which leads to high energy efficiency.

The MSF evaporator produces fresh water with a constant high quality and reliability as the process is independent of changing seawater temperatures, and very tolerant to impurities for example algae, in the seawater, the company says. The extremely low salt content remaining in the end product (less than 5ppm) makes it suitable for even the most demanding technical applications.

"Major cruise ship owners are already using Wärtsilä Serck Como evaporators on their vessels and are clearly satisfied with the reliability and quality of the fresh water produced by our solutions. This is evidenced by the fact that more than 130 cruise ships in global operation have our evaporators on board. We are very proud to continue to support these leading cruise companies with systems that feature numerous benefits, including improved energy efficiency, flexible design and easy maintenance," says Vesa-Pekka Virkki, managing director, Wärtsilä Serck Como.

Methanol system

For those that want to go down the alternative fuel route, cruise ferry *Stena Germanica* is being converted to a dual-fuel methanol propulsion system at Poland's Remontowa shipyard.

The 240m, 1,500-passenger ferry, which will be converted over a 45-day period, starting from January, will be the world's first ever methanol-powered sea vessel. Approval and classification will be by surveying teams from Lloyd's Register (LR).

Preliminary tests on a methanol-modified Wärtsilä engine 6ZAL40S similar to *Germanica's* have already taken place LR said.

According to LR lead specialist, Roberto Costantino: "We carried out three days of tests on a modified engine at Wärtsilä R&D laboratory so as to understand the engine performance when running with methanol. While the test engine is a similar type to the four engines on the vessel, it has fewer cylinders. So the builders are converting the existing ones on the ship."

The new fuel arrangement on *Germanica* will combine methanol as its primary fuel with marine gas oil (MGO) as a back-up power source. SOx emissions are expected to be cut by 99%, NOx; by 60%, particulates by 95% and CO₂ by 25%.

Stena Line's CEO Carl-Johan Hagman said: "The emissions from methanol are comparable to LNG, but the requirements for handling and infrastructure are much lower. The construction team are looking at and will use several different exhaust gas treatment technologies.

Wi-Fi

Carnival unveiled its new hybrid wireless network – an enhanced high-speed service to eventually be rolled out to all 101 of its ships on all nine of its brands in November.

Carnival Corporation's backbone connectivity network, known as WiFi@Sea, will integrate a combination of strategically located land-based antennas installed along cruise routes, Wi-Fi from a port connection and advanced satellites, forming an innovative network that is a first in the cruise industry on this scale. The "smart hybrid" network is designed to provide passengers and crew with faster and more stable internet access throughout their voyage – a feature becoming increasingly important to travellers of all ages looking to stay

connected and share their experiences through social media.

Once completed, the integrated network will seamlessly switch among its various technology solutions to give passengers the highest available bandwidth capacity and strength of signal. The network will be capable of providing Internet connectivity speeds that can be roughly 10 times faster than those previously offered on Carnival Corporation's ships – ultimately expected to provide passengers with the best possible connectivity in the cruise industry.

"This is a major technology breakthrough designed to enhance the cruise experience for our passengers," said Ramon Millan, senior vice president and global chief information officer for Carnival Corporation. "Our integrated network is also designed to be highly flexible. As technology changes, we can change how our network operates. So it is very possible that one of the technologies we are using today in our network may be replaced by a newer, better technology a few months from now. That flexibility means we can constantly be on the leading edge of updating our integrated network and making sure our passengers have the best possible solution for staying in touch."

The newly equipped ships will connect to the new wireless network via multiple technologies – port Wi-Fi, long-range

Quantum of the seas arriving in New York in December, steel cutting for the latest *Quantum* class ship has taken place at Meyer Werft



Wi-Fi and a fleet of advanced satellite systems over multiple frequency bands. The network will seamlessly switch back and forth between connection types based on which option will provide the best user experience at that time. Much like a cell phone changing from one data connection to another while moving across a coverage area, the toggle between networks will be transparent for travellers and managed behind the scenes by a high-tech system.

Meyer Werft

German yard Meyer Werft implemented a new building strategy in Papenburg last year. "The only way to build two large ships per year in building dock II is to divide each new ship in two large floating parts. This new building strategy is also a benefit for Neptun Werft because in the future the yard will be able to deliver complete engine room modules. This ensures a balanced workload in Papenburg and Warnemünde; hence the prioritised strategic goal of securing the economic future of both yards is reached," the company said.

In the next few years Neptun Werft and Meyer Werft will plan, design and build a total of eight cruise ships and 17 river cruise vessels. These order books as well as the consistent implementation of the corporate strategy offer both yards a good chance to stand their ground in the highly competitive shipbuilding market.

In 2014 Meyer Turku delivered *Mein Schiff 3* to TUI Cruises, which will be followed by *Mein Schiff 4* in 2015. Another two ships for TUI Cruises will be delivered in 2016 and 2017. Meyer Werft currently has *Anthem of the Seas* under construction, which is scheduled for completion in the spring of 2015. Construction work on a second ship, *Norwegian Escape*, has started as well with the production of two floating parts in the yard's building dock II. This ship will be delivered to Norwegian Cruise Line in the autumn of 2015. All told, the yard's order book comprising eight ships will last into 2019.

ABB, the leading power and automation technology group, has signed an extensive service agreement with Royal Caribbean to increase cost efficiency and predictability of maintenance costs. The agreement spans 15 years and encompasses six vessels under RCC's brands Celebrity Cruises and Royal Caribbean International. The financial value of the service agreement is in excess of US\$50 million.

The agreement covers four Solstice and two Oasis class vessels and includes an option to extend the agreement to additional existing vessels, vessels that are currently under construction and future newbuilds. The Solstice and Oasis class vessels all feature ABB's Azipod propulsion technology.

Under the service agreement, ABB will deliver to RCC vessels a range of services that optimise the life cycle of the vessels: scheduled dry docking services, Azipod propulsion unit modernisations and condition based maintenance services, which contributes to better predictability of maintenance costs.

"Cruise segment customers are increasingly focusing on optimising the life cycle of their fleet and investing in solutions that boost cost efficiency. The service agreement with Royal Caribbean is a token of trust that we understand the needs of our customers and deliver tangible benefits, improving their profitability", says Heikki Soljama, head of ABB's Business Unit Marine and Cranes.

The steel cutting for *Ovation of the Seas*, Royal Caribbean's third Quantum class ship from Meyer Werft took place last year and the ship is scheduled to be delivered in the autumn of 2016.

The Quantum class ships will have features like robotic bartenders in the Bionic Bar; RipCord by iFLY, the first skydiving experience at sea; the North Star that transports passengers more than 300 feet above the ocean among other innovations.

The Quantum Class spans 18 decks, encompasses 167,800gt and carries 4,180 passengers at double occupancy with 2,090 cabins. **NA**



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Blue whale series surfaces

Following the delivery of the latest vessel for the Chinese operator Chipol, vessel designer Odely outlines the key design developments of the latest multi-purpose cargo carrier, in a series of four vessels known as the Blue Whale series

Launched in September last year and delivered in early January *Chipol Changjiang* is the first in a series of four heavy lift multi-purpose carriers, also known as the Blue Whale Series.



Chipol Changjiang has the largest lifting capacity of any multi-purpose heavy-lift vessel in the world

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D	16.00 m Complement 29+4 P
d'designed	9.80 m
DWT	~30,200 t M/E F.O.C. 23.3 +5%toler.
D _{scantling}	11.20 m
DWT	~36,900 T (F.O. 10,200 kcal/kg , ISO conditions)

CAPACITY

Container total	abt. 1880 TEU
In hold	974 TEU
On deck (8')	~906 TEU
Reefer	100 on Deck
Cargo hold 100%	~44,200m ³
F.O.T.	1,400m ³
D.O.T.	150m ³
F.W.T.	200m ³

MAIN ENGINE

Type	MAN B&W 6S46ME-B.8.2 1 set
MCR:	6480kW x 110
CSR:	5832kW x 106

GENERATOR

Main Generator	3 x 860kW, 900
Emer. Generator	1 x 120kW, 1800

EQUIPMENT

Hatch Covers	Upper dk: folding + pontoon / Tw dk: pontoon
Hatch No.1	18.96 x 18.00m (Up/Tw Dk)
Hatch 2, 3	53.72 x 23.0mm (Up&Tw Dk)
Tween Deck covers can be used as grain Bulkheads.	
Deck crane	45/80/200/260t x36/32/20/15.5m x 2 sets 36/60/120t x 36/30/16m x 1 set

The first ship was delivered in early January with the final three following during the coming year.

Chipol Changjiang is a 36,000dwt vessel built by Yangzhijiang Shipbuilding Company's subsidiary Jiangsu New Yangzi Shipbuilding Company shipyard.

Designed by Odely, the Shanghai-based naval architects, and operated by Chipol Ship Management Company the vessel has the largest loading capacity in world when compared to other heavy lift vessels.

Three electro-hydraulic cranes are installed on the deck and the two rear cranes have a heavy-lift capability, each with the capacity to lift 260tonnes, or up to 520tonnes when working in tandem.

The cargo hold is equipped with adjustable lift-on, lift-off hatch covers which are suitable for a variety of products including extra-long, huge and heavy cargos and complete sets of mechanical equipment.

The vessel is also designed with a 155m clear deck space for deck cargo, three tween deck levels in holds two and three and the tank tops are heavy cargo reinforced.

Powered by an MAN B&W 6S46ME-B.8.2 main engine driving a single propeller and the vessel also designed with an optimised hull and is fitted with a number of fuel saving devices giving a daily fuel oil consumption of just over 23tonnes per day and an endurance of 12,000 nautical miles.

Cargo capacity includes 1,880TEU on deck, a further 974TEU in the hold and includes 100 reefer container plugs on deck. The total double hulled cargo hold space is

44,200m³ and is intended to carry general and project cargo as well as containers.

The tween deck covers can be stowed in front of the superstructure and can also be deployed as grain tight bulkheads. The double bottom of the ship is reinforced to allow for heavy cargoes and for grab operations and giving the ship the capability of transporting 30tonne steel coil in two tiers.

Yangzhijiang Shipbuilding Company is located on the banks of the Yangtze River and the group manages a number of yards, including Jiangsu New Yangzi Shipbuilding Co., Ltd., Jiangsu Yangzi Xinfu Shipbuilding Co., Ltd. and Jiangsu Yangziji Jiang Shipbuilding Co., Ltd.

The yards are located in the, so-called, golden channel of Jingjiang and Taixing City, downstream of the Yangtze River in Jiangsu Province, which is some 170km from Shanghai. The Group also operates the Jiangsu Yangziji Jiang Offshore Engineering Equipment Co., Ltd. and owns two design companies in Shanghai.

Group assets total over RMB63 billion (US\$10.28 billion), covering an area of 6.3 million square meters, along a coastline of about 7km with 20,000 employees. Yangziji Jiang Group has three large dry-docks and six large and medium sized slipways, with shipbuilding capacity of annual output of six million DWT and has mainstream products of 700TEU to 14,000TEU large container vessels, 7,600dwt to 400,000dwt bulk carriers, multi-purpose vessels and offshore engineering equipment together with large steel structures. **NA**

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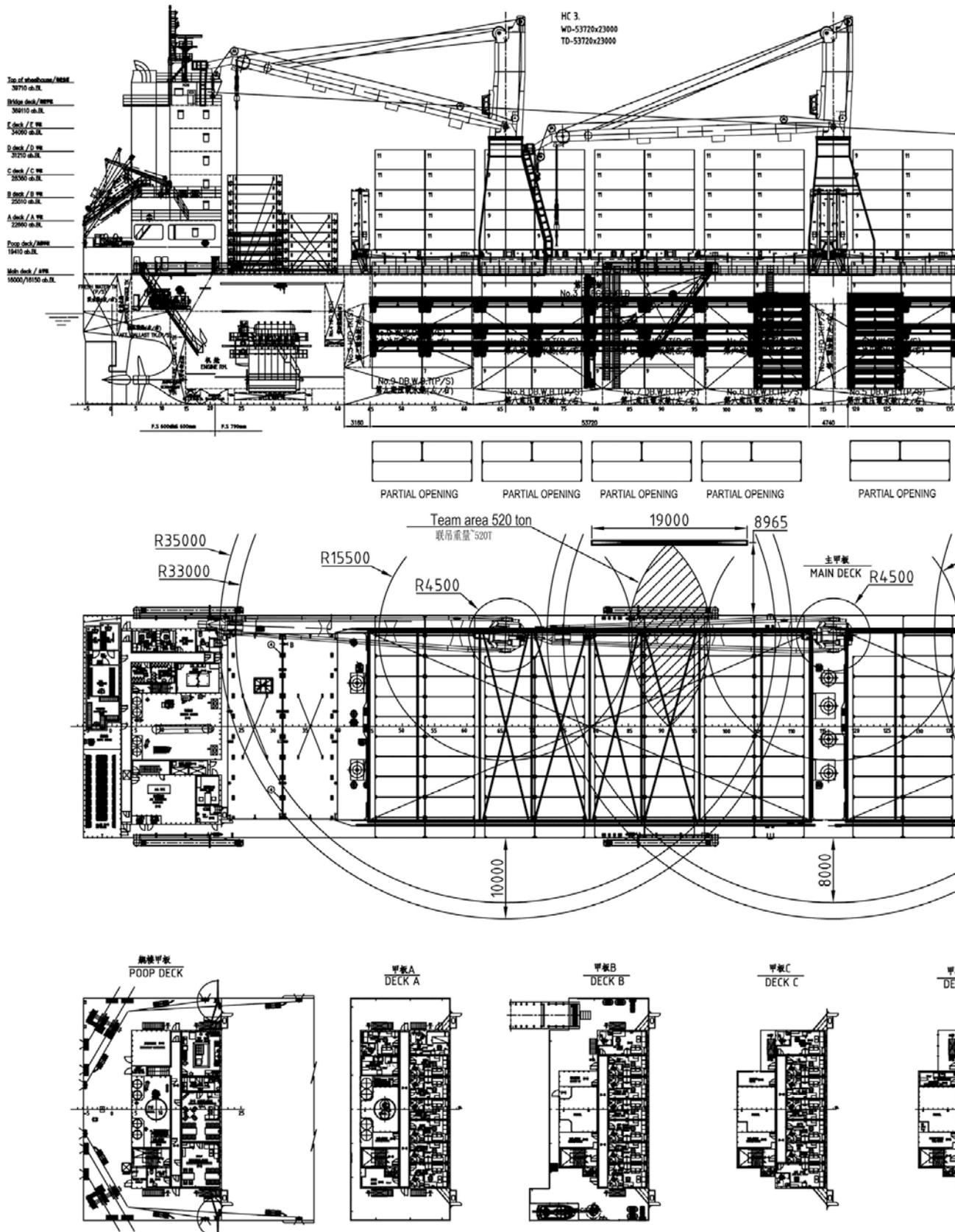
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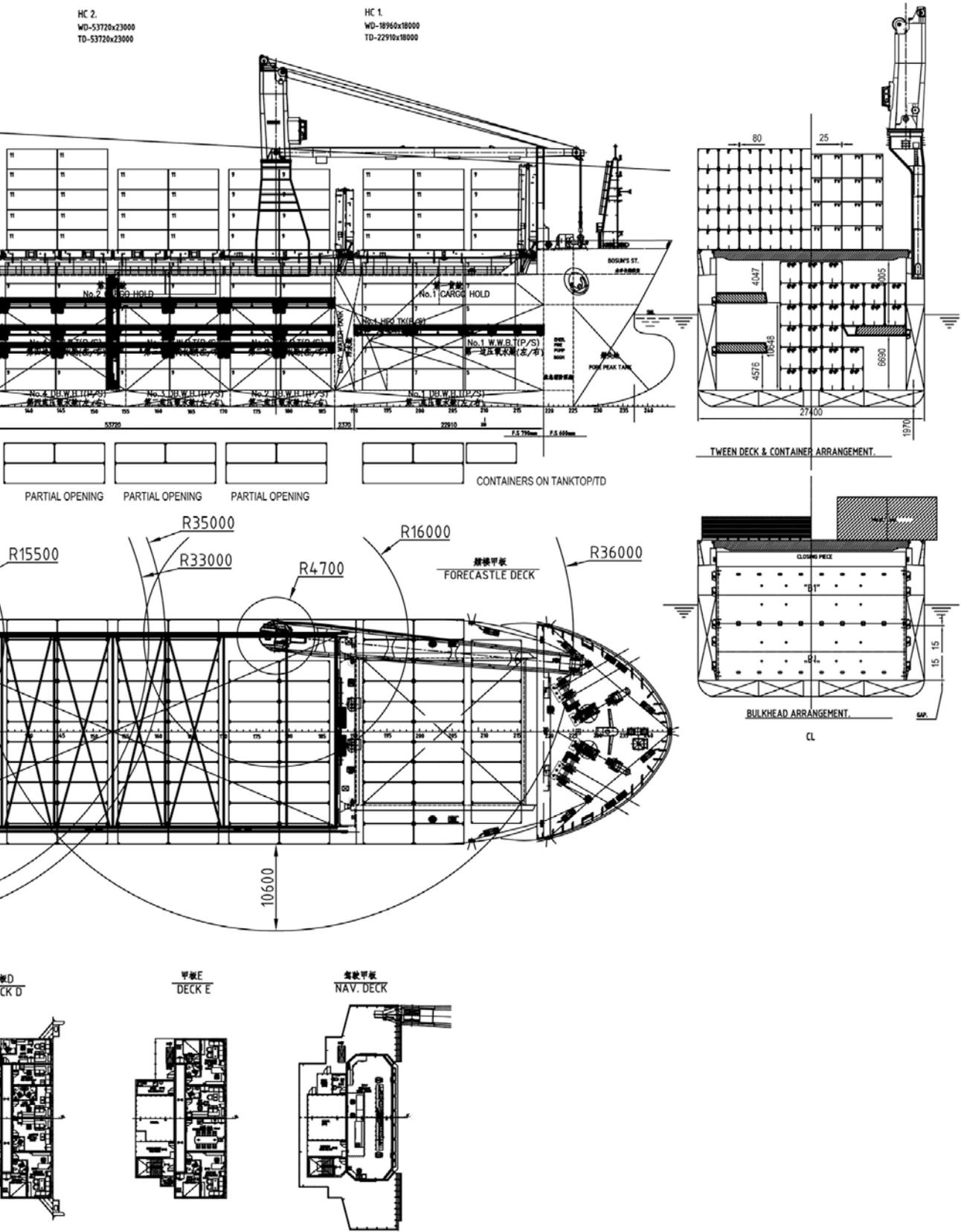
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Market doubts Issue 55 effectiveness

Beijing's attempt to force consolidation in the shipbuilding market has run into heavy weather as its latest 'White List' of approved yards has been met with some scepticism by the Chinese industry. Meanwhile, the yards in question are continuing to produce new vessels, in spite of the government's efforts

In December 2013 China's government produced guidelines for the development of its shipbuilding industry. Issue 55, as the directive is known, laid down regulations that shipyards were meant to adhere to.

These new rules are costly to implement as they include the employment and training of staff, rather than the use of poorly trained sub-contractors, pensions for staff, energy efficiency measures and safety measures to protect workers and rules governing investment into research and development. (See *The Naval Architect* February 2014 pages 30-33).

Government has now drawn up a list of 60 'qualified' shipyards (see page 49) the so-called "White List" of shipbuilders that have met Beijing's criteria for ship building operations.

According to one analyst, however, "the market doubts its [the government's] guidance. Some yards

in the list are approaching bankruptcy, while some other yards, not on the list, are actually doing well. Nevertheless, such a list is a symbol of the strict control of China's shipbuilding capacity. More and more low standard yards will be phased out definitely."

Among the yards that achieved the approved status on the White List is Rongsheng Shipyard which has well documented financial problems (See *The Naval Architect* September 2014 page 50). Other yards, such as Nantong Mingde, have already been through a bankruptcy reorganisation process. Meanwhile some yards that have not been included not on the White List are doing very well. "Yards, which now have good business are not included," explained the analyst. "A yard such as Xinle which is doing very well in the stainless steel tanker and gas carrier market, in which sector it is almost a benchmark yard," he said.

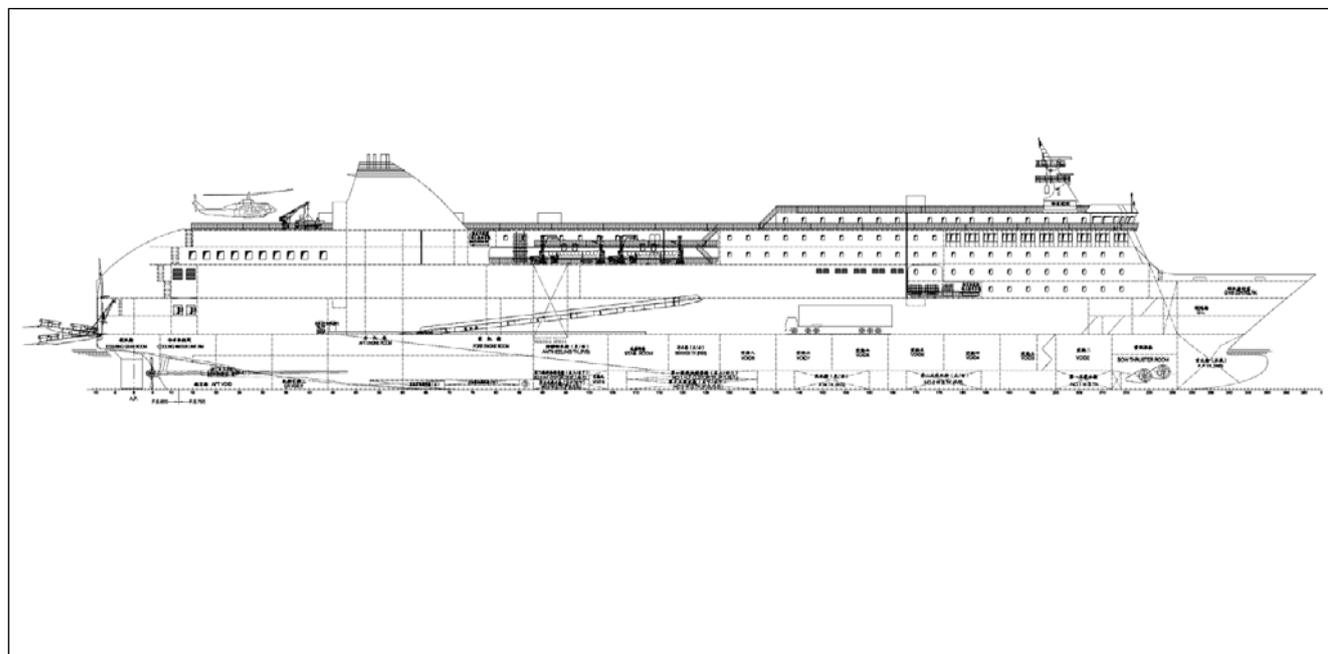
Meanwhile, one yard that did make the White List is Shandong Huanghai which is currently undertaking to build, what has been described as "a challenging ro-pax project" work on which began this year.

The 197m vessel, designed by Shanghai naval architect Odely, will have a capacity of 1,500 passengers with 2,500 lane metres on three decks for cars and trucks. When the vessel is delivered it will be the largest in Asia and it will serve on the Sino-Korea route.

Following the *Sewol* catastrophe last year safety issues are prominent factors in the design of this vessel.

Powered by two MAN B&W 9L48/60CR diesel engines the ships has been designed with two engine rooms to meet the SOLAS safe return to port requirements. The engines will drive two controllable pitch propellers with twin-flap type rudders, a bulbous bow, a bow thruster, stability fins and anti-heeling equipment. **NA**

Work on Asia's largest ferry began this year with the Odely designed 34,700gt ship targeting the China/South Korea market making safety a priority in its development



List of enterprises qualified under the "Shipbuilding Industry Model Standard"

- | | | |
|--|---|---|
| 1) Dalian Liaonan Shipyard | 22) Zhejiang Shipbuilding | 43) CSSC Chengxi Shipyard |
| 2) Jiangsu New Yangzi Shipbuilding | 23) Taizhou Maple Leaf Shipbuilding | 44) CSSC Xijiang Shipbuilding |
| 3) Jiangsu New Times Shipbuilding | 24) Fujian Mawei Shipbuilding | 45) Bohai Shipbuilding Heavy Industry |
| 4) Jiangsu Rongsheng Heavy Industries | 25) Xiamen Shipbuilding Industry | 46) Dalian Shipbuilding Industry |
| 5) Yangzhou Dayang Shipbuilding | 26) Jiangxi Jiangzhou Union Shipbuilding | 47) Qingdao Beihai Shipbuilding Heavy Industry |
| 6) Taizhou Kouan Shipbuilding | 27) Tongfang Jiangxin shipbuilding | 48) Shanhaiguan Shipbuilding Industry |
| 7) Jiangsu Hantong Ship Heavy Industry | 28) Yantai CIMC Raffles Offshore Limited | 49) Wuchang Shipbuilding Industry Group |
| 8) Jiangsu Zhenjiang Shipyard (Group) | 29) Penglai Zhongbai Jinglu Shipbuilding | 50) Chongqing Chuandong Shipbuilding Industry |
| 9) Nantong Mingde Heavy Industry | 30) Huanghai Shipbuilding | 51) Tianjin Xingang Shipbuilding Heavy Industry |
| 10) Sinopacific Offshore and Engineering | 31) Qingdao Shipbuilding | 52) Nantong COSCO KHI Ship Engineering |
| 11) Sainty Marine Corporation | 32) Guangdong Yuxin Ocean Engineering | 53) Dalian COSCO KHI Ship Engineering |
| 12) Taizhou Sanfu Ship Engineering | 33) CSSC Guangzhou Huangpu Shipbuilding | 54) COSCO (Guangdong) Shipyard |
| 13) AVIC Dingheng Shipbuilding | 34) Guangzhou Shipyard International | 55) COSCO (Dalian) Shipyard |
| 14) Jiangsu Hongqiang Marine Heavy Industry | 35) Jiangnan Shipyard (Group) | 56) COSCO (Zhoushan) Shipyard |
| 15) Jiangsu East Marine Equipment | 36) Hudong-Zhonghua Shipbuilding (Group) | 57) China Shipping Industry (Jiangsu) |
| 16) Jinhai Heavy Industry | 37) Shanghai Shipyard | 58) Sinotrans & CSC Jinling Shipyard |
| 17) Zhejiang Ouhua Shipbuilding | 38) Shanghai Waigaoqiao Shipbuilding | 59) Sinotrans & CSC Qingshan Shipyard |
| 18) Yangfan Group | 39) Shanghai Jiangnan Changxing Shipbuilding Heavy Industry | 60) AVIC Weihai Shipyard |
| 19) Zhejiang Zhenghe Shipbuilding | 40) Shanghai Jiangnan Changxing Heavy Industry | |
| 20) Zhou Shan Chang Hong International Shipbuilding & Repair Company | 41) CSSC Guijiang Shipbuilding | |
| 21) Zhejiang Zengzhou Shipbuilding | 42) Guangzhou Wenchong Shipyard | |

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3D design approach saves time and money

Collaboration between class societies, yard and CAD system providers allows designers to develop 3D models significantly faster while sharing information through two different platforms

Modelling the hull structure is a key cost factor both for yards and for classification societies. Therefore re-use of hull structure models has been a goal of CAD system manufacturers and classification societies for many years. But until recently, fully 3D design from the start involving the transfer of complete 3D structural models to rule calculation tools has proven an elusive challenge.

Now a Joint Industry Project between NAPA, Samsung Heavy Industries (SHI), DNV GL, and ClassNK has cracked this nut. The project focused on container ships and tankers. The new capabilities between NAPA Steel and POSEIDON have just been verified in a recent container ship newbuilding project.

The project made the hull design process at the yard much more efficient. A key decision for Samsung was then

to use 3D modelling directly from initial or basic design. As the recent project experience of the Structural Engineering Team has confirmed, 3D modelling requires a bit more effort in initial design, but leads to major savings in later design stages.

For the dimensioning of the steel structure of a ship, both prescriptive rules and Finite Element Analysis (FEA) are needed. Class rules software, such as POSEIDON and NAUTICUS Hull for DNV GL, check Rules compliance for single members (plates, stiffeners) and full cross sections automatically. FEA checks fatigue of local details (such as openings) and global strength. Often, FEAs for several cargo holds are sufficient for dimensioning, but in some cases a complete global ship model is required.

Prescriptive rules check and finite-element analysis requires a different

model that has a different level of detail. Also, the structural information is stored differently in NAPA Steel and POSEIDON. A correct exchange of model information in both ways was the key challenge. The new interface, which is independent of ship type, allows transferring complete 3D blocks to POSEIDON.

A typical block can contain three cargo holds with all longitudinal and transverse plates and stiffeners and is not limited to the prismatic mid-ship part. The software then performs the rule check calculations at any cross-section inside the transferred block boundaries. The updated scantlings are automatically passed back from POSEIDON to NAPA Steel. Furthermore, FEA can either be performed in POSEIDON or FEA where results are imported and assessed.

This process was first applied in

Figure 2: Complete 3D structural model of the 14,400TEU vessel as transferred from NAPA Steel to POSEIDON

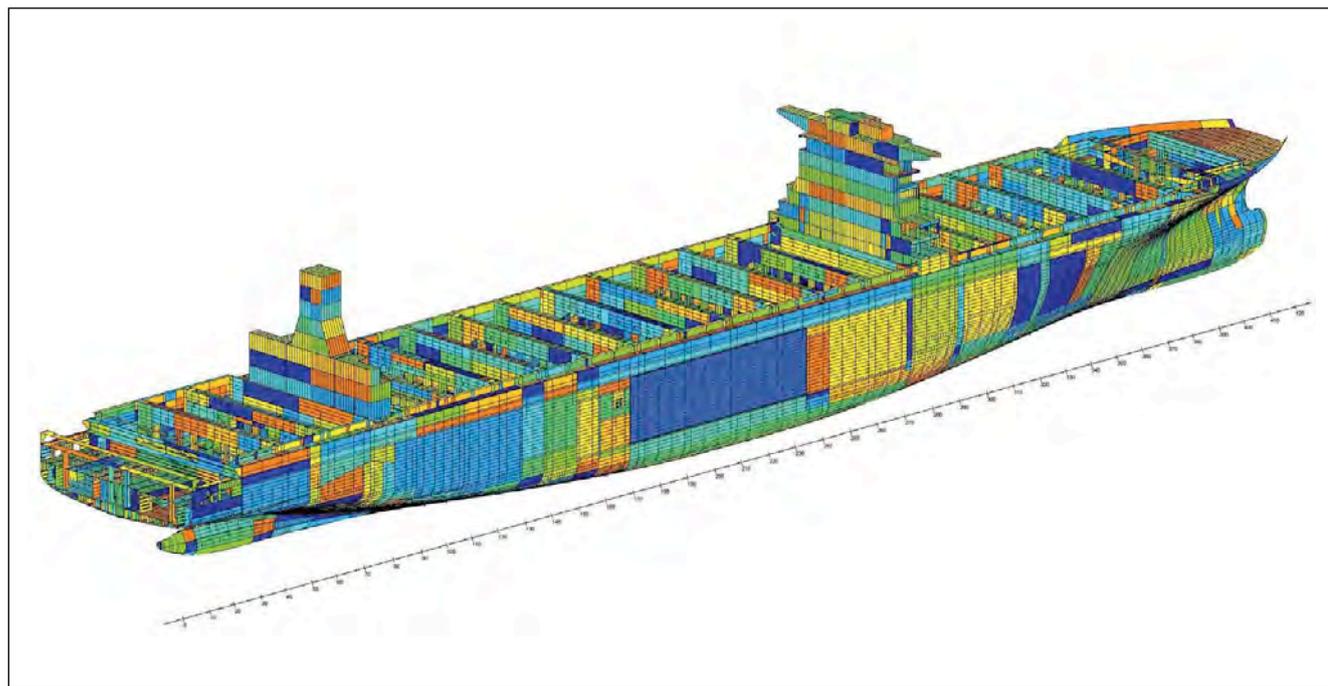
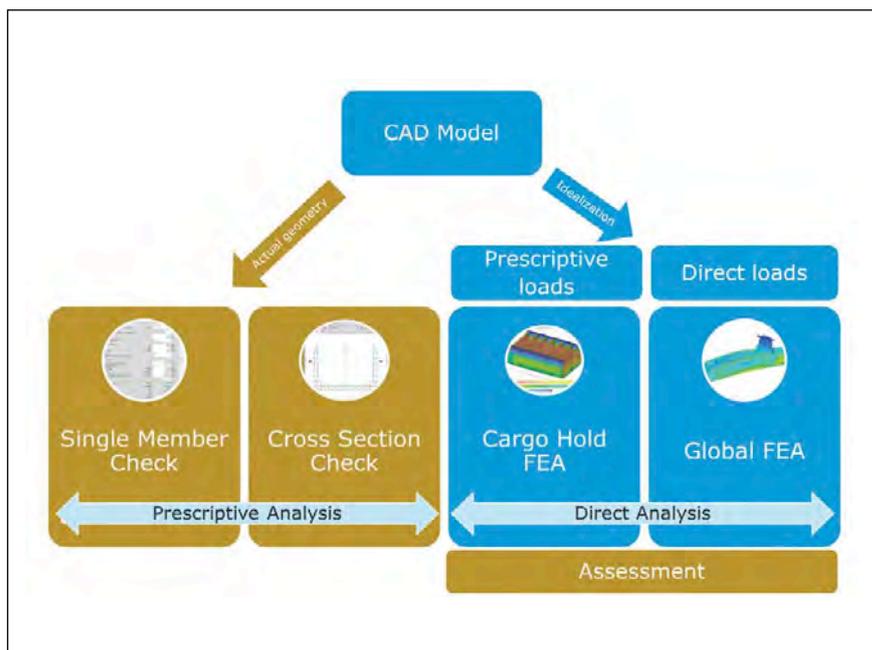


Figure 1: Central 3D model allows class rules check and finite-element analyses

practice by Samsung in 2014 for a 14,400TEU containership project. “The total effort for building up a global POSEIDON model was reduced from previous 4-6 weeks to now only one week using the interface with NAPA Steel,” reports Hyo-Kil Son, DNV GL approval engineer in Korea. “In addition, all cargo hold analyses were performed as part of a single global finite-element analysis which resulted in additional time savings.”

More details can be found in the upcoming Compit 2015 paper “3D Ship Design from the Start – An Industry Case Study”. [NA](#)



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A glass apart

Finnish fire resistant glass door and wall manufacturer Pocadel is one of Europe's success stories with some 80% of its production exported to outfitting suppliers for cruise ships around Europe. The company and its fully tested and certified glass partitions are now making inroads into the offshore sector

Some of the most important safety devices are often the ones we take for granted the most, such as fire resistant doors and walls. They are right in front of us doing a job with the minimum of fuss.

Technologically, however, the design that has gone into such items is important and the walls supplied by Pocadel, of Finland, are no different in this respect. Pocadel's door designs are tested by accredited organisations and certified as meeting tough IMO standards.

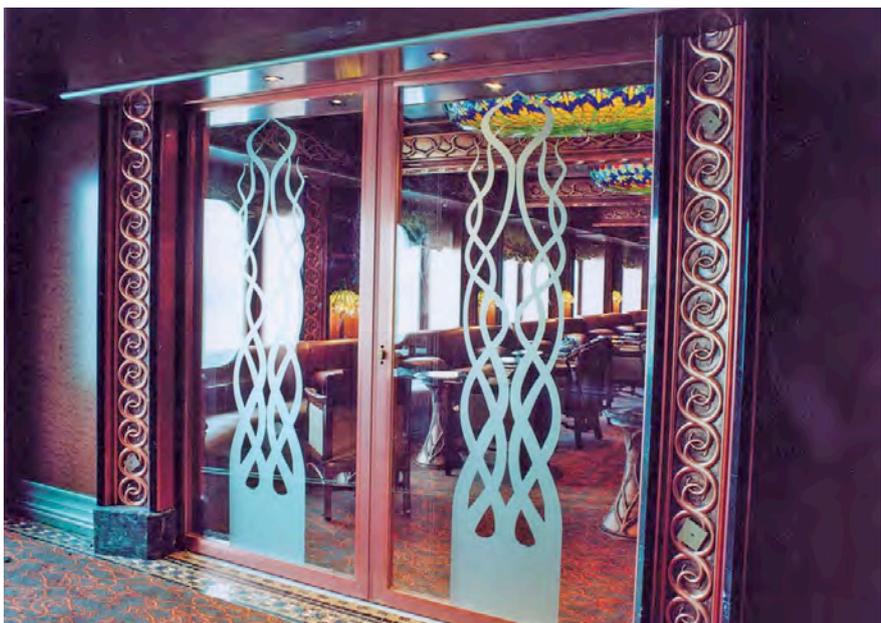
"In the fire test the product is installed in the furnace. There are several sensors placed on the glass and frame surface. The test measures both insulation and integrity. In the furnace on fire's side the temperature can reach 1,000°C. In test of a B15 door the insulation (temperature) is average +140°C on product surface and it is not allowed to exceed 225°C in 15 minutes. The integrity requirements are no flaming and no gaps in the surface within 30 minutes," says Tommy Löytynoja, chief designer of Pocadel.

Löytynoja went on to say in the A60 door tests the structures are tested to an average of 140°C on product surface and it is not allowed to exceed 180°C in 60 minutes and the integrity requirements: no flaming or no gaps in surface in 60 minutes."

Pocadel uses aluminum frames in their products and the company claims that in 1998 it was the first manufacturer to develop, test and have approved certificates for aluminum fire resistant glass structures for marine use. Soon after aluminum structures replaced the traditional steel profiles in framings of B15 and A60 glass doors and walls. "We started immediately after that to export our products to Europe and the USA. Besides aluminum is light, there are several ways for finishing and it is corrosion-free," explained Löytynoja.



Doors designs can be stylish and fun for the cruise market this door design was installed on a Carnival cruise ship



Stylish and safe; Pocadel's doors on Carnival Spirit

Established in 1997 Pocadel is a small company employing just 15 staff in both design and manufacturing. The company is based in Finland, some 50km south east of the Meyer Turku shipyard and its turnover last year was



One of Pocadel's new products, a seamless glass wall after having been tested successfully at VTT's testing laboratory



New super wide tandem sliding doors can be used in extra width openings. Tommy Löytynoja says that often these doors are left open continuously, but can be closed from the bridge in the event of an emergency

€2.5 million (US\$2.91 million) with 80% of its production exported mainly to four European countries, Italy, Germany, France and Norway and the US, Singapore and South Korea outside of Europe.

“Besides the fire tests, we have also completed the so called ‘hose stream test’ for A60 structures. The hose stream test is required for walls used in emergency exits and life boat decks. This is a great benefit

as – as far as we know – there are not many suppliers to have this test made. (Shortly, hose stream test shows how the structure stands water in fire),” says Löytynoja.

Pocadel says that it believes that it is a leading supplier of fire rated glass doors and partitions, though it cannot be certain of its exact position in the market. Certainly its vessels supplied list is impressive, it includes *Queen Mary 2, Mariner of the Seas, Norwegian Dawn, Aida Vita* and the *Carnivals Miracle, Legend, Spirit, Dream, Breeze* and *Pride* with a number of Costa and Celebrity ships included and the Oasis class vessels too on the cruise side.

In an effort to develop the business the company is now actively seeking business in the offshore sector where its client list already includes Ulstein, Daewoo Shipbuilding and Marine Engineering, Hyundai Heavy Industries and Hertel, says Maria Perrakoski, the head of marketing since 1997.

“The best way to keep our position as a leading supplier of fire rated glazings is constant product development. At this moment we have a wide up-dated selection of glass doors and walls both for marine and offshore use,” the company says. **NA**

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Rolls-Royce thrusts into the future

Propulsion manufacturer Rolls-Royce has been making further developments both in the areas of research and product development

The company recently announced an order that it has received from Norwegian Cruise Lines for its permanent magnet thrusters for the vessel *Norwegian Epic*.

The permanent magnet tunnel thruster offers numerous advantages over traditional tunnel thrusters including significant reduction in noise and vibration, an increase in power output of around 25% from the same size propeller, and is removable underwater, eliminating the need for dry docking.

Göran Grunditz, manager, Rolls-Royce Hydrodynamic Research Centre explains that the thruster has been hydrodynamically designed, so that the housing of the thruster is more streamlined and because of this approach in the design it also has benefits such as easier access to the motor and less cavitation from the unit as a whole.

“There is no space between the ring and the blades like a normal thruster. The blades go into the ring and rotate together, reducing cavitation. The loading of the blades has been reduced because of the design of the housing,” he adds.

The 25% increase in power can be achieved from the permanent magnet thruster because the design of thruster means that it runs more smoothly; in addition the six blades in the thruster allow more load to be put on to the propeller for increased power.

The permanent magnet tunnel thruster design concept comprises a permanent magnet motor in a rim, which drives the propeller in the centre. The permanent magnet motor consists of two main parts – a stator that carries a number of electrical coil windings, and a rotor fitted with a number of very strong permanent magnets. A rotating magnetic field is created by the stator which interacts with the fields of the permanent magnets on the rotor, which generates force to drag the rotor around, providing the mechanical power.

Other benefits of permanent magnet technology include the freeing up of space directly above the thruster where traditional tunnel thruster motors are located, and a symmetrical design that gives equal thrust to



Rolls-Royce secures more orders for its permanent magnet thrusters

port or starboard. It is available in 1.6m and 2.0m diameter.

Rolls-Royce is carrying out further developments at its Hydrodynamic Research Centre, in Kristinehamn, Sweden. Rolls-Royce also has two University Technology Centres (UTC) covering marine technologies (Rolls-Royce has 29 globally, covering a wide range of topics). These are Chalmers, Sweden covering propulsion hydrodynamics, and Trondheim, Norway which covers hull design / performance in a seaway.

Grunditz says that lots of vessels today are slow steaming and customers are looking for solutions that will help to reduce fuel consumption. One solution that the company believes offers a feasible solution for fuel consumption reduction is its Promas propeller.

“A lot of vessels are slow steaming; this is where this type of propeller works. We have

seen a 5%-25% increase in efficiency on customers’ vessels when they have installed one of these onboard”, he says.

Going forward Rolls-Royce aims to look at new features for these systems, both at the system level and the design of the propeller. New tools in how to analyse propeller and hull interaction are coming on to the market, with these further developments can be made on the design of the propeller blade for different operational profiles.

Grunditz says that analysis and development are carried out at the Rolls-Royce hydrodynamic facilities, cavitation details are still hard to calculate and having the test facilities to help validate results is an important factor. “We still see the need for test facilities and the need for how they are used has changed,” he concluded. [NA](#)

Göran Grunditz, Rolls-Royce says that there is still a need for model tests to be carried out to validate the results





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KEY DATES

- Abstract Submissions Open:
10 November 2014
- Registrations Open:
17 February 2015
- Abstract Submission Deadline
9 March 2015
- Author Acceptance Notification
6 April 2015
- Refereed Paper Submission
22 June 2015
- Full Paper Submission Deadline
13 July 2015
- Early Bird and Presenter Deadline
10 August 2015
- Conference
6-8 October 2015

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Veth goes green

Veth propulsion has been focusing its latest developments on making its propulsion systems more environmentally friendly to make them more sustainable for the future

With the introduction of the vessel general permit (VGP) in America and environmentally acceptable lubricants (EALs) coming on to the market and class societies green notations, Veth has undergone testing with its own products for these requirements.

“We are using our own diesel electric test vessel to perform live testing with both rudder propeller installations to test different environmentally acceptable lubricants”, says Bastiaan van Zuijlekom, project manager, Veth. “On the other hand we are using a significant part of our in house R&D department to design seal systems which comply with the latest demands on green notations from Class societies, for example Clean Ship from Bureau Veritas.”



Clean ship retractable thruster for Acta Marine

Veth claims that it is the first thruster manufacturer in the world which is able to meet the requirements of this notation, because of a sustainable adjustments to it seals. The main issue surrounding the seals is the leakage that is caused from them. In order to counteract this Veth has taken steps to develop a seal that gives better protection through being more resilient to leakage. Adding to this is a monitoring system

that Veth says monitors not the amount of oil, but the amount of water getting into the system as this give a better idea to the oil pressure inside the system.

Zuijlekom notes that a recent example of Veth's seal development can be is on the

vessel *Deep Helder*, a dive support vessel (DSV) for Seamar *Den Helder* is our most recent delivery. The vessel is fully classed DP2 and Cleanship. Both the bow thruster and retractable azimuth thrusters have the latest seal development fitted. *NA*

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Stena's many happy returns

In a move to improve the operational efficiency of the Knud E. Hansen designed reefer ro-ro vessel that is operated by Stena on its Central America to Europe route, the Danish naval architect firm has upgraded the vessel design so that the operator can load return cargoes following its eastbound banana and pineapple run

Swedish shipping company Stena operates a service carrying bananas and pineapples from two Central and South American ports, Moin in Costa Rica and Santa Marta in Columbia, into Antwerp. The service operates on a four week cycle with ships required to call at each port on specific days in the cycle.

By operating their own reefer ship services through a charter deal with Stena, rather than relying on container carriers, the charterers can maintain control of the supply chain for their products.

“Today the big fruit companies are in control of the supply chain,” explained Birger Lindberg Skov, managing director of Reefer Intel a Danish design company. However, he points out that: “The real challenge is that the average age of conventional reefer ships is 24 years old, there are 600 of them; so if they don’t do something the reefer business will be taken over and controlled by the container lines.”



An added design feature is that fruit can be loaded from the quarter ramp at the stern of the vessel



It is expected that the ro-ro design will be able to achieve significant fuel savings along with reduced CO₂ emissions

TECHNICAL PARTICULARS

Ro-ro reefer vessel

Length oa:.....	199.00m
Length bp:	185.00m
Breadth:.....	29.00m
Depth to main deck:	10.20m
Draught:	8.4m Capacity
Containers 1st layer:.....	100FEU
Containers 2nd layer:	110FEU
Cassettes in holds:	365
Total number of HC pallets:.....	11,500
Service speed:	20.5knots
Propulsion	
Main engine:	Two-stroke turbo charged slow-speed marine diesel engine
Installed power:	25,340kW
Aux. engines:.....	4 x 2,540kW
PTO-generator:	3,500kW

The Knud E. Hansen designed reefer ro-ro, the design patent for which is held by Reefer Intel, is designed to replace the conventional reefer ships and to add to the efficiency of the service by offering the possibility of return cargoes.

In addition to the increased load efficiency, the service is timed on a four week cycle with ships required to call on certain days at particular ports within that four week period. Slow steaming is only a possibility for the new ships

because the loading and discharge period has been slashed from 48 hours for the conventional reefer to just 12 hours for the ro-ro version.

By loading fruit on the translifter and cassette system, as with conventional ro-ro ships, the loading and discharge process is so rapid that the vessel is able to maintain its schedule whilst travelling at a speed of 15knots rather than the 20.5knots of a conventional reefer vessel. Fuel savings as a consequence are

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substantial, with the fuel consumption on the new vessels reduced to 42tonnes/day compared with 68tonnes/day for the conventional reefer.

Conventional reefer vessels have also had to return to South America empty, but the latest version of the reefer ro-ro has increased internal deck heights from 3.3m to 4.5m allowing the operator to load cars and trucks for backloads to Central and South America.

As with the original ro-ro reefer design the cassettes are stacked in such

a way as to allow cool air to circulate around the cargo in order to maintain the freshness of the fruit for the duration of the voyage.

In addition, conventional reefers have traditionally loaded fruit into the vessel hold and then loaded containers onto the hatch covers and weather deck. The reefer ro-ro is designed so that the fruit can be loaded by means of a quarter ramp at the rear of the vessel and the ship can be simultaneously loaded with containers on deck, again speeding

up the loading and discharge of the cargo when compared to conventional reefer ships.

In effect the latest version of the ro-ro reefer will allow significant savings in fuel consumption, through slower steaming, and thereby significantly reducing CO₂ emissions, while allowing owners to increase their revenue streams by loading back cargoes of cars and trucks from Europe to Latin America, making the vessels more efficient and more economical to operate. **NA**

Stena opts for operational efficiency with Knud E. Hansen's ro-ro design



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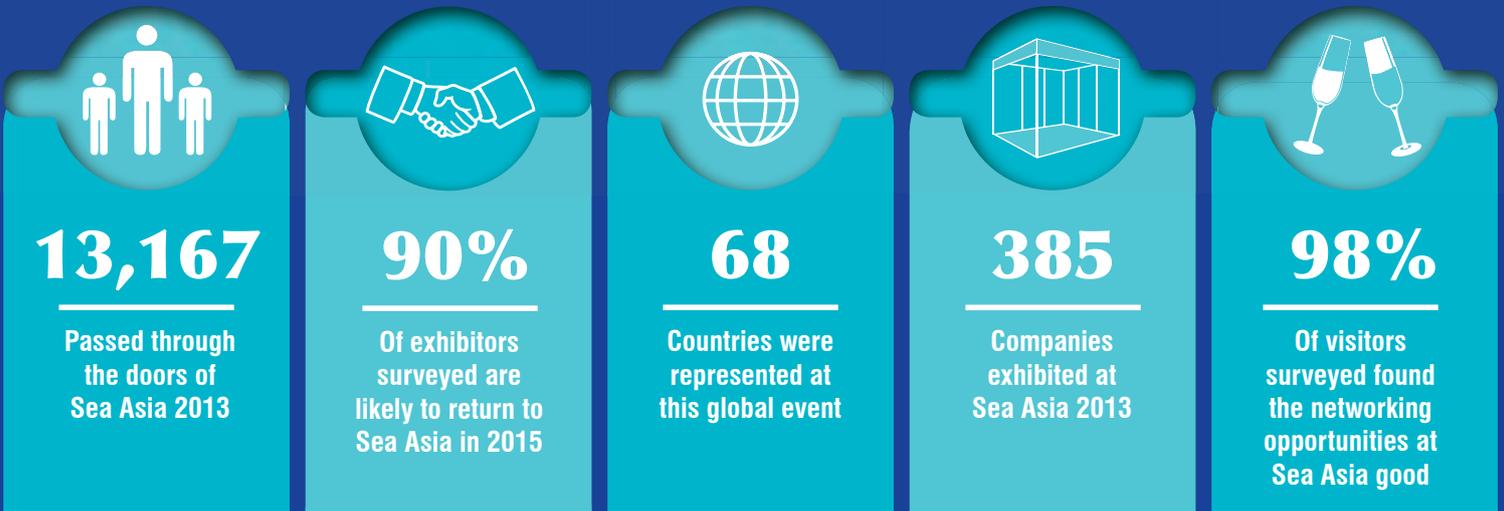
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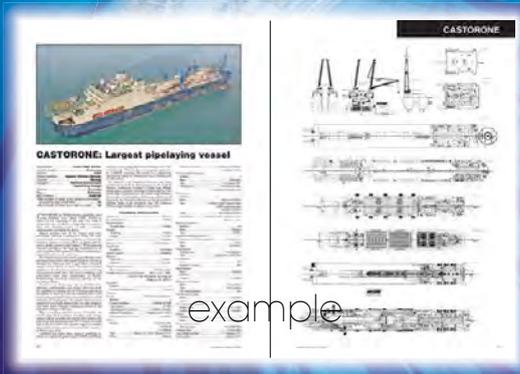
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It's designed to be relevant to Dock Masters, Docking Officers, Engineers, Naval Architects, Port Engineers and others involved in the dry docking of ships and vessels. The course is presented through classroom lectures, student participation in projects and practical application exercises. The course addresses the deck plate level of practical operation needed by the dock operator and the universally accepted mathematical calculations required to carry out operations in accordance with established sound engineering practices.

To register, visit the website or contact the RINA Conference Department: 8 - 9 Northumberland Street, London, WC2N 5DA

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www.rina.org.uk/Basic_Drydock_Training_Course_2015

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The Royal Institution of Naval Architects published **Significant Small Ships of 2014** in February 2015, following the success of the previous editions and the lead set by Significant Ships, now in its 17th year of publication. A total of approximately 28 new vessels are selected, each being singularly significant or the first in a series which will include: Fast Ferries, Passenger Vessels, Tugs and Workboats, Fishing and Offshore Patrol Vessels, etc. This mixed, but fascinating, selection of small craft, all between 15m and 100m in length, will be hand-picked by the same editorial team that produces Ship & Boat International, RINA's own leading small craft publication, and will be backed by its world-renowned resources.

Non-member £31.50 (RINA member £26)

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The 17th International Conference on Computer Applications in Shipbuilding (ICCAS) will review operational experience from existing computer applications in the design and build of ships and offshore structures and will cover a full range of topics including; engineering analysis, data modelling, PLM, CAD, CAM, integrated systems, knowledge management, systems engineering, simulation, visualisation, processes and standards.

It will also examine the advances in Information Technology which have contributed to increased productivity in both shipbuilding and maritime operations; including increasing co-operative working between shipyards, marine equipment and system manufacturers, engineering partners and shipping companies.

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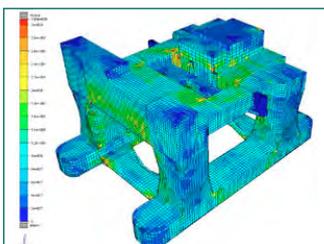
International Conference: Structural Load & Fatigue on Floating Structures

25th February 2015, London, UK



Registration Open

Floating structures, whether ship shaped, semi-submersible or spar design have been deployed in offshore developments since the 1970s. Today these systems are being deployed in more remote and harsher environments, and sometimes beyond their original design life, this results in increased loading that affects not only on the structure but also critical components. This means the investigation into through life structural analysis and the effects of fatigue on a structure is important not only in the assessment of risk, but the potential in extending the life of a structure.



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By Chris Thomas

HMS Vanguard sank in thick fog in Dublin Bay in September 1875 rammed by her sister ship. No lives were lost (except perhaps that of the Captain's dog) but this one event provides valuable insight into naval history of the late nineteenth century. Chris Thomas examines what happened, setting it in the context of naval life, the social and economic situation of officers and ratings. He describes the furore caused by the unjust verdict of the Court Martial, vividly illustrating the joys and trials of the seagoing life in the Victorian era, and the tragic effect on the life of Captain Richard Dawkins and his family.

Price: UK £9.00 EUR £10.00 OVS £12.00
AMAZON PRICE: £12.74

SHIPS AND SHIPBUILDERS: PIONEERS OF SHIP DESIGN AND CONSTRUCTION

By Fred Walker FRINA

Ships and Shipbuilders describes the lives and work of more than 120 great engineers, scientists, shipwrights and naval architects who shaped ship design and shipbuilding world wide. Told chronologically, such well-known names as Anthony Deane, Peter the Great, James Watt, and Isambard Kingdom Brunel share space with lesser known characters like the luckless Frederic Sauvage, a pioneer of screw propulsion who, unable to interest the French navy in his tests in the early 1830s, was bankrupted and landed in debtor's prison. With the inclusion of such names as Ben Lexcen, the Australian yacht designer who developed the controversial winged keel for the

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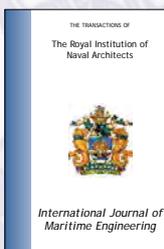
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2015

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The Royal Institution of Naval Architects

International Conference: Damaged Ship III

25-26 March 2015, London, UK



Registration Open

Recent incidents at sea have shown that investigations and understanding of the behaviour of damaged ships are as important as ever. This event will focus on the assessment and analysis of stability, strength, sea worthiness of a ship damaged by collision, grounding, etc. It will also consider procedures to minimise risks for passengers, crew, ship, and environment and to develop safe countermeasures.



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The Royal Institution of Naval Architects

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13-14 May 2015, Genoa, Italy



Call for Papers

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